Appendix W

Geotechnical Report

Sydney Metro West

Sydney Olympic Park Over and Adjacent Station Development Geotechnical Report

Appendix W

July 2022

Document Number: SMWSTEDS-SMD-OLP-SN400-GE-RPT-044003

REVISION	DATE	SUITABILITY CODE	TEAMBINDER DOCUMENT NUMBER	TB REVISION
E	14/07/2022	S4	SMWSTEDS-SMD-OLP-SN400-GE-RPT-044003	E

Approval Record

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Amendment Record

DATE	REVISION	AMENDMENT DESCRIPTION	AUTHOR
03/12/2021	A	Initial issue (combined Geotechnical and Contamination Report)	Athina Simou / Jason Hellmuth
25/02/2022	B	Second issue (combined Geotechnical and Contamination Report)	Velautham Jeyakanthan/Phil Matevski
25/03/2022	C	Third issue. Standalone Geotechnical Report. See Appendix Z of the EIS for the Contamination Report	Velautham Jeyakanthan
08/04/2022	D	Final issue	Velautham Jeyakanthan
14/07/2022	E	Final issue with minor amendments	Velautham Jeyakanthan

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Contents

List of Tables

List of Figures

Glossary

Term	Definition
AHD	Australian Height Datum
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality guidelines
ASD	Adjacent Station Development
ASS	Acid sulfate soils
CBD	Central business district
CEMP	Construction Environmental Management Plan
Concept and Stage 1 CSSI Application	Application SSI-10038, including all major civil construction works between Westmead and The Bays, including station excavation and tunnelling, associated with the Sydney Metro West line
Concept SSDA	A concept development application defined in section 4.22 of the EP&A Act, as a development application that sets out concept proposals for the development of a site, and for which detailed proposals for the site or for separate parts of the site are to be the subject of a subsequent development application or applications
Council	City of Parramatta
CSSI	Critical Stage Significant Infrastructure
DPE	Department of Planning and Environment
EIS	Environmental impact statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	Environment Protection Authority
GFA	Gross floor area
GFRP	Glass-fibre reinforced plastic
OSD	Over Station Development
POEO Act	*Protection of the Environment Operations Act 1997*
RL	Reduced level
SEARs	Secretary's Environmental Assessment Requirements
SSDA	State Significant Development Application
SSI	State Significant Infrastructure
Stage 2 CSSI Application	Application SSI-19238057, including major civil construction works between The Bays and Hunter Street station
Stage 3 CSSI Application	Application SSI-22765520, including rail infrastructure, stations, precincts and operation of the Sydney Metro West line
Sydney Metro West	Construction and operation of a metro rail line and associated stations between Westmead and the Sydney CBD as described in section 1.1
TfNSW	Transport for New South Wales
The site	The site which is the subject of the Concept SSDA

Executive summary

This Geotechnical Report supports a Concept State Significant Development Application (Concept SSDA) 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 SSDA is made under section 4.22 of the EP&A Act.

Sydney Metro is seeking to secure concept approval for an over station development (OSD) and adjacent station development (ASD) on an area defined as Site 47 within the Central Precinct of Sydney Olympic Park (referred collectively as the 'proposed development'). The proposed development will comprise of one new commercial and retail building (Building 1) above the Sydney Olympic Park metro station and two residential accommodation buildings (Buildings 2 and 3) with retail and commercial space, adjacent to the Sydney Olympic Park metro station.

The Concept SSDA seeks consent for a building envelope and mixed-use purposes, maximum building height, a 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.

The Geotechnical Report presents a geotechnical assessment including anticipated subsurface ground condition and geotechnical risk associated with the Concept SSDA. Key geotechnical findings of this report are:

- the area is underlain by fill material of variable type and consistency up to 3m overlying 1 to 3 m thick residual soil of medium to high plasticity silty clay with a trace of fine to medium grained, sub-angular ironstone gravel
- the underlying bedrock below fill and residual soil is Ashfield shale of varying weathering and strength profile
- depth to the top of bedrock within the study area ranges from 2 to 6 m.

Based on the findings of this geotechnical assessment, the following recommendations are made:

- Geotechnical information available within Building 1 footprint is considered reasonable. However, the geotechnical data available within Buildings 2 and 3 footprints is limited. The geotechnical assessment presented in this report is based on available geotechnical data in the vicinity of the proposed development. This geotechnical data is considered adequate for the assessment at concept stage. Based on the assessment using available geotechnical data and experience on similar ground conditions, the proposed development in the context of the existing geotechnical conditions on the site is considered suitable for its intended use.
- While the site contains a number of geotechnical challenges including the presence of high groundwater table, acid sulphate soils and working in brownfield environment, it is considered that these challenges can be adequately addressed through the utilisation of industry standard design and construction techniques and practices.
- The ground conditions assumed in design can vary from actual site conditions that may be encountered during construction. To reduce the impact of such potential variations, further geotechnical investigation will need to be carried out prior to or as part of detailed design.
- Application of appropriate design standards and industry best practice, as well as mitigation measures throughout the life of the construction and operation of this

proposal, would minimise impacts to the receiving waterbodies around this proposed development.

- Measures to manage erosion would be included in the Construction Environmental Management Plan.

1 Introduction

1.1 Sydney Metro West

Sydney Metro West will double rail capacity between Greater Parramatta and the Sydney Central Business District (CBD), transforming Sydney for generations to come. The once in a century infrastructure investment will have a target travel time of about 20 minutes between Parramatta and the Sydney CBD, link new communities to rail services and support employment growth and housing supply.

Metro stations have been confirmed at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays, Pyrmont and Hunter Street (Sydney CBD).

Sydney Metro West station locations are shown in Figure 1-1.

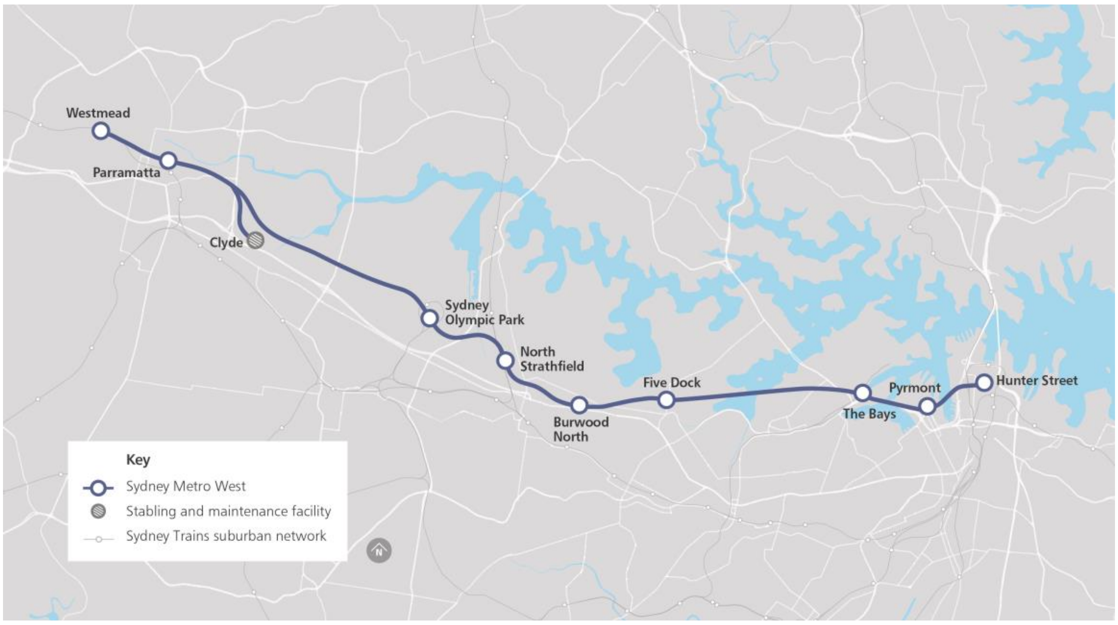

Figure 1-1 Sydney Metro West

1.2 Background and planning context

Sydney Metro is seeking to deliver Sydney Olympic Park metro station under a two-part planning approval process. The station fit out infrastructure is to be delivered under a Critical State Significant Infrastructure (CSSI) application subject to provisions under division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), while the over and adjacent station developments are to be delivered under a State Significant Development (SSD) subject to the provisions of part 4 of the EP&A Act.

1.2.1 Critical State Significant Infrastructure

The State Significant Infrastructure (SSI) planning approval process for the Sydney Metro West metro line, including delivery of station infrastructure, has been broken down into a number of planning application stages, comprising the following:

- Concept and Stage 1 CSSI Approval (SSI-10038) – All major civil construction works between Westmead and The Bays including station excavation, tunnelling and demolition of existing buildings (approved 11 March 2021).

- Stage 2 CSSI Application (SSI-19238057) – All major civil construction works between The Bays and Hunter Street Station (under assessment).
- Stage 3 CSSI Application (SSI-22765520) – Tunnel fit-out, construction of stations, ancillary facilities and station precincts between Westmead and Hunter Street Station, and operation and maintenance of the Sydney Metro West line (under assessment).

1.2.2 State Significant Development Application

The SSD will be undertaken as a staged development with the subject Concept State Significant Development Application (Concept SSDA) being consistent with the meaning under section 4.22 of the EP&A Act and seeking conceptual approval for a building envelope, land uses, maximum building heights, a maximum gross floor area, pedestrian and vehicle access, vertical circulation arrangements and associated car parking. A subsequent Detailed SSD/s is to be prepared by a future development partner which will seek consent for detailed design and construction of the development.

1.3 Purpose of the report

This geotechnical assessment supports a Concept SSDA submitted to the Department of Planning and Environment (DPE) pursuant to part 4 of the EP&A Act. The Concept SSDA is made under section 4.22 of the EP&A Act.

This report has been prepared to specifically respond to the Secretary's Environmental Assessment Requirements (SEARs) issued for the Concept SSDA on 18 February 2022 which states that the environmental impact statement (EIS) is to address the following requirements:

SEARs requirement	Where addressed in report
12. Ground and Water Conditions Provide an assessment of potential impacts on soil resources, including related infrastructure and riparian lands on and near the site. Provide an assessment of the potential impacts on surface and groundwater resources (quality and quantity), including related infrastructure, hydrology, aquatic and groundwater dependent ecosystems, drainage lines, downstream assets and watercourses. Where applicable, provide an assessment of salinity and acid sulfate soil (ASS) impacts.	Section 3 addresses the ground and groundwater conditions and potential impact related to the proposed development and geotechnical risks. A high-level discussion on erosion potential is presented in section 3.3.2. ASS risk is briefly discussed in this report in section 3.2.2. Further assessment and discussion on ASS and land use are provided in the Contamination Report (Appendix Z of the EIS) Erosion, salinity and ASS, if encountered, would be managed in accordance with site specific management plans.

Section 3 of this report presents the assessment of the ground conditions and groundwater at the location of the proposed development and provides comment on geotechnical risks and constraints to consider during the planning stage. The interpretations and assessments made are based on project specific geotechnical site investigation data (available at the time of writing) and historical site information data from projects carried out in proximity to the proposed development site. In preparation of this report, the following specific geotechnical objectives were considered:

- review of existing geotechnical data points and results

- analysis of geotechnical risks
- recommendations to assist in assessing the suitability of the proposed land use described in this report.

2 The site and proposal

2.1 Site location and description

The site is located within Sydney Olympic Park and is situated within the City of Parramatta Local Government Area. The site is in the Central Precinct of Sydney Olympic Park and defined as Site 47 in the Proposed Master Plan 2030 (Interim Metro Review). The broader metro site is bound by Herb Elliot Avenue to the north, Olympic Boulevard to the west and Figtree Drive to the south as shown in Figure 2-1.

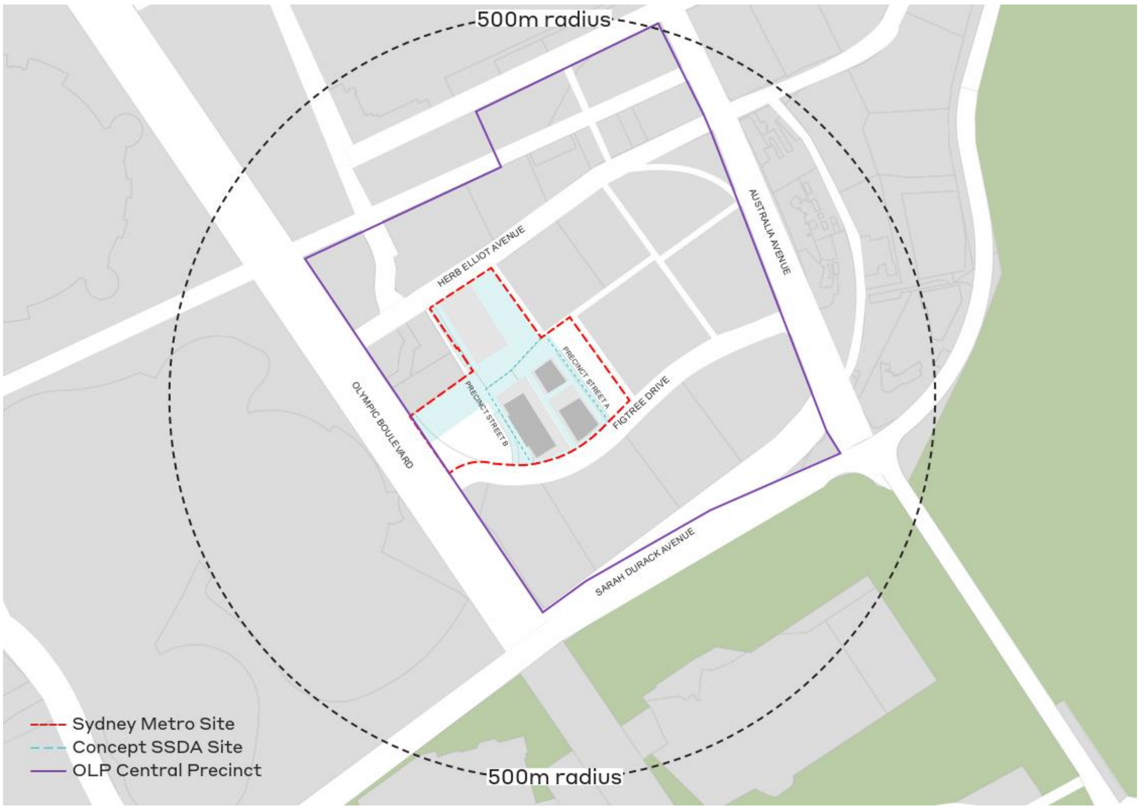

Figure 2-1 Sydney Olympic Park metro station location precinct

As described in Table 2-1, the site comprises part of Lot 59 in DP 786296 and Lot 58 in DP 786296, and comprises approximately 11,407m^2 of land.

Table 2-1 Site legal description

Street address	Legal description
5 Figtree Drive, Sydney Olympic Park	Lot 58 in DP 786296
7 Figtree Drive, Sydney Olympic Park	Lot 59 in DP 786296

2.2 Overview of this proposal

The Concept SSDA will seek consent for three building envelopes and the delivery of Precinct Street A as detailed in Table 2-2 and Figure 2-2.

Table 2-2 Sydney Olympic Park proposed development overview

Item	Description
Land use	**Building 1:** Commercial and retail **Building 2:** Commercial, retail and residential **Building 3:** Commercial, retail and residential
Building height (RL) / Number of storeys	**Building 1:** 120.20 / 21 storeys **Building 2**: 116.90 / 27 storeys **Building 3:** 171.50 / 45 storeys
Gross Floor Area (m^2)	**Building 1:** 28,517 **Building 2:** 12,089 **Building 3:** 27,384 **TOTAL: 68,000**
Car parking spaces	358

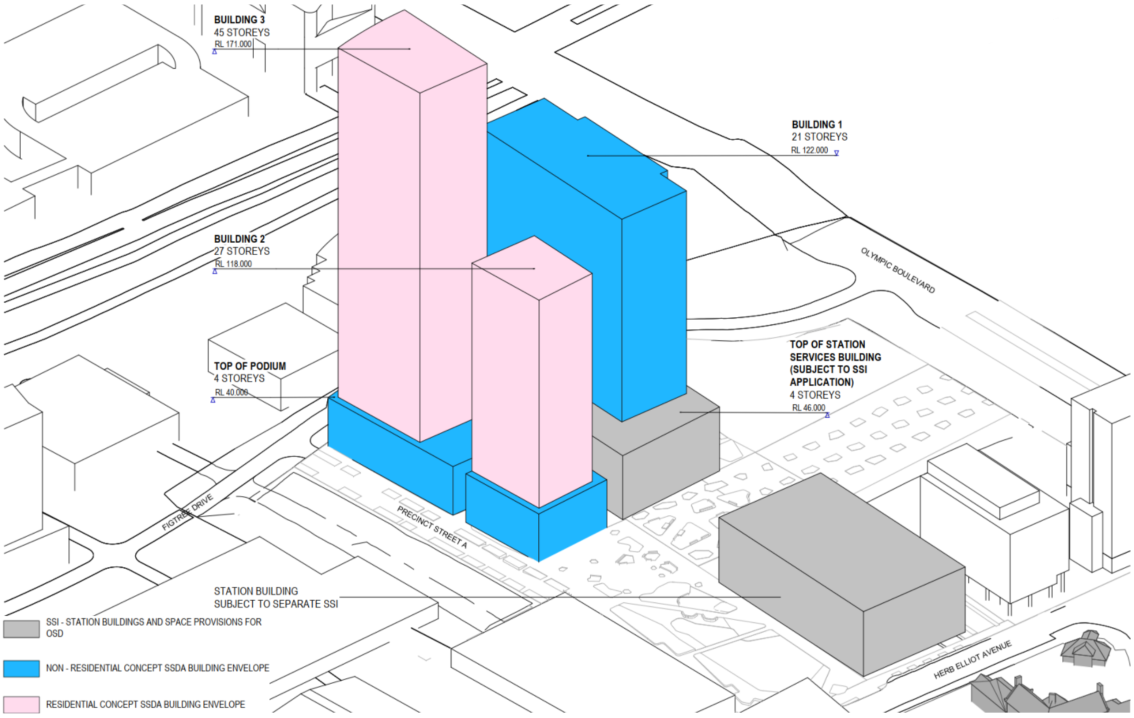

Figure 2-2 Proposed Concept SSDA development and CSSI scope

3 Assessment

3.1 Topography and basements

The site is located to the south of the existing Sydney Olympic Park Station, on the block bounded by Dawn Fraser Avenue, Figtree Drive, Australia Avenue and Olympic Boulevard. Building 1 will be located above Sydney Olympic Park metro station which will be a fully underground station. The metro station platforms are approximately 30m below at -4m AHD. Buildings 2 and 3 will be located north-east of the metro station and includes basement car parks. The lower level of the basements is approximately at -8m AHD. The existing surface levels at the site are approximately 20 to 24m AHD. The site is approximately 650m southwest of Bicentennial Park and approximately 2.5km south of the Parramatta River. The Sydney Olympic Park precinct topography is shown in Figure 3-1.

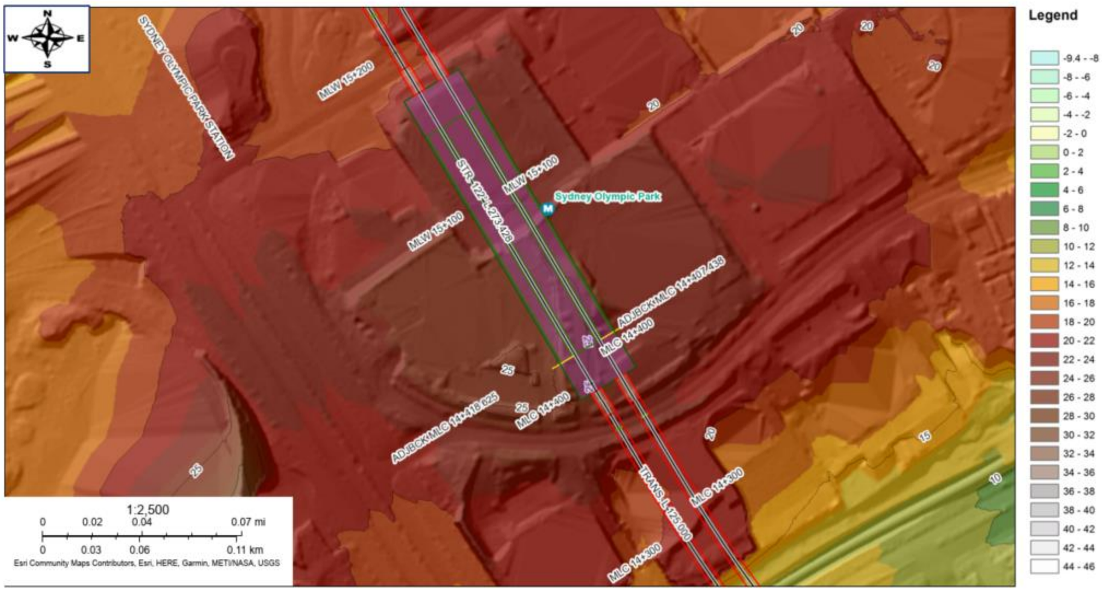

Figure 3-1 Sydney Olympic Park precinct topography

3.2 Ground conditions

3.2.1 Regional geology

Based on available limited geotechnical information, the development site of Sydney Olympic Park has a relatively thin cover of anthropogenic ground (filling) which overlies residual soils of the siltstones of the Ashfield Shale.

The underlying bedrock is Ashfield Shale underlain by Mittagong Formation and Hawksbury Sandstone. However, the building basements and station box at the development site will be constructed fully within Ashfield Shale. The Ashfield Shale is described as black to dark grey shale and laminite.

Several fault zones are also interpreted to cross the proposed station box. Therefore, the Ashfield Shale at these locations might decrease in quality and can have a significant reduction in rock mass strength.

3.2.2 Acid sulfate soils

The DPE hosts online ASS risk maps that are available to view via eSPADE (a Google Maps™ based information system). These maps predict the distribution of

ASS. They are based on landform assessment, extensive fieldwork and laboratory testing. These maps show the chance of ASS occurring.

Sydney Olympic Park metro station is to be constructed within an area of a thin fill material and residual soils. A review of the ASS risk mapping indicates that the development site has a low chance to be affected by ASS.

Additional discussion on ASS is presented in Contamination Report (Appendix Z of the EIS).

3.2.3 Preliminary geotechnical model

A summary of anticipated subsurface profile within the proposed development site is presented in Table 3-1. The shale classes presented in Table 3-1 are based on the Classification of Sandstones and Shales in the Sydney Region: A Forty Year Review (Pells, et al 2019)

Ashfield Shale of Class III or better (according to Pells et al 2019) within the footprint of the proposed development ranges from approximately 19m AHD in the east to 15m AHD in the west.

Table 3-1 Indicative ground profile

Geotechnical unit	Description	Depth to top of Unit (m)	Unit thickness (m)
Fill	Existing, with variable material type and consistency	Ground Surface	Up to 3m
Residual soil	Medium to high plasticity silty clay, trace fine to medium grained, sub-angular ironstone gravel.	0.5 to 3m	1 to 3m
Ashfield Shale Class V and IV	Shale, usually extremely to very weathered, very low to low rock strength	2 to 6m	2 to 5m
Ashfield Shale Class III or better	Shale typically moderately to slightly weathered. Low to high rock strength.	5 to 9m	> 25m

The unit depths, thicknesses and material properties presented in Table 3-1 should not be assumed to represent the maximum or minimum values within the proposed development site. Actual unit boundaries and material properties can be highly variable, particularly for fill. Figure 3-2 to Figure 3-4, below present inferred surfaces of the tops of the predominant units, namely residual soils, Ashfield Shale and Hawkesbury Sandstone. The surfaces representing the unit boundaries are based on interpolation, often between widely and variably spaced boreholes. Actual unit boundaries within the proposed development 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.

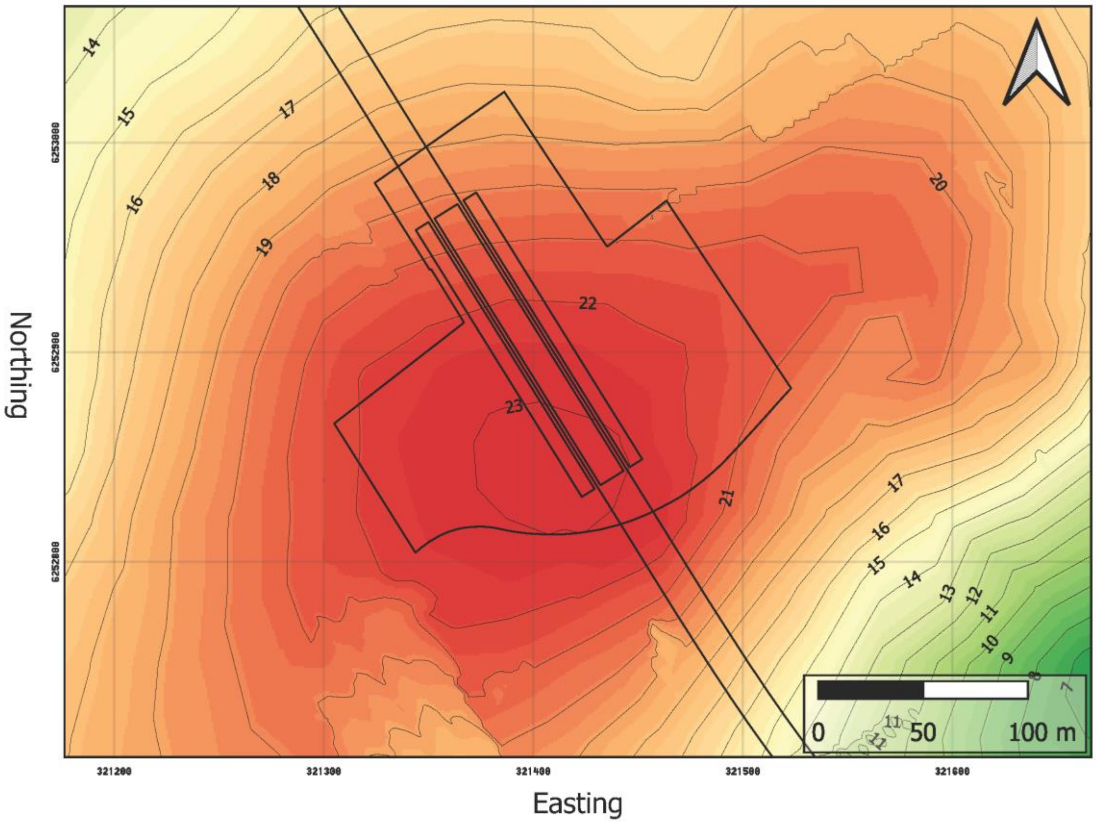

Figure 3-2 Inferred contours of elevation of top of residual soils

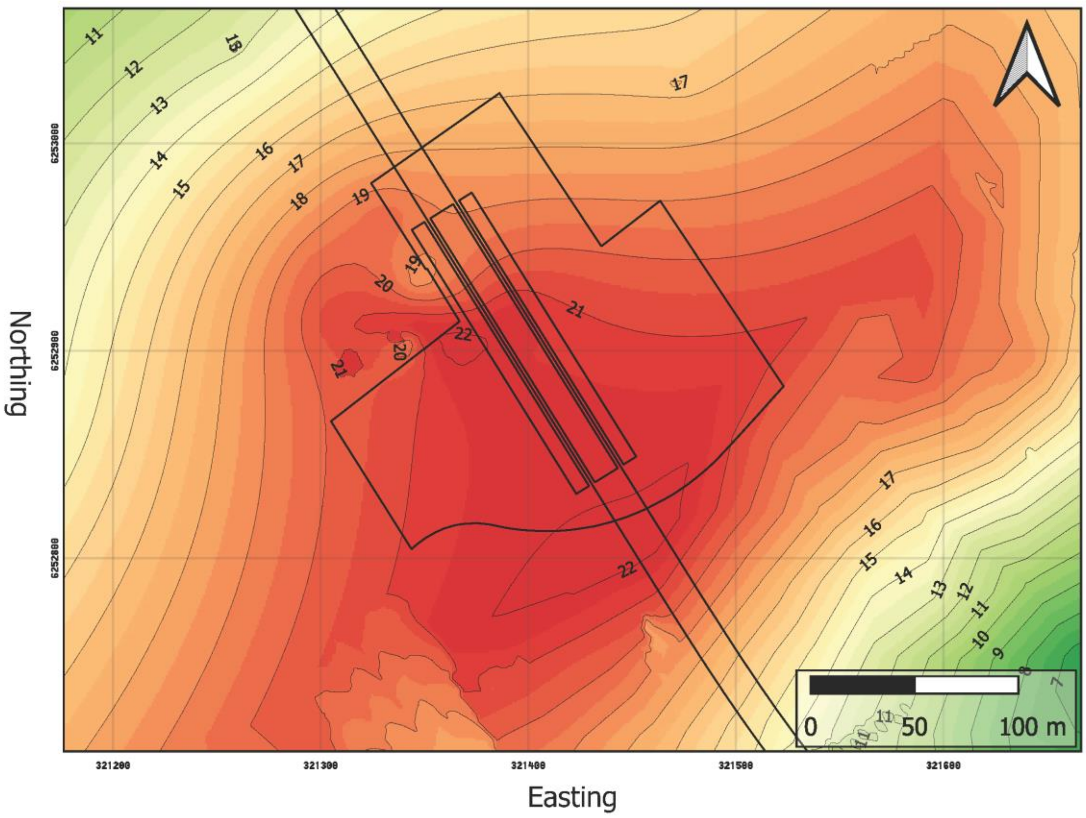

Figure 3-3 Inferred contours of elevation of top of shale grade V and IV.

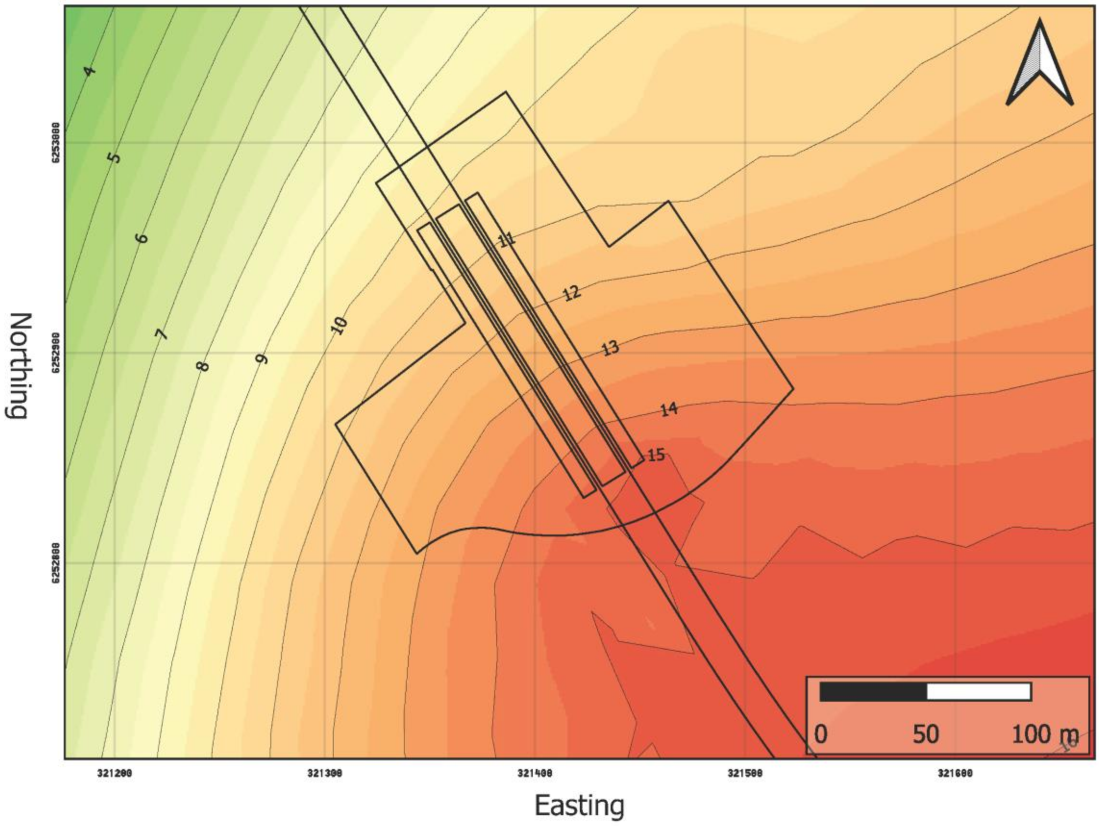

Figure 3-4 Inferred contours of elevation of top of Hawkesbury Sandstone

3.2.4 Groundwater

The existing Sydney Trains Olympic Park Station is connected to an underground rail loop which encircles the proposed station development. The loop is a drained structure which is closer to the surface on the eastern side and slopes downwards towards the west. Consequently, groundwater levels around site tend to dip from east to west. The rail loop causes some dewatering of overlying sediments. Based on the groundwater monitoring data, the groundwater levels in piezometers screened at shallow depth indicates that the wells are mostly dry. Perched water levels are occasionally observed within overburden soil for a short duration, associated with rainfall events. Groundwater level within shale bedrock on the upper eastern side of the rail loop are typically around 12m AHD with maximum groundwater levels at 14m AHD for a short duration. Therefore, design groundwater level at 12m AHD is considered reasonable for concept stage. A lower groundwater level of 0.0m AHD occurs within deeper shale bedrock on the deeper western side of the rail loop.

Further review of groundwater information and assessment of groundwater level and interaction of dewatering by the existing rail loop and the proposed station would be required as part of Detailed SSDAs.

The design of the proposed development should also consider the following key geotechnical features that could affect groundwater levels and inflows.

- poor ground conditions and greater groundwater inflows could occur where geological structures such as faults are encountered
- drainage and paleo-channels can be associated with increased geological structures, deep soils and changes in hydraulic behaviour.

The basement structure for Building 1, will be designed as a ‘drained’ structure and has been assessed under the Concept and Stage CSSI Approval. The metro station box is expected to act as a groundwater sink, causing surrounding groundwater in the Ashfield Shale to flow towards the area of excavation.

Basements of the proposed development (Building 2 and Building 3) will also be expected to act as a groundwater sink if designed as 'drained' basements.

Packer tests conducted at Sydney Olympic Park indicate a generally low lugeon value with the exception of two tests which indicated a moderate lugeon value. The moderate lugeon values are likely due to the tight rock joints with small openings. Therefore, hydraulic conductivity is in general expected to be low.

3.3 Surface water

3.3.1 Sensitive receiving environments

Waterways and water bodies have been identified as receiving environments of high sensitivity predominantly due to:

- key fish habitat classification which include Type 1 (highly sensitive key fish habitat), Type 2 (moderately sensitive key fish habitat) and Class 1 (major key fish habitat)
- proximity to coastal wetlands as defined by the State Environmental Planning Policy (Resilience and Hazards) 2021.

These watercourses have a high conservation or community value, supporting ecosystems or human uses of water, and are particularly sensitive to pollution or degradation of water quality.

Table 3-2 identifies sensitive surface water receiving environments specific to the proposed development and describes their condition and sensitivity (Sydney Metro, 2020a).

Table 3-2 Existing environmental values, water quality and surface water features of receiving waterways for the Concept SSDA

Watercourse and/or receiving waters	Environmental values	Water quality characteristics	Surface water features	Condition	Sensitive receiving environment rating
Saleyards Creek	• Visual amenity • Secondary contact recreation	• Low dissolved oxygen levels • Elevated nutrient concentrations • Elevated heavy metal concentrations high turbidity	• Type 1 key fish habitat • State Environment Planning Policy (SEPP) coastal wetlands within 0.5 kilometres • First-order waterway • Concrete-lined channel	Highly disturbed	Moderate
Powells Creek/Mason Park Wetland	• Aquatic ecosystems • Visual amenity	• Low dissolved oxygen levels • Elevated nutrient concentrations • Elevated heavy metal concentrations • High turbidity	• Highly modified channel with limited aquatic habitat • SEPP coastal wetlands within 0.5 kilometres • First-order waterway permanently flowing estuarine with tidal limit 0.1 kilometres upstream of Allen Street Bridge, Homebush	Moderately disturbed	Moderate
Haslams Creek	• Aquatic ecosystems • Visual amenity • Secondary contact recreation	• Elevated nutrient concentrations • Elevated concentrations of faecal coliforms	• Type 1 key fish habitat • SEPP coastal wetlands within 0.5km • Third-order waterway	Moderately disturbed	High
Bicentennial Park Wetlands	N/A	N/A	• Rehabilitated wetland/nature reserve • SEPP coastal wetlands within 0.5 kilometres	Moderately disturbed	High

3.3.2 Erosion and sedimentation

This proposed development would require minor earthwork activities which could expose the ground/soils at Building 1 construction site as the bulk work activities for the basement would be undertaken as part of permanent station under Stage 1 CSSI Application. This work is covered under Stage 1 CSSI.

The construction site for Building 2 and 3 basements would require activities that may pose a high risk of impact to water quality. These include basement excavations and other earthworks associated with Precinct Street A such as landscaping, road alignment and drainage infrastructure.

The earthwork activities may lead to export of sediment and the potential for increased erosion within and around waterways and slopes in these areas. These risks would be ongoing throughout the construction phase and would be highest at locations with a slope greater than 2.5%, in areas that are near waterways and frequently disturbed, and during high rainfall and wind activities. By increasing the amount of disturbed and exposed soil, surface water quality may be impacted through:

- Changes to surface water run-off due to clearing vegetation coverage. This may increase run-off volumes at both the temporary and long-term term scale.
- Increased surface water run-off due to any potential soil stabilisation earthworks. Soil stabilisation may result in change to the permeability of the natural soils.
- Increased turbidity; lowered dissolved oxygen levels and increased nutrients in waterways.
- Reduction in channel habitat from sediment transport and deposition.

Erosion and sediment control would focus on areas of surface disturbance, particularly near waterways. These impacts would be adequately managed through the implementation of standard mitigation measures including progressive erosion and sediment controls, and on-site management protocols within the Construction Environmental Management Framework. These controls would be used to manage and minimise risks of impacts to water quality.

3.4 Discussion and recommendations

3.4.1 Groundwater drawdown and environmental risk

The floor of the drained station development will be deeper than that of the basements for the OSD development. Dewatering by the station box would underdrain the basements of the OSD development close to the station box. Impacts of groundwater dewatering should therefore be attributed largely to drainage into the station and the nearby rail loop west of the station. The predicted groundwater drawdown due to the station development is presented in Figure 3-5.

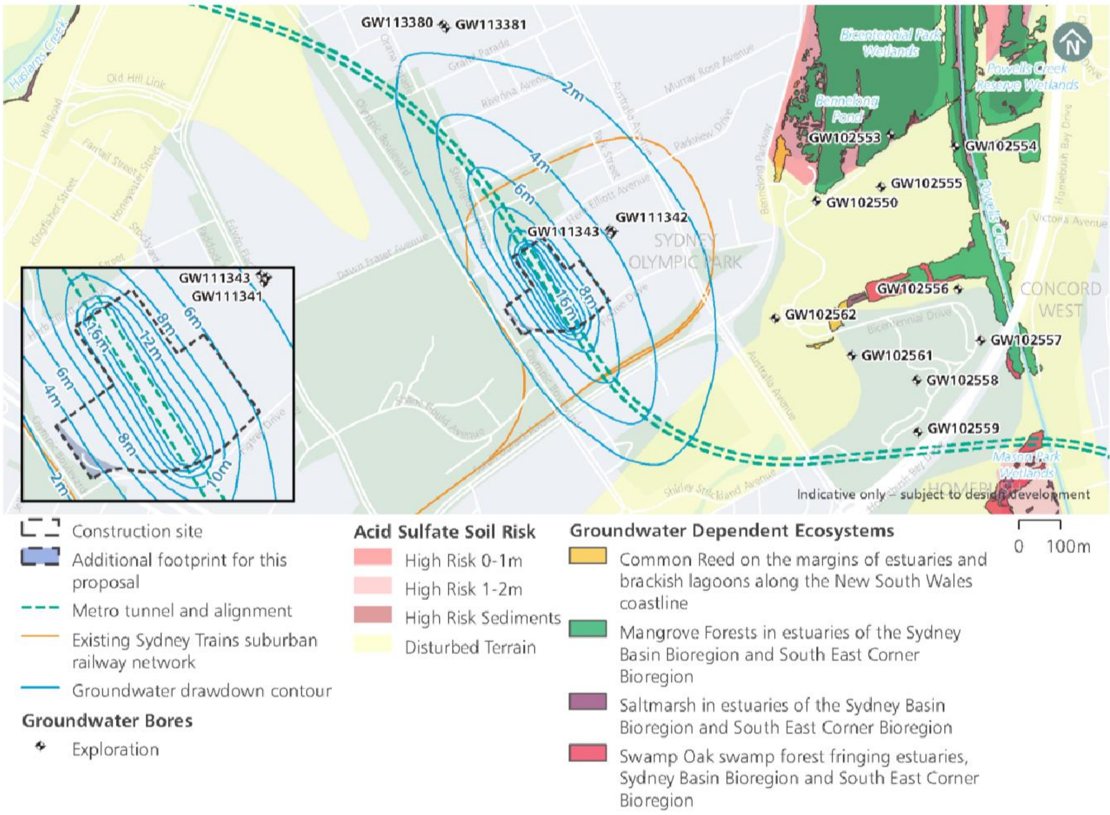

Figure 3-5 Baseline groundwater conditions showing drawdown due to inflow to the drained station box (Drawdown caused by the rail loop is not shown)

It can be seen from Figure 3-5 that two registered exploration boreholes, GW111343 and GW111342 would be impacted upon by the piezometric surface being lowered by almost 4m in their vicinity.

The drawdown does not extend far enough to impact on any nearby natural drainage features, namely Haslams Creek, Powells Creek, Saleyards Creek and the Bicentennial Park Wetland. Similarly, it does not reach any of the groundwater dependent ecosystems which exist near these drainage features.

Because the excavated basements of the OSD's and the station box will act as groundwater sinks towards which subsurface water will flow, they should not be considered to be sources of water pollution.

Six former landfill sites exist in the area surrounding the station site. There is a risk that groundwater inflow to the station box and, to a smaller extent the basements of the OSD developments, would gradually induce contaminated water to migrate towards the station site which will act as a groundwater sink. Any water that seeps into the excavated areas, or polluted water that is accidently spilt in these areas would, in the long term be captured and transported, as part of the Sydney Metro line wide groundwater transfer system, to a water treatment facility at Clyde. During construction the water that enters the system would be captured and treated as explained in section 3.4.7. Large quantities of contaminants are not expected as remedial measures are in place at the contaminated sites to mitigate groundwater pollution. The water quality will, however, be monitored and, if necessary, further remedial measures would be implemented to limit the migration of contaminants towards the station.

3.4.2 Cumulative development risks

The extent of groundwater drawdown, due to the station developments is not large as shown in Figure 3-5. The drawdown would most likely underdrain the parts of basements below the proposed OSD developments and no significant compounding groundwater drawdown effects are expected.

Proposed nearby developments within the area of reduced groundwater levels are at:

- Site 2A and 2B Australia Avenue
- Site 43/44 Herb Elliot Avenue.

Basements located below new properties with the zone of reduced water levels around the station site may cause a localised depression within the zone of groundwater drawdown surrounding the station site. It is recommended that the combined groundwater drawdown effects of the developments be assessed as part of the OSD design.

3.4.3 Geotechnical risks

Based on the ground profile as described in section 3.2 above, commercial and residential developments with basements for Buildings 2 and 3 should be practicable within the proposed scheme. However, some geotechnical challenges exist that include:

- High groundwater table and the potential for rapid increase in groundwater level to the ground surface during heavy/intense rain events or flooding.
- Interaction with existing structures such as the metro station box and running tunnels (such as the Metro West tunnels and the Sydney Trains tunnels). Restrictions associated with existing and proposed structures may result in increased site retention and foundation costs and impact on the construction program.
- The risk associated with underground services along the site boundaries in the brown-field environment. The retention system design will have to consider the risk of excavation induced ground movements on existing services and structures. A relatively stiff retention system may be required to limit ground displacement beyond the site boundaries, along with construction monitoring to reduce the risk.

The soils within the proposed development construction site are predominantly residual clays and 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 conditions. 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.

In the following sections 3.4.4 to 3.4.6, preliminary comments and recommendations are provided on geotechnical issues associated with basement excavation design and foundation design for the buildings and other structural elements.

3.4.4 Excavation retentions systems

Existing infrastructures will need to be considered as part of the design process for the proposed development within the precinct. Importantly, the groundwater flow and groundwater levels are likely to be impacted by the excavation of the basement structures and any deep foundations that are associated with the proposed development. Currently, groundwater level at the site appears to vary greatly between 0m AHD and 14m AHD with some perched groundwater at shallow depth, based on the monitoring data available to date. Within the rock mass, lugeon values (representative of permeability) were generally seen to be low. As the Sydney Olympic Park metro station box is being designed as a drained solution, and if a drained basement solution is adopted for Buildings 2 and 3 as well, no significant impact on metro station box is anticipated. If the basements of proposed development are to be designed as tanked solution, hydrostatic pressure resulting from the groundwater on the basement slabs and walls of the basements need to be considered.

Medium to high strength Ashfield Shale is relatively close to surface (approximately 6 metres below ground level at the deepest); therefore, it may be possible to adopt an unsupported excavation with appropriately battered slopes within soil and the weaker rock profile, provided that space for a stable and safe batter slopes are available. Excavation within the medium to high strength rock mass can be carried out with a sub-vertical batter slope but may require spot bolts where unstable rock wedges are identified.

Alternatively, excavation support may be adopted where spatial constraints limit the ability to adopt appropriate batter angles for the material quality. These may also be necessary where limited ground movement associated with excavation is required. Excavation support may include soldier pile walls, with or without temporary ground anchors, or driven sheet pile walls with temporary ground anchors to the top of Ashfield Shale Class III. The feasibility of driven sheet pile walls within the rock mass would need to be assessed prior to adoption as a support treatment.

Depending on factors such as construction sequence, soil/rock strength and stiffness and structural stiffness, even well-constructed anchored retaining walls can deflect laterally in the order of 0.1% to 1% of the wall height. Typically, the ground movements are greatest at the excavation face and decrease to negligible values at a distance of up to 2 times the excavation depth. It should also be noted that the stress relaxation within the rock during the excavation will also contribute to additional ground movement. Detailed soil-structure interaction analysis should be carried out to assess the lateral and vertical ground movements that could result from basement excavation.

3.4.5 Temporary ground anchors

Temporary ground anchors may be required for the excavation retention system for the extended section of the proposed development beyond station box. The feasibility of installing temporary ground anchors should consider buried structures including the nearby metro station box, running tunnels, and other underground spaces, as well as near-surface utilities. All these elements may have associated exclusion zones as well. Imposition of additional stresses may affect the buried infrastructure.

Once the permanent design solution is fully constructed, the temporary ground anchors may be de-tensioned (destressed) and are no longer considered integral to the overall stability of the excavation. However, it is also possible that these ground anchors will be incorporated into the permanent design solution (such as is often the case with caverns and tunnels. Given this, it is vital that the structural and geotechnical design of the proposed development is coordinated with the permanent design of the Sydney Olympic Park metro station box, such that:

- the requirements to retain existing ground anchors around the metro station box is understood by the proposed development designer
- the impact of any potential load on the rock or soil mass surrounding the ground anchors, and the impact on the embedment length of a grouted anchor, or deflection of the anchor, as incurred by the construction of Buildings 2 and 3 is understood by the designer

- the location and nature of the existing ground anchors, and the presence of spatial reserves around mined or bored tunnels, are understood by the designer.

Note that this section considers ground anchors to include rock bolts (mechanical or grouted) and soil nails.

Destressed temporary ground anchors as part of the metro station box construction may interfere with the excavation retention system for the proposed development and compromise performance of the retaining walls if designed as groundwater cut-off walls. A coordinated approach with the metro station box temporary works contractor may help to reduce this construction related risk. The spacing and angle of the temporary ground anchors for the station box may be modified so that they do not to pass through Buildings 2 and 3 basement wall locations where possible. Alternatively, glass-fibre reinforced plastic (GFRP) anchors can be used at locations where these anchors are likely to interfere with basement walls. GFRP can be cut through relatively easily during the construction of the retention system.

3.4.6 Foundations

Foundations for the proposed development will be required for design elements such as buildings, signposts etc. Given the geological conditions prevalent at the precinct, proposed development structures are typically expected to be supported by either deep (piled) or shallow (slab or strip) foundations, these are both discussed in the sub-sections below.

Deep foundations

Bored piles support axial loads by end bearing, shaft friction or a combination of both. Typically, bored piles are adopted due to their suitability to minimise vibration created during construction, ability to penetrate moderately hard bedrock materials to achieve higher geotechnical capacities.

Due to groundwater, tension piles (or anchors) may be required below the base of the tanked basements (if adopted) to resist uplift forces.

Piled foundation design should be carried out in accordance with the Australian Standard AS 2159 – Piling Design and Installation. The appropriate geotechnical reduction factors should be determined in accordance with this standard.

Allowances should be made for the use of temporary or permanent casing depending on the strata where piles will be drilled through.

All pile foundations should be inspected by an experienced geotechnical engineer or engineering geologist to assess the ground conditions in relation to those assumed in the design prior to the pouring of concrete.

Shallow foundations

Shallow foundations typically take the form of strip or pad foundations and represent the simplest form of load transfer from a structure to the ground beneath. They are typically constructed with generally small excavations into the ground, do not require specialised construction equipment or tools, and are relatively inexpensive.

Foundation design should be carried out in accordance with the Australian Standard AS 5100.3 Bridge Design part 3: Foundations and Soil Supporting Structures. The appropriate geotechnical reduction factors should be determined in accordance with this standard.

Shallow foundations should be designed to allow for both axial and lateral (if applicable) loadings and assessed to see whether they meet the required settlement and differential settlement allowances.

Shallow footings, if proposed, should not be placed on existing fill, they should either be taken down to natural soils or rock with the required consistency strength to meet the design requirements, or place on engineered fill placed and compacted to the appropriate standard.

All shallow foundations should be inspected by an experienced geotechnical engineer or engineering geologist to assess the ground conditions in relation to those assumed in the design prior to the pouring of concrete.

3.4.7 Groundwater interactions and quality

Investigations completed under the prior CSSI application, identified the potential for groundwater to be contaminated with nutrients, metals, hydrocarbons, volatile organic compounds, perfluorooctanesulfonic acid, asbestos and land fill gas.

As part of the Concept SSDA, the basements to Buildings 2 and 3 will be excavated. It is expected that these excavation works will cause groundwater inflow. During excavation groundwater dewatering would occur, and groundwater would be extracted, tested, and treated as required, prior to being dispersed. There are no groundwater dependant ecosystems within the area surrounding the Concept SSDA study area that would be affected by groundwater drawdown (Figure 3-5 presented earlier)

3.4.8 Surface water interactions and quality

Four watercourses have been identified within 1.5km of the site, including:

- Haslams Creek – Located 1km to the west of the site, this creek is a highly modified third order watercourse, which drains into the Parramatta River at Homebush Bay. Construction water treatment plant discharge will drain into Haslams Creek from the Concept SSDA site via the stormwater drainage system. Haslams Creek is a highly urbanised catchment with the upper extents being concrete lined opened channels and pipes. Haslams Creek is mapped as a key fish habitat and is classified as Type 1 (key fish habitat). It is also classified as Class 1 (major key fish habitat) as it is a permanently flowing river.
- Powells Creek – Located 1km to the east of the site, this creek is a concrete lined first order drainage channel, which becomes semi-neutralised downstream. The construction water treatment plant discharges would discharge to Powells Creek via the local stormwater network from the North Strathfield metro station. The Powells Creek catchment includes residential and recreational land uses including Bicentennial Park and Sydney Olympic Park. Powells Creek is mapped as a key fish habitat and is classified as Type 1 (key fish habitat). It is also classified as Class 1 (major key fish habitat) as it is a permanently flowing river.
- Salesyard Creek – Located about 350m from Sydney Olympic Park metro station, this creek is a highly modified first order watercourse which is a concrete lined channel and contains minimal instream habitat. It is mapped as a key fish habitat, however given the creek is a first order stream and a concrete lined channel which contains little instream habitat, it is not considered a key fish habitat and is classified as Class 3 (minimal key fish habitat).
- Bicentennial Park Wetlands, and Newington Wetlands – Located approximately 700m and 1.5km from the site respectively. These two wetlands are the only nationally important wetlands within close proximity to the site. However, these wetlands are unlikely to be impacted.

A review of available data indicated the watercourses mentioned above are generally in poor condition and are representative of a highly urbanised system (Sydney Metro, 2020a). These watercourses were assessed against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality guidelines 2018 (ANZG) as part of the prior CSSI application works.

Prior to being discharged, all water will be treated by a water treatment plant configured to ensure that all treated water will be compliant with the ANZG guideline values. The water treatment plant will be present at the commencement of the construction of this proposal. Given this, the impacts to surface water are expected to be very low.

3.4.9 Riparian land

No impacts on riparian lands are expected during the construction and operation of the Sydney Olympic Park metro station.

3.4.10 Erosion and sedimentation

During construction of this proposed development, there remains the potential for erosion in recently disturbed areas. This risk would be higher during initial periods of bulk excavation particularly where spoil removal is required for the basements at Buildings 2 and 3. This creates the greatest risk of sediment loads entering waterways through the stormwater system. Erosion protection and/or soil stabilisation work may be required at the proposed development following construction activities and severe storms, to prevent further erosion, topsoil and soil loss mitigation. Measures to manage erosion would be included in the CEMP.

3.4.11 Impacts on NSW Water Quality Objectives

During the operation phase of this proposal, the Water Quality and River Flow Objectives (NSW Department of Environment, Climate Change and Water, 2006) and the ANZG (2018) trigger values would be used as a guideline so discharged water either maintains or improves the water quality of surface waterways and the marine environment.

3.4.12 Cumulative impacts

Cumulative water quality impacts are not likely as the proposed development mitigation measures would be implemented and wastewater treated so that all discharges would maintain the existing water quality.

3.4.13 Further geotechnical investigations

Ground conditions assumed in design may vary from actual site conditions encountered during construction. To reduce the potential for this variation, further geotechnical investigation will be carried out prior to detailed design and to subsequent construction as part of Detailed SSDAs.

The purpose of additional investigations would be to:

- assess typical subsurface conditions in areas where no or limited information is currently available
- collect samples for geotechnical testing to assist with further assessment and development of geotechnical design parameters

- obtain more data on anticipated ground conditions between existing site investigation localities
- assess subsurface conditions at specific features such as building foundations or retaining walls.

4 Conclusion

This report has addressed the geotechnical requirements as per the SEARs in section 1.3. Key geotechnical findings of this report include:

- The area underlain by a significant amount of fill material, which has been placed on top of natural residual soil, namely a very stiff, medium to high plasticity clay.
- The underlying bedrock is Ashfield Shale underlain by Mittagong Formation and Hawksbury Sandstone, though the basement excavations as part of the proposed development are only expected to interact with Ashfield Shale.
- The top of bedrock within the study area ranges from between 2 to 6 metres below the existing surface level.
- There are no groundwater dependant ecosystems within the Concept SSDA study area.

Based on the findings of this geotechnical assessment, the following recommendations are provided:

- Considerable geotechnical information is available within the metro station footprint which includes Building 1. However, the geotechnical data available within the footprint of proposed Buildings 2 and 3 is limited. The geotechnical assessment presented in this report is based on available geotechnical data in the vicinity of the proposed development. This geotechnical data is considered adequate for the assessment at concept stage. Based on the assessment using available geotechnical data and experience on similar ground conditions, the proposed development site in the context of the existing geotechnical conditions are considered suitable for its intended use.
- While the site contains a number of geotechnical challenges including the presence of joins/faults and high groundwater, we consider that these challenges can be adequately addresses through the utilisation of industry standard design and construction techniques and practices.
- Ground conditions assumed in design may vary from actual site conditions encountered during construction. To reduce the potential for this variation, further geotechnical investigation will need to be carried out prior to detailed design and subsequent construction.
- Application of appropriate design standards and industry best practice, as well as mitigation measures throughout the life of the construction and operation of this proposal, would minimise impacts to the receiving waterbodies around this proposed development.
- Measures to manage erosion would be included in the Construction Environmental Management Plan.

5 Limitations

This report has been prepared for use by the Client who has commissioned the works in accordance with the Concept SSD brief only and has been based in part on information obtained from the Client and other parties.

The advice in this report relates only to the Concept SSD and all results, conclusions and recommendations made should be reviewed before being used for any other purpose. Mott MacDonald accepts no liability for use or interpretation by any person or body other than the Client who commissioned the works.

This geotechnical assessment should not be reproduced without prior approval by the Client or amended in any way without prior approval by Mott MacDonald, and should not be relied upon by other parties, who should make their own enquires.

The interpretations, assessment, conclusions and any recommendations in this report are based on information obtained and reviewed at the date of preparation of this report, conditions encountered and findings at the time of fieldwork investigations, and testing undertaken at or in connection with specific sample points by. Site conditions at other parts of the site may be different from the site conditions found at the specific sample/investigation points which are relied upon for the assessment. Changes to site conditions may also occur subsequent to the investigations, through natural processes or through the construction or other human activities.

The assessment conducted relies on the geotechnical investigation carried out by various consultants for Sydney Metro West and publicly available information such as limited historical geotechnical information, aerial photographs and government records. Mott MacDonald has not independently verified or checked information other than scoped by Mott MacDonald. Mott MacDonald does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in the that information.

This report does not provide a complete assessment of the geotechnical conditions at the site, and it is limited to the purpose defined herein. Should any new information become available regarding conditions at the site, Mott MacDonald reserves the right to review the report in the context of the additional information.

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