GEOTECHNICAL AND CONTAMINATION REPORT

APPENDIX Z

Sydney Metro City & Southwest:
Waterloo Over Station Development

Geotechnical and Contamination Report

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1.0 Introduction

1.1 Purpose of this report

This report accompanies a concept State Significant Development Application (concept SSD Application) submitted to the Department of Planning and Environment (DPE) pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The concept SSD Application is made under Section 4.22 of the EP&A Act.

This report should be read in conjunction with the Nominated State Significant Precinct (SSP) Study – Waterloo, submitted to the Minister for Planning (The Minister) in July 2018. That study proposes new planning controls to facilitate the development proposed.

Sydney Metro is seeking to secure concept approval for over station development (OSD) above and adjacent to Waterloo Station comprising a podium and three taller buildings which include commercial, residential, and community land uses. The concept SSD Application seeks consent for a building envelope and use for residential, retail, commercial, entertainment, community and recreational purposes, maximum building height, maximum gross floor area (GFA), pedestrian and vehicular access, circulation arrangements and associated car parking and the strategies and design parameters for the future detailed design of development.

Sydney Metro proposes to procure the construction of the OSD as part of an integrated station development package, which would result in the combined delivery of the station, OSD and public domain improvements. The station and its public domain elements form part of a separate planning approval for Critical State Significant Infrastructure (CSSI) approved by DPE on 9 January 2017.

As the development is within a rail corridor, is associated with railway infrastructure and is for "commercial premises or residential accommodation" with a Capital Investment Value of more than $30 million, the project is identified as State Significant Development (SSD) pursuant to Schedule 1, 19(2)(a) of the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP).

This report has been prepared to outline the Geotechnical and Contamination impacts and specifically respond to the Secretary's Environmental Assessment Requirements (SEARs) issued for the concept SSD Application on 29th June 2018 which states that the Environmental Impact Statement (EIS) is to address the following requirements:

Reference	SEARs Requirement	Where Addressed in Report
15. Geotechnical and Contamination		
SEAR 15.1	*Provide an assessment of the site's conditions, outlining the site's suitability for the proposed uses with respect to soil erosion, salinity and acid sulphate soil.*	• Assessment of soil condition involving erosion, salinity and acid sulphate soils is outlined in **Section 3.0** and **Section 4.0.**
SEAR 15.2	*Provide an assessment of the proposed in accordance with State Environmental Planning Policy No 55 - Remediation of Land and relevant guidelines.*	• Assessment of proposed land use in accordance with SEEP 55 addressed in **Section 3.5** and **Section 4.8.**

***NOTE**: In cases where land is potentially contaminated, the investigation and any remediation and validation work is to be carried out in accordance with guidelines made or approved by the EPA under Section 105 of the Contaminated Land Management Act 1997 and be in accordance with the requirements and procedures in the Contaminated Land Management Act 1997, Contaminated Land Management Regulation 2013 and State Environmental Planning Policy No 55 – Remediation of Land.*

1.2 Overview of the Sydney Metro in its context

Sydney Metro is Australia's biggest public transport project. A new standalone metro railway system, this 21st century network will deliver 31 metro stations and 66km of new metro rail for Australia's biggest city — revolutionising the way Sydney travels. Services start in the first half of 2019 on Australia's first fully-automated railway.

Sydney Metro was identified in *Sydney's Rail Future*, as an integral component of the *NSW Long Term Transport Master Plan*, a plan to transform and modernise Sydney's rail network so it can grow with the city's population and meet the future needs of customers. In early 2018, *the Future Transport Strategy 2056* was released as an update to *the NSW Long Term Transport Master Plan* and *Sydney's Rail Future*. Sydney Metro City & Southwest is identified as a committed initiative in the *Future Transport Strategy 2056*.

Sydney Metro is comprised of three projects (refer to Figure 1):

Sydney Metro Northwest — formerly the 36km North West Rail Link. This $8.3 billion project is now under construction and will open in the first half of 2019 with a metro train every four minutes in the peak.

Sydney Metro City & Southwest — a new 30km metro line extending the new metro network from the end of Sydney Metro Northwest at Chatswood, under Sydney Harbour, through the CBD and south west to Bankstown. It is due to open in 2024 with an ultimate capacity to run a metro train every two minutes each way through the centre of Sydney.

Sydney Metro West – a new underground railway connecting the Parramatta and Sydney central business districts. This once-in-a-century infrastructure investment will double the rail capacity of the Parramatta to Sydney CBD corridor and will establish future capacity for Sydney's fast growing west. Sydney Metro West will serve five key precincts at Westmead, Parramatta, Sydney Olympic Park, The Bays and the Sydney CBD. The project will also provide an interchange with the T1 Northern Line to allow faster connections for customers from the Central Coast and Sydney's north to Parramatta and the Sydney CBD.

Sydney's new metro, together with signalling and infrastructure upgrades across the existing Sydney suburban rail network, will increase the capacity of train services entering the Sydney CBD – from about 120 an hour currently to up to 200 services beyond 2024. That's an increase of up to 60 per cent capacity across the network to meet demand.

Figure 1: Sydney Metro alignment map

Sydney Metro City & Southwest includes the construction and operation of a new metro rail line from Chatswood, under Sydney Harbour through Sydney's CBD to Sydenham and on to Bankstown through the conversion of the existing line to metro standards.

The project also involves the delivery of six (6) new metro stations, including at Waterloo, together with new underground platforms at Central. Once completed, Sydney Metro will have the ultimate capacity for a train every two minutes through the CBD in each direction - a level of service never seen before in Sydney.

On 9 January 2017, the Minister approved the Sydney Metro City & Southwest - Chatswood to Sydenham application lodged by TfNSW as a CSSI project (reference SSI 15_7400).

The CSSI Approval includes all physical work required to construct the CSSI, including the demolition of existing buildings and structures on each site. Importantly, the CSSI Approval also includes provision for the construction of below and above ground structures and other components of future OSD (including building infrastructure and space for future lift cores, plant rooms, access, parking and building services, as relevant to each site). The rationale for this delivery approach, as identified within the CSSI application is to enable the OSDs to be more efficiently built and appropriately integrated into the metro station structures.

The EIS for the Chatswood to Sydenham alignment of the City & Southwest project identified that the OSD would be subject to a separate assessment process.

Since the CSSI Approval was issued, Sydney Metro has lodged four modification applications to amend the CSSI Approval as outlined below:

- Modification 1 - Victoria Cross and Artarmon Substation which involves relocation of the Victoria Cross northern services building from 194-196A Miller Street to 50 McLaren Street together with inclusion of a new station entrance at this location referred to as Victoria Cross North. The modification also involves the relocation of the substation at Artarmon from Butchers Lane to 98 – 104 Reserve Road. This modification application was approved on 18 October 2017.
- Modification 2 - Central Walk which involves additional works at Central Railway Station including construction of a new eastern concourse, a new eastern entry, and upgrades to suburban platforms. This modification application was approved on 21 December 2017.
- Modification 3 - Martin Place Station which involves changes to the Sydney Metro Martin Place Station to align with the Unsolicited Proposal by Macquarie Group Limited (Macquarie) for the development of the station precinct. The proposed modification involves a larger reconfigured station layout, provision of a new unpaid concourse link and retention of the existing MLC pedestrian link and works to connect into the Sydney Metro Martin Place Station. It is noted that if the Macquarie proposal does not proceed, the original station design remains approved. This modification application was approved on 22 March 2018.
- Modification 4 - Sydenham Station and Sydney Metro Trains Facility South which incorporated Sydenham Station and precinct works, the Sydney Metro Trains Facility South, works to Sydney Water's Sydenham Pit and Drainage Pumping Station and ancillary infrastructure and track and signalling works into the approved project. This modification application was approved on 13 December 2017.

The CSSI Approval as modified allows for all works to deliver Sydney Metro between Chatswood and Sydenham Stations and also includes upgrade of Sydenham Station.

The remainder of the City & Southwest alignment (Sydenham to Bankstown) proposes the conversion of the existing heavy rail line from west of Sydenham Station to Bankstown to metro standards. This part of the project, referred to as the Sydenham to Bankstown upgrade, is the subject of a separate CSSI Application (Application No. SSI 17_8256) for which an EIS was exhibited between September and November 2017. A Response to Submissions and Preferred Infrastructure Report was submitted to DPE in June 2018 for further exhibition and assessment. This application is subject to assessment and determination by DPE, taking into consideration a further Response to Submissions Report which was submitted to DPE in September 2018.

1.3 Nominated State Significant Precinct - Waterloo

Following the decision to locate a metro station in Waterloo, the Minister determined that parts of Waterloo are of State planning significance which should be investigated for urban renewal through the SSP process. Study requirements for such investigations were issued by the Minister on 19 May 2017.

Investigation of the Precinct is being undertaken by UrbanGrowth NSW Development Corporation (UrbanGrowth NSW), in partnership with Sydney Metro and the Land and Housing Corporation (LAHC). The outcome of the SSP process will be new planning controls that will enable future development applications for renewal of the Precinct.

The Precinct includes two separate but contiguous and inter-related parts:

- The Waterloo Metro Quarter (the Metro Quarter)
- The Waterloo Estate (the Estate)

A separate SSP Study for the Metro Quarter was lodged in July 2018 in advance of the SSP Study for the Estate to provide a planning framework for the construction of OSD within the Metro Quarter. The staged submission of the Metro Quarter SSP Study also facilitates the proposed development to be delivered concurrently with the metro station, as an integrated station development.

As this concept SSD Application relies upon the planning framework proposed in the Metro Quarter SSP Study, it is anticipated that the SSP Study and EIS for the SSD Application will be exhibited concurrently.

1.4 Planning relationship between Waterloo Station and the OSD

While Waterloo Station and the OSD will form an integrated station development, the planning pathways defined under the EP&A Act require separate approval for each component of the development. In this regard, the approved station works (CSSI Approval) are subject to the provisions of Part 5.1 of the EP&A Act (now referred to as Division 5.2) and the OSD component is subject to the provisions of Part 4 of the EP&A Act.

For clarity, the approved station works under the CSSI Approval included the construction of below and above ground structures necessary for delivering the station and also enabling construction of the integrated OSD. This includes but is not limited to:

- demolition of existing development
- excavation
- integrated station and OSD structure (including concourse and platforms)
- lobbies

- retail spaces within the station building
- public domain improvements associated with the station
- access arrangements including vertical transport such as escalators and lifts
- space provisioning and service elements necessary to enable the future development of the OSD, such as lift cores, plant rooms, access, parking, retail, utilities connections and building services.

The vertical extent of the approved station works above ground level is defined by the 'transfer level' level (which for Waterloo is defined by approximately RL 33.1 over the northern station box and RL 35.1 over the southern station box), above which would sit the OSD. An example of this delineation is illustrated in Figure 2.

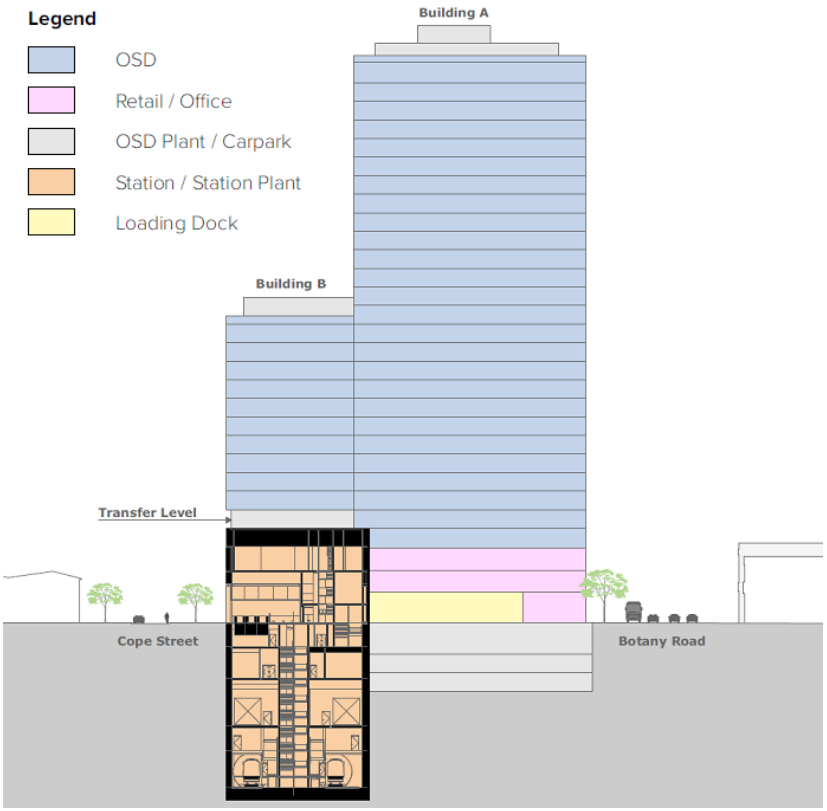

Figure 2: Delineation between the Metro station and OSD

It is noted that the structural and service requirements and space provisioning to support OSD vary from station to station. For example, based on the current level of design, Waterloo Station is not expected to provide for OSD lobbies, end of trip facilities and plant rooms. However, the detailed design may be amended to incorporate these elements as part of the integrated station development.

The CSSI Approval also establishes the general concept for the ground plane of Waterloo Station including access strategies for commuters, pedestrians and workers. In this regard, the main pedestrian access to the station would be via an entry located at the corner of Raglan and Cope Streets. The station design has continued to be developed having regard to its integration with the Metro Quarter OSD, and as a result, a second entrance to the station is to be provided from a proposed public plaza adjacent to Cope Street. Retail uses (approved under the CSSI Approval) would be located on the ground floor of the station development along the Cope Street frontage of the site.

Since the issue of the CSSI Approval, Sydney Metro has design work to determine the technical requirements for the structural integration of the OSD with the station. This level of design work, together with the planning and design undertaken for the remainder of the Metro Quarter has informed the concept proposal for the OSD. It is noted that ongoing design development of the works to be delivered under the CSSI Approval would continue with a view to developing an Interchange Access Plan (IAP) and Station Design Precinct Plan (SDPP) for Waterloo Station to satisfy Conditions E92 and E101 of the CSSI Approval. The detailed design for the Metro Quarter would continue to evolve having regard to the IAP and SDPP.

Public domain improvement works immediately adjacent to Waterloo Station would be delivered as part of the CSSI Approval to support pedestrian movements between transport modes (including to new and relocated bus stops, bike parking on Cope Street, and taxi and kiss-and-ride bays on Cope Street), while other public domain works within the Metro Quarter are proposed as part of the OSD. Final details of public domain works for the OSD will be provided with the detailed SSD Application(s) following finalisation of the SDPP and IAP for the CSSI Approval.

1.5 The site

1.5.1 Location

The site is located within the City of Sydney Local Government Area (LGA).

The Metro Quarter comprises land to the west of Cope Street, east of Botany Road, south of Raglan Street and north of Wellington Street. The heritage listed Waterloo Congregational Church located at 103–105 Botany Road is within this block but is not part of the site.

The site has an approximate area of 1.287 hectares (refer to Figure 3).

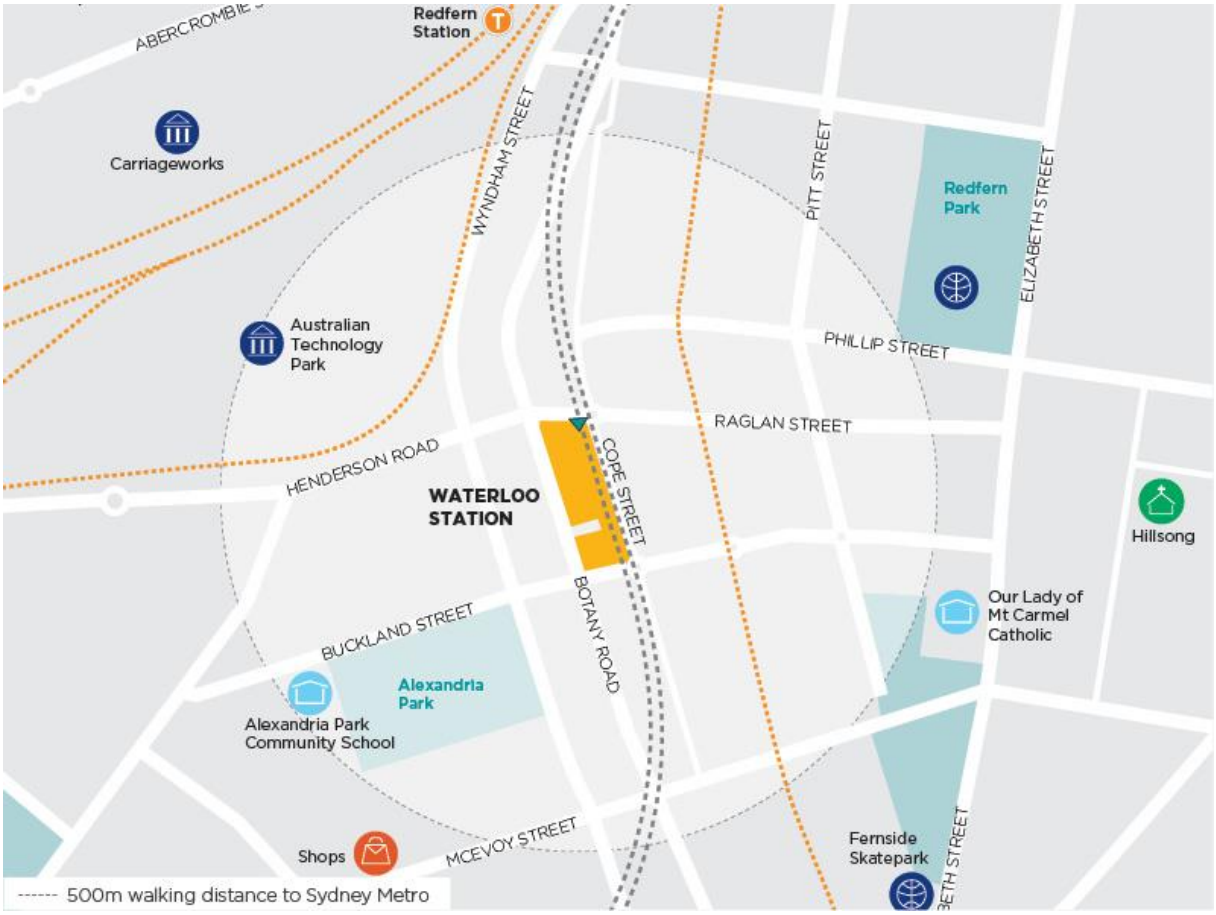

Figure 3: **Waterloo Station location plan**

1.5.2 Site context

The Metro Quarter is located in Redfern Street Village (see Figure 4) in the City of Sydney LGA approximately 3.3 kilometres south of Sydney CBD, 1 kilometre north of Green Square and less than 1 kilometre south of Redfern Station.

Directly east is the Waterloo Estate (see Figure 5), which is owned by the NSW Government and is under the management of NSW LAHC. The Waterloo Estate comprises 2,012 social housing dwellings and a small number of private dwellings in medium and high density forms, ranging from single storey attached dwellings to apartment buildings of up to thirty storeys.

The Metro Quarter is less than 1 kilometre south-east of the Australian Technology Park (ATP), a technology micro-cluster that currently contains around 3,000 – 3,500 workers with a range of businesses in technology and creative industries; and a start-up/business incubator hub. It is set to grow into a business park that will soon accommodate new

premises currently under construction (i.e. Commonwealth Bank Australia (CBA) has committed to two major office towers).

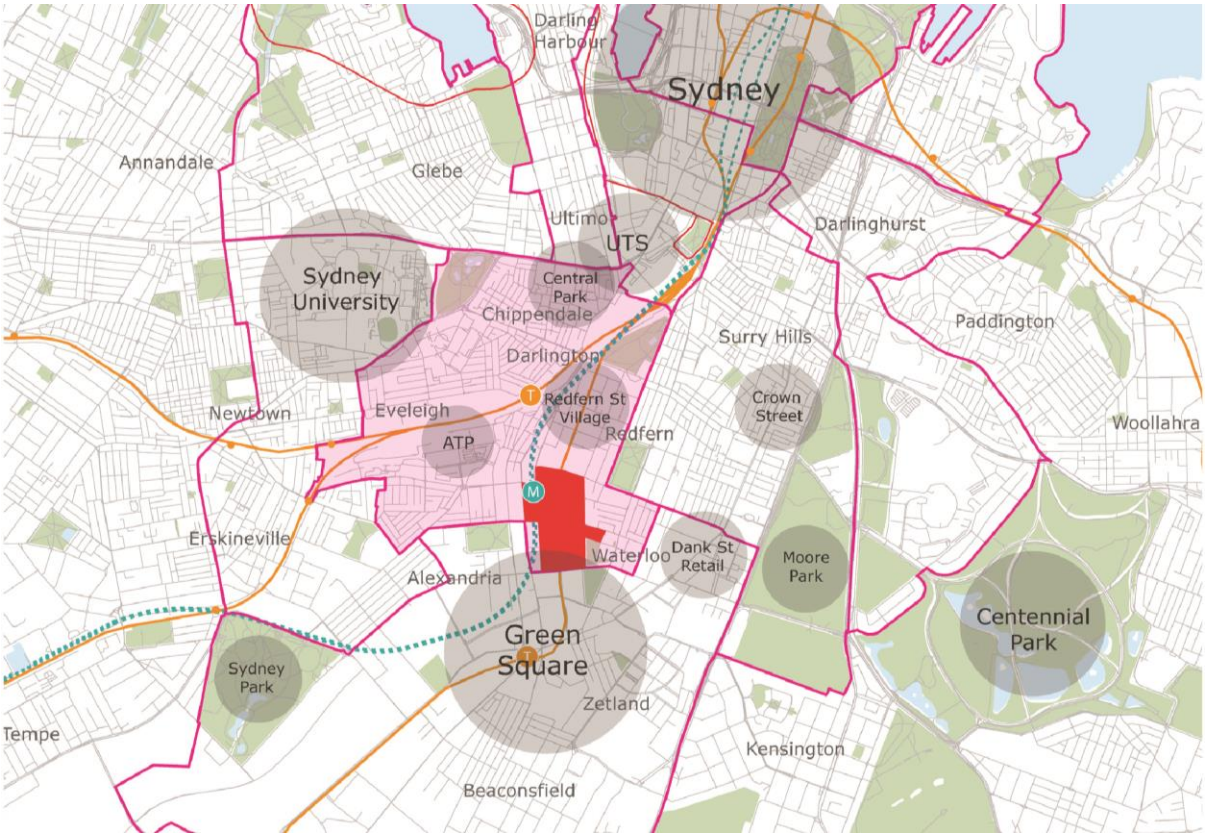

Figure 4 Location and site plan of the Waterloo State Significant Precinct (in red) and Redfern street village (in pink)

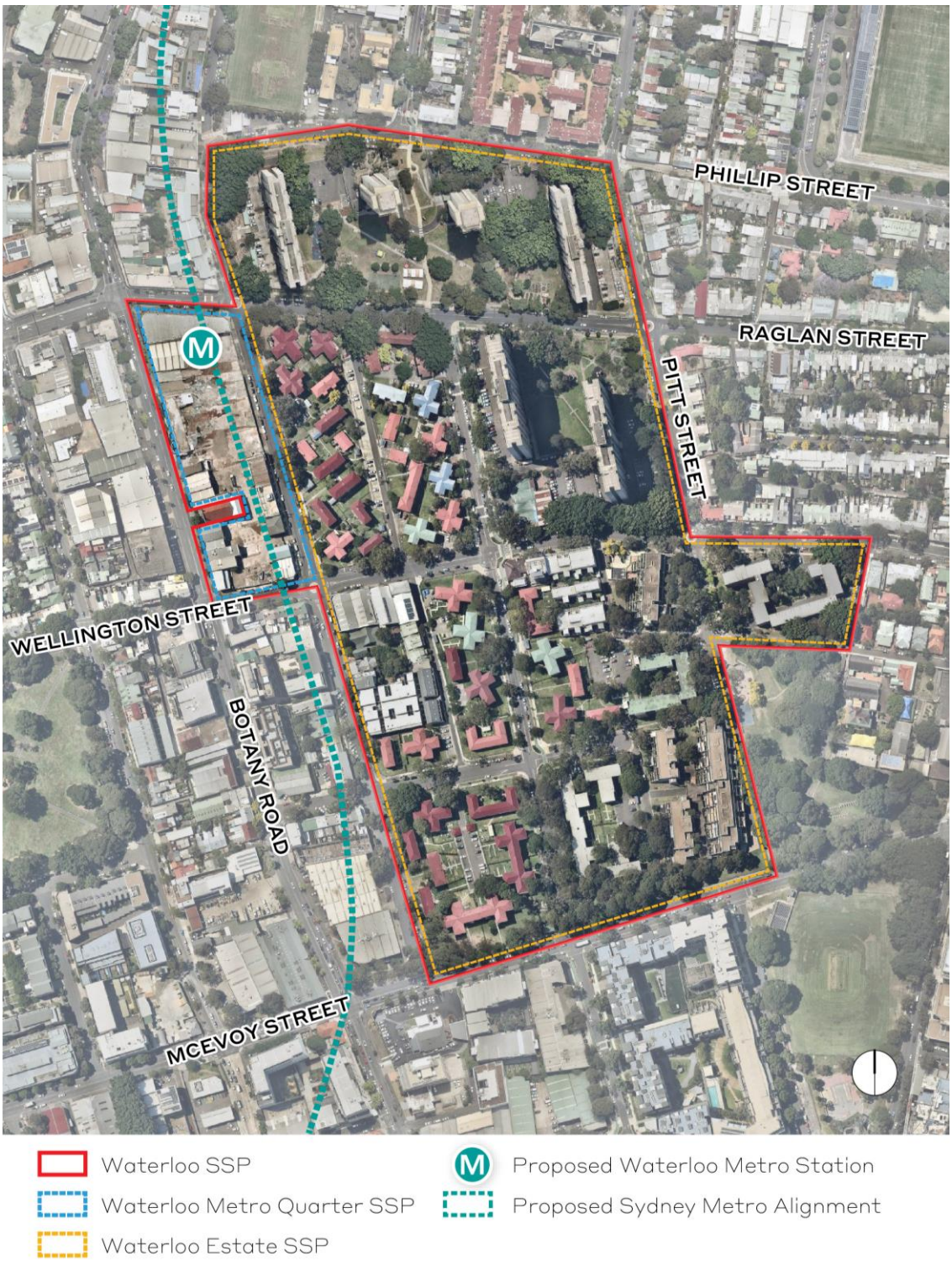

Figure 5 Nominated State Significant Precinct – Waterloo

The site comprises the following properties:

- 136B Raglan Street — Lot 4 DP 215751
- 59 Botany Road — Lot 5 DP 215751
- 65 Botany Road — Lot 1 DP814205
- 67 Botany Road — Lot 1 DP228641
- 124-128 Cope Street — Lot 2 DP228641
- 69-83 Botany Road — SP75492
- 130-134 Cope Street — Lot 12 DP399757
- 136-144 Cope Street — Lots A-E DP108312
- 85 Botany Road — Lot 1 DP27454
- 87 Botany Road — Lot 2 DP27454
- 89-91 Botany Road — Lot 1 DP996765
- 93-101 Botany Road — Lot 1 DP433969 & Lot 1 DP738891
- 156-160 Cope Street — Lot 31 DP805384
- 107-117A Botany Road — Lot 32 DP805384 & Lot A DP408116
- 119-121 Botany Road — Lot 1 DP205942 & Lot 1 DP436831
- 170-174 Cope Street — Lot 2 DP205942

The buildings and structures on the site are now demolished in accordance with the CSSI Approval with the exception of one building which is being used to support construction.

1.6 Overview of the proposed development

This concept SSD Application follows the submission of a SSP Study which supports a proposal to amend existing controls to facilitate the proposed development. The concept SSD Application will in turn comprises the first stage of seeking SSD development consent for the Waterloo OSD project. It will be followed by a future detailed SSD Application(s) for the design and construction of the OSD built form.

This concept SSD Application seeks approval for the planning and development framework and strategies to inform the future detailed design of the OSD. It specifically seeks approval for:

- maximum building envelopes, including maximum building heights, street-wall heights and ground and upper level setbacks
- a maximum gross floor area (GFA) of 68,750 square metres, comprising:

  - approximately 56,200 square metres GFA of residential accommodation, providing for approximately 700 dwellings, including 5 to 10 percent affordable housing and 70 social housing dwellings
  - approximately 3,905 square metres GFA of retail premises and entertainment facilities
  - approximately 8,645 square metres GFA for business and commercial premises and community, health service and recreational facilities (indoor), including at least 2,000 square metres of floor space for community uses
- a three storey podium and a free standing building located within a public plaza, accommodating non-residential land uses.
- residential uses above podium level in various building forms including three taller buildings of 23, 25 and 29 storeys (Reduced Level (RL) 96.9, 104.2 and 116.9 metres AHD respectively).
- use of OSD space provisioning within the footprint of the CSSI Approval
- public domain works, including open spaces, through-site links, footpaths, provision for cycle facilities and enhanced pedestrian crossings and roads.
- car parking for up to 427 vehicles
- cycle parking to support residential and non-residential land uses and visitors to the Metro Quarter. Approval is also being sought for space within the future basement for a bike hub which would also support future bike parking for Waterloo Station
- loading, vehicular and pedestrian access arrangements
- strategies for utilities and services provision
- strategies for managing stormwater and drainage
- a strategy for the achievement of ecologically sustainable development
- a public art strategy
- provision for future signage zones
- a design excellence framework
- the future subdivision of parts of the OSD footprint (if required).

It is noted that the Sydney Metro comprises GFA of approximately 8,415 square metres on the site, approved under CSSI Approval. The total GFA for the integrated station development, including the station GFA is approximately 77,165 square metres, which is equivalent to an FSR of approximately 6:1.

Key parameters of the concept proposal based on the current level of design development are indicated at Figure 6 and Figure 7.

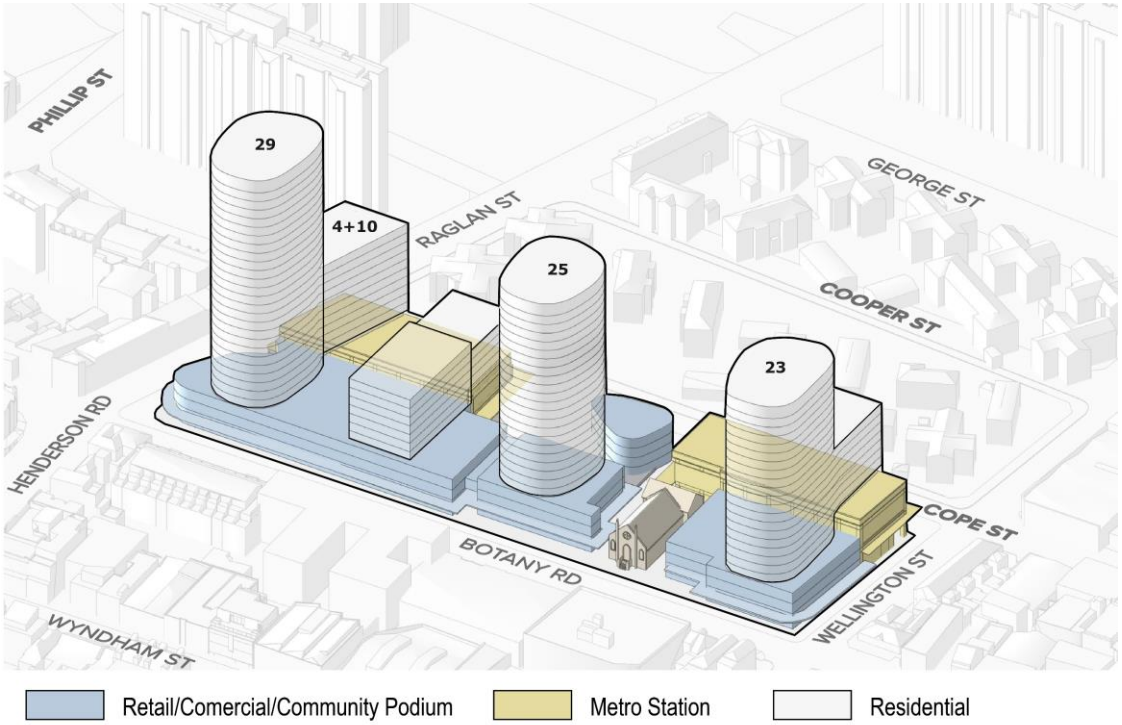

Figure 6 Proposed massing, viewed from the west

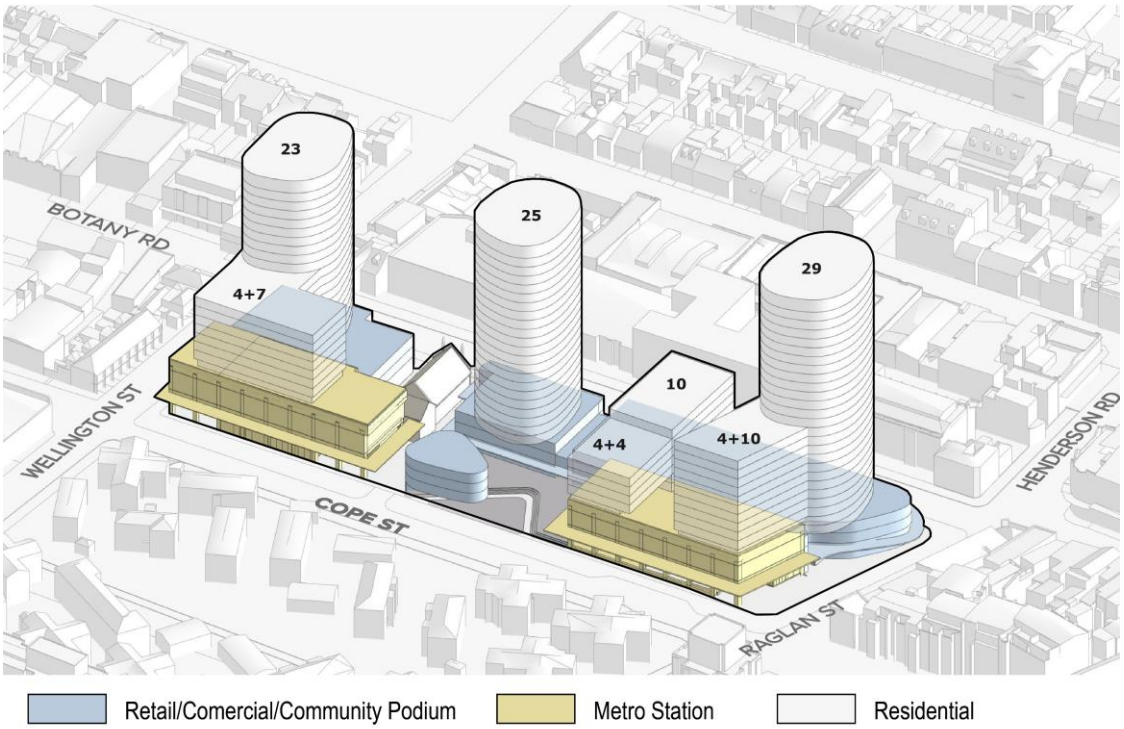

Figure 7 Proposed massing, viewed from the east

The proposal is a significant opportunity to contribute to the urban renewal process for the Waterloo SSP. The objective to deliver the Metro Quarter project as soon as reasonably possible after completion of the Sydney Metro works (earmarked to open 2024) would ensure buildings within the Metro Quarter are occupied to support maximum patronage of the proposed metro station.

The Metro Quarter would contain a mix of uses including residential, commercial, retail, community facilities and services and cultural opportunities sufficient for daily life to be provided for within the wider neighbourhood and to support the activation of the precinct. This would help make Waterloo one of the most connected and attractive inner-city places to live, work and visit.

1.7 Staging and framework for managing environmental impacts

Sydney Metro proposes to procure the delivery of the Waterloo integrated station development in one single package, which would entail the following works:

- station structure fit-out, including mechanical and electrical
- OSD structure fit-out, including mechanical and electrical.

Separate delivery packages are also proposed by Sydney Metro to deliver the excavation of the station boxes/shafts ahead of the integrated station development delivery package, and linewide systems (e.g. track, power, ventilation) and operational readiness works prior to the Sydney Metro City & Southwest metro system being able to operate.

For the purposes of considering construction related impacts, three possible staging scenarios have been identified for delivery of the integrated station development:

1. Scenario 1 – the station and OSD are constructed concurrently by constructing the transfer slab first and then building in both directions. Both the station and OSD would be completed in 2024.
2. Scenario 2 – the station is constructed first and ready for operation in 2024. OSD construction may still be incomplete or soon ready to commence after station construction is completed. This means that some or all OSD construction is likely to still be underway upon opening of the station in 2024.
3. Scenario 3 – the station is constructed first and ready for operation in 2024. The OSD is built at a later stage, with timing yet to be determined. This creates two distinct construction periods for the station and OSD.

The final staging for the delivery of the OSD would be resolved as part of the detailed SSD Application(s).

For the purposes of providing a high level assessment of the potential environmental impacts associated with construction, the following have been considered:

- Impacts directly associated with the OSD, the subject of this SSD Application
- Cumulative impacts of the construction of the OSD at the same time as the station works (subject of the CSSI Approval).

Given the integration of the delivery of the Sydney Metro City & Southwest metro station with an OSD development, Sydney Metro proposes the framework detailed in Figure 8 to manage the design and environmental impacts, in relation to Geotechnical and Contamination, consistent with the framework adopted for the CSSI Approval.

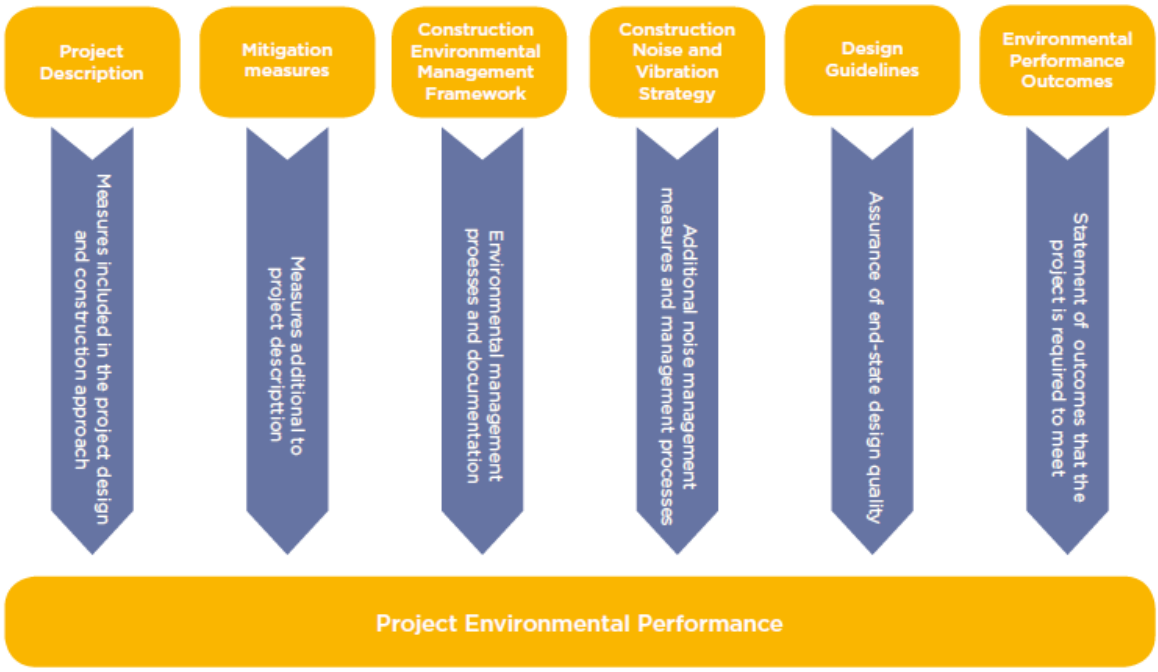

Figure 8 Project approach to environmental mitigation and management

This approach would be implemented until such time as completion of the station works (i.e. works under the CSSI Approval) is achieved. Beyond that point, standard construction environmental management practices would be implemented by the OSD developer in accordance with relevant guidelines and any conditions of approval.

2.0 Scope of assessment

The overarching objective of the report is to address the requirements outlined in Section 15 (Geotechnical and Contamination) of the Secretary's Environmental Assessment Requirements (SEARs) to evaluate the suitability of the concept Metro Quarter over station development. To achieve this overarching objective, the following specific objectives were undertaken:

- Review of existing geotechnical and contamination data points and results;
- Analysis of geotechnical risks;
- Identify whether potential contamination issues may be associated with the Metro Quarter;
- Evaluate whether potential contamination issues are likely to preclude the Metro Quarter from being suitable for the proposed residential and train station redevelopment; and
- Make recommendations to assist in making the Metro Quarter suitable for the proposed land use, which will inform the proposed redevelopment of the Metro Quarter.

To achieve the objectives, the following works were undertaken:

- Analysis of surrounding borehole information;
- Study of desktop geotechnical information (including geological sheets);
- Review of NSW Environment Protection Authority (EPA) records, historical aerial photographs, land ownership details, published maps and other records;
- Development of a conceptual site model (CSM) to identify potential sources of contamination, human health and environmental receptors and pathways in which these receptors may be exposed to the identified contamination;
- Metro Quarter inspection observations; and
- Risk ranking of the potential pollutant linkages to illustrate the relative risk of each pathway to current and future human health and environmental receptors.

Key findings of this report include:

- This desktop geotechnical study has been based on limited data. However, there is sufficient information to assess (from a geotechnical perspective) that the proposed development is suitable for the Metro Quarter.
- The study area is underlain by Quaternary Sediments, (Qhd), described as medium to fine grained "marine" sand with podsols;
- The underlying bedrock is Ashfield Shale underlain by Mittagong Formation and/or Hawkesbury Sandstone;
- The top of bedrock within the Metro Quarter ranges from about RL+9.5 m AHD in the north to about RL +6.5 m AHD in the south;

Potential sources of contamination identified during the Stage 1 PSI which may impact the condition of soil and groundwater within the Metro Quarter and its surrounds include the following:

- Commercial and light industrial properties including car repair centres (J&S Smash Repairs), car servicing and mechanical repairs (All Mechanic Repairs and Waterloo Automotive), panel beaters and/or spray painters, cleaning product manufacturers, printer machinery and supplies, sheet metal workers, woodworking machinery and battery manufacturers;
- Dry cleaning facilities including Waterloo Laundry;
- Service station including former Total Service Station;
- Use of fill material of unknown origin that could potentially contain or be impacted with contaminants;
- Historical use of asbestos containing materials (ACM) within buildings and structures erected since the 1920s; and
- Historical use of lead based paints on the interior and exterior of historical and current buildings.

Of the potential pollutant linkages identified in the CSM, three linkages were considered to present a high risk to human health and/or the environment that are expected to have implications for remediation/management costs:

- The historical and current commercial/light industrial activities undertaken within the Metro Quarter have likely resulted in contaminants of potential concern (CoPC) being released into the environment. Although it is understood that the redeveloped Metro Quarter is likely to be capped with limited access to soil, future sub-slab intrusive works may be required for service maintenance purposes. As such, there is a potential for workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale CoPC in soil/dust. Additionally, a number of CoPC are considered to be volatile e.g. light-end total recoverable hydrocarbons (TRH) fractions, benzene, toluene, ethylbenzene and xylenes (BTEX) and volatile organic compounds (VOCs). Therefore, future residents, commercial workers or construction/intrusive maintenance workers may be exposed to volatile CoPC via inhalation;
- Since 1930, a number of buildings within the Metro Quarter have been demolished and erected potentially depositing CoPC such as asbestos containing materials (ACM) and lead onto the soil.
- Although specific areas could not be identified where fill material may have been used it is likely to be present across given the level nature of the Metro Quarter. Imported fill material of unknown origin can contain a range of CoPC. Therefore, there is a potential for intrusive maintenance workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale CoPC in soil/dust. Based on the findings of this geotechnical assessment, AECOM presents the following recommendations. It is noted that the additional work scope would be undertaken during the detailed development application stage:

- An allowance for up to 15 cored boreholes to 20 m depth and five standpipe piezometers in five of these boreholes to allow for groundwater monitoring. If site-specific information such as from the metro rail investigations can be relied upon and is of a suitable scale and distribution then geotechnical investigations may not need to be as extensive;
- Development of geotechnical models for design and to assess interactions between the Metro Precinct development and the metro station box and running tunnels;

Based on the findings of this Stage 1 PSI and CSM developed for the Metro Quarter, AECOM recommends undertaking the following additional stages of work to ensure the SEARs are being fulfilled. It is noted that the additional work scope would be undertaken during the detailed development application stage:

- A Stage 2 contamination assessment to characterise the nature and extent of potential soil and groundwater contamination identified within the Metro Quarter to confirm that the Metro Quarter is either suitable in its current condition or can be made suitable following remediation for the proposed land use and zoning in accordance with clause 6(1)(b) of SEPP 55;
- In accordance with clause 6(1)(c) of SEPP 55, remediation and/or management of impacted areas may be required to mitigate risks associated with the identified impacts during the proposed construction works;
- Development of a Construction and Environment Management Plan (CEMP) to manage risks to construction and maintenance workers from erosion, impacted soils and groundwater during the redevelopment of the Metro Quarter; and
- Development of a Materials Management Plan (MMP) to include a strategy for the management of materials so that impacted material can be reused in less sensitive areas or managed within the Metro Quarter to manage erosion, salinity (if encountered) and mitigate off-site disposal of excavated material.
- In the event that potential or actual acid sulfate soil is identified, preparation of an acid sulfate soils management plan (ASSMP) to manage material that may require disturbance and/or movement.

Based on the investigations undertaken, the SEARs outlined in Section 15 have been wholly satisfied, with appropriate future investigations recommended for further development applications relating to detailed design.

3.0 Geotechnical Baseline Investigation

3.1 Introduction

This section presents our desktop review of available geotechnical information around the Metro Quarter project. Parts of the Metro Quarter are to be underlain by a metro station and tunnels. The proposal is to redevelop the Metro Quarter with commercial and residential buildings. The metro line is proposed to run beneath the eastern half of the Metro Quarter. Commercial and residential buildings are being considered for the Metro Quarter, to be located considering the station box and tunnels.

The purpose of the desktop geotechnical study is to provide an assessment of ground conditions and groundwater to inform design development in accordance to Section 15 of the SEARs as outlined in Section 1.1.

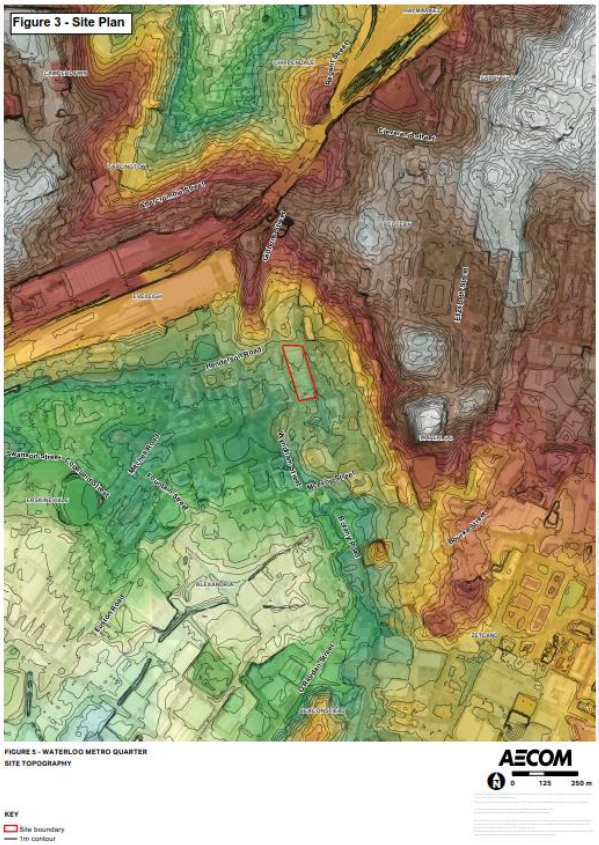

Figure 9 Metro Quarter - Site Topography

3.2 Data Sources

AECOM has looked at the following sourced of information:

- Sydney 1:100,000 Geological Series Sheet 9130;
- NSW Office of Environment and Heritage Acid Sulphate Soil Map;
- Sydney Local Environmental Plan (LEP) 2010, the ASS map Sheet 010; and
- Borehole information from the AECOM database.

3.3 Metro Quarter Description

The ground surface in the locality of the Metro Quarter is relatively flat, with the ground elevation falling about 3 metres from north to south, i.e. a grade of about 1 percent.

Currently, the site has been levelled with the exception of the heritage-listed Congregational Church located at 103 Botany Rd, Waterloo, which has been retained. Early works undertaken by Sydney Metro under the CSSI approval have also commenced.

3.4 Ground Conditions

3.4.1 Regional Geology

Based on the Sydney 1:100,000 Geological Series Sheet 9130, the study area is underlain by Quaternary Sediments, (Qhd), described as medium to fine grained “marine” sand with podsols, which have a low potential for salinity, erosion and acid sulfate soils.

The underlying bedrock is Ashfield Shale underlain by Mittagong Formation and/or Hawkesbury Sandstone. The geology sheet describes the Ashfield Shale as black to dark grey shale and laminite. The Mittagong formation is an intermediate unit sometimes present between the Ashfield Shale and Hawkesbury Sandstone. It is sometimes referred to as transition beds between the fine grained Ashfield Shale and relatively coarse grained Hawkesbury Sandstone and is described as shale, laminite, and medium grained quartz sandstone. The Hawkesbury Sandstone is described as medium to coarse grained quartz sandstone, very minor shale and laminite lenses.

3.4.2 Acid Sulfate Soils

The Acid Sulfate Soils (ASS) Map provided by the NSW Office of Environment and Heritage (OEH) shows no potential ASS occurrence in the Metro Quarter and that the site is within Class 5 land according to Sheet 010.

The *Sydney Local Environment Plan 2012* (LEP), requires development consent for works on Class 5 land within 500 metres of Class 1, 2, 3 and 4 land that is below 5 metres Australian Height Datum (AHD), and where the groundwater is likely to be lowered below 1 metre AHD on the adjacent Class 1, 2, 3 and 4.

With a tanked basement, long-term groundwater impact beyond the Metro Quarter boundary is not an issue.

3.4.3 Preliminary Geotechnical Model

We have used borehole data within the vicinity of the Metro Quarter from our database to develop the preliminary geotechnical model in Table 1.

Of the natural soils, the Alluvium/Marine Sediments are underlain by Residual Soil formed by weathering of the underlying Shale bedrock that is in turn underlain by Sandstone bedrock. The top of bedrock at the Metro Quarter ranges from about RL+9.5m AHD in the north to about RL +6.5 m AHD in the south.

Table 1 | Indicative Ground Profile

Geotechnical Unit	Description	Depth to Top of Unit (m)	Unit thickness (m)
1. Fill	Likely to be variable Sands or Clays containing Silt, Gravel, possibly waste materials	Ground surface	Less than 1
2. Alluvium/Marine Sediments	Sand: mainly fine to medium grained, loose and medium dense SPT 'N' values ranging from 15 to 30	Less than 1	3.0 to 5.0
3. Residual Soil	Silty Clay: medium plasticity, very stiff and hard. SPT 'N' values ranging from 26 to refusal	3.5 to 5.0	2.7 to 4.6
4. Ashfield Shale 4a. Shale Class V and IV (Note 1)	Shale: extremely weathered to highly weathered, very low to medium strength	7.5 to 9.0	1.8 to 3.8
4b. Shale Class II or better (Note 1)	Shale: slightly weathered and fresh, medium and high strength	9.0 to 13.0	5.0 to 8.0
5. Mittagong Formation and/or Hawkesbury Sandstone	Sandstone: mainly fresh rock with medium to high strength	16 to 18	Not proven

Note 1: Rock classifications based on Pells et al 1998.

The unit depths, thicknesses and material properties presented in Table 1 should not be assumed to represent the maximum or minimum values within the Metro Quarter. Actual unit boundaries and material properties can be highly variable, particularly for fill. Figure 10 to Figure 14 present inferred surfaces of the tops of Units 2, 3, 4a, 4b and 5. The surfaces representing the unit boundaries are based on interpolation, often between widely and variably spaced boreholes. Actual unit boundaries within the Metro Quarter may vary significantly from those shown. Features such as erosion channels, faults and igneous intrusions into the sedimentary bedrock sequences can affect bedrock surfaces within the Sydney region.

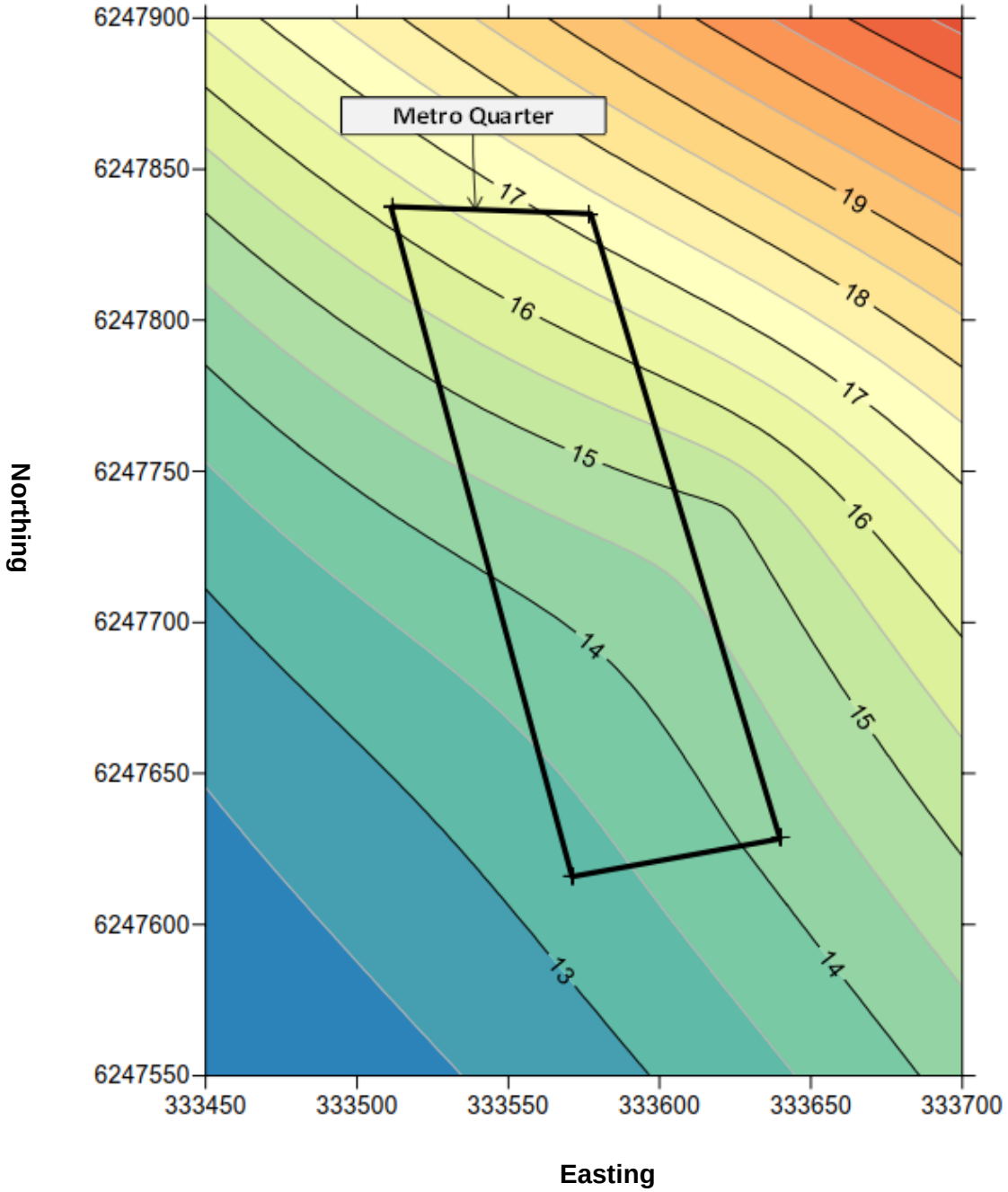

Figure 10 | Inferred Contours of Elevation of Top of Unit 2 – Alluvium/Marine Sediments

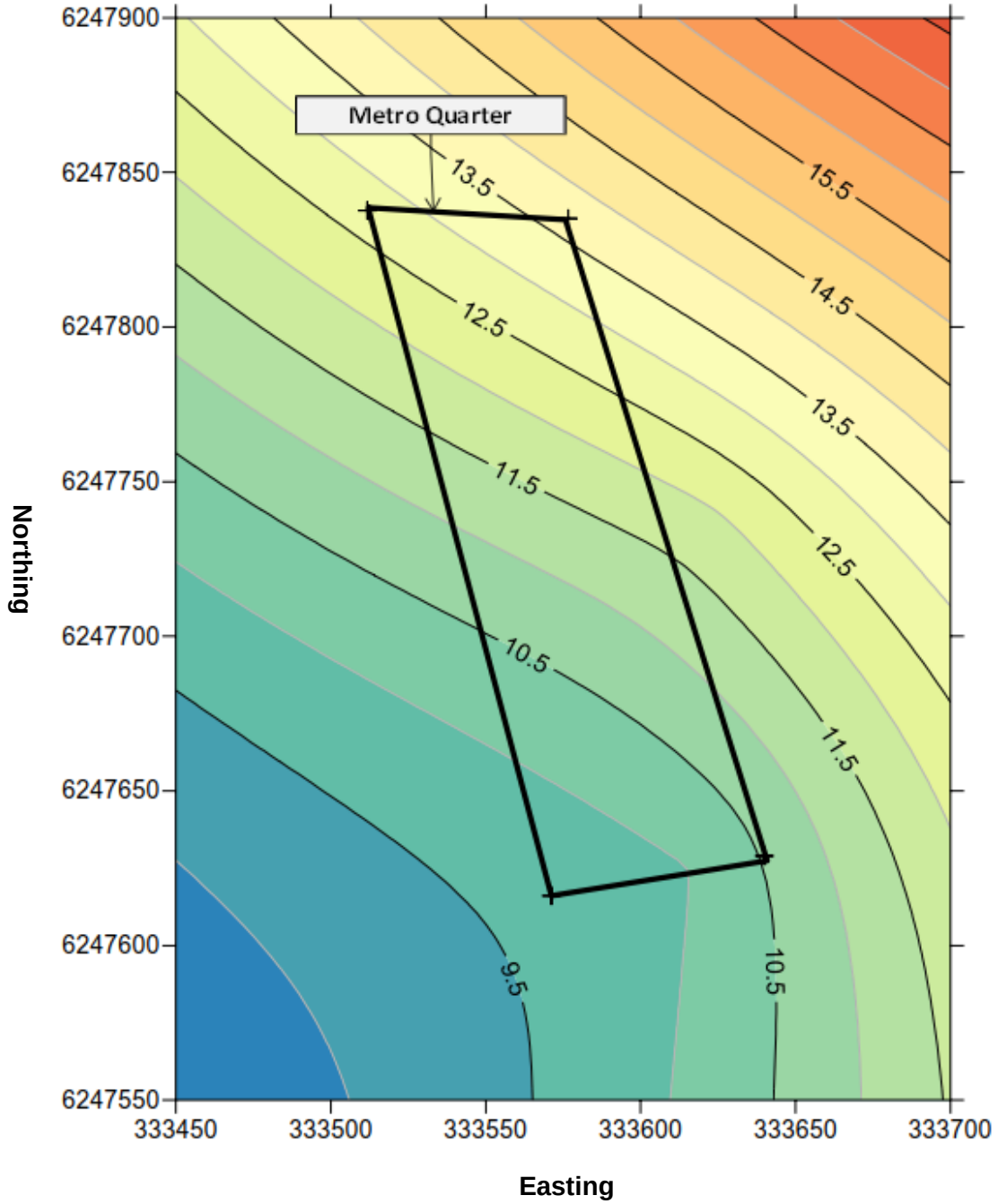

Figure 11 | Inferred Contours of Elevation of Top of Unit 3 - Residual Soil

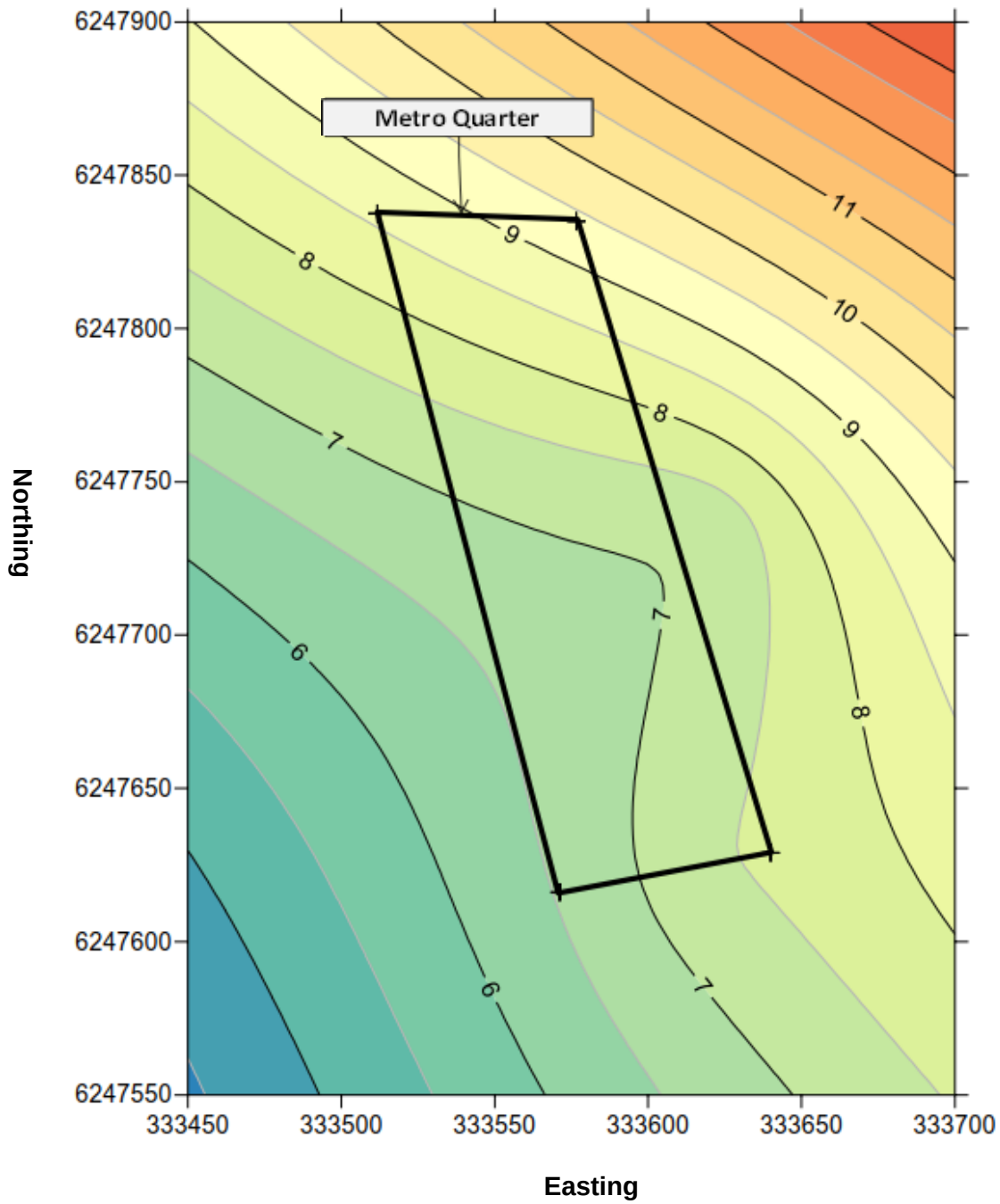

Figure 12 | Inferred Contour of Elevation of Top of Unit 4a – Class V and IV Shale

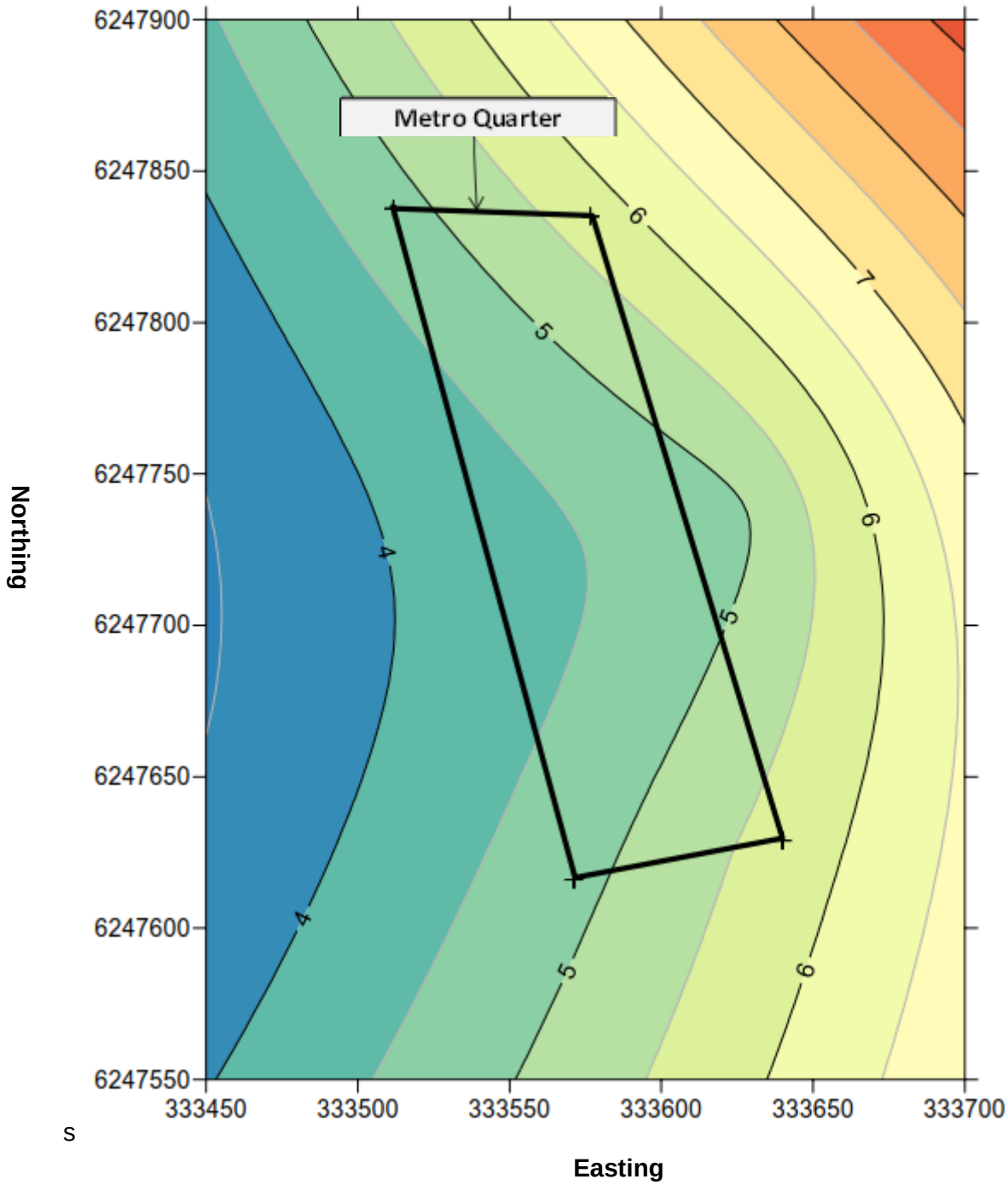

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Figure 13 | Inferred Contours of Elevation of Top of Unit 4b – Class II Shale or better

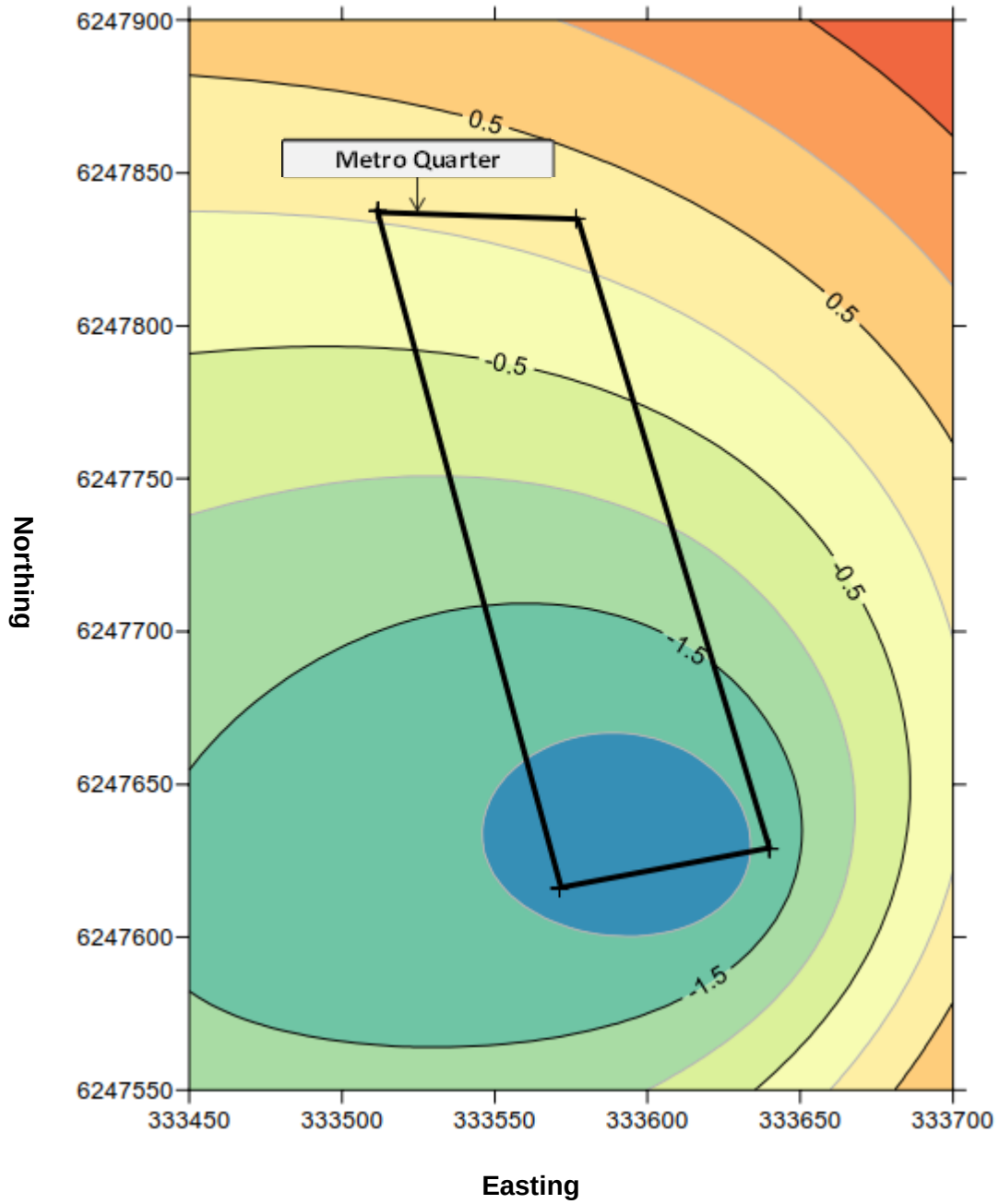

Figure 14 | Inferred Contours of Elevation of Top of Unit 5 – Class II Sandstone or better

3.4.4 Material Properties

Based on the results of in-situ testing from our database we infer the soil and rock properties summarised in Table 2 and Table 3.

Table 2 | Inferred Unit 1, 2 and 3 Soil and Unit 4a Rock Properties

Geotechnical Unit	Bulk Density, γ_b, kN/m^3	Undrained Cohesion, c_u, kPa	Drained Cohesion, c', kPa	Drained Friction Angle, Φ', degrees	Drained Young's Modulus, E', MPa
1. Fill (Note 1) variable Sands or Clays	20	-	0	25	5 to 10
2. Alluvium/Marine Sediments Sand	20	0	0	33	25 to 50
3. Residual Soil Silty Clay	20	100	10	25	20 to 30
4a. Shale Class V and IV	22	500	10	28	50 to 300

Note	1. Existing fill should be treated as uncontrolled fill and should not be relied upon to support structures. The parameters for fill are for estimating retaining wall earth pressures and displacements and should not be used to assess existing fill as a bearing stratum.

Table 3 | Preliminary Rock Strength Estimates and Rock Mass Classifications

Geotechnical Unit	Point Load Strength, I_{s50}, MPa	Uniaxial Compressive Strength, UCS, MPa Note 1	Rock Mass Classification based on Pells et al 1998
4a. Shale	<0.1	<2	Class V and IV
4b. Shale	1.0 to1.1	20 to 22	Class II or better
5. Sandstone	1.0 to 1.5	20 to 30	Class II or better

Note	1. UCS has been estimated based on I_{s50} values, assuming a multiplier of 20 to convert point load strength to UCS.

3.4.5 Groundwater

Groundwater is likely to be relatively shallow in this locality. Standing groundwater levels have been monitored in the Unit 2 – Alluvium/Marine Sediments, at a depth of 1.9 m in proximity to the Metro Quarter. Figure 15 shows inferred contours of groundwater elevation based on this borehole and a limited number of additional boreholes more remote from the Metro Quarter.

Groundwater levels could rise to the ground surface, depending on infiltration rates, flood levels and drainage paths.

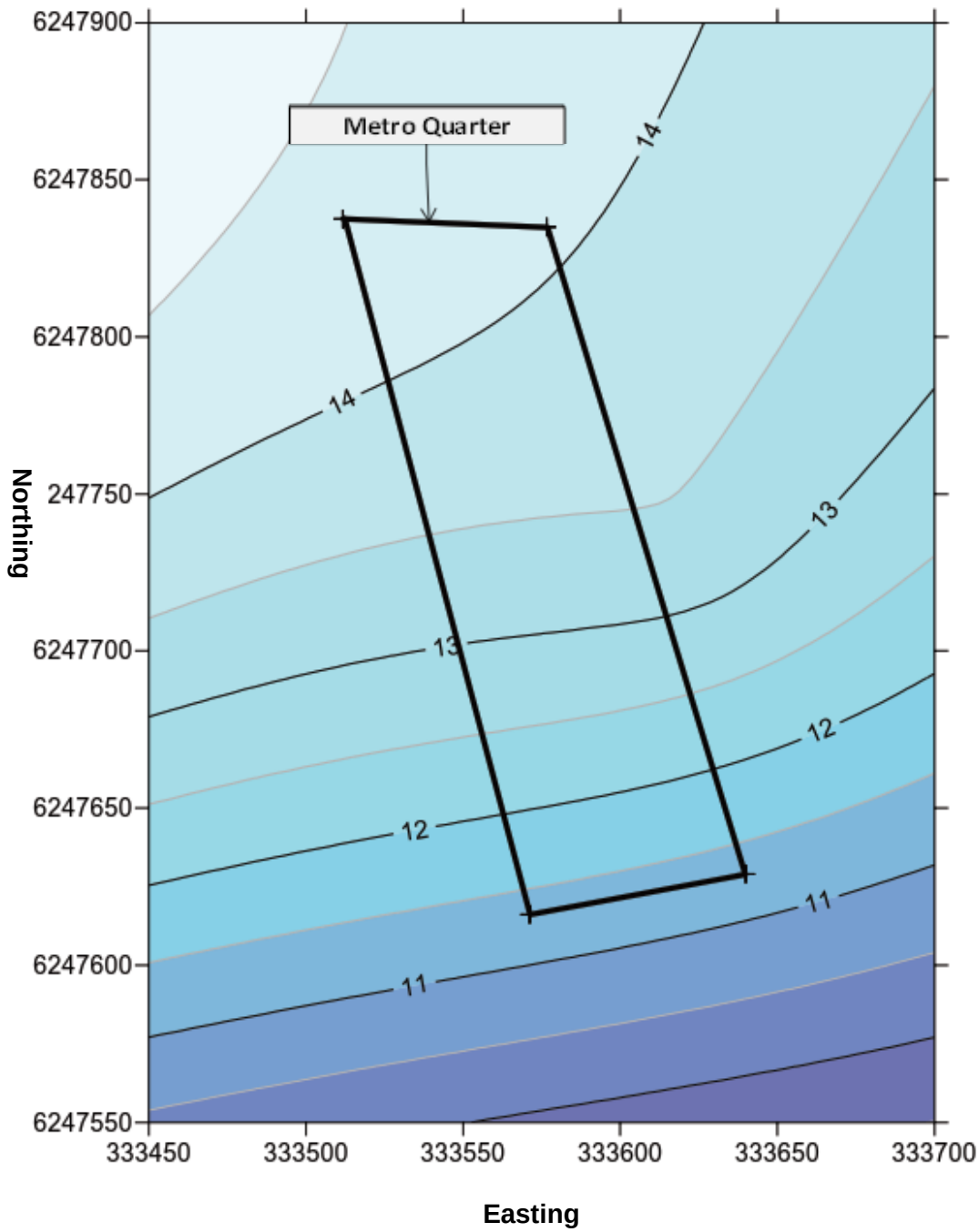

Figure 15 | Inferred Contours of Groundwater Elevation

3.5 Discussion and Recommendations

3.5.1 Geotechnical Risks

Commercial and residential development with basements should be practicable for the Metro Quarter with conventional structural elements and normal construction techniques. However, some geotechnical challenges exist that include:

- High groundwater table and the potential for rapid increase in groundwater levels to the ground surface during heavy/intense rain events or flooding;
- Potentially saturated cohesionless soils (Unit 2 – Botany Sands);
- Interaction with existing structures such as the metro station box, running tunnels and the heritage-listed Waterloo Congregational Church if it is retained as part of the redeveloped Metro Quarter. Restrictions associated with existing structures may result in increased site retention and foundation costs and impact on construction programs; and
- The risk associated with underground services along the site boundaries. Retention system design will have to consider the risk of excavation induced ground movements on existing services. Relatively stiff retention systems may be required to limit ground displacements beyond the site boundaries.

The predominantly sandy soils at the site are unlikely to be highly erodible. However, sediment or dust could still be an issue during construction under adverse conditions such as during very wet or dry weather. Erosion and sediment control would be managed using standard construction methods managed in accordance with a construction environmental management plan (CEMP) and material management plan (MMP).

In the following sections, preliminary comments and recommendations are provided on geotechnical issues associated with basement excavation and structural design and building foundations. Preliminary parameters are provided for concept design, but are based on very limited data from boreholes that were not drilled for this project and should not be relied upon.

3.5.2 Groundwater and Excavation Retention Systems

A tanked retention system will be required for the development of basements through the Botany Sands (Unit 2) that are laterally continuous and of relatively high permeability. Dewatering using spear points may be possible within an excavation enclosed by a groundwater cut-off such a sheet pile wall. If excavations extend into the Residual Soil (Unit 3) they should be able to be maintained dry by pumping from sumps, provided lateral inflows from the overlying sands are cut off.

Given the presence of a relatively low permeability clay layer (Unit 3 – Residual Soil) a cut-off for within the Unit 2 Alluvium/Marine Sediments should be able to be formed by driven steel sheet piles or a secant pile wall. A hydrostatic slab will be required to tank the base of the excavation. If it could be demonstrated that basements penetrate into a very low permeability strata then it may be possible to adopt a semi-tanked basement. The retaining

walls would be tanked and the basement slab designed with a drainage layer to relieve any hydrostatic pressures from groundwater inflows through the foundations. Such a semi-drained basement would be subject to regulatory approvals.

Driven steel sheet piles could be considered to form a temporary retention system to allow dewatering and excavation prior to constructing a permanent cast in place retaining wall. The sheet piles may be sacrificial where used as formwork for the permanent retaining wall.

Secant pile walls need to be constructed carefully to maintain pile verticality and avoid gaps between piles through which groundwater and soil could flow. Soldier pile walls with shotcrete infill panels or contiguous bored piles are unlikely to be practicable through the Botany Sands. These wall types are not suitable for cohesionless and/or saturated soils.

The parameters in Table 2 can be used for preliminary design of retention systems. If temporary ground anchors are required, provision should be made for effectively sealing up the anchor heads to prevent groundwater ingress should the groundwater level rise to above the anchor head.

Depending on factors such as construction sequence and structural stiffness, even well-constructed anchored retaining walls can deflect laterally in the order of 0.1 % to 0.3% of the wall height. Detailed soil-structure interaction analysis should be carried out to assess the lateral and vertical ground movements that could result from basement excavation.

3.5.3 Temporary Ground Anchors

Typically, exclusion zones are declared around buried structures associated with infrastructure such as shafts, station boxes and running tunnels associated with metro lines. Such exclusion zones restrict the imposition of additional stresses on the ground that may affect the buried infrastructure. The feasibility of installing temporary ground anchors should consider such exclusion zones as they may prevent anchors being adopted or require them to be inclined more steeply, which reduces their efficiency.

Table 4 provides recommendations for preliminary design of ground anchors. The parameters are valid for anchors with bond lengths between 3 m and 7 m. In addition to bond and structural capacity, anchors should be checked for a cone pullout failure mechanism.

Table 4 | Preliminary anchor design parameters

Geotechnical Unit	Ultimate Bond Stress kPa
4b. Shale – Class II or better	600
5. Sandstone Class II or better	1,000

3.5.4 Foundations

Piled foundations taken into bedrock are likely to be adopted to support structures within the Metro Quarter. Given the nature of the proposed development, building loads are likely to be relatively high. There may also be a requirement for deep piles to take loads to levels below which they may affect metro rail infrastructure.

If piles are allowed to be located close to metro rail infrastructure there also may be a need to isolate pile shafts from the rock so that loads are not transferred to rail structures. This could be achieved by sacrificial steel sleeves. Open bored piles are unlikely to be practicable unless temporary liners are installed through the Unit 2 Botany Sands and a seal can be achieved in the residual soils or bedrock.

Continuous flight auger (CFA) piles should be practicable. Care will be required if CFA piles are required to have long sockets into relatively high strength rock, resulting in slow auger penetration rates. If there are loose sands within the Unit 2 Botany Sands they could be drawn into the auger while the rock socket is being drilled. This can result in loosening of the sands and potentially unexpected ground movements near the piles. This aspect should be further assessed with additional investigation of the sand density, as the risk is lower in more dense sands.

Table 5 presents preliminary pile design parameters.

Table 5 | Preliminary Pile Design Parameters

Geotechnical Unit	Ultimate End Bearing Capacity, Mpa Note 1	Serviceability Bearing Pressure, Mpa Note 2	Ultimate Shaft Adhesion, kPa Note 3	Elastic Modulus, E, Mpa Note 4
4a. Shale Class V and IV	3	0.7	100	100
4b. Shale Class II or better	60	6	800	1,000
5. Sandstone Class II or better	100	10	1,400	1,600

Note

1. End bearing pressures assume a minimum embedment of 0.3 m into the relevant bearing stratum.
2. End bearing pressures should be checked under Serviceability Limit State (SLS) loads against the Serviceability Bearing Pressure value to confirm that the base of piles remain within the elastic range.
3. Ignore shaft adhesion where the embedment total embedment into rock is less than 1 pile diameter 1 pile diameter.
4. Pile settlement should be calculated using SLS loads and the elastic modulus values in the table.

To design piles in accordance with AS 2159-2009 a geotechnical strength reduction factor, Φ_g, should be applied to check pile capacity under Ultimate Limit State (ULS) loads. The value will depend on a calculated Average Risk Rating (ARR) that considers various factors such as the level of investigation, level of redundancy in capacity, pile load testing, and level of construction review. Typically for single (low redundancy) piles that develop most of their capacity in Sydney sedimentary rock strata the ARR is less than or equal to 2.5.

We estimate an ARR of about 2 should be able to be assessed for this Metro Quarter, from which a Φ_g value of 0.61 can be assessed without considering a testing benefit factor. Minimum pile testing requirements still apply as per AS 2159-2009 Clause 8.2.4.

3.5.5 Further Geotechnical Investigations

This desktop study has been based on a limited number of boreholes, some of which are remote from the Metro Quarter. However, there is sufficient information to assess that proposed land uses are suitable for the Metro Quarter.

Further investigations should form part of detailed development applications. Comprehensive geotechnical models will be required for design and assessing interactions between the Metro Quarter development and the metro station box and running tunnels.

In the absence of borehole information that can be relied upon for the Metro Quarter development, we recommend an allowance for up to 15 cored boreholes to 20 metre depth and five standpipe piezometers in five of these boreholes to allow for groundwater monitoring. If Metro Quarter-specific information such as from the metro rail investigations can be relied upon and is of a suitable scale and distribution then geotechnical investigations may not need to be as extensive. A further desktop study should be carried out to make use of additional information that becomes available and to scope investigations.

4.0 Contamination Baseline Investigation – Stage 1 PSI

4.1 Introduction

AECOM was engaged by UrbanGrowth NSW to undertake a Stage 1 Preliminary Site Investigation (Stage 1 PSI) of the Metro Quarter. The location of the Metro Quarter is shown on **Figure F1, Appendix A** and the properties included within the Metro Quarter are shown on **Figure F2, Appendix A**. The purpose of this Stage 1 PSI is to evaluate the potential for contamination to be present within the Metro Quarter in accordance with the SEARs and assess the requirement for further intrusive investigation.

4.1.1 Objectives

The objectives of the Stage 1 PSI are to:

- To satisfy the requirements of Section 15 of the SEARs summarised in Section 1.1;
- Identify whether potential contamination issues may be associated with the Metro Quarter;
- Identify whether potential contamination at the Metro Quarter is likely to preclude it from being suitable for the proposed residential and train station redevelopment; and
- Make recommendations to assist in making the Metro Quarter suitable for the proposed development of the Metro Quarter and inform future detailed development applications.

4.1.2 Scope of Work

To achieve the objectives, the following scope of work was undertaken:

- Review of available drawings / plans / reports relating to the Site and assessment of data gaps (if any);
- Identification of known contaminated sites as detailed on the NSW Environment Protection Authority (EPA) list of NSW contaminated sites notified to the EPA;
- Identification of properties which are listed on the NSW EPA Contaminated Land record of Notices;
- Source and review current and historical ownership details and aerial photographs for the Metro Quarter;
- Identification of current or historical land uses at the Metro Quarter that are likely to have caused contamination;
- Review published maps of the area to gain an understanding of surface and subsurface conditions (e.g. geology, hydrogeology, soil, topography etc.) including erosion, salinity and acid sulphate soil potential;

- Search/review information readily available through the internet (e.g. historical parish maps, council records, registered groundwater bore database within identified areas of concern etc.);
- Development of a conceptual site model (CSM) to identify potential sources of contamination, human health and environmental receptors and pathways in which these receptors may be exposed to the identified contamination;
- Risk ranking of the potential pollutant linkages to illustrate the relative risk of each pathway to receptors; and
- Site inspection observations.

Investigative work was conducted with reference to relevant parts of the following guidelines:

- NSW DECC, 2009. *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* – used to determine potential significant risk of harm issues associated with the Metro Quarter, where required;
- NSW DEC, 2006. *Guidelines for the Site Auditor Scheme (2nd Edition)* – used to apply the NSW EPA decision processes for assessing and redevelopment of urban sites;
- NEPC, 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999, 2013 Amendment (herein referred to as the ASC NEPM [2013])* – considered throughout the investigation; and
- NSW EPA, 1997. *Guidelines for Consultants Reporting on Contaminated Sites* – considered during the preparation of this report.

4.2 Metro Quarter Identification

An overview of the Metro Quarter identification details are provided in **Table 6** below. Further details on the location and zoning of the Metro Quarter are provided in **Section 4.3**.

Table 6 | Metro Quarter Identification

Item	Description
Local Government Authority (LGA)	City of Sydney
County	Cumberland
Parish	Waterloo
Area	Approximately 1 hectare (Ha)
Elevation	Ranges from 16 – 18 m AHD (refer to **Appendix B**)
Distance from Sydney CBD[1]	3.3km
Current Land Zoning	Sydney Local Environmental Plan (LEP) 2012: Zone B4 Mixed Use.
Current Land Use	Residential and Commercial
Proposed Land Use	Residential and commercial (mixed use)
Metro Quarter Location	Refer to **Figure F1, Appendix A**.
Metro Quarter Layout	Refer to **Figure F2, Appendix A**.

Notes: AHD: Australian Height Datum
CBD: Central business district
1. Distance: Google maps (http://maps.google.com.au)

4.3 Site Condition and Surrounding Environment

4.3.1 Metro Quarter Land Use and Zoning

The zoning of the Metro Quarter is Zone B4 Mixed Use under the Sydney LEP2012. The site zoning map is provided in the Lotsearch Report in **Appendix B**.

The Metro Quarter, as inspected on 10 April 2017, currently consists of commercial and light industrial properties including car repair centres (J&S Smash Repairs), car servicing and mechanical repairs (All Mechanic Repairs and Waterloo Automotive), dry cleaning facilities (Waterloo Laundry) and various commercial facilities (such as printers/graphic services, factory outlets, retail stores, marine supplies [i.e. inflatable boats], convenience store, pharmacy and a medical centre). However, all structures within the site have since been demolished as approved under the CSSI Approval for the metro station.

4.3.2 Surrounding Land Use

Land uses surrounding the Metro Quarter identified during the site visit on 10 April 2017 are described below:

- North: Raglan Street and commercial properties including a hotel (Abbotts Hotel), restaurants, a convenience store and pharmacy beyond. A former service station was previously located approximately 150 metres north of the Metro Quarter;
- East: Cope Street and low to medium density residential housing beyond;
- South: Wellington Street, medium density housing and commercial properties including a hotel (Cauliflower Hotel) and office supply store and a recruitment agency beyond; and
- West: Botany Road, medium density housing and commercial properties including restaurants, furniture store (Wild Reeds), a fitness centre, factory outlets and bike store beyond.

4.3.3 Topography and Drainage

The Metro Quarter is relatively flat and elevated at approximately 16 – 18 metres AHD. The Metro Quarter generally slopes to the south with the northern portion at 18 metres AHD and the southern portion at 16 metres AHD. Given the generally flat nature of the Metro Quarter, erosion is unlikely to be a significant issue assuming excavated material is appropriately managed during construction.

The surrounding landscape is also relatively flat, although some mounding is noted approximately 350 metres east of the Metro Quarter. No major easements were identified by Property Boundary & Topographic Data (as presented in the Lotsearch Report) or during the site inspection on 10 April 2017 within the Metro Quarter. However, three undefined easements were identified within 1 kilometre of the Metro Quarter i.e. northeast (627 metres), southeast (755 metres) and east (799 metres).

4.3.4 Surface Water and Flood Potential

No obvious surface water bodies were observed within or surrounding the Metro Quarter during the site inspection on 10 April 2017. Alexandria Canal is noted to be located approximately 150 metres southwest of the Metro Quarter.

It is noted that development within the Metro Quarter or land surrounding may be subject to flood related development controls i.e. 110 Wellington Street, Waterloo (AECOM, 2014).

4.3.5 Regional Meteorology

According to the Bureau of Meteorology Station (www.bom.gov.au) at the Sydney Airport monitoring station (066037) (data from 1929 to 2017), which is located approximately 5.3 kilometres from the Metro Quarter, the Metro Quarter could expect to experience:

- Moderate to warm summers, with a mean maximum temperature of 26.6ºC in January;
- Mild to cool winters, with a mean minimum temperature of 7.2ºC in July; and
- Average annual rainfall of approximately 1,085.8 millimetres, which is generally highest from February through to June.

4.3.6 Geology and Acid Sulfate Soils

The Metro Quarter is located within the Sydney Basin, which in turn forms part of the Cumberland Plain.

According to the 1:100,000 Sydney Region Geological Map from NSW Department of Industry, Resources & Energy (see Lotsearch Report, **Appendix B**), the Metro Quarter is underlain by Quaternary age medium to fine-grained marine sand with podsols. To the northwest of the Metro Quarter (about 400 metres) is Triassic Ashfield Shale of the Wianamatta Group. The Ashfield Shale is described as black to dark grey shale and laminate.

Further north of the Metro Quarter (about 800 metres) is an unknown land filling area containing dredged estuarine sand and mud, demolition rubble, industrial and household waste) which overlays silty to peaty quartz sand, silt and clay with ferruginous and humic cementation in placed and common shell layers. Due to the previous and current land uses at the Metro Quarter, fill material is generally expected to be present on-site overlying the natural soils.

Soils within the Metro Quarter are classified as Acid Sulfate Soil (ASS) – Soil Class 5 (indicating no known risk of acid sulfate soils), see Lotsearch Report, **Appendix B**.

4.3.7 Hydrogeology

The Metro Quarter is situated on the Botany Sands, an unconfined aquifer, which has large groundwater capacity. The Hydrogeology Map of Australia (see Lotsearch Report, **Appendix**

B) described the local aquifers underlying the Metro Quarter as porous, extensive highly productive aquifers.

The Botany Sands aquifer recharges from the following sources:

- Infiltration of rainfall into the unconsolidated sediments;
- Open space areas including five local golf courses, Randwick Racecourse and Centennial Park;
- Direct run-off from the Hawkesbury Sandstone rim; and
- Discharge of water from springs rising through cracks and bedding planes in the Hawkesbury Sandstone.

The groundwater levels in the Botany Basin are highly variable depending on topographic relief, ranging between 0.0 metres and 23 metres below ground surface. For the identification of hydrogeological position relative to the Metro Quarter, it has been assumed that groundwater flow direction is to the southwest towards the Alexandria Canal.

The NSW Office Water website (www.water.nsw.gov.au) and Lotsearch Report indicate that there are eight registered groundwater bores within 500 m of the Metro Quarter, as summarised in **Table 7**. An annotated map of these groundwater bores is provided in the Lotsearch Report (**Appendix B**).

Table 7 | Registered Groundwater Bore Summary

Bore ID	Depth of Bore (m bgs)	SWL (m bgs)	Approximate distance and direction from Metro Quarter	Purpose	Construction Details	Comments
GW106192	6	4	152m southwest	Domestic	0.0 – 5.4 m bgs Casing 5.4 – 6.0 m bgs Screen	Water bearing zone: 4.00 to 6.00 m bgs
GW111958	6	3.49	282m south	Monitoring	0.0 – 2.5 m bgs Casing 2.5 – 4.5 m bgs Screen	Water bearing zone: 3.49 to 4.50 m bgs.
GW113037	5		375m south	Monitoring	-	-
GW113039	5		376m south	Monitoring	-	-
GW113038	5		381m south	Monitoring	-	-
GW113036	4		400m south	Monitoring	-	-
GW113035	5		415m south	Monitoring	-	-
GW071907	180	11.6	486m northeast	Recreation	0.0 – 17.5 m bgs Casing 17.5 – 17.7 m bgs Screen 17.7 – 57.5 m bgs Casing 57.5 – 57.7 m bgs Screen 57.7 – 180 m bgs Casing	Water bearing zone: 24.5 to 24.7 m bgs, 55.0 to 55.5 m bgs 82.0 to 85.0 m bgs 138.0 to 154 m bgs

Notes:

m bgs – metres below ground surface

- denotes no information available

It is noted that the groundwater bore GW106192 registered for domestic use is located approximately 150 metres hydraulically downgradient of the Metro Quarter. Domestic water use is water used for indoor and outdoor household purposes including drinking water. However, given the metropolitan setting of the Metro Quarter and the availability of potable mains water supply, groundwater in the Waterloo area is unlikely to be used for consumption purposes. Additionally, the yield from this domestic bore is considered to be low (i.e. 0.5 L/s) and therefore would not be suitable for ongoing use.

4.4 Metro Quarter Background

The background to the Metro Quarter, including history, council records and EPA records are summarised in the following sections. AECOM engaged Lotsearch to provide an Environmental Risk and Planning Report for the Metro Quarter and surrounds (hereafter referred to as the Lotsearch Report). The Lotsearch Report, dated 5 April 2017, was reviewed by AECOM for relevant background to the Metro Quarter, and is presented in **Appendix B**.

4.4.1 Council Records

A review of the Development Application (DA) Records database on the City of Sydney's website (https://online.cityofsydney.nsw.gov.au/DA/) was undertaken on 6 April 2017 to determine whether any contamination issues had been identified during the DA process within the vicinity of the Metro Quarter.

The City of Sydney Records DA Application database records applications processed in the last 28 days. All relevant Das (five in total) processed in the Waterloo area did not contain any comment on potential contamination issues, excluding D/2017/407 (change of land use from a commercial clothing retailer to an art gallery) where a Statement of Environmental Effects (SEE) stated that "there would be no negative environment impacts resulting from the proposed development in regards to noise, air quality and impacts to soil and water. No hazardous chemicals will be used or stored on site and all fire safety equipment necessary for the type of development are present on site".

4.4.2 Aerial Photographs

Historical aerial photographs for the Metro Quarter and surrounds were reviewed to identify former land uses that may have the potential to be sources of contamination. The photographs were obtained from the NSW Department of Land and Property Management Authority (DLPMA) and are presented in the Lotsearch Report provided in **Appendix B**, except the 2016 aerial photograph, which was obtained from Google Earth. Details of the aerial photographs are detailed below.

Table 8 | Historical Aerial Photograph Review

Photograph Details	Description of Metro Quarter	Description of Surrounds
1930 (black and white)	The Metro Quarter appears to comprise small-scale and larger commercial/industrial properties. The Waterloo Congregation Church appears to be present near the southwest corner of the Metro Quarter while a garage/service station appears to be located in the northwest corner. At least three lots along Cope Street appear to be vacant.	The Metro Quarter is bound by Raglan Street, Cope Street, Wellington Street and Botany Road. The surrounding blocks appear to comprise residential properties and small-scale and larger commercial/industrial properties. Open space/parkland (i.e. Alexandria Park) was located southwest of the Metro Quarter.
1943 (black and white)	As per 1930 photograph. Additionally, a commercial/industrial property was constructed on the vacant lot in the northeast corner of the Metro Quarter and an L shape building replaced some smaller buildings in the northwest corner of the Metro Quarter (understood to be the J. Skinner metal merchant).	Additional commercial/industrial buildings have been constructed, including a large warehouse to the southwest of the Metro Quarter. A number of smaller buildings to the west of the Metro Quarter along Botany Road had been demolished.
1955 (black and white)	As per the 1943 photograph. A building had been extended on the northern portion of the Metro Quarter (understood to be the F.P. Wadds woodworkers and turners property).	As per the 1943 photograph.

Photograph Details	Description of Metro Quarter	Description of Surrounds
1961 (black and white)	Some redevelopment works were being undertaken across Metro Quarter. Two long buildings extending from Botany Road to Cope Street are observed on the northern portion of the Metro Quarter and three large warehouses had been constructed near the centre of the Metro Quarter following demolition of some existing smaller buildings.	A number of large warehouses had been constructed to the west of the Metro Quarter along Botany Road.
1965 (black and white)	Another large warehouse had been constructed on the northern portion of the Metro Quarter following demolition of some existing smaller buildings e.g. J. Skinner metal merchant building.	Significant redevelopment works had occurred on the two blocks east of the Metro Quarter with the demolition of most buildings and the construction of the Social Housing Estate. Additionally, at least three large warehouses were constructed to the west of the Metro Quarter replacing what appeared to be residential properties.
1970 (black and white)	All buildings along Raglan Street, including the garage/service station, had been demolished and replaced by one large building. Two car parking areas were observed in the southeast corner of the Metro Quarter.	Significant redevelopment works had occurred on the two blocks northeast of the Metro Quarter with the demolition of most buildings. Additionally, a large warehouse (or warehouses) had been constructed on the block north of the Metro Quarter replacing what appeared to be commercial/industrial properties.
1982 (colour)	The Metro Quarter appears to be similar to the 1970 photograph.	High-rise residential apartments and associated open space had been constructed on the two blocks northeast of the Metro Quarter. A number of larger commercial/industrial buildings had been constructed on the southern portion of the block located to the west of the Metro Quarter replacing what appeared to be smaller commercial/industrial properties.
1991 (colour)	The Metro Quarter appears to be similar to the 1982 photograph, although commercial/industrial buildings were constructed approximately halfway along Botany Road and in the southeast corner of the Metro Quarter.	A number of larger commercial/industrial buildings had been constructed on the southern portion of blocks located to the north and northwest of the Metro Quarter replacing what appeared to be smaller commercial/industrial properties.
2005 (colour)	One of the long buildings extending from Botany Road to Cope Street on the northern portion of the Metro Quarter had been demolished and a new elongated commercial/industrial warehouse was constructed in a slightly extended footprint.	A large commercial/industrial building had been constructed on the northern portion of the block located to the west of the Metro Quarter. A swimming pool appears to be located to the west of this building.

Photograph Details	Description of Metro Quarter	Description of Surrounds
	Additionally, a large commercial building was constructed approximately halfway along Botany Road.	Vegetation (i.e. trees) had matured to the northeast and east of the Metro Quarter.
2007 (colour)	The Metro Quarter appears to be similar to the 1982 photograph; however a commercial/industrial building had been constructed in one of the car parking areas located in the southeast corner of the Metro Quarter.	As per the 2005 photograph.
2014 (colour)	The Metro Quarter appears to be similar to the 2007 photograph.	A large warehouse on the block northwest of the Metro Quarter has been demolished and replaced with another commercial/industrial building. This is similar to the block located north of the Metro Quarter whereby a large building was demolished and replaced with smaller buildings.
2017 (colour)	The Metro Quarter appears to be similar to the 2014 photograph.	As per the 2014 photograph.

4.4.3 NSW EPA Records

4.4.3.1 Contaminated Land Records of Notices

A review of the NSW EPA website (www.epa.nsw.gov.au) and the Lotsearch Report was undertaken on 6 April 2017 to evaluate if the EPA has issued a regulatory notice in relation to the Project Area under Section 60 of the *Contaminated Land Management Act 1997* (*CLM Act 1997*).

No listed properties were identified within the Metro Quarter; however the following current notices were listed within 1 kilometre of the Metro Quarter:

- Formerly Gas N Go, Alexandria (located 141 metres northwest of the Metro Quarter). A Preliminary Investigation Order was issued on 30 May 2016 and an Amendment or Repeal of Order was issued on 30 November 2016; and
- Lawrence Dry Cleaners, Waterloo (located 784 metres east of the Metro Quarter). The seven current notices are detailed below:
  - Declaration of Investigation Area issued 31 October 2003
  - Agreed Voluntary Investigation Proposal issued 4 May 2004
  - Declaration of a Remediation Site issued on 2 November 2005.
  - Management Order issued 26 May 2011 and amended on 28 August 2014.
  - Amendment of Repeal of Order issued on 27 February 2015.
  - Amendment of Repeal of Order issued on 9 February 2016.

A copy of the search is provided in the Lotsearch Report in **Appendix B**. The former Gas N Go was located hydraulically upgradient of the Metro Quarter and impacted groundwater may have migrated toward the Metro Quarter. However, given the Gas N Go site was redeveloped into residential apartments in September 2016 and there is no ongoing source

of contamination, any legacy groundwater contamination is not likely to be significant at the Metro Quarter. Due to the distance of Lawrence Dry Cleaners and its cross hydraulic gradient location from the Metro Quarter, the contamination associated with this site is not considered relevant to this investigation.

4.4.3.2 NSW Contaminated Sites Notified to the EPA

A review of the NSW EPA website (www.epa.nsw.gov.au) and the Lotsearch Report was undertaken on 6 April 2017 to evaluate if, under Section 60 of the *CLM Act 1997*, any properties within the boundaries of Metro Quarter or the surrounding areas had been reported to the EPA.

No listed properties were identified within the Metro Quarter; however the following notices were listed within 1 km of the Metro Quarter:

- Alexandria Gardens, 146-156 Wyndham Street and 146-156 Botany Road, Alexandria (65 m south of the Metro Quarter). Currently under assessment;
- Proposed Construction Site, 2 John Street, Waterloo (137 m south of the Metro Quarter). Regulation under the *CLM Act 1997* not required;
- Formerly Gas N Go (fully redeveloped into residential apartment as of September 2016), 10-20 Botany Road, Alexandria (141 m northwest of the Metro Quarter). Contamination currently regulated under the *CLM Act 1997*;
- Australian Technology Park, Henderson Road, Eveleigh (208 m northwest of the Metro Quarter). Regulation under the *CLM Act 1997* not required;
- BP Service Station, 116 Regent Street, Redfern (315 m north of the Metro Quarter). Currently under assessment;
- Caltex Service Station, 133 Wyndham Street cnr McEvoy Street, Alexandria (365 m south of the Metro Quarter). Regulation under the *CLM Act 1997* not required;
- Lawrence Dry Cleaners, 887-893 Bourke Street, Waterloo (784 m east of the Metro Quarter). Contamination currently regulated under the *CLM Act 1997*;
- Diversity Waterloo, 1-13 Archibald Avenue, Waterloo (818 m southeast of the Metro Quarter). Currently under assessment;
- Waverley Woollahra Process Plant, 355 Botany Road, Waterloo (861 m southeast of the Metro Quarter). Regulation under the *CLM Act 1997* not required;
- Former Industrial Site, 16 O'Riordan Street, Alexandria (923 m south of the Metro Quarter). Currently under assessment;
- Former Mobil Service Station, 20 O'Riordan Street, Alexandria (960 m south of the Metro Quarter). Regulation under the *CLM Act 1997* not required; and
- Perry Park, 1B Maddox Street, Alexandria (995 m south of the Metro Quarter). Site no longer on EPA Contaminated Land List.

A copy of the Contaminated Land Search is provided in the Lotsearch Report, **Appendix B**.

Of the abovementioned sites notified to the EPA, two are considered to be located hydraulically upgradient of the Metro Quarter i.e. former Gas N Go and BP Service Station.

As discussed in **Section 4.4.3.1**, the legacy groundwater contamination associated with the former Gas N Go is unlikely to significantly impact the Metro Quarter. Given the distance of the BP service station from the Metro Quarter (i.e. greater than 300 m), any contamination associated with this site is not considered relevant to this investigation.

Due to the distance and/or location (i.e. hydraulically cross gradient or upgradient) of the remaining notified sites from the Metro Quarter the contamination of these sites is not considered relevant to this investigation.

4.4.3.3 Licensed Activities under the POEO Act 1997

The Lotsearch Report listed one business with licenced activities under the *Protection of the Environment Operations Act 1997* (*POEO Act 1997)* within 1 km of the Metro Quarter:

- Sydney Trains: railway (131 m south of [and surrounding] the Metro Quarter)

A full list of formerly licenced activities under the *POEO Act 1997* is provided in the Lotsearch Report, attached as **Appendix B**.

The Sydney Trains licence (No. 12208) was issued to allow for railway system activities. Based on information contained within the Sydney Trains licence, these activities are unlikely to result in significant contamination (if any) being released to the environment. Therefore, the Metro Quarter is unlikely to be impacted by activities undertaken at the Sydney Trains site.

4.4.4 Business Directory Records

The Lotsearch Report lists businesses in the 1950, 1970 and 1991 Universal Business Directories within 150 m of the Metro Quarter and dry cleaners, garages and service stations within 1km of the Metro Quarter. Those businesses within the Metro Quarter or located 500 m hydraulically up gradient of the Metro Quarter with potentially contaminating activities that may impact the Metro Quarter are summarised in

Table 9. The full list of Business Directory Records and their locations are provided in the Lotsearch Report, attached as **Appendix B**.

Table 9 | Historical Business Directory Records

Potentially Contaminating Businesses	Approximate distance and direction from closest Metro Quarter boundary
1991	
Motor repairs, 85 Botany Road Waterloo 2017	Within Metro Quarter
Motor panel beaters and/or spray painters, 65 Botany Road Waterloo 2017	Within Metro Quarter
Various manufacturers, importers and/or distributors (e.g. toilet paper, adhesives, packaging), 128 Cope Street Waterloo 2017	Within Metro Quarter
Abrasive merchants, 128 Cope Street Waterloo 2017	Within Metro Quarter
Motor brake/clutch specialists and engine reconditioners, 129 Wellington Street Waterloo 2017	Within Metro Quarter

Potentially Contaminating Businesses	Approximate distance and direction from closest Metro Quarter boundary
Cleanser and/or cleaning preparation manufacturers and/or distributors, 23 Botany Road Alexandria 2015	102 m north
Regent auto repairs, 156 Regent Street Redfern 2016	219 m north
Redfern service station, 131 Regent Street Redfern 2016	389 m north
1970	
Cleaners (general, industrial, window), 87 Botany Road Waterloo 2017	Within Metro Quarter
Forgings manufacturers, 146 Botany Street Waterloo 2017	Within Metro Quarter
Printers machinery and furnishers, 128 Botany Road Waterloo 2017	Within Metro Quarter
Metal extrusion tooling and steel merchant, 146 Botany Street Waterloo 2017	Within Metro Quarter
Motor painters and panel beaters, 65 Botany Road Waterloo 2017	Within Metro Quarter
Printers machinery and supplies, 128 Botany Road Waterloo 2017	Within Metro Quarter
Chemist manufacturing and/or wholesale, 89 Botany Road Waterloo 2017	Within Metro Quarter
Sheet metal workers machinery, 59-63 Botany Road Waterloo 2017	Within Metro Quarter
Woodworking machinery, 59-63 Botany Road Waterloo 2017	Within Metro Quarter
Electronic motor dealers and/or wholesalers, 59-63 Botany Road Waterloo 2017	Within Metro Quarter
Motor garages and engineers, 69-83 Botany Road Waterloo 2017	Within Metro Quarter
Total service station, 69-83 Botany Road Waterloo 2017	Within Metro Quarter
Town auto repairs, 60 Botany Road Redfern 2016	221 m north
Palm dry cleaners, 130 Regent Street Redfern 2016	274 m north
Renault, 153 George Street, Redfern 2016	328 m northeast
BP service station, 118 Regent Street Redfern 2016	336 m north
McDermotts dry cleaners, 134 Pitt Street Redfern 2016	360 m northeast
Redfern Service Station, 133 Regent Street Redfern 2016	367 m north
Johnson's dry cleaning, 144 Renwick Street Redfern 2016	375 m north
Personality dry cleaning, 74 Regent Street Redfern 2016	447 m north
1950	
Dowel manufacturers, 87 Botany Road Waterloo 2017	Within Metro Quarter
Timber merchants, 87 Botany Road Waterloo 2017	Within Metro Quarter
Moulding manufacturers, 87 Botany Road Waterloo 2017	Within Metro Quarter
Sheet metal workers, 67 Botany Road Waterloo 2017	Within Metro Quarter
Motor electricians, 51 Botany Road Waterloo 2017	Within Metro Quarter
Battery manufacturers and service stations, 51 Botany Road Waterloo 2017	Within Metro Quarter

Potentially Contaminating Businesses	Approximate distance and direction from closest Metro Quarter boundary
Motor garages, painter, panel beaters, welders, 101 Botany Road Waterloo 2017	Within Metro Quarter
Coppersmiths, welders and sheet metal workers, 79 Botany Road Waterloo 2017	Within Metro Quarter
Motor carburettor and tuning specialists, 117 Botany Road Waterloo 2017	Within Metro Quarter
Statuette and model manufacturers, 77 Botany Road Waterloo 2017	Within Metro Quarter
Woodwork and turners, 63 Botany Road Waterloo 2017	Within Metro Quarter
Motor engineer, 101 Botany Road Waterloo 2017	Within Metro Quarter
Cabinet manufacturers, 15-19 Botany Road Waterloo 2017	124 m north
Furniture manufacturers, 11 Botany Road Waterloo 2017	150 m north
Dry cleaners, 199 Regent Street Redfern 2016	177 m north
Tasman dry cleaners, 195 Regent Street Redfern 2016	213 m north
Dalton motor garage, 150 Regent Street Redfern 2016	232 m north
Jones dry cleaners, 147 Regent Street Redfern 2016	324 m north
Redfern service station, 131 Regent Street Redfern 2016	388 m north
Redfern dry cleaners, 74 Regent Street Redfern 2016	447 m north
Anderson Bros dry cleaners, 46 Regent Street Redfern 2016	491 m north

Given the presence of light industrial and commercial businesses within or hydraulically upgradient of the Metro Quarter in 1991, there is a potential for petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), heavy metals, asbestos and volatile organic compounds (VOCs) to have impacted the Metro Quarter.

It is noted that petroleum and chlorinated hydrocarbon impacts biodegrade over time, and therefore service station and dry cleaner records from 1950 and 1970 are not considered further.

4.4.5 Unexploded Ordanance

A search of the Australian Department of Defence Unexploded Ordnance (UXO) Contamination database was conducted on 7 April 2017 to evaluate whether the Metro Quarter or surrounding areas were listed. There were no records of UXO contamination in the City of Sydney Local Government Area.

4.5 Previous Environmental Investigations

AECOM is unaware of and has not been provided with any previous environmental investigation reports relevant to the condition of soil and groundwater which have been completed within the Metro Quarter.

However, AECOM has previously undertaken a Stage 1 Contamination Assessment dated 15 January 2014 on the Social Housing Estate located east of the Metro Quarter (AECOM, 2014). The information collated during this Stage 1 Contamination Assessment has been included in this Stage 1 PSI with regard to discussions on off-site land uses.

4.6 Site Walkover

AECOM conducted a walkover of the Metro Quarter and adjacent areas on 10 April 2017. A photographic log has been provided in **Appendix C**.

The Metro Quarter is located in a metropolitan setting which is generally highly developed with areas of green space. The Metro Quarter was identified to comprise commercial buildings (**Photograph 1**), some with residential dwellings above, and light industrial warehouses (**Photograph 2**). The buildings were typically of brick construction and ranged from one to three stories in height (**Photograph 3**). A number of commercial buildings along Raglan Street had awnings over the fronting footpath which may have been constructed with asbestos containing materials (ACM) (**Photograph 4**). However, it is noted that a hazardous building materials survey was not undertaken and therefore the presence of asbestos and other hazardous building materials on the interior or exterior of buildings could not be confirmed. Two unsealed or poorly sealed car parking areas were located within the Metro Quarter and hydrocarbon staining was observed on the car park surface (**Photograph 5**). The buildings within the Metro Quarter were surrounded by a concrete footpath, asphalt driveways, mature trees (particularly along Botany Road, **Photograph 6**) and grassy nature strips (along Wellington Street, **Photograph 7**).

The footpath and driveways within the Metro Quarter were observed to be typically cracked and uneven, particularly along Cope Street (**Photograph 8**). It should be noted that there were sections where the footpath had been replaced e.g. southern end of Cope Street and mid to southern end of Botany Road (adjacent to Two Lights Waterloo and former Wittner factory outlet). Therefore, the poor condition concrete/asphalt appears to be attributable to a

poor state of repair and not due to the subsidence of the underlying soils. There was also evidence of trench reinstatement within the concrete footpath (**Photograph 9**).

The vegetation that was observed within the Metro Quarter appeared to be healthy although patches of grass had eroded exposing the soil beneath (**Photograph 7**).

There was evidence of cut and fill across the Metro Quarter to level the land for building and road construction. Additionally, raised garden beds were observed outside the Waterloo Congregational Church (**Photograph 10**). Whilst rubbish was noted on the surface of the garden beds (and nature strips), no buried anthropogenic material was observed to be exposed at the surface.

During the walkover, no significant staining indicative of surface spills or contamination was observed and no unusual odours were noted.

The following land uses were observed adjacent to the Metro Quarter (i.e. off-site) (also depicted on **Figure F2**):

- Medium density residential houses (i.e. Waterloo Social Housing Estate) were observed to the east of the Metro Quarter (**Photograph 11**);
- Commercial and light industrial properties were typically observed to the north, south and west of the Metro Quarter (**Photograph 12**); and
- A number of terrace houses were located south and southwest of the Metro Quarter (**Photograph 13**).

4.7 Conceptual Site Model

A conceptual site model (CSM) presents information about potential contamination sources, receptors and potential exposure pathways between the identified sources and receptors. As detailed in the ASC NEPM 2013, the development of a CSM is a key component of contaminated site assessments and provides the framework for identifying how potential receptors may be exposed to contamination from historical and/or current site sources. The sources, pathways and receptors identified for the Metro Quarter are discussed and tabulated below.

4.7.1 Sources

4.7.1.1 Potential Areas of Concern

Based on the review of available historical information and available imagery, the following potential sources of contamination were identified, which may impact the condition of soil and groundwater within the Metro Quarter:

- Commercial and light industrial properties including car repair centres (J&S Smash Repairs), car servicing and mechanical repairs (All Mechanic Repairs and Waterloo Automotive), panel beaters and/or spray painters, cleaning product manufacturers, printer machinery and supplies, sheet metal workers, woodworking machinery and battery manufacturers;
- Dry cleaning facilities including Waterloo Laundry;
- Service station including former Total Service Station.

- Use of fill material of unknown origin that could potentially contain or be impacted with contaminants;
- Historical use of asbestos containing material (ACM) within buildings and structures erected since the 1920s; and
- Historical use of lead based paints on the interior and exterior of historical and current buildings.

The following potentially contaminated areas were identified on surrounding land located in proximity to or hydraulically upgradient of the Metro Quarter:

- Surrounding areas of former and current buildings erected since the 1920s which are likely to have been constructed using potentially contaminating or hazardous materials including asbestos and lead based paints (primarily located to the northeast and east of the Metro Quarter);
- Light industrial and commercial properties surrounding the Metro Quarter including dry cleaning facilities, service stations, car repair centres, furniture manufacturers and cleaning product manufacturers; and
- Groundwater in the vicinity of the Metro Quarter that may be contaminated from the surrounding historical commercial and industrial land uses. It is noted that the Metro Quarter footprint is located within the Botany Sands Beds aquifer which has been contaminated as a result of historical industrial land use activities.

4.7.1.2 Contaminants of Potential Concern

Based on the review of available information and observations made during the site inspection, the contaminants of potential concern (CoPC) relating to current and historical activities in and surrounding the Metro Quarter include, but may not be limited to, the following:

- Asbestos – there is potential for historical and current building materials to be constructed using ACM. ACM has historically been used since the 1920s, and then more widely in the post war years from 1945 to the end of the 1960s, and is reported to be present in almost 20 percent of all housing stock (The Asbestos Network, 2008). As buildings existed within the Metro Quarter in the 1930s aerial photographs, it is possible that the buildings and associated infrastructure were constructed using ACM. With the demolition of these buildings overtime, it is possible that residual ACM may be present in soils within the Metro Quarter. Asbestos can also potentially be present in fill (dependent on the origin of the fill material);
- Heavy metals including lead – which may occur in fill originating from industrial sites. Common metals include arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc. Also, selected metals (lead, cadmium, chromium and zinc) may be sourced from the metal-based paints and lithium from battery manufacturing waste. There is also potential for buildings to have been treated with lead paint. In Australia, paints containing at much as 50 percent lead were used on the inside and outside of houses built before 1950, and paint containing more than 1 percent lead was still being used

until the late 1960s. Lead paint may have been applied to and still exist on the interior and exterior walls of the current buildings, or may be present within the soil since re-development;

- Petroleum Hydrocarbons – can be found in emulsions, fuels, solvents and oils etc. and are commonly encountered in service stations, car maintenance and smash repair facilities. Petroleum hydrocarbons are generally quantified by analytical laboratories as total recoverable hydrocarbons (TRH) as four fractions of hydrocarbons grouped into ranges of volatility;
- Polycyclic Aromatic Hydrocarbons (PAHs) – related to some petroleum hydrocarbon use, bitumen emulsion, lubricating oils and waste oils. PAHs can also potentially be present in fill (dependent on the origin of the fill material);
- Volatile Organic Compounds (VOCs) including chlorinated hydrocarbons – related to various industrial processes, particularly where solvents are used and are associated with contamination from dry cleaning facilities and maintenance facilities. VOCs can also potentially be present in fill (dependent on the origin of the fill material); and
- Organochlorine pesticides (OCP), organophosphorous pesticides (OPP) and polychlorinated biphenyls (PCBs) can also potentially be present in fill (dependent on the origin of the fill material) which was placed across the Metro Quarter during its development.

4.7.2 Receptors

Based on the review of available information and observations made during the site inspection, the following potential human health and ecological receptors have been identified:

- Current and future on-site and off-site residents;
- Current and future on-site and off-site commercial workers;
- Current and future on-site and off-site construction/intrusive maintenance workers;
- Current and future off-site recreational users of Alexandria Park located south west of the Metro Quarter; and
- Alexandra Canal.

4.7.3 Tabulated SSM and Risk Planning

Based on the review of the Metro Quarter and sources and receptors discussed in **Section 4.7.1** and **Section 4.7.2**, a tabulated CSM has been prepared to illustrate the relative risk of each source-pathway-receptor linkage identified for the Metro Quarter. The qualitative risk ranking has been completed using a colour coding system, with green representing low risk, orange medium risk and red representing a high risk, as follows:

- Low risk – based on the available information, a complete pollutant linkage is considered to be unlikely.
- Medium risk – based on the available information, a complete pollutant linkage may potentially be present, however the likelihood and consequence is considered to be medium.
- High risk – based on the available information, a complete pollutant linkage is considered to be likely.

A discussion on the likelihood for potential pollutant linkages is provided for each source above, in **Section 4.7.1**.

Table 10 | CSM and Qualitative Risk Ranking of Potential Source-Pathway-Receptor Linkages

Source	CoPC	Pathway	Receptor	Qualitative Risk Ranking
Light industrial and commercial properties (within Metro Quarter)	• Asbestos • Heavy metals • TRH, BTEX, PAH, VOCs	• Direct contact during soil disturbance activities. • Inhalation of wind-blown dust (in unsealed areas). • Inhalation of volatiles that migrate through the vadose zone	• Current and future on-site commercial workers • Current and future on-site residents • Current and future on-site construction/ intrusive maintenance workers	High
		• Leaching from soil and migration through groundwater • Inhalation of volatiles that migrate through the vadose zone	• Current and future off-site commercial workers • Current and future off-site residents • Current and future off-site construction/ intrusive maintenance workers • Alexandria Canal	Medium
Imported fill	• Asbestos • Heavy metals • TRH, BTEX, PAH, VOCs, OCP, OPP, PCBs	• Direct contact during soil disturbance activities. • Inhalation of wind-blown dust (in unsealed areas) • Inhalation of volatiles that migrate through the vadose zone	• Current and future on-site commercial workers • Current and future on-site residents • Current and future on-site construction/ intrusive maintenance workers	High
		• Leaching from soil and migration through groundwater	• Alexandria Canal	Low

Source	CoPC	Pathway	Receptor	Qualitative Risk Ranking
Hazardous building materials	• Asbestos	• Disturbance of soils and inhalation of fibres released	• Current and future on-site commercial workers • Current and future on-site residents • Current and future on-site construction/ intrusive maintenance workers	High
	• Lead	• Direct contact during soil disturbance activities. • Inhalation of wind-blown dust (in unsealed areas)	• Current and future on-site commercial workers • Current and future on-site residents • Current and future on-site construction/ intrusive maintenance workers	Medium
		• Leaching from soil and migration through groundwater	• Alexandria Canal	Low
Light industrial and commercial properties (outside Metro Quarter)	• Heavy metals • TRH, BTEX, PAH, VOCs	• Leaching from off-site soil and migration through groundwater • Inhalation of volatiles that migrate through the vadose zone	• Current and future on-site commercial workers • Current and future on-site residents • Current and future on-site construction/ intrusive maintenance workers	Low

4.8 Conclusion and Recommendations

AECOM has reviewed historical and current records pertaining to the Metro Quarter and its surrounds and characterised the contamination status of the Metro Quarter. The Metro Quarter has primarily been used for commercial/light industrial purposes, while the surrounding area has been used for commercial/light industrial (typically north, south and west of the Metro Quarter), residential (east of the Metro Quarter) and recreational (southwest of Metro Quarter) purposes.

The CSM (presented in **Section 4.7**) identifies potential sources of contamination, receptors and exposure pathways, and risk ranked these potential pollutant linkages to illustrate the relative risk of each pathway. Potential sources of contamination identified during the Stage 1 PSI which may impact the condition of soil and groundwater within the Metro Quarter and its surrounds include the following:

Within the Metro Quarter

- Commercial and light industrial properties including car repair centres (J&S Smash Repairs), car servicing and mechanical repairs (All Mechanic Repairs and Waterloo Automotive), panel beaters and/or spray painters, cleaning product manufacturers, printer machinery and supplies, sheet metal workers, woodworking machinery and battery manufacturers;
- Dry cleaning facilities including Waterloo Laundry;
- Service station including former Total Service Station;
- Use of fill material of unknown origin that could potentially contain or be impacted with contaminants;
- Historical use of asbestos containing materials (ACM) within buildings and structures erected since the 1920s; and
- Historical use of lead based paints on the interior and exterior of historical and current buildings.

Outside the Metro Quarter

- Surrounding areas of former and current buildings erected since the 1920s which are likely have been constructed using potentially contaminating or hazardous materials including asbestos and lead based paints (primarily located to the northeast and east of the Metro Quarter);
- Light industrial and commercial properties surrounding the Metro Quarter including dry cleaning facilities, service stations, car repair centres, furniture manufacturers and cleaning product manufacturers; and
- Groundwater in the vicinity of the Metro Quarter that may be contaminated from the historical surrounding commercial and industrial land uses in surrounding areas. It is noted that the Metro Quarter footprint is located within the Botany Sands Beds aquifer, which has been contaminated as a result of historical industrial land use activities.

Of the potential pollutant linkages identified in the CSM, three linkages were considered to present a high risk to human health and/or the environment that are expected to have implications for remediation/management costs.

1. The historical and current commercial/light industrial activities undertaken within the Metro Quarter have likely resulted in contaminants of potential concern (CoPC) being released into the environment. Although it is understood that the redeveloped Metro Quarter is likely to be capped with limited access to soil, future sub-slab intrusive works may be required for service maintenance purposes. As such, there is a

potential for workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale CoPC in soil/dust. Additionally, a number of CoPC are considered to be volatile e.g. light-end total recoverable hydrocarbons (TRH) fractions, benzene, toluene, ethylbenzene and xylenes (BTEX) and volatile organic compounds (VOCs). Therefore, future residents, commercial workers or construction/intrusive maintenance workers may be exposed to volatile CoPC via inhalation.

2. Since 1930, a number of buildings within the Metro Quarter have been demolished and erected potentially depositing CoPC such as asbestos containing materials (ACM) and lead onto the soil. Therefore, there is a potential for intrusive maintenance workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale asbestos and lead in soil/dust.
3. Although specific areas could not be identified where fill material may have been used it is likely to be present across given the level nature the Metro Quarter. Imported fill material of unknown origin can contain a range of CoPC. Therefore, there is a potential for intrusive maintenance workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale CoPC in soil/dust. Additionally, future residents, commercial workers or construction/intrusive maintenance workers may be exposed to volatile CoPC via inhalation if not managed or remediated appropriately.

With consideration to Clause 7 of SEPP 55, this Stage 1 PSI has evaluated the contamination status of the Metro Quarter and identified the potential for contamination to be present. Notwithstanding, AECOM considers that the Metro Quarter can be made suitable for the proposed development following the completion of further investigation and remediation works (if required). Based on the findings of this Stage 1 PSI and CSM developed for the Metro Quarter, AECOM recommends undertaking the following additional stages of work to ensure the SEARs are being fulfilled. It is noted that the additional work scope would be undertaken during the detailed development application stage:

- Completion of a stage 2 contamination assessment to characterise the nature and extent of potential soil and groundwater contamination targeting the potential areas of concern identified within the Metro Quarter. Findings of available contamination and remediation reports for the metro station should be considered in the preparation of the assessment for the OSD. Soil and groundwater samples should be analysed for the identified CoPCs listed in **Section 4.7.1.2** and assessed in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM, 2013).
- The stage 2 contamination assessment would likely incorporate the following elements:
  - Preparation of a Sampling, Analysis & Quality Plan (SAQP), which will include an assessment of:
    - Data quality objective (DQO) development;
    - Refinement of the Conceptual Site Model (CSM) for the Site;
    - Confirmation of proposed sampling and analysis program, incorporating the findings of this Stage 1 PSI. The sampling program would likely comprise a combination of targeted and grid based sampling focusing on identified areas of concern; and

    - Consideration would also be given to the requirement for waste classification sampling and analysis in the event that offsite disposal of material will be required.
  - Preparation of a site specific Health and Safety Plan (HASP) including consideration of environmental management; and
  - Project Management including subcontractor management, access approvals, stakeholder liaison, etc.
  - Field Investigation comprising:
    - Service location in all areas that will be subject to intrusive investigations;
    - Drilling work and monitoring well installation;
    - Groundwater and soil sampling;
    - Survey of newly installed monitoring wells to a site specific datum to facilitate understanding of inferred groundwater flow direction; and
    - Laboratory analysis of soil and groundwater samples.
- Based on the results of the stage 2 contamination assessment, remediation cost estimates can be developed.
- Remediation and/or management of impacted areas may be required to mitigate risks during the construction works program and for the future proposed development. Any remediation works which may be required as an outcome of the stage 2 contamination assessment would be informed by the preparation of a remediation action plan (RAP).

It is noted that the information detailed within the RAP may also be used to inform the following UrbanGrowth requirements:

- Provision of tender documentation for intrusive ground works;
- Validation sampling based on the scope outlined in the RAP following completion of remediation works. It is noted that the validation sampling scope would likely incorporate the following requirements:
  - Groundwater and soil validation sampling;
  - Laboratory analysis of soil and groundwater samples; and
  - Preparation of a validation report
- Development of a CEMP to manage risks to construction and maintenance workers from impacted soils and groundwater during the redevelopment of the Metro Quarter.
- Develop a Materials Management Plan to include a strategy for the management of materials so that impacted material can be potentially reused in less sensitive areas or managed within the Metro Quarter to minimise off-site disposal of excavated material to a licensed landfill.

5.0 SEARs Response

This geotechnical and Contamination report presents a response to the SEARs outlined in Table 11:

Table 11 | SEARs Reponses

Metro Quarter Requirements	Geotechnical and Contamination Responses
15. Geotechnical and Contamination	
15.1. Provide an assessment of the site's conditions, outlining the site's suitability for the proposed uses with respect to soil erosion, salinity and acid sulphate soil.	An assessment of the local soil conditions specifically addressing erosion, salinity and acid sulfate issues has been included in this report. Erosion, salinity and acid sulfate soil, if encountered, would be managed in accordance with Site specific management plans developed for Metro Quarter
15.2. Provide an assessment of the proposal in accordance with State Environmental Planning Policy No 55 - Remediation of Land and relevant guidelines.	An assessment of the proposed land uses satisfying the State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55) has been provided in this report, specifically addressing Clause 6(1)(b),(c). It is noted that: - A Stage 2 contamination assessment is required to characterise the nature and extent of potential soil and groundwater contamination identified within the Metro Quarter to confirm that the Metro Quarter is either suitable in its current condition or can be made suitable following remediation for the proposed land use and zoning in accordance with clause 6(1)(b) of SEPP 55 - In accordance with clause 6(1)(c) of SEPP 55, remediation and/or management of impacted areas may be required to mitigate risks associated with the identified impacts during the proposed construction works

6.0 Conclusion

This study has addressed the geotechnical and contamination requirements outlined Section 5.0 of this report. Key geotechnical and contamination findings of this report include:

- The study area is underlain by Quaternary Sediments, (Qhd), described as medium to fine grained “marine” sand with podsols;
- The underlying bedrock is Ashfield Shale underlain by Mittagong Formation and/or Hawkesbury Sandstone;
- The top of bedrock within the Metro Quarter ranges from about RL+9.5 metres AHD in the north to about RL +6.5 metres AHD in the south;

Potential sources of contamination identified during the Stage 1 PSI which may impact the condition of soil and groundwater within the Metro Quarter and its surrounds include the following:

- Commercial and light industrial properties including car repair centres (J&S Smash Repairs), car servicing and mechanical repairs (All Mechanic Repairs and Waterloo Automotive), panel beaters and/or spray painters, cleaning product manufacturers, printer machinery and supplies, sheet metal workers, woodworking machinery and battery manufacturers;
- Dry cleaning facilities including Waterloo Laundry;
- Service station including former Total Service Station;
- Use of fill material of unknown origin that could potentially contain or be impacted with contaminants;
- Historical use of asbestos containing materials (ACM) within buildings and structures erected since the 1920s; and
- Historical use of lead based paints on the interior and exterior of historical and current buildings.

Of the potential pollutant linkages identified in the CSM, three linkages were considered to present a high risk to human health and/or the environment that are expected to have implications for remediation/management costs:

- The historical and current commercial/light industrial activities undertaken within the Metro Quarter have likely resulted in contaminants of potential concern (CoPC) being released into the environment. Although it is understood that the redeveloped Metro Quarter is likely to be capped with limited access to soil, future sub-slab intrusive works may be required for service maintenance purposes. As such, there is a potential for workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale CoPC in soil/dust. Additionally, a number of CoPC are considered to be volatile e.g. light-end total recoverable hydrocarbons (TRH) fractions, benzene, toluene, ethylbenzene and xylenes (BTEX) and volatile organic compounds (VOCs). Therefore, future residents, commercial workers or construction/intrusive maintenance workers may be exposed to volatile CoPC via inhalation;
- Since 1930, a number of buildings within the Metro Quarter have been demolished and erected potentially depositing CoPC such as asbestos containing materials

(ACM) and lead onto the soil. Therefore, there is a potential for intrusive maintenance workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale asbestos and lead in soil/dust; and

- Although specific areas could not be identified where fill material may have been used it is likely to be present across given the level nature of the Metro Quarter. Imported fill material of unknown origin can contain a range of CoPC. Therefore, there is a potential for intrusive maintenance workers to come into direct contact (i.e. incidental ingestion and/or dermal contact) with and/or inhale CoPC in soil/dust. Additionally, future residents, commercial workers or construction/intrusive maintenance workers may be exposed to volatile CoPC via inhalation if not managed or remediated appropriately.

Based on the findings of this geotechnical assessment, AECOM presents the following recommendations. It is noted that the additional work scope would be undertaken during the detailed development application stage:

- We recommend an allowance for up to 15 cored boreholes to 20 m depth and five standpipe piezometers in five of these boreholes to allow for groundwater monitoring. If site-specific information such as from the metro rail investigations can be relied upon and is of a suitable scale and distribution then geotechnical investigations may not need to be as extensive; and
- Development of geotechnical models for design and to assess interactions between the Metro Precinct development and the metro station box and running tunnels.
- If Metro Quarter-specific information, such as from the metro rail investigations, can be relied upon and is of a suitable scale and distribution, then geotechnical investigations may not need to be as extensive.

Based on the findings of this Stage 1 PSI, AECOM presents the following contamination recommendations:

- A Stage 2 contamination assessment to characterise the nature and extent of potential soil and groundwater contamination identified within the Metro Quarter to confirm that the Metro Quarter is either suitable in its current condition or can be made suitable following remediation for the proposed land use and zoning in accordance with clause 6(1)(b) of SEPP 55. Findings of any available contamination assessments and/or remediation action plans for the metro station should be considered in the preparation of the assessment for the OSD;
- In accordance with clause 6(1)(c) of SEPP 55, remediation and/or management of impacted areas may be required to mitigate risks associated with the identified impacts during the proposed construction works;
- Development of a Construction and Environment Management Plan (CEMP) to manage risks to construction and maintenance workers from impacted soils and groundwater during the redevelopment of the Metro Quarter; and
- Development of a Materials Management Plan (MMP) to include a strategy for the management of materials so that impacted material can be reused in less sensitive areas or managed within the Metro Quarter to manage erosion, salinity (if encountered) and mitigate off-site disposal of excavated material.

- In the event that potential or actual acid sulfate soil is identified, preparation of an acid sulfate soils management plan (ASSMP) to manage material that may require disturbance and/or movement.

Based on the investigations undertaken, the SEARs outlined in Section 15 have been wholly satisfied, with appropriate future investigations recommended for further development applications relating to detailed design.

7.0 Important information about this Geotechnical and Contamination Report

Client details, scope and reliance

AECOM has prepared this report for the sole use of the Client and for a specific purpose, each as expressly stated in the report. No other party should rely on this report without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this report. This report has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM's findings represent its reasonable judgment within the time and budget context of its commission and utilising the information available to it at the time.

No section or element of this report may be removed, reproduced, electronically stored or transmitted in any form by parties other than those for whom the report has been prepared without the written permission of AECOM. All sections in this report must be viewed in the context of the entire report/document including, without limitation, any assumptions made and disclaimers provided. No section in this report may be excised from the body of the report without AECOM's prior written consent.

Standard of care

AECOM has prepared this report using the standard of reasonable skill, care and diligence required of a consultant performing the same or similar Services. The report should be read in full. No warranty, expressed or implied, is made as to the professional advice included in this report.

Data sources

AECOM may have relied on information provided by the Client and third parties (Information Providers) to produce this report and arrive at its conclusions. AECOM has not verified information provided by the Information Providers (unless specifically agreed as part of AECOM's scope of work) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM assumes no responsibility for inaccuracies in reporting by the Information Providers including, without limitation, by the Client's employees or representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the report.

Variability in conditions and limitations of data

Subsurface conditions are formed through a variety of natural processes and can be altered by human activities. The behaviour of the ground, groundwater and contaminants are complex and conditions can vary across a particular Metro Quarter. As a result, subsurface conditions cannot be exhaustively defined by investigations at discrete locations. Therefore, it is unlikely that the results and assessments expressed in this report will represent conditions at any location removed from the specific points of sampling. The precision with which conditions can be inferred depends largely on the uniformity of subsurface conditions and on the frequency and method of sampling as constrained by factors such as project budget and time limitations and physical constraints.

Furthermore, subsurface conditions can change over time, which should be considered when interpreting or using the data within this report.

Verification of opinions and recommendations

The opinions and recommendations in this report apply to the proposed development and the Metro Quarter existing at the time of our investigation and cannot necessarily apply to changes in the proposed development or Metro Quarter changes of which AECOM is not aware and has not had the opportunity to evaluate. Our recommendations should be considered to be preliminary and subject to verification during project implementation. If conditions encountered within the Metro Quarter are subsequently found to differ significantly from those anticipated, AECOM must be notified and be provided with an opportunity to review the recommendations.

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