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URBAN APARTMENTS PTY LTD

Geotechnical Investigation

160 Lord Sheffield Circuit, Penrith NSW

E25358.G03_Rev1
4 November 2022

Document Control

Report Title: Geotechnical Investigation, 160 Lord Sheffield Circuit, Penrith NSW

Report No: E25358.G03_Rev1

Copies	Recipient
1 Soft Copy (PDF – Secured, issued by email)	Mark Elias Urban Apartments Pty Ltd Level 10/11-15 Deane St, BURWOOD NSW 2134
2 Original (Saved to Digital Archives) (Z:\07 - Projects\E25358_Urban Apartments_Penrith_GI\05_Deliverables\Work in Progress\E25358.G03_Rev2 - Geotechnical Investigation Report.docx)	EI Australia Suite 6.01, 55 Miller Street, PYRMONT NSW 2009

Author	Technical Reviewer
[redacted]	[redacted]
Kalyu Xu **Geotechnical Engineer**	**Shahzada Rizvi** **Principal Engineering Geologist**

Revision	Details	Date	Amended By
	Original	4 February 2022	
1	Updated Drawings, Parameters and Groundwater Take Assessment Results	23 September 2022	MC
2	Updated Architectural and Structural Drawings	4 November 2022	MC

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1. Introduction

1.1 Background

At the request of Urban Apartments Pty Ltd (the Client), EI Australia (EI) has carried out a Geotechnical Investigation (GI) for the proposed development at 160 Lord Sheffield Circuit, Penrith NSW (the Site).

This GI report has been prepared to provide advice and recommendations to assist in the preparation of designs for the proposed development. The investigation has been carried out in accordance with the agreed scope of works outlined in EI's proposal referenced P19814.1, dated 15 September 2021, and with the Client's signed authorisation to proceed, dated 17 September 2021.

EI has completed a Groundwater Take Assessment (GTA) Report, referenced E25358.G12_Rev1, dated 4 November 2022. This GI report should be read in conjunction with the GTA report.

1.2 Proposed Development

The following documents, supplied by the Client, were used to assist with the preparation of this GI report:

- A mark-up plan of proposed borehole locations provided to EI by Mark Elias, dated on 2 November 2021;
- Architectural Drawings prepared by SJB Architects – Job No.6626, Drawing Nos. A-1000, Revision 8 and A-1501, Revision 7, Drawing No. A-1001, Revision 12, Drawing No. A-1002, Revision 11, Drawing No. A-1502, Revision 5, dated 1 November 2022;
- Preliminary Structural Drawings prepared by van der Meer (NSW) Pty Ltd – Job No. SY220-070, Drawing Nos. S02-01 and S02-02 (RevC), and S02-11 (RevB), dated 3 November 2022;
- Transport for New South Wales Piling Report prepared by van der Meer (NSW) Pty Ltd – Job No. SY220-070, RevB, dated 2 November 2022; and
- Detail Survey Plan prepared by SDG Pty Ltd – Reference No.8635, Issue A, dated 11 January 2022.

Based on the provided documents, EI understands that the proposed development involves the construction of a ten storey mixed use development overlying a three-level basement. The lowest basement level is proposed to have a finished floor level (FFL) of RL 18.15m. The Bulk Excavation Level (BEL) is assumed as RL 17.80m to allow for the construction of the basement slab. To achieve the BEL, an excavation depth up to 9.20m to 10.20m Below Existing Ground Level (BEGL) is expected. Locally deeper excavations may be required for footings, service trenches, crane pads, and lift overrun pits.

1.3 Objectives

The objective of the GI was to assess site surface and subsurface conditions at six borehole locations, and to provide preliminary geotechnical advice and recommendations addressing the following:

- Dilapidation Surveys;

- Excavation methodologies and monitoring requirements;
- Groundwater considerations;
- Vibration considerations;
- Excavation support requirements, including preliminary geotechnical design parameters for retaining walls and shoring systems;
- Building foundation options, including;
  - Preliminary design parameters.
  - Earthquake loading factor in accordance with AS1170.4:2007.
- The requirement for additional geotechnical works.

1.4 Scope of Works

The scope of works for the GI included:

- Preparation of a Work Health and Safety Plan;
- Review of relevant geological maps for the project area;
- Site walkover inspection by a Geotechnical Engineer to assess topographical features and site conditions;
- Scanning of proposed borehole locations for buried conductive services using a licensed service locator with reference to Dial Before You Dig (DBYD) plans;
- Auger drilling of six boreholes (BH1, BH2, BH3, BH4M, BH5, and BH6) by a track-mounted drill rig using solid flight augers equipped with a 'Tungsten-Carbide' (T-C) bit. The boreholes were drilled to depths as shown in **Table1-1** below:

Table 1-1 Augering, Rotary Tricone Bit Drilling and Rock Coring Depths

Borehole ID	Augering		Rotary Tricone Bit Drilling		Rock Coring	
	Depth (m BEGL)	RL (m AHD)	Depth (m BEGL)	RL (m AHD)	Depth (m BEGL)	RL (m AHD)
BH1	6.20	21.30	12.10	15.40	18.87	8.63
BH2	7.40	20.00	11.10	16.30	17.17	10.23
BH3	6.50	21.00	11.35	16.15	17.83	9.67
BH4M	7.40	20.20	12.00	15.60	18.10	9.50
BH5	8.10	19.40	12.50	15.00	19.17	8.33
BH6	7.80	20.00	14.10	13.70	20.30	7.50

  - Standard Penetration Testing (SPT) was carried out (as per AS 1289.6.3.1-2004), where possible, during auger drilling of the boreholes to assess soil strength/relative densities;
  - Measurements of groundwater seepage/levels, where possible, in the augered sections of the boreholes during and shortly after completion of auger drilling;

    - No RL information was available at time of writing this report. Approximate borehole locations are shown on **Figure 2**;
- Boreholes were advanced through the locally extensive Cranebrook Formation (Penrith Gravels) using rotary tricone bit drilling method (tricone roller with casing advancer);
- Continuation of all boreholes using NMLC diamond coring techniques to termination depths shown above in **Table 1-1**. The rock core photographs are presented in **Appendix A**;
- Borehole BH4M was converted into a groundwater monitoring well with a depth of 10.70m BEGL (RL 18.30m) to allow for long-term groundwater monitoring;
- All remaining Boreholes were backfilled with drilling spoils upon completion;
- Soil and rock samples were sent to STS Geotechnics Pty Ltd (STS) and SGS Australia (SGS), which are National Australian Testing Authority (NATA) accredited laboratories, for testing and storage; and
- Preparation of this GI report.

EI's Geotechnical Engineer was present full-time onsite to set out the borehole locations, direct the testing and sampling, log the subsurface conditions and record groundwater levels.

1.5 Constraints

The GI was limited by the intent of the investigation and the presence of existing site structures. The discussions and advice presented in this report are preliminary and intended to assist in the preparation of initial designs for the proposed development. Further geotechnical inspections should be carried out during construction to confirm the geotechnical and groundwater models, and the preliminary design parameters provided in this report.

2. Site Description

2.1 Site Description and Identification

The site identification details and associated information are presented in **Table 2-1** below while the site locality is shown on **Figure 1.** An aerial photograph of the site is presented in **Plate 1** below.

Table 2-1 Summary of Site Information

Information	Detail
Street Address	160 Lord Sheffield Circuit, Penrith NSW
Lot and Deposited Plan (DP) Identification	Lot 3001, 3002 and 3011 in DP1184498
Brief Site Description	At the time of our investigation, the site was a vacant block of land covered with low lying grass, with a few trees and shrubs along the southern boundary fence adjoining the train line.
Site Area	The site area is approximately 8280m^2 (based on the provided survey plan).

Plate 1: Aerial photograph of the site (source: SIX Maps, accessed 3/11/22)

2.2 Local Land Use

The site is situated within an area of residential use. Current uses on surrounding land at the time of our presence on site are described in **Table 2-2** below. For the sake of this report, the site boundary adjacent to Lord Sheffield Circuit shall be adopted as the northern site boundary.

Table 2-2 Summary of Local Land Use

Direction Relative to Site	Land Use Description
North	Lord Sheffield Circuit, a two lane, asphalt-paved road with parking lanes. Beyond this are multi-storey residential apartment, with basements observed. This location is on a similar elevation to the site.
East	Lot 10 in DP 1159973, comprised of a number of disused and abandoned warehouses. The closest warehouse has an offset of about 30m from the eastern site boundary. This property is accessed from Empire Lane. This location is on a similar elevation to the site.
South	Railway Corridor of the T1 Western Line, an asset of Sydney Trains. The tracks are formed on a high embankment, with the embankment beginning about 1m from the southern site boundary. The closest track is located about 7m from the southern site boundary.
West	Pedestrian access way for Penrith train station. The access way is composed of an elevated staircase and elevator shaft that is assumed to be piled. This location is on a similar elevation to the site.

2.3 Regional Setting

The site topography and geological information for the locality is summarised in **Table 2-3** below**.**

Table 2-3 Topographic and Geological Information

Attribute	Description
Topography	The site is located on the south side of Lord Sheffield Circuit within almost flat topography.
Regional Geology	Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Penrith 1:100,000 Geological Series Sheet 9030 (DMR 1991) indicates the site to be underlain by gravel, sand, silt and clay. This is underlain by Bringelly Shale, consisting of shale, carbonaceous claystone, laminate, lithic sandstone and rare coal.

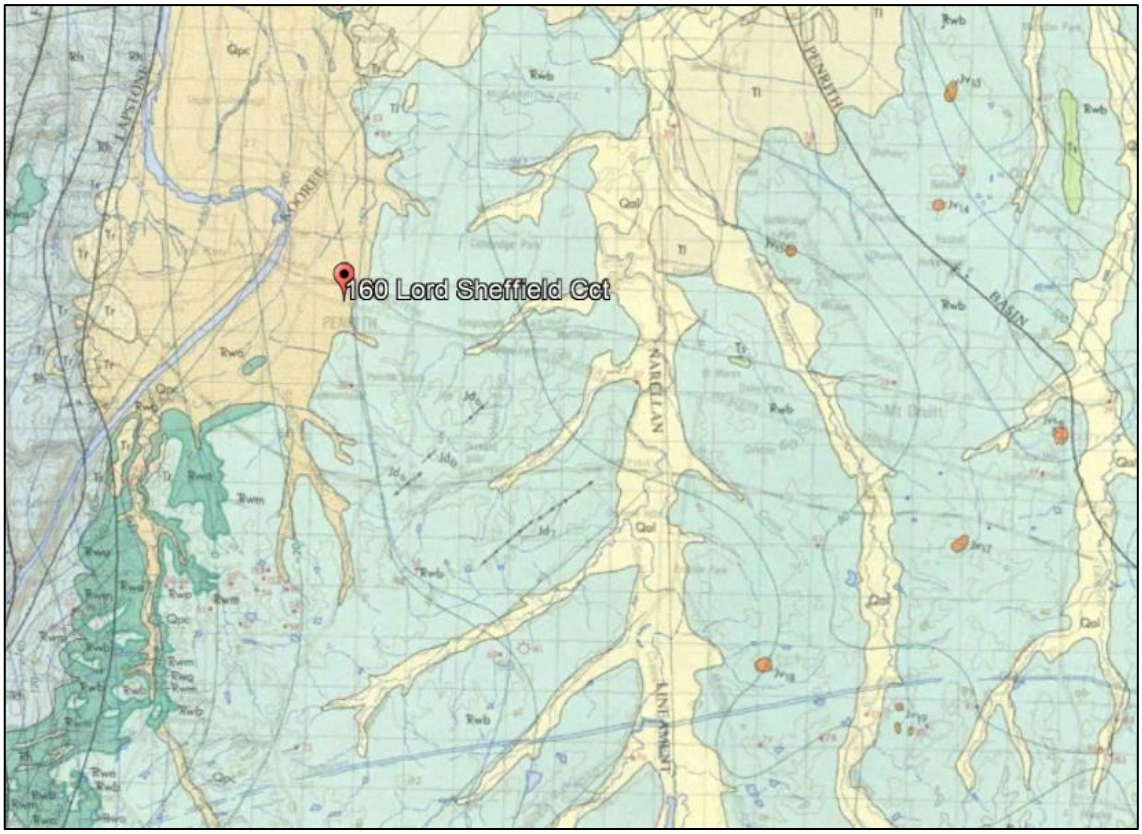


Plate 2: Excerpt of geological map showing location of site.

3. Investigation Results

3.1 Stratigraphy

For the development of a site-specific geotechnical model, the stratigraphy observed in the GI has been grouped into four geotechnical units. A summary of the subsurface conditions across the site, interpreted from the assessment results, is presented in **Table 3-1** below. More detailed descriptions of subsurface conditions at each borehole location are available on the borehole logs presented in **Appendix A**. The details of the methods of soil and rock classifications, explanatory notes and abbreviations adopted on the borehole logs are also presented in **Appendix A.**

Table 3-1 Summary of Subsurface Conditions

Unit	Material[2]	Depth to Top of Unit (m BEGL)[1]	RL of Top of Unit (m AHD)[1]	Observed Thickness (m)	Comments
1	**Topsoil / Fill**	0.00	27.4 to 27.8	0.20 to 1.20	Topsoil / fill composed of silty clay with traces of rootlets. Topsoil / fill was assessed, based on our observations during drilling and SPT N Values to be poorly compacted;
2a	**Silty / Sandy Clay (Fluvial Soil)**	0.20 to 1.20	26.3 to 27.2	3.00 to 5.60	Low to high plasticity, firm to very stiff silty / sandy clay. SPT N values ranged from 7 to 24.
2b	**Clayey / Silty Sand (Fluvial Soil)**	3.50 to 6.80	20.8 to 24	1.00 to 3.70	Fine to medium grained, loose to medium dense clayey / silty sand. SPT N values within the fluvial sands ranged from 5 to 16.
2c	**Sandy Gravel (Fluvial Soil)**	6.00 to 8.10	19.4 to 21.5	3.70 to 6.50	Sandy Gravel, sub-angular to rounded fine to coarse gravel with medium to coarse grained sand, with rounded cobbles, trace silt and clay. Formally defined as the regionally extensive *Cranebrook Formation.*
3	**Very Low to Low Strength Sandstone / Shale**	11.45 to 14.30	13.5 to 16.05	0.20 to 0.75	Observed in BH1, BH3 and BH6 only. The very low to low strength sandstone / shale generally consisted of closely to moderately spaced defects consisting of sub-vertical joints and decomposed zones.
4	**Medium to High Strength Laminite / Sandstone / Shale**	11.10 to 14.50	13.3 to 16.3	-[3]	Medium to high strength laminite / sandstone / shale generally consisted of moderately spaced defects consisting of sub-vertical joints, sub-horizontal bedding partings, and decomposed zones.

Note 1 Approximate depth and level at the time of our assessment. Depths and levels may vary across the site. RL information not available at time of writing this report.

Note 2 For more detailed descriptions of the subsurface conditions, reference should be made to the borehole logs attached to **Appendix A.**
Note 3 Observed up to termination depth in all boreholes.

3.2 Groundwater Observations

Groundwater seepage was observed during auger drilling of all boreholes. Following completion of auger drilling, the boreholes were left open and one groundwater monitoring well was installed in BH4M and bailed dry. The groundwater observations are detailed as per **Table 3-2** below:

Table 3-2 Groundwater Levels

Borehole ID	Groundwater Seepage Level During Augering	
	m BEGL	RL (m AHD)
BH1	6.00	21.50
BH2	7.10	20.30
BH3	6.45	21.05
BH4M	7.00	20.60
BH5	7.10	20.40
BH6	7.60	20.20

Borehole ID	Measurement Date	Depth to Groundwater (m BEGL)	Groundwater RL (m AHD)
BH4M	15/12/2021	7.10	20.50
	15/07/2022	6.10	21.50

We note that the groundwater levels may not have become evident or stabilised in the augered boreholes within the limited observation period. No long term groundwater monitoring was carried out. Water circulation due to coring within the boreholes prevented further observations of groundwater levels.

3.3 Test Results

Five soil samples were selected for laboratory testing to assess the following:

- Atterberg Limits and Linear Shrinkage.
- Soil aggressivity (pH, chloride and sulfate content and electrical conductivity).

A summary of the soil test results is provided in **Table 3-3** below. Laboratory test certificates are presented in **Appendix B**.

Table 3-3 Summary of Soil Laboratory Test Results

Test/ Sample ID		BH1 1.5-1.95	BH1 3.0-3.45	BH2 1.5-1.95	BH3 6.0-6.45	BH3 6.0-6.45	BH4M 1.5-1.95
Unit		2	2	2	2	2	2
Material Description [1]		Silty CLAY	Silty CLAY	Silty CLAY	Clayey SAND	SAND	Silty CLAY
Aggressivity	Chloride Cl (ppm)	-	710	-	600	-	2000
	Sulfate SO_4 (ppm)	-	<5.0	-	63	-	82
	pH	-	6.3	-	8.0	-	4.7
	Electrical Conductivity (µS/cm)	-	500	-	520	-	1200
	Moisture Content (%)	14.3	10.1	28.7	17.9	16.7	18.7
Atterberg Limits	Liquid Limit (%)	30	-	68	-	23	-
	Plastic Limit (%)	13	-	22	-	14	-
	Plasticity Index (%)	17	-	46	-	9	-
	Linear Shrinkage (%)	10	-	15.5	-	5.5	-

Note 1 More detailed descriptions of the subsurface conditions at each borehole location are available on the borehole logs presented in **Appendix A**.

The Atterberg Limits result on the selected clay sample indicated clays to be of low to high plasticity and of moderate shrink-swell potential.

The assessment indicated low to medium permeability soil was present above the groundwater table. In accordance with Tables 6.4.2(C) and 6.5.2(C) of AS 2159:2009 'Piling – Design and Installation', the results of the pH, chloride and sulfate content and electrical conductivity of the soil provided the following exposure classifications:

- 'Moderate' to 'Mild' for buried concrete structural elements; and
- 'Severe' to 'Moderate' for buried steel structural elements.

41 selected rock core samples were tested by STS to estimate the Point Load Strength Index (Is_{50}) values to assist with rock strength assessment. The results of the testing are summarised on the attached borehole logs. The point load strength index tests correlated reasonably well with our field assessments of rock strength. The approximate Unconfined Compressive Strength (UCS) of the rock core, estimated from correlations with the point load strength index test results, varied from <1 MPa to 78 MPa.

4. Recommendations

4.1 Geotechnical Considerations

Based on the results of the assessment, we consider the following to be the main geotechnical considerations for the proposed development:

- Basement excavation and retention to limit lateral deflections and ground loss as a result of excavations, resulting in damage to nearby structures;
- Groundwater within the depth of the excavation; and
- Foundation design for building loads.

4.2 Dilapidation Surveys

Prior to excavation and construction, we recommend that detailed dilapidation surveys be carried out on all structures and infrastructures surrounding the site that falls within the zone of influence of the excavation to allow assessment of the recommended vibration limits and protect the client against spurious claims of damage. The zone of influence of the excavation is defined by a distance back from the excavation perimeter of twice the total depth of the excavation. The reports would provide a record of existing conditions prior to commencement of the work. A copy of each report should be provided to the adjoining property owner who should be asked to confirm that it represents a fair assessment of existing conditions. The reports should be carefully reviewed prior to demolition and construction.

4.3 Excavation Methodology

4.3.1 Excavation Assessment

Prior to any excavation commencing, we recommend that reference be made to the Safe Work Australia Excavation Work Code of Practice, dated January 2020.

EI assumes that the proposed development will require a BEL of RL 17.80m for the basement, or an excavation depth up to 10.35m BEGL. Locally deeper excavations for footings, service trenches, crane pads and lifts overrun pits may be required.

Based on the borehole logs, the proposed basement excavations will potentially extend through Units 1 and 2 as outlined in **Table 3-1** above. As such, an engineered retention system must be installed prior to excavation commencing.

Units 1 and 2 could be excavated using buckets of large earthmoving Hydraulic Excavators.

Based on our limited observation of groundwater depths from the monitoring wells, free standing water was measured at RL 21.5m which is within the depth of excavation. The primary issues associated with the excavation will be controlling the groundwater and provide adequate support to adjoining structures/infrastructures. Groundwater is expected to be encountered during excavation. Therefore, to allow for the construction of the basement slab, lift pits and service trenches in ‘dry’ condition, temporary dewatering will be required. In this regards, it is anticipated that the groundwater table will be maintained at a depth of about 1 m below the bulk excavation level and potentially deeper around lift pits or working platforms (if required).

Dewatering has the potential to cause some drawdown and ground settlement below the adjoining sites; the extent of the drawdown depends upon the depth to which the cut-off system

is installed and the pumping operations. Outlets into the stormwater system will require Council approval.

Groundwater seepage monitoring should be carried out during bulk excavation works and prior to finalising the design of a pump out facility. Outlets into the stormwater system will require Council approval.

Furthermore, any existing buried services, which run below the site, will require diversion prior to the commencement of excavation or alternatively be temporarily supported during excavation, subject to permission or other instructions from the relevant service authorities. Enquiries should also be made for further information and details, such as invert levels, on the buried services.

4.3.2 Excavation Monitoring

Consideration should be made to the impact of the proposed development upon neighbouring structures, roadways and services. Basement excavation retention systems should be designed so as to limit lateral deflections.

Contractors should also consider the following limits associated with carrying out excavation and construction activities:

- Limit lateral deflection of temporary or permanent retaining structures;
- Limit vertical settlements of ground surface at common property boundaries and services easement; and
- Limit Peak Particle Velocities (PPV) from vibrations, caused by construction equipment or excavation, experienced by any nearby structures and services.

Monitoring of deflections of retaining structures and surface settlements should be carried out by a registered surveyor at agreed points along the excavation boundaries and along existing building foundations / services / pavements and other structures located within or near the zone of influence of the excavation. Owners of existing services adjacent to the site should be consulted to assess appropriate deflection limits for their infrastructures. Measurements should be taken in the following sequence:

- Before commencing installation of retaining structures where appropriate to determine the baseline readings. Two independent sets of measurements must be taken confirming measurement consistency;
- After installation of the retaining structures, but before commencement of excavation;
- After excavation to the first row of supports or anchors, but prior to installation of these supports or anchors;
- After excavation to any subsequent rows of supports or anchors, but prior to installation of these supports or anchors;
- After excavation to the base of the excavation;
- After de-stressing and removal of any rows of supports or anchors; and
- One month after completion of the permanent retaining structure or after three consecutive measurements not less than a week apart showing no further movements, whichever is the latter.

4.4 Groundwater Considerations

Groundwater was observed in the monitoring well as detailed in **Table 3-2**, which is above the assumed BEL RL of 17.80m.

EI suggests that long term groundwater monitoring should be carried out to confirm the design requirements of partially tanked basement. We also recommend permeability testing to be conducted in the installed monitoring well to confirm the expected seepage rate of the fluvial gravels.

The volume of groundwater entering the basement excavation (which will require dewatering) decreases as the depth of embedment of the perimeter shoring system increases.

The groundwater level observed during the investigation shows the groundwater to be within the anticipated excavation depth and, as such, provisional consideration can be given to a partially tanked basement subject to long term groundwater monitoring to confirm long term groundwater levels. Council and the NSW Department of Primary Industries (DPI) do not allow permanent dewatering; therefore, the portion of the basement below the observed groundwater must be designed as a tanked structure. Temporary dewatering for construction purposes is normally allowed provided it is properly designed and managed to ensure that the likely drawdown will have no adverse impact on adjoining structures / infrastructures. A dewatering licence may also be required. Groundwater quality testing, particularly with regard to acidity generated as a result of acid sulfate soils, will be required to permit discharge into the stormwater.

Spear points will need to be installed internally around the perimeter of the retention system, as well as possibly internally for the lift overrun pits. The spear points should be connected with a header pipe to allow the pumped water to discharge into the stormwater system, or to the recharge wells / infiltration trenches.

Dewatering has the potential to cause some drawdown and ground settlement below adjoining sites; the extent of the drawdown depends upon the depth to which the cut-off system is installed and the pumping operations. Settlements would affect any adjoining buildings supported on shallow footing systems and if records of the footing systems of the adjoining buildings are available, these should be reviewed to assess the risk from dewatering.

A critical factor relating to dewatering of the site is maintenance of the depressed groundwater levels until such a time as the building has significant weight to prevent movement should the pump system fail and the groundwater level rise.

A detailed monitoring program should be implemented to identify the risks and trigger levels decided for when the contingency measures need to be taken. A seepage model in SEEP/W was completed by EI to assess the effectiveness of perimeter cut off and to estimate the groundwater inflow volumes. The results show that, assuming a secant pile wall socketed 1m into bedrock, the construction phase groundwater take will be approximately 0.10ML/180 days and the operational phase groundwater take will be negligible for a tanked basement. Reference should be made to the Groundwater Take Assessment (GTA) report (E25358.G12, dated 4 November 2022) for further details.

4.5 Excavation Retention

4.5.1 Support Systems

From a geotechnical perspective, it is critical to maintain the stability of all adjacent structures and infrastructures during demolition, excavation and construction works.

Since no architectural or structural drawings were provided at time of writing this report and the footprint of the proposed basement is unknown, temporary batters may or may not be feasible for this site. The application of temporary batters needs to take account of the encountered subsurface conditions, the depth of groundwater, and the required excavation depth. If temporary batters are to be used, advice should be sought from the geotechnical engineer.

Unsupported vertical cuts of the soil are not recommended for this site as these carry the risk of potential slumping/collapse especially after a period of wet weather. Slumping/Collapse of the material may result in injury to personnel and/or damage to nearby structures / infrastructures and equipment.

Where space for temporary batters is not available, a suitable retention system will be required for the support of the entire depth of the excavation. Due to the presence of sandy soils and the groundwater within the anticipated depth of excavation, suitable retention / cut-off system will comprise an anchored / propped contiguous / secant pile wall installed to be founded into medium to high strength shale (Unit 4) for the support of the entire excavation:

- Secant Pile Walls: Alternate piles are first drilled and concreted at a close spacing. The intermediate piles are then installed by drilling out the soil between each pair and part of the already installed piles. Cased secant methods provide a high degree of security when in granular soils adjacent to heavily loaded foundations or adjacent structures. Use of specialist high capacity, cased continuous flight auger rigs is likely to result in little disengagement of the secant piles. Should the second ‘hard’ piles disengage from the first ‘soft’ piles, then remedial works would be required to rectify any seepage inflows. Any gaps between the piles may result in loss of material and water inflow from behind the wall which may lead to settlements adjacent to the wall and may result in damage to neighbouring structures and services. The resulting out of position piles may also affect internal layout / clearances.
    - Grout injected CFA piles may be used for this site. The proposed pile locations should take into account the presence of the neighbouring anchors and/or the presence of buried services. Further advice should be sought from prospective piling contractors who should be provided with a copy of this report.

The retention system will need to be installed to depths which satisfy stability, piping, founding and groundwater cut-off considerations. Anchors / props and shotcrete must be installed progressively as excavation proceeds.

Grout injected, cased CFA piles are most suitable. Due to the collapsible nature of the sandy soils and the presence of groundwater, bored piers are not recommended for this site. The proposed pile locations should take into account the presence of the neighbouring anchors and / or the presence of buried services. Further advice should be sought from prospective piling contractors who should be provided with a copy of this report.

Working platforms may also be required. We can complete the design of the working platform, if commissioned to do so.

Alternatively, sheet pile walls may be used to provide temporary retention during construction. Pre-drilling of the sheet piles will be required however, it should be noted that collapse of the material is expected following the extraction of the auger. The sheet piles may also have difficulties penetrating through the gravel layer, which may result in damage to the sheets leading to delays. Vibration during installation must be monitored and controlled.

4.5.2 Retaining Wall Design Parameters

The following parameters may be used for static design of temporary and permanent retaining walls at the subject site:

- Conventional free-standing cantilever walls which support areas where movement is of little concern (i.e. where only gardens or open areas are to be retained), may be designed using a triangular lateral earth pressure distribution and an 'active' earth pressure coefficient, K_a, as shown in **Table 4-1;**
- For progressively anchored or propped walls where minor movements can be tolerated (provided there are no buried movement sensitive services), we recommend the use of a rectangular earth pressure distribution of 6H kPa for the soil profile, where H is the retained height in meters;
- For progressively anchored or propped walls which support areas which are highly sensitive to movement (such as areas where movement sensitive structures or infrastructures or buried services are located in close proximity), we recommend the use of a rectangular earth pressure distribution of 8H kPa for the soil profile, where 'H' is the retained height in meters;
- All surcharge loading affecting the walls (including from construction equipment, construction loads, adjacent high level footings, etc.) should be adopted in the retaining wall design as an additional surcharge using an 'at rest' earth pressure coefficient, K_o.
- Full hydrostatic pressures should be taken into consideration in the design of the retaining walls, assuming an external water level, say at least 1.0m, above the highest groundwater level measured to date. The hydrostatic pressure should extend to the base of the perimeter cut-off.
- For piles embedded into Unit 4 or better, the allowable lateral toe resistance values outlined in **Table 4-1** below may be adopted. These values assume excavation is not carried out within the zone of influence of the wall toe and the rock does not contain adverse defects etc. The upper 0.3m depth of the socket should not be taken into account to allow for tolerance and disturbance effects during excavation.
- If temporary anchors extend beyond the site boundaries, then permission from the neighbouring properties would need to be obtained prior to installation. Also, the presence of neighbouring basements and/or services and their levels must be confirmed prior to finalising anchor design**.**
- For the design of anchors, the allowable bond stress value outlined in **Table 4-1** below may be used, subject to the following conditions:

    1. Anchor bond lengths of at least 3m behind the 'active' zone of the excavation (taken as a 45 degree zone above the base of the excavation) is provided;
    2. Overall stability, including anchor group interaction, is satisfied;
    3. All anchors should be proof loaded to at least 1.33 times the design working load before locked off at working load. Such proof loading is to be witnessed by and engineer independent of the anchoring contractor. We recommend that only experienced contractors be considered for anchor installation with appropriate insurances;
    4. If permanent anchors are to be used, these must have appropriate corrosion provisions for longevity.

- **Uncased anchor holes within the sands and gravels will almost certainly collapse and temporary casing of these holes will be required. It is good practice for anchors to be a "design and construct" sub-contract to avoid disputes should anchors fail to hold their test load;**

Table 4-1 Geotechnical Design Parameters

Material [1]		Unit 1 TOPSOIL / Fill	Unit 2a Silty Clay (Fluvial Soil)	Unit 2b Clayey Sand (Fluvial Soil)	Unit 2c Sandy Gravel (Fluvial Soil)	Unit 3 Very Low to Low Strength Shale	Unit 4 Medium to High Strength Laminite / Sandstone / Shale
RL of Top of Unit (m AHD) [2]		27.4 to 27.8	26.3 to 27.2	20.8 to 24	19.4 to 21.5	13.5 to 16.05	13.3 to 16.3
Bulk Unit Weight (kN/m^3)		18	20	20	22	24	24
Friction Angle, ϕ' (°)		25	25	33	33	37	45
Cohesion c' (kPa)		0	15	5	5	75	200
Young's Modulus E' (MPa)		5	15	20	40	75	500
Poisson's ratio		0.3	0.3	0.3	0.3	0.25	0.25
Earth Pressure Coefficients	At rest, K_o [3]	0.58	0.58	0.45	0.45	0.40	-
	Active, K_a [3]	0.41	0.41	0.29	0.29	0.25	-
	Passive, K_p [3]	-	-	-	3.39	4.02	-
Allowable Bearing Pressure (kPa) [5]		-	-	-	-	700	3500
Allowable Shaft Adhesion (kPa) [4, 5]	in Compression	-	-	-	-	70	350
	in Uplift	-	-	-	-	35	175
Allowable Toe Resistance (kPa)		-	-	-	-	70	350
Allowable Bond Stress (kPa)		-	-	-	-	50	250
Earthquake Site Risk Classification		▪ AS 1170.4:2007 indicates an earthquake subsoil class of Class C_e.(Shallow Soil) ▪ AS 1170.4:2007 indicates that the hazard factor (z) for Sydney is 0.09.					

Notes:

1 More detailed descriptions of subsurface conditions are available on the borehole logs presented in **Appendix A.**
2 Approximate levels of top of unit at the time of our investigation. Levels may vary across the site.
3 Earth pressures are provided on the assumption that the ground behind the retaining walls is horizontal.
4 Side adhesion values given assume there is intimate contact between the pile and foundation material and should achieve a clean socket roughness category R2 or better. Design engineer to check both 'piston pull-out' and 'cone liftout' mechanics in accordance with AS4678-2002 Earth Retaining Structures.
5 To adopt these parameters we have assumed that:
- Footings have a nominal socket of at least 0.3m, into the relevant founding material;
- For piles, there is intimate contact between the pile and foundation material (a clean socket roughness category of R2 or better);
- Potential soil and groundwater aggressivity will be considered in the design of piles and footings;
- Piles should be drilled in the presence of a Geotechnical Engineer prior to pile construction to verify that ground conditions meet design assumptions. Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremmie system could be used;
- The bases of all pile, pad and strip footing excavations are cleaned of loose and softened material and water is pumped out prior to placement of concrete;
- The concrete is poured on the same day as drilling, inspection and cleaning.
- The allowable bearing pressures given above are based on serviceability criteria of settlements at the footing base/pile toe of less than or equal to 1% of the minimum footing dimension (or pile diameter).

4.6 Foundations

At the assumed BEL level of 17.80m, we expect Unit 2c gravels to be exposed. It is recommended that all footings for the building be founded within material of similar strength to provide uniform support and reduce the potential for differential settlements.

Due to the expected moderate to high column loads, and relatively shallow depths to bedrock, we recommend that the building be supported on piles founded within Unit 5 bedrock or better. However an option for a raft slab founded on gravels has also been provided.

4.6.1 Raft Slab in Sandy Gravels

Raft slabs may be suited to support the building loads. Further detailed evaluation of expected performance including the evaluation of allowable bearing pressures and settlements would be required once design loads, founding level, and column layout are better known. A preliminary allowable bearing pressure of 200kPa may be assumed for a raft slab founded in Unit 2c Gravels. Due to expected groundwater rise, the raft slab may require to be designed against uplift or may require tension piles.

In the case of a piled stiffened raft slab, the piles are designed to their ultimate capacity and act as settlement reducers to the stiffened raft slab.

The subgrade preparation below any raft slabs will be important in the final performance of the raft. Detailed analysis of a piled raft would be required to estimate the settlements and the contact pressures below the raft. Further discussion regarding sub-grade preparation is provided in **Section 4.8** below. It is also recommended that a 150mm thick layer of good quality granular material such as recycled concrete or crushed rock be placed and compacted over the prepared surface, particularly at heavily loaded areas. This layer helps confine the sandy/gravelly soils from disturbances and improve the compacted and density of the surface soils.

4.6.2 Pile Footings

Piles socketed within the underlying Unit 4 bedrock may be designed for an allowable bearing capacity of 3500kPa, based on serviceability.

Based on the encountered subsurface material, grout injected, cased CFA piles are best suited for this site. Bored piers are not recommended. We note that due to the presence of cobbles and boulder sized gravel, a relatively large piling rig will be required and the piling company should be provided with a copy of this report.

All piles must be designed in accordance with the Australian Standard AS2159-2009 Piling – Design and installation.

At least the initial stages of pile installation should be observed by a geotechnical engineer to ascertain that the recommended foundation material and depth has been reached and to check initial assumptions about foundation conditions and possible variations that may occur between test locations. The need for further inspections can be assessed following the initial visit.

4.7 Basement Floor Slab

Following bulk excavations for the proposed basements, Unit 2c gravel is expected to be exposed at BEL. We therefore recommend that the lowest basement floor slab should be designed fully tanked and the design is likely to be controlled by the hydrostatic uplift pressures. However, further groundwater monitoring is required to assess the groundwater fluctuations which may lead the design of raft slab into partially tanked system.

4.8 Subgrade Preparation and Engineered Fill

4.8.1 Subgrade Preparation for Raft Slab

If raft slab foundations are adopted, it is recommended that they be founded on medium dense sands or better.

Earthworks recommendations provided in this report should be complemented by reference to AS3798.

Our recommendations regarding subgrade perpetration are as follows:

- The subgrade below the basement slab or footing will need to be prepared prior to construction of the slab or footing, but the extent of the preparation, inspection and testing will depend on the footing systems adopted. A more rigorous control will be required where a raft slab is adopted.
- Following bulk excavation, if sands are exposed, the exposed subgrade should be proof rolled with at least a 2 tonne dead weight smooth drum vibratory roller, with the final pass of the proof rolling inspected by a geotechnical engineer or experienced earthworks foreman to detect any weak subgrade areas.
- Any weak areas detected during proof rolling should be locally excavated to a sound base and the excavated materials replaced with engineered fill. During proof rolling and any fill compaction care must be taken due to the risk of damage to the adjoining buildings from vibrations generated by such work. All vibrations should be monitored and if they are considered to be excessive they should be reduced or ceased
- Engineered fill should preferably comprise well graded granular materials, such as ripped rock, processed demolition spoil or crushed sandstone, free of deleterious substances and having a maximum particle size not exceeding 75mm. The excavated sand may be reused as engineered fill provided it is free of deleterious material and particles greater than 75mm in size. Such fill should be compacted in horizontal layers of not greater than 200mm loose thickness, to achieve a minimum Density Index of 70%. A method specification, comprising placement of granular materials in 150mm loose layers and then compacting by not less than eight passes by a minimum 2-tonne dead weight smooth drum roller, may be adopted.
- For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness.
- Where a raft slab is adopted, we expect that a capping layer of well graded crushed rock or recycled concrete (maximum particle size limited to 40mm) will be required to achieve adequate compaction of the upper sands. This granular layer will be required below the entire raft slab and would be of about 150mm thick.
- The performance of raft (including piled raft) slabs are also dependent on the whole of the design and construction team being familiar with the sensitivity of the situation. It is essential that any services which have to be placed in the subgrade are carefully positioned and an appropriate construction schedule/sequence is provided to the geotechnical engineer for approval at the planning stage.
- Disturbance of the subgrade must be minimised and kept outside the zone of influence of column or wall loads. A documented Inspection and Test Plan (ITP) should be prepared prior to construction with appropriate “hold” points in the Quality System.

5. Further Geotechnical Inputs

Below is a summary of the previously recommended additional work that needs to be carried out:

- Long term groundwater monitoring;
- Dilapidation surveys;
- Design of working platforms (if required) for construction plant by an experienced and qualified geotechnical engineer;
- Classification of all excavated material transported off site;
- Witnessing installation of support measures and proof-testing of anchors (if required).
- Geotechnical inspections of all new footings/piles by an experienced geotechnical professional before concrete or steel are placed to verify their bearing capacity and the in-situ nature of the founding strata; and
- Ongoing monitoring of groundwater inflows into the bulk excavation.

We recommend that a meeting be held after initial structural design has been completed to confirm that our recommendations have been correctly interpreted. We also recommend a meeting at the commencement of construction to discuss the primary geotechnical considerations and inspection requirements. EI considers that the site is suitable for the proposed development, providing that the recommendations provided in this GI report are followed.

6. Statement of Limitations

This report has been prepared for the exclusive use of Mark Elias and Urban Apartments Pty Ltd who is the only intended beneficiary of EI's work. The scope of the assessment carried out for the purpose of this report is limited to those agreed with Mark Elias and Urban Apartments Pty Ltd

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the geotechnical industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on a limited investigation of conditions, with specific sampling and test locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during construction. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

We draw your attention to the document "Important Information", which is included in **Appendix D** of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by EI, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

Should you have any queries regarding this report, please do not hesitate to contact EI.

References

AS1289.6.3.1:2004, *Methods of Testing Soils for Engineering Purposes,* Standards Australia.

AS1726:2017, *Geotechnical Site Investigations*, Standards Australia.

AS2159:2009, *Piling – Design and Installation*, Standards Australia.

AS3600:2009, *Concrete Structures,* Standards Australia

Safe Work Australia Excavation Work Code of Practice, dated January 2020 – WorkCover NSW

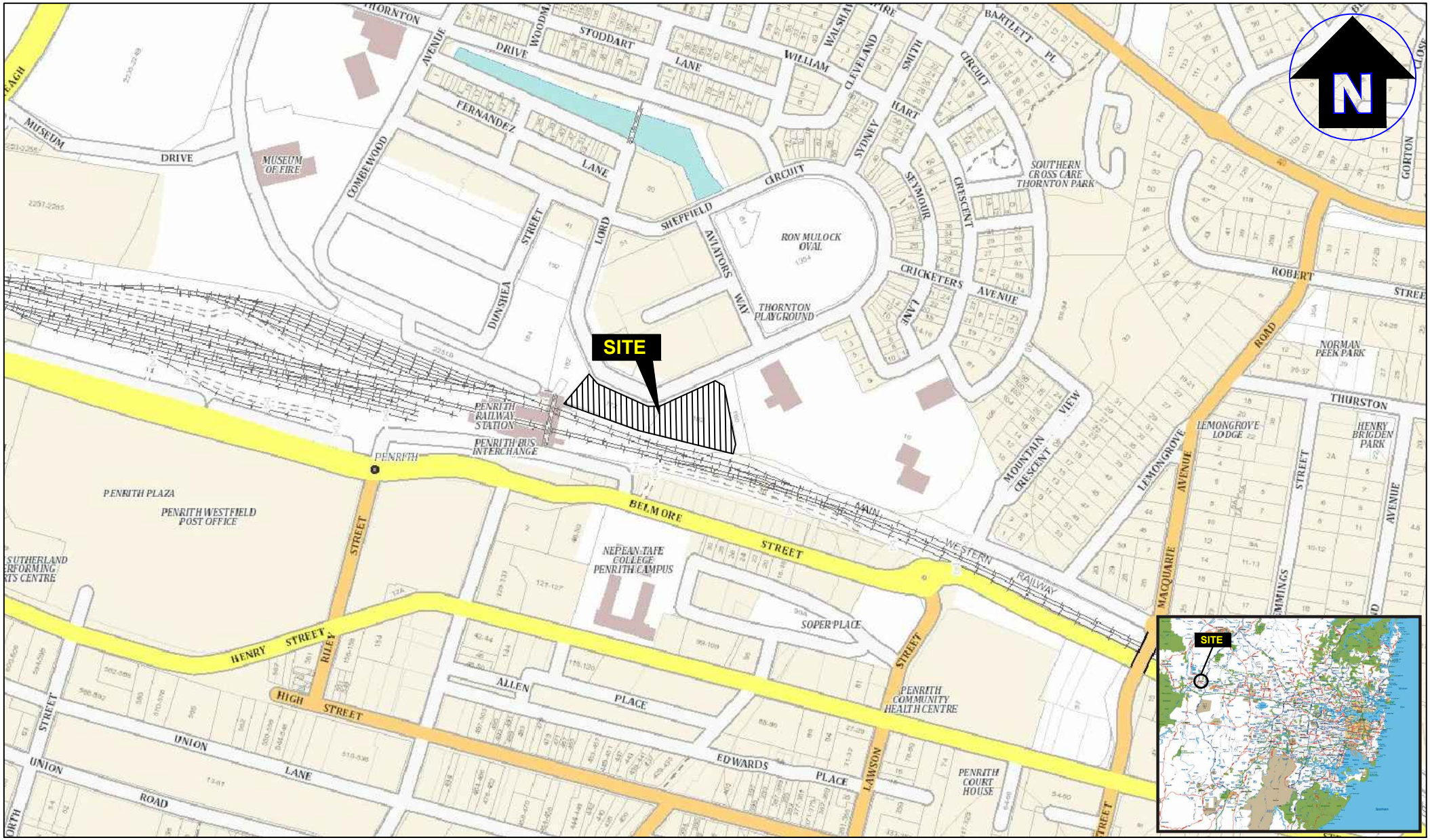
NSW Department of Finance and Service, Spatial Information Viewer, maps.six.nsw.gov.au.

NSW Department of Mineral Resources (1991) Penrith 1:100,000 Geological Series Sheet 9030 (Edition 1). Geological Survey of New South Wales, Department of Mineral Resources.

Abbreviations

AHD	Australian Height Datum
AS	Australian Standard
BEL	Bulk Excavation Level
BEGL	Below Existing Ground Level
BH	Borehole
DBYD	Dial Before You Dig
DP	Deposited Plan
EI	EI Australia
GI	Geotechnical Investigation
NATA	National Association of Testing Authorities, Australia
RL	Reduced Level
SPT	Standard Penetration Test
T-C	Tungsten-Carbide
UCS	Unconfined Compressive Strength

Figures



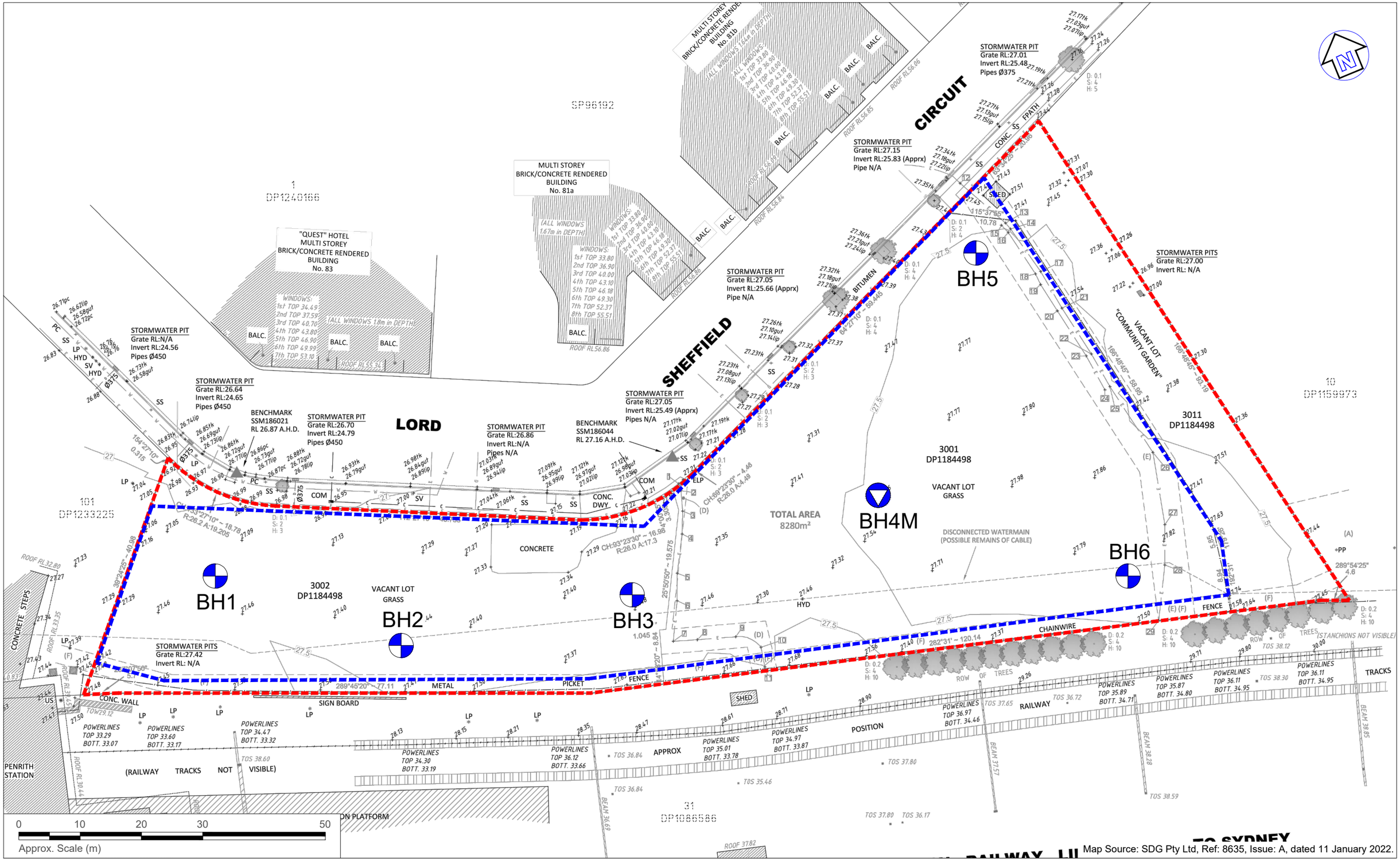
eiaustralia
Practical Solutions for Built Environments
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

Drawn:	AM.H.
Approved:	K.X.
Date:	25/1/22
Scale:	Not To Scale

Urban Apartments Pty Ltd
Geotechnical Investigation
160 Lord Sheffield Circuit, Penrith NSW
Site Locality Plan

Figure:
1

Project: E25358.G03



Map Source: SDG Pty Ltd, Ref: 8635, Issue: A, dated 11 January 2022.

LEGEND (All Locations are Approximate)

- Site boundary
- Basement boundary
- Borehole location
- Borehole/monitoring well location

eiaustralia
Practical Solutions for Built Environments
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

Drawn:	M.C.
Approved:	S.K.
Date:	23-09-22

Urban Apartments Pty Ltd
Geotechnical Investigation
160 Lord Sheffield Circuit, Penrith NSW

Borehole Location Plan

Figure: 2

Project: E25358.G03

Appendix A – Borehole Logs And Explanatory Notes

BOREHOLE LOG

BH NO. BH1

Project	Proposed Development	**Sheet**	1 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	08/11/2021
Position	Refer to Figure 2	**Date Completed**	09/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 08/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	27.50				-	FILL: Sandy CLAY: medium plasticity, fine to medium grained sand, dark brown and dark grey, with silt, with fine to medium gravels	M	-	FILL
				0.50								
				27.00	SPT 0.50-0.95 m 5,10,11 N=21			CL	Silty CLAY; low plasticity, grey and orange brown, with fine grained sand and fine gravels.			FLUVIAL SOIL
			1							M (<PL)	VSt	
					SPT 1.50-1.95 m 9,10,13 N=23							
			2									
				2.50								
				25.00				CL	Sandy Silty CLAY; low plasticity, orange-brown, fine grained sand, trace fine gravels.			
			3		SPT 3.00-3.45 m 7,11,13 N=24					M (<PL)	VSt	
				3.50								
				24.00				SC	Clayey Silty SAND; fine grained sand, orange-brown.	M	L	
			4	*4.40*								
				23.10	SPT 4.50-4.95 m 4,5,5 N=10			SP	SAND; fine to medium grained, orange-brown and grey, with silt and clay.	M		
	-			*5.00*								
			5	22.50					From 5.00m, grey and grey-brown, trace clay and silt.	M - W	L	
					SPT 5.50-5.95 m 4,5,0 N=5							
		▽	6	*6.00*								
RT				21.50				GW	Sandy GRAVEL; fine to coarse gravel, sub-angular to rounded, medium to coarse grained sand, with rounded cobbles and boulders, trace silt and clay.			
			7									
			8							-	-	
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

BH NO. BH1

Project	Proposed Development	**Sheet**	2 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	08/11/2021
Position	Refer to Figure 2	**Date Completed**	09/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 08/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
RT	-		10					GW	Sandy GRAVEL; fine to coarse gravel, sub-angular to rounded, medium to coarse grained sand, with rounded cobbles and boulders, trace silt and clay.	-	-	FLUVIAL SOIL
			11	*11.50*								
				16.00				-	SHALE; dark grey, highly weathered, very low to low strength.	-	-	BEDROCK
			12	*12.10*					Continued as Cored Borehole			
			13									
			14									
			15									
			16									
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BH NO. BH1

Project	Proposed Development	**Sheet**	3 OF 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	08/11/2021
Position	Refer to Figure 2	**Date Completed**	09/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 08/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) (30, 100, 300, 1000, 3000)
				10							
				11							
				12	*12.10*		Continuation from non-cored borehole				
NMLC	90% RETURN	100	79		15.40 *12.42*		LAMINITE; SANDSTONE and SHALE; brown and grey, thinly bedded.	DW		12.13-12.14: XWS, Clay, 10 mm. 12.22-12.30: XWS, Clay, 80 mm. 12.30-12.33: CS, 30 mm.	
				13	15.08 *13.90*		SANDSTONE; fine to medium grained, dark grey and grey, medium bedded.	SW		13.78: JT, 25°, CN, PR, RO	
				14	13.60 *14.30*		SHALE; dark grey, medium bedded.				
	90% RETURN	100	90		13.20 *15.30* *15.45* 12.05 *15.80* 11.70		LAMINITE; SANDSTONE and SHALE; dark grey and grey, medium bedded. From 15.30m, dark grey. From 15.45m, thinly bedded. From 15.80m, dark grey and grey.			14.57: JT, 10°, CN, CU, RO 14.66: XWS 15.62-15.63: XWS, Clay, 10 mm.	
				15							
				16							
				17						16.73: JT, 45°, CN, CU, SM 16.94-17.01: XWS, 70 mm.	
	90% RETURN	100	71		*17.71* 9.79 *18.87*		SANDSTONE; fine to medium grained, dark grey and grey, medium bedded.	FR		17.67-17.72: CS, 50 mm.	
				18							
				19	8.63		Hole Terminated at 18.87 m Target Depth Reached.				
				20							

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH1

Project	Proposed Development			**Depth Range**	12.1m to 18.87m BEGL		
Location	160 Lord Sheffield Circuit, Penrith NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	Refer to Figure 2	**Surface RL**	≈ 27.50 m AHD	**Drill Rig**	Comacchio Geo 205		
Job No.	E25358.G03	**Inclination**	-90°	**Logged**	DD	**Date**	08 / 11 / 2021
Client	Urban Apartments Pty Ltd	**Box**	1-2 of 2	**Checked**	SR	**Date**	03 / 02 / 2022

BOREHOLE LOG

BH NO. BH2

Project	Proposed Development	**Sheet**	1 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	13/12/2021
Position	Refer to Figure 2	**Date Completed**	14/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 13/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.40 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	27.40				-	FILL: Gravelly CLAY; high plasticity, brown, fine to coarse gravel, with rootlets.	M (=PL)	-	FILL
				0.20 27.20				CH	Silty CLAY; high plasticity, brown and grey, trace rootlets.			FLUVIAL SOIL
			1							M (>PL)	F	
					SPT 1.50-1.95 m 2,3,4 N=7							
			2	*2.20* 25.20					From 2.20m, brown and orange, with fine to medium grained sand.			
			3		SPT 3.00-3.45 m 4,5,9 N=14					M (<PL)	St	
				3.70 23.70				SC	Clayey SAND; fine to medium grained, grey, trace silt.			
			4									
					SPT 4.50-4.95 m 4,4,6 N=10					M	MD	
	-		5	*5.00* 22.40					From 5.00m, grey and orange-brown.			
				5.50 21.90				SM	Silty SAND; fine to medium grained, grey and orange-brown, trace clay.			
			6		SPT 6.00-6.45 m 3,5,9 N=14					M	MD	
			7							W		
				7.40 20.00				GW	Sandy GRAVEL; fine to coarse rounded to sub-angular gravel, fine to coarse grained sand, with cobbles and boulders.			
RT			8							-	-	
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

BH NO. BH2

Project	Proposed Development	**Sheet**	2 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	13/12/2021
Position	Refer to Figure 2	**Date Completed**	14/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 13/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.40 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
RT	-		10					GW	Sandy GRAVEL; fine to coarse rounded to sub-angular gravel, fine to coarse grained sand, with cobbles and boulders.	-	-	FLUVIAL SOIL
			11	*11.10*					Continued as Cored Borehole			
			12									
			13									
			14									
			15									
			16									
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

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BH NO. BH2

Project	Proposed Development	**Sheet**	3 OF 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	13/12/2021
Position	Refer to Figure 2	**Date Completed**	14/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 13/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.40 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) (30, 100, 300, 1000, 3000)
				10							
				11	*11.10*		Continuation from non-cored borehole				
NMLC	90% RETURN	100	29		16.30		LAMINITE; SANDSTONE and SHALE; grey and brown, thinly bedded.	DW		11.34: JT, 90°, Fe SN, PR, RO 11.41-11.42: XWS, 10 mm. 11.54-11.57: CS, 30 mm. 11.65-11.80: CZ, 150 mm.	
					11.60						
	80% RETURN	100	79	12	15.80		SANDSTONE; fine to medium grained, grey, medium bedded.	SW			
				13	*13.30*					13.24-13.31: JT	
					14.10		LAMINITE; SANDSTONE and SHALE; dark grey and grey, medium bedded.			13.84: JT, 30°, CN, PR, RO 14.19-14.26: XWS, 7mm.	
	60% RETURN	100	83	15						15.34-15.35: CS, 10 mm. 15.41-15.54: CZ, 130 mm. 15.57: JT, 20°, CN, CU, SM	
				16						16.61-16.67: CS, 60 mm.	
				17	*17.17*						
					10.23		Hole Terminated at 17.17 m Target Depth Reached.				
				18							
				19							
				20							

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH2

Project	Proposed Development			**Depth Range**	11.1m to 17.17m BEGL		
Location	160 Lord Sheffield Circuit, Penrith NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	Refer to Figure 2	**Surface RL**	≈ 27.40 m AHD	**Drill Rig**	Comacchio Geo 205		
Job No.	E25358.G03	**Inclination**	-90°	**Logged**	DD	**Date**	13 / 12 / 2021
Client	Urban Apartments Pty Ltd	**Box**	1-2 of 2	**Checked**	SR	**Date**	03 / 02 / 2022

BOREHOLE LOG

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Practical Solutions for Built Environments

BH NO. BH3

Project	Proposed Development	**Sheet**	1 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	09/11/2021
Position	Refer to Figure 2	**Date Completed**	10/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 09/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	27.50				-	FILL; Silty CLAY: high plasticity, dark brown and brown, trace fine to medium gravels, trace concrete rubble.	M (<PL)	-	FILL
				0.40								
				27.10	SPT 0.50-0.95 m 7,8,9 N=17			CH	Silty CLAY; high plasticity, mottled orange-brown and grey, trace fine gravels.			FLUVIAL SOIL
			1									
					SPT 1.50-1.95 m 3,7,9 N=16							
			2							M (<PL)	VSt	
				2.50								
				25.00					From 2.50m, grey mottled orange-brown.			
			3		SPT 3.00-3.45 m 6,12,12 N=24							
			4	*4.10*								
				23.40				SM	Silty SAND; fine to medium grained, orange-brown, with clay, trace fine gravels.			
					SPT 4.50-4.95 m 5,7,9 N=16					M	D	
	-		5	*5.10*								
				22.40				SP	SAND; fine to medium grained, orange-brown, with silt, trace clay.			
										M	MD	
			6		SPT 6.00-6.45 m 5,6,7 N=13							
		▽		*6.50*								
RT				21.00				GP	GRAVEL; fine to coarse grained, rounded to sub-angular, trace fine to medium grained sand.			
			7							-	-	
			8	*8.60*								
				18.90	SPT 8.60-9.05 m 6,8,15 N=23			SP	SAND; fine to medium grained, pale grey and grey.			
			9							W	D	
				9.20								
				18.30				GW	GRAVEL; fine to coarse grained, rounded to sub-angular, trace fine to medium grained sand.			
										-	-	
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

BH NO. BH3

Project	Proposed Development	**Sheet**	2 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	09/11/2021
Position	Refer to Figure 2	**Date Completed**	10/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 09/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
RT / NMLC	-		10					GW	GRAVEL; fine to coarse grained, rounded to sub-angular, trace fine to medium grained sand.	-	-	FLUVIAL SOIL
			11	*11.35*					Continued as Cored Borehole			
			12									
			13									
			14									
			15									
			16									
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

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BH NO. BH3

Project	Proposed Development	**Sheet**	3 OF 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	09/11/2021
Position	Refer to Figure 2	**Date Completed**	10/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 09/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) (30, 100, 300, 1000, 3000)
				10							
				11							
	90% RETURN				*11.35*		Continuation from non-cored borehole				
NMLC		100	0		16.05		GRAVEL; fine to coarse grained, rounded to sub-angular, trace fine to medium grained sand.	DW			
					11.70		SANDSTONE; fine grained, grey, with dark grey shale laminations.				
				12	15.80		NO CORE; 500 mm.				
					12.20						
	90% RETURN				15.30		SANDSTONE; fine grained, grey, medium bedded, with dark grey shale laminations.	FR		12.20-12.28: CS, 80 mm. 12.38: JT, 8°, CN, IR, RO 12.43: JT, 50°, CN, IR, RO	
		100	70	13							
	25% RETURN			14						14.05-14.20: CZ, 150 mm.	
					14.50						
					13.00		SHALE; dark grey, very thinly bedded.			14.74-14.77: CS, 30 mm.	
				15	*15.00*						
	20% RETURN	100	62		12.50		LAMINITE; SANDSTONE and SHALE; grey and dark grey, thinly bedded.			15.10-15.20: CS, 100 mm. 15.47-15.51: CS, 40 mm. 15.88-15.97: CS, 90 mm. 16.04-16.09: CS, 5 mm. 16.17: JT, 8°, CN, PR, RO	
				16							
				17						17.16: JT, 5°, CN, IR, RO 17.30: JT, 15°, CN, IR, RO	
					17.40						
	50% RETURN	100	93		10.10		SANDSTONE; grey, fine grained, medium bedded.				
					17.83						
				18	9.67		Hole Terminated at 17.83 m Target Depth Reached.				
				19							
				20							

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH3

Project	Proposed Development			**Depth Range**	11.35m to 17.83m BEGL		
Location	160 Lord Sheffield Circuit, Penrith NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	Refer to Figure 2	**Surface RL**	≈ 27.50 m AHD	**Drill Rig**	Comacchio Geo 205		
Job No.	E25358.G03	**Inclination**	-90°	**Logged**	DD	**Date**	09 / 11 / 2021
Client	Urban Apartments Pty Ltd	**Box**	1-2 of 2	**Checked**	SR	**Date**	03 / 02 / 2022

BOREHOLE LOG

BH NO. BH4M

Project	Proposed Development	**Sheet**	1 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	10/11/2021
Position	Refer to Figure 2	**Date Completed**	11/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 10/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.60 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	27.60				-	FILL: Silty CLAY: high plasticity, grey brown and brown, trace rootlets.	M (=PL)	-	FILL
				0.40								
				27.20	SPT 0.50-0.95 m 6,10,11 N=21			CH	Silty CLAY; high plasticity, pale grey and grey-brown, trace rootlets, trace fine grained sand.			FLUVIAL SOIL
			1									
					SPT 1.50-1.95 m 6,10,14 N=24							
			2							M (<PL)	VSt	
			3		SPT 3.00-3.45 m 5,7,10 N=17							
			4									
				4.60	SPT 4.50-4.95 m 8,12,13 N=25							
	-			23.00				CI	Sandy CLAY; medium plasticity, orange-brown and grey, fine grained sand, with silt.	M (<PL)	VSt	
			5	*5.40*								
				22.20				SM	Silty SAND; fine to medium grained, orange-brown, with clay, with clay.	M	MD	
			6		SPT 6.00-6.45 m 5,7,8 N=15							
		▽	7							W		
				7.40								
RT				20.20				GW	GRAVEL; fine to coarse grained, rounded to sub-angular, with sand, fine to coarse grained with cobbles, trace clay.	-	-	
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

BH NO. BH4M

Project	Proposed Development	**Sheet**	2 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	10/11/2021
Position	Refer to Figure 2	**Date Completed**	11/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 10/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.60 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
RT	-		10					GW	GRAVEL; fine to coarse grained, rounded to sub-angular, with sand, fine to coarse grained with cobbles, trace clay.	-	-	FLUVIAL SOIL
			11									
			12	*12.00*					Continued as Cored Borehole			
			13									
			14									
			15									
			16									
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

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BH NO. BH4M

Project	Proposed Development	**Sheet**	3 OF 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	10/11/2021
Position	Refer to Figure 2	**Date Completed**	11/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 10/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.60 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) (30, 100, 300, 1000, 3000)
				10							
				11							
				12	*12.00*		Continuation from non-cored borehole				
NMLC	90% RETURN	100	0		15.55		GRAVEL; fine to coarse grained, rounded to sub-angular, with sand, fine to coarse grained with cobbles, trace clay.	DW		12.05-12.15: XWZ, 100 mm.	
							SANDSTONE; fine grained, grey-brown and grey, thinly bedded, with dark grey shale laminations.	SW			
	30% RETURN	100	47	13						13.68-13.71: CS, 30 mm.	
				14						14.06-14.07: XWS, 10 mm.	
										14.64-14.73: XWS, 90 mm.	
				15	*15.00*						
					12.60		SHALE; dark grey, thinly bedded.				
					15.40						
					12.20		LAMINITE; SANDSTONE and SHALE; pale grey and grey, medium bedded.	FR		15.35-15.42: CS, 70 mm.	
	30% RETURN	100	84	16							
				17						16.51-16.55: CS, 40 mm.	
				18	*18.10*						
					9.50		Hole Terminated at 18.10 m Target Depth Reached.				
				19							
				20							

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH4M

Project	Proposed Development			**Depth Range**	11.2m to 18.1m BEGL		
Location	160 Lord Sheffield Circuit, Penrith NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	Refer to Figure 2	**Surface RL**	≈ 27.60 m AHD	**Drill Rig**	Comacchio Geo 205		
Job No.	E25358.G03	**Inclination**	-90°	**Logged**	DD	**Date**	10 / 11 / 2021
Client	Urban Apartments Pty Ltd	**Box**	1-2 of 2	**Checked**	SR	**Date**	03 / 02 / 2022

MONITORING WELL LOG

MW NO. BH4M

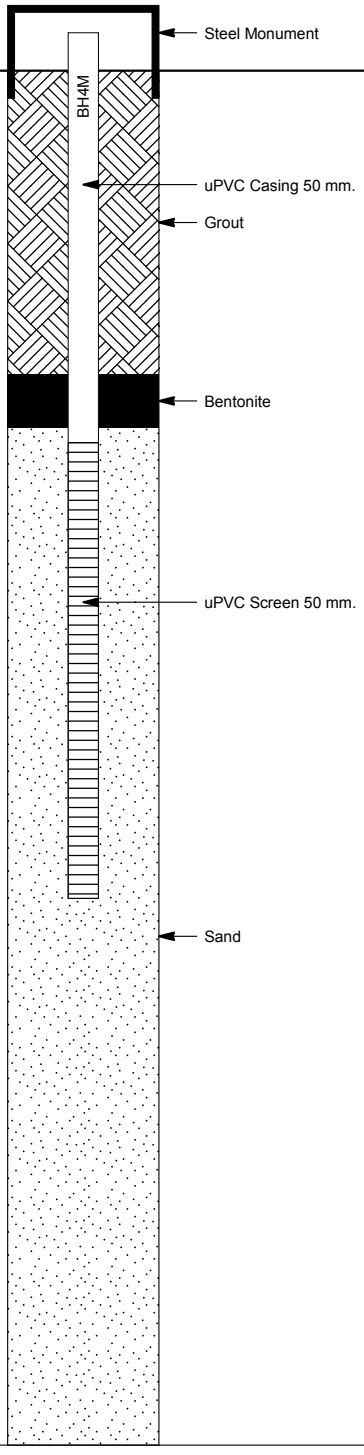
Project	Proposed Development	**Sheet**	1 of 2
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	10/11/2021
Position	Refer to Figure 2	**Date Completed**	11/11/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 10/11/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.60 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH4M	Standpipe	0.47 m 27.13 m	10.90 m 16.70 m		

METHOD	WATER	DEPTH (m)	RL (m AHD)	SOIL/ROCK MATERIAL DESCRIPTION
AD/T		0	28	FILL: Silty CLAY: high plasticity, grey brown and brown, trace rootlets.
				Silty CLAY; high plasticity, pale grey and grey-brown, trace rootlets, trace fine grained sand.
		2	26	
		4	24	Sandy CLAY; medium plasticity, orange-brown and grey, fine grained sand, with silt.
				4.90 m
		6	22	Silty SAND; fine to medium grained, orange-brown, with clay, with clay.
RT		8	20	GRAVEL; fine to coarse grained, rounded to sub-angular, with sand, fine to coarse grained with cobbles, trace clay.
		10	18	
				10.90 m
	90% RETURN	12	16	GRAVEL; fine to coarse grained, rounded to sub-angular, with sand, fine to coarse grained with cobbles, trace clay.
NMLC	30% RETURN	14	14	SANDSTONE; fine grained, grey-brown and grey, thinly bedded, with dark grey shale laminations.
				SHALE; dark grey, thinly bedded.
	30% RETURN	16	12	LAMINITE; SANDSTONE and SHALE; pale grey and grey, medium bedded.
		18	10	Hole Terminated at 18.10 m Target Depth Reached.



This well log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

BH NO. BH5

Project	Proposed Development	**Sheet**	1 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	14/12/2021
Position	Refer to Figure 2	**Date Completed**	15/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 14/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-		0	27.50				-	TOPSOIL: Silty CLAY; high plasticity, with rootlets.	M (=PL)	-	TOPSOIL
				0.20								
				27.30				-	FILL: Gravelly SILT; fine to medium gravel, with fine to coarse grained sand.			FILL
			1							M (<PL)	-	
				1.20								
				26.30				CH	Silty CLAY; high plasticity, dark brown and red, trace fine gravel.			FLUVIAL SOIL
			2		DS 1.50-1.80 m							
				2.30								
				25.20					From 2.30 m, grey.			
			3		SPT 3.00-3.45 m 3,4,6 N=10							
			4							M (=PL)	St	
				5.00								
			5	22.50					From 5.00m, grey and grey-brown, trace fine grained sand.			
			6		SPT 6.00-6.45 m 4,5,6 N=11							
				6.70								
				20.80				SM	Silty SAND; fine to medium grained sand, orange-yellow with clay.	M		
		▽	7		DS 7.20-7.50 m					W	-	
			8	*8.10*								
				19.40				GW	Sandy GRAVEL; fine to coarse rounded to sub-angular gravel, fine to coarse grained sand.			
			9							-	-	
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

BH NO. BH5

Project	Proposed Development	**Sheet**	2 of 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	14/12/2021
Position	Refer to Figure 2	**Date Completed**	15/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 14/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-		10					GW	Sandy GRAVEL; fine to coarse rounded to sub-angular gravel, fine to coarse grained sand.	-	-	FLUVIAL SOIL
			11									
			12	12.50					Continued as Cored Borehole			
			13									
			14									
			15									
			16									
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

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BH NO. BH5

Project	Proposed Development	**Sheet**	3 OF 3
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	14/12/2021
Position	Refer to Figure 2	**Date Completed**	15/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 14/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

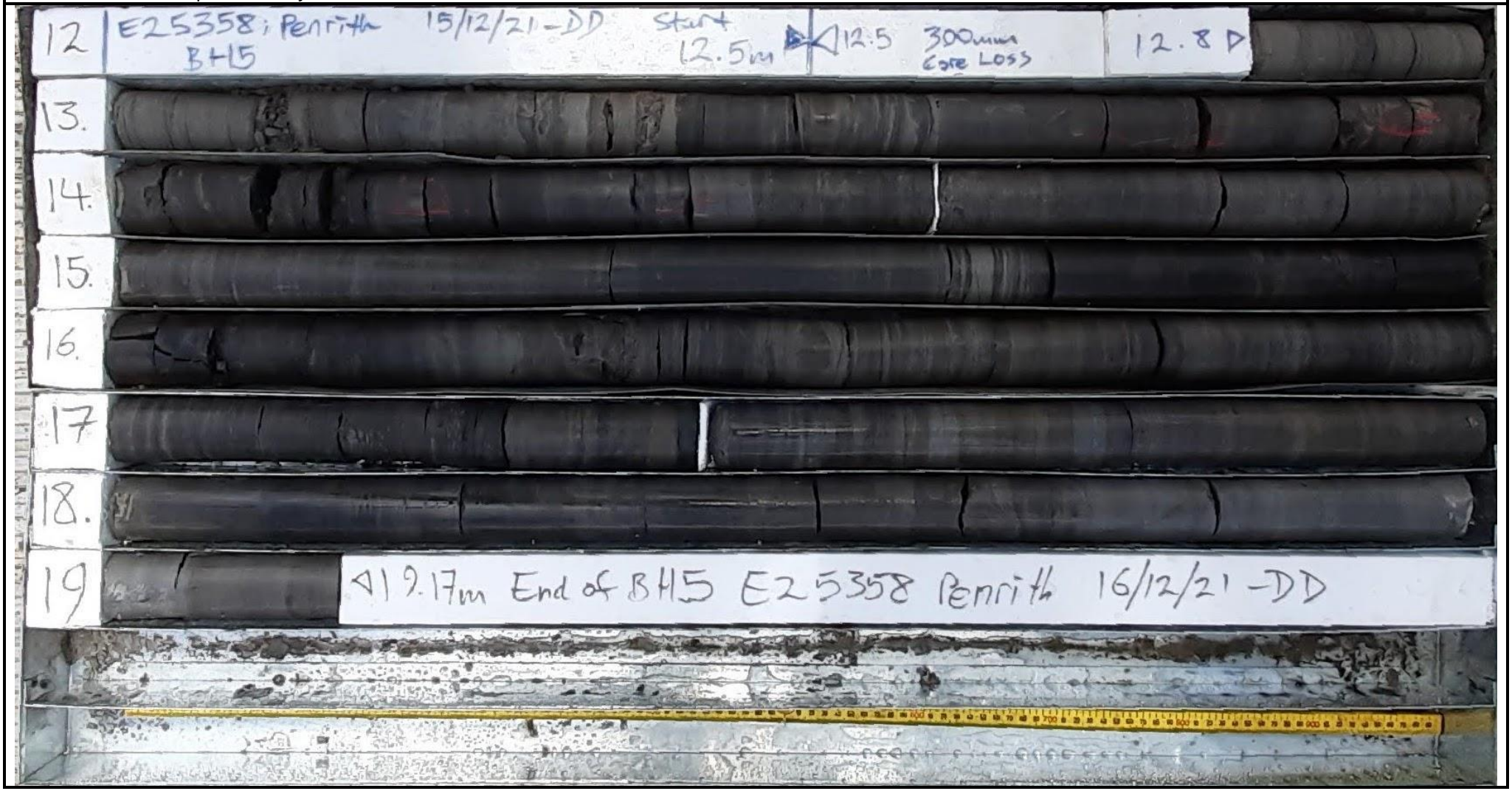
Drilling Contractor	Geosense	**Surface RL**	≈27.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) (30, 100, 300, 1000, 3000)
				10							
				11							
				12							
					12.50		Continuation from non-cored borehole				
NMLC	80% RETURN	81	74		15.00 *12.80*		NO CORE; 300 mm.	-			
				13	14.70		LAMINITE; SANDSTONE and SHALE; grey and dark grey, medium bedded.	SW		13.11-13.16: XWS, 50 mm. 13.38-13.40: XWS, 20 mm.	
				14						14.12: JT, 20°, CN, ST, RO 14.16-14.18: CS, 20 mm.	
	80% RETURN	100	92	15							
				16						16.06: JT, 90°, CN, ST, SM 16.07-16.09: CS, 20 mm. 16.35-16.37: CS, 20 mm.	
				17							
	80% RETURN	100	100	18						18.61: JT, 10°, CN, IR, RO	
				19	*19.17*						
					8.33		Hole Terminated at 19.17 m Target Depth Reached.				
				20							

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH5

Project	Proposed Development			**Depth Range**	12.8m to 19.17m BEGL		
Location	160 Lord Sheffield Circuit, Penrith NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	Refer to Figure 2	**Surface RL**	≈ 27.50 m AHD	**Drill Rig**	Comacchio Geo 205		
Job No.	E25358.G03	**Inclination**	-90°	**Logged**	DD	**Date**	16 / 12 / 2021
Client	Urban Apartments Pty Ltd	**Box**	1-2 of 2	**Checked**	SR	**Date**	03 / 02 / 2022



BOREHOLE LOG

BH NO. BH6

Project	Proposed Development	**Sheet**	1 of 4
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	16/12/2021
Position	Refer to Figure 2	**Date Completed**	17/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 16/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.80 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	27.80				-	TOPSOIL: Silty CLAY; high plasticity, dark brown, with rootlets.	M (=PL)	-	TOPSOIL
				0.20								
				27.60				-	FILL: Silty CLAY; medium plasticity, orange-brown with fine grained sand.	M (=PL)	-	FILL
				0.70								
			1	27.10				-	FILL: Silty CLAY: medium to high plasticity, brown, with rootlets, with fine grained sand.	M (<PL)	-	
				1.20								
				26.60				CH	Silty CLAY; high plasticity, pale-brown, trace fine grained sand.			FLUVIAL SOIL
					SPT 1.50-1.95 m 2,4,4 N=8							
				1.80								
				26.00					From 1.80m, brown and pale grey, trace fine gravel.			
			2								St	
					SPT 3.00-3.45 m 3,3,6 N=9					M (<PL)		
			3									
			4								VSt	
					SPT 4.50-4.95 m 6,9,12 N=21							
				5.00								
			5	22.80				CL	Sandy CLAY; low plasticity, brown and pale grey, with silt.			
					SPT 6.00-6.45 m 4,6,9 N=15					M (<PL)	St	
			6									
				6.80								
				21.00				SC	Clayey SAND; fine grained, brown and grey, with silt.			
			7							M	MD	
					SPT 7.50-7.85 m 4,8 HB N=8/200mm					W		
				7.80								
				20.00				GW	Sandy GRAVEL; fine to coarse gravel, fine to coarse grained sand, rounded to sub-angular gravel, with clay, with cobbles.			
			8									
										-	-	
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

BH NO. BH6

Project	Proposed Development	**Sheet**	2 of 4
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	16/12/2021
Position	Refer to Figure 2	**Date Completed**	17/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 16/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.80 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-		10					GW	Sandy GRAVEL; fine to coarse gravel, fine to coarse grained sand, rounded to sub-angular gravel, with clay, with cobbles.	-	-	FLUVIAL SOIL
			11									
			12									
			13									
			14	14.10								
									Continued as Cored Borehole			
			15									
			16									
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

eiaustralia
Practical Solutions for Built Environments

BH NO. BH6

Project	Proposed Development	**Sheet**	3 OF 4
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	16/12/2021
Position	Refer to Figure 2	**Date Completed**	17/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 16/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.80 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) (30, 100, 300, 1000, 3000)
				10							
				11							
				12							
				13							
				14	*14.10*		Continuation from non-cored borehole				
NMLC	60% RETURN	100	0		13.70 *14.30*		CLAYSTONE; dark grey, thinly bedded.	DW	A		
					13.50		LAMINITE; SANDSTONE and SHALE; dark grey and pale grey, medium bedded.	SW		14.35-14.40: JT, 90°, CN, ST, RO 14.67-14.68: CS, 10 mm.	
		100	64	15						15.53: XWS, 4 mm. 15.59-15.76: XWS, 170 mm.	
				16						15.90-15.96: CS, 60 mm.	
				17						16.66-16.71: XWS, 5 mm. 16.68-16.72: XWS, 4 mm. 16.92-16.95: XWS, 3 mm. 17.00-17.09: CS, 90 mm.	
				18	*18.20*					17.95: JT, 20°, CN, PR, SM 18.10-18.20: CS, 10 mm.	
	60% RETURN	100	98		9.60		SANDSTONE; fine grained, pale grey, medium bedded.	FR			
				19							
				20							

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

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Practical Solutions for Built Environments

BH NO. BH6

Project	Proposed Development	**Sheet**	4 OF 4
Location	160 Lord Sheffield Circuit, Penrith NSW	**Date Started**	16/12/2021
Position	Refer to Figure 2	**Date Completed**	17/12/2021
Job No.	E25358.G03	**Logged By** DD	**Date** 16/12/2021
Client	Urban Apartments Pty Ltd	**Reviewed By** SR	**Date** 03/02/2022

Drilling Contractor	Geosense	**Surface RL**	≈27.80 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) (30, 100, 300, 1000, 3000)
NMLC		100	98	20	*20.30* 7.50		SANDSTONE; fine grained, pale grey, medium bedded.	FR			
							Hole Terminated at 20.30 m Target Depth Reached.				
				21							
				22							
				23							
				24							
				25							
				26							
				27							
				28							
				29							
				30							

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH6

Project	Proposed Development			**Depth Range**	14.1m to 20.3m BEGL		
Location	160 Lord Sheffield Circuit, Penrith NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	Refer to Figure 2	**Surface RL**	≈ 27.80 m AHD	**Drill Rig**	Comacchio Geo 205		
Job No.	E25358.G03	**Inclination**	-90°	**Logged**	DD	**Date**	17 / 12 / 2021
Client	Urban Apartments Pty Ltd	**Box**	1-2 of 2	**Checked**	SR	**Date**	03 / 02 / 2022

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT LOGS

DRILLING/EXCAVATION METHOD

HA	Hand Auger	**ADH**	Hollow Auger	**NQ**	Diamond Core - 47 mm
DT	Diatube Coring	**RT**	Rotary Tricone bit	**NMLC**	Diamond Core - 52 mm
NDD	Non-destructive digging	**RAB**	Rotary Air Blast	**HQ**	Diamond Core - 63 mm
AD*	Auger Drilling	**RC**	Reverse Circulation	**HMLC**	Diamond Core - 63 mm
***V**	V-Bit	**PT**	Push Tube	**EX**	Tracked Hydraulic Excavator
***T**	TC-Bit, e.g. AD/T	**WB**	Washbore	**HAND**	Excavated by Hand Methods

PENETRATION RESISTANCE

L	**Low Resistance**	Rapid penetration/ excavation possible with little effort from equipment used.
M	**Medium Resistance**	Penetration/ excavation possible at an acceptable rate with moderate effort from equipment used.
H	**High Resistance**	Penetration/ excavation is possible but at a slow rate and requires significant effort from equipment used.
R	**Refusal/Practical Refusal**	No further progress possible without risk of damage or unacceptable wear to equipment used.

These assessments are subjective and are dependent on many factors, including equipment power and weight, condition of excavation or drilling tools and experience of the operator.

WATER

Standing Water Level — **Partial water loss**

Water Seepage — **Complete Water Loss**

GWNO	GROUNDWATER NOT OBSERVED - Observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave-in of the borehole/ test pit.
GWNE	GROUNDWATER NOT ENCOUNTERED - Borehole/ test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/ test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following a 150mm seating drive
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported, N is not reported
RW	Penetration occurred under the rod weight only, N<1
HW	Penetration occurred under the hammer and rod weight only, N<1
HB	Hammer double bouncing on anvil, N is not reported
Sampling	
DS	Disturbed Sample
ES	Sample for environmental testing
BDS	Bulk disturbed Sample
GS	Gas Sample
WS	Water Sample
U50	Thin walled tube sample - number indicates nominal sample diameter in millimetres
Testing	
FP	Field Permeability test over section noted
FVS	Field Vane Shear test expressed as uncorrected shear strength (sv= peak value, sr= residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket Penetrometer test expressed as instrument reading in kPa
WPT	Water Pressure tests
DCP	Dynamic Cone Penetrometer test
CPT	Static Cone Penetration test
CPTu	Static Cone Penetration test with pore pressure (u) measurement

GEOLOGICAL BOUNDARIES

———— = Observed Boundary (position known)

– – – – – – – – – – = Observed Boundary (position approximate)

– –?– –?– –?– – = Boundary (interpreted or inferred)

ROCK CORE RECOVERY

TCR=Total Core Recovery (%)

$$= \frac{\textit{Length of core recovered}}{\textit{Length of core run}} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum \textit{Axial lengths of core} > 100mm}{\textit{Length of core run}} \times 100$$

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT LOGS

	FILL		ORGANIC SOILS (OL, OH or Pt)		CLAY (CL, CI or CH)
	COUBLES or BOULDERS		SILT (ML or MH)		SAND (SP or SW)
	GRAVEL (GP or GW)	Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay			

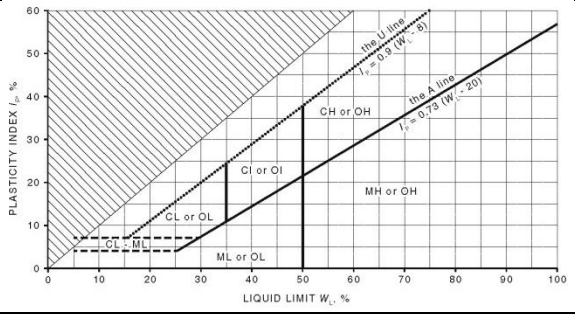
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS 1726:2017, Section 6.1 – Soil description and classification.

PARTICLE SIZE CHARACTERISTICS

Fraction	Components	Sub Division	Size mm
Oversize	BOULDERS		>200
	COBBLES		63 to 200
Coarse grained soil	GRAVEL	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	SAND	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine grained soil	SILT		0.002 to 0.075
	CLAY		<0.002

PLASTICITY PROPERTIES



GROUP SYMBOLS

Major Divisions		Symbol	Description
COARSE GRAINED SOILS More than 65% of soil excluding oversize fraction is greater than 0.075mm	GRAVEL More than 50% of coarse fraction is >2.36mm	GW	Well graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GP	Poorly graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GM	Silty gravel, gravel-sand-silt mixtures, zero to medium dry strength.
		GC	Clayey gravel, gravel-sand-clay mixtures, medium to high dry strength.
	SAND More than 50% of coarse fraction is <2.36 mm	SW	Well graded sand and gravelly sand, little or no fines, no dry strength.
		SP	Poorly graded sand and gravelly sand, little or no fines, no dry strength.
		SM	Silty sand, sand-silt mixtures, zero to medium dry strength.
		SC	Clayey sand, sandy-clay mixtures, medium to high dry strength.
FINE GRAINED SOILS More than 35% of soil excluding oversized fraction is less than 0.075mm	Liquid Limit less < 50%	ML	Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands, zero to medium dry strength.
		CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, medium to high dry strength.
		OL	Organic silts and organic silty clays of low plasticity, low to medium dry strength.
	Liquid Limit > than 50%	MH	Inorganic silts of high plasticity, high to very high dry strength.
		CH	Inorganic clays of high plasticity, high to very high dry strength.
		OH	Organic clays of medium to high plasticity, medium to high dry strength.
Highly Organic soil		PT	Peat muck and other highly organic soils.

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Non- cohesive and free-running.
M	Moist	Soils feel cool, darkened in colour. Soil tends to stick together.
W	Wet	Soils feel cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture content of cohesive soils shall be described in relation to plastic limit (PL) or liquid limit (LL) for soils with higher moisture content as follows: Moist, dry of plastic limit (w < PL); Moist, near plastic limit (w ≈ PL); Moist, wet of plastic limit (w < PL); Wet, near liquid limit (w ≈ LL), Wet, wet of liquid limit (w > LL),

CONSISTENCY

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N" #
VS	Very Soft	≤ 12	≤ 2
S	Soft	>12 to ≤ 25	>2 to ≤ 4
F	Firm	>25 to ≤ 50	>4 to 8
St	Stiff	>50 to ≤ 100	>8 to 15
VSt	Very Stiff	>100 to ≤ 200	>15 to 30
H	Hard	>200	>30
Fr	Friable	-	

DENSITY

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	≤ 15	0 to 4
L	Loose	>15 to ≤ 35	4 to 10
MD	Medium Dense	>35 to ≤ 65	10 to 30
D	Dense	>65 to ≤ 85	30 to 50
VD	Very Dense	>85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.
SPT correlations are not stated in AS1726:2017, and may be subject to corrections for overburden pressure, moisture content of the soil, and equipment type.

MINOR COMPONENTS

Term	Assessment Guide	Proportion by Mass
Add 'Trace'	Presence just detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: ≤ 5% Fine grained soil: ≤ 15%
Add 'With'	Presence easily detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: 5 - 12% Fine grained soil: 15 - 30%
Prefix soil name	Presence easily detectable by feel or eye in conjunction with the general properties of primary component	Coarse grained soils: >12% Fine grained soil: >30%

TERMS FOR ROCK MATERIAL STRENGTH AND WEATHERING

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

ROCK MATERIAL STRENGTH CLASSIFICATION

Symbol	Term	Point Load Index, $Is_{(50)}$ (MPa) #	Field Guide
VL	Very Low	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

 # Rock Strength Test Results

▼ Point Load Strength Index, $Is_{(50)}$, Axial test (MPa)

● Point Load Strength Index, $Is_{(50)}$, Diametral test (MPa)

Relationship between rock strength test result ($Is_{(50)}$) and unconfined compressive strength (UCS) will vary with rock type and strength, and should be determined on a site-specific basis. However UCS is typically 20 x $Is_{(50)}$.

ROCK MATERIAL WEATHERING CLASSIFICATION

Symbol		Term	Field Guide
RS		Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
XW		Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW	Distinctly Weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
	MW		
SW		Slightly Weathered	Rock slightly discoloured but shows little or no change of strength relative to fresh rock.
FR		Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

CLASSIFICATION AND INFERRED STRATIGRAPHY
Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

DETAILED ROCK DEFECT SPACING

Defect Spacing

Spacing/width (mm)	Descriptor	Symbol
<20	Extremely Close	EC
20-60	Very Close	VC
60-200	Close	C
200-600	Medium	M
600-2000	Wide	W
2000-6000	Very Wide	VW

Bedding Thickness (Stratification)

Term	Spacing (mm)
Thinly laminated	<6
Laminated	6 – 20
Very thinly bedded	20 – 60
Thinly bedded	60 – 200
Medium bedded	200 – 600
Thickly bedded	600 – 2,000
Very thickly bedded	> 2,000

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT TYPES

Defect Type	Abbr.	Description
Joint	JT	Surface of a fracture or parting, formed without displacement, across which the rock has little or no tensile strength. May be closed or filled by air, water or soil or rock substance, which acts as cement.
Bedding Parting	BP	Surface of fracture or parting, across which the rock has little or no tensile strength, parallel or sub-parallel to layering/ bedding. Bedding refers to the layering or stratification of a rock, indicating orientation during deposition, resulting in planar anisotropy in the rock material.
Contact	CO	The surface between two types or ages of rock.
Sheared Surface	SSU	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.
Sheared Seam/ Zone (Fault)	SS/SZ	Seam or zone with roughly parallel almost planar boundaries of rock substance cut by closely spaced (often <50 mm) parallel and usually smooth or slickensided joints or cleavage planes.
Crushed Seam/ Zone (Fault)	CS/CZ	Seam or zone composed of disoriented usually angular fragments of the host rock substance, with roughly parallel near-planar boundaries. The brecciated fragments may be of clay, silt, sand or gravel sizes or mixtures of these.
Extremely Weathered Seam/ Zone	XWS/XWZ	Seam of soil substance, often with gradational boundaries, formed by weathering of the rock material in places.
Infilled Seam	IS	Seam of soil substance, usually clay or clayey, with very distinct roughly parallel boundaries, formed by soil migrating into joint or open cavity.
Vein	VN	Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.

NOTE: Defects size of <100mm SS, CS and XWS. Defects size of >100mm SZ, CZ and XWZ.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

Shape	Abbr.	Description	Roughness	Abbr.	Description
Planar	PR	Consistent orientation	Polished	POL	Shiny smooth surface
Curved	CU	Gradual change in orientation	Slickensided	SL	Grooved or striated surface, usually polished
Undulating	UN	Wavy surface	Smooth	SM	Smooth to touch. Few or no surface irregularities
Stepped	ST	One or more well defined steps	Rough	RO	Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper
Irregular	IR	Many sharp changes in orientation	Very Rough	VR	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper

Orientation: **Vertical Boreholes –** The dip (inclination from horizontal) of the defect.
Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

Coating	Abbr.	Description
Clean	CN	No visible coating or infilling
Stain	SN	No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)
Veneer	VNR	A visible coating of soil or mineral substance, usually too thin to measure (< 1 mm); may be patchy

DEFECT APERTURE

Aperture	Abbr.	Description
Closed	CL	Closed.
Open	OP	Without any infill material.
Infilled	-	Soil or rock i.e. clay, silt, talc, pyrite, quartz, etc.

Appendix B – Laboratory Certificates

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Atterberg Limits and Linear Shrinkage Report

Project: E25358.G03: 162 - 172 Lord Sheffield Circuit, Penrith — Project No.: 31380

Client: EI Australia Pty Ltd — Report No.: 21/3532

Address: Suite 6.01, 55 Miller Street, Pyrmont NSW 2009 — Report Date: 29/11/2021

Test Method: AS1289.3.1.2, 3.2.1, 3.1.1, 3.4.1, 2.1.1 — Page: 1 of 2

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

STS / Sample No.	5842D-L/1	5842D-L/2				
Sample Location	Borehole 1	Borehole 3				
Material Description	Silty Sandy Clay, red brown trace of gravel	Clayey Silty Sand, red brown trace of gravel				
Depth (m)	1.5 - 1.95	6.0 - 6.45				
Sample Date	12/11/2021	12/11/2021				
Sample History	Oven Dried	Oven Dried				
Method of Preparation	Dry Sieved	Dry Sieved				
Liquid Limit (%)	**30**	**23**				
Plastic Limit (%)	**13**	**14**				
Plasticity Index	**17**	**9**				
Linear Shrinkage (%)	**10**	**5.5**				
Mould Size (mm)	127	127				
Crumbing	N	N				
Curling	N	N				

Remarks:

[redacted]

Approved Signatory.....

Technician: LL

David Ly - Senior Geotechnician

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Moisture Content of Soil and Aggregate Samples

Project: E25358.G03: 162 - 172 Lord Sheffield Circuit, Penrith — Project No.: 31380

Client: EI Australia Pty Ltd — Report No.: 21/3532

Address: Suite 6.01, 55 Miller Street, Pyrmont NSW 2009 — Report Date: 29/11/2021

Test Method: AS1289.2.1.1 — Page: 2 of 2

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

STS / Sample No.	5842D-L/1	5842D-L/2				
Sample Location	Borehole 1	Borehole 3				
Material Description	Silty Sandy Clay, red brown trace of gravel	Clayey Silty Sand, red brown trace of gravel				
Depth (mm)	1.5 - 1.95	6.0 - 6.45				
Sample Date	12/11/2021	12/11/2021				
Moisture Content (%)	**14.3**	**16.7**				

Remarks:

Approved Signatory.....

Technician: LL — David Ly - Senior Geotechnician

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Atterberg Limits and Linear Shrinkage Report

Project: E25358.G03.2 | 162 - 172 Lord Sheffield Circuit, Penrith Project No.: 31380

Client: EI Australia Pty Ltd Report No.: 22/0287

Address: Suite 6.01, 55 Miller Street, Pyrmont NSW 2009 Report Date: 28/01/2022

Test Method: AS1289.3.1.2, .3.2.1, .3.1.1, .3.4.1 Page: 1 OF 2

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

STS / Sample No.	5976D-L/1					
Sample Location	Borehole 2					
Material Description	Silty Clay, orange/grey brown					
Depth (m)	1.5 - 1.95					
Sample Date	7/01/2022					
Sample History	Oven Dried					
Method of Preparation	Dry Sieved					
Liquid Limit (%)	**68**					
Plastic Limit (%)	**22**					
Plasticity Index	**46**					
Linear Shrinkage (%)	**15.5**					
Mould Size (mm)	250					
Crumbing	N					
Curling	Y					

Remarks:

[redacted]

Approved Signatory.....

Technician: DH

Orlando Mendoza - Laboratory Manager

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

NATA Accredited for Compliance with ISO/IEC 17025 - Testing No. 2750

Moisture Content of Soil and Aggregate Samples

Project: E25358.G03.2 | 162 - 172 Lord Sheffield Circuit, Penrith — Project No.: 31380

Client: EI Australia Pty Ltd — Report No.: 22/0287

Address: Suite 6.01, 55 Miller Street, Pyrmont NSW 2009 — Report Date: 28/01/2022

Test Method: AS1289.2.1.1 — Page: 2 OF 2

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

STS / Sample No.	5976D-L/1					
Sample Location	Borehole 2					
Material Description	Silty Clay, orange/grey brown					
Depth (mm)	1.5 - 1.95					
Sample Date	7/01/2022					
Moisture Content (%)	**28.7**					

Remarks:

[redacted]

Approved Signatory.....

Technician: DH

Orlando Mendoza - Laboratory Manager

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

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14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Point Load Strength Index Report

Project: E25358.G03: 162 - 172 Lord Sheffield Circuit, Penrith
Project No.: 31380/5842D-L

Client: EI Australia Pty Ltd
Report No.: 21/3529

Address: Suite 6.01, 55 Miller Street, Pyrmont NSW 2009
Report Date: 29/11/2021

Test Method: AS4133.4.1

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

Date Samples Drilled / Taken: 12/11/21

Borehole No. 1

Depth	Test Type	Is(50) (Mpa)	Rock Type	Failure Type	Moisture
12.15	A	0.890	SS	3	D
12.42	A	1.200	SS	3	D
13.51	A	3.200	SS	3	D
13.48	A	1.600	SS	3	D
15.48	A	0.370	SS	3	W
16.49	A	1.800	SS	3	D
17.48	A	1.600	SS	3	D

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

Date Samples Drilled / Taken: 12/11/21

Borehole No. 3

Depth	Test Type	Is(50) (Mpa)	Rock Type	Failure Type	Moisture
12.45	A	3.80	SS	3	D
13.45	A	1.00	SS	3	D
14.40	A	0.50	SS	3	D
15.54	A	1.90	SS	3	D
16.50	A	3.90	SS	3	D

FAILURE TYPE
1= FRACTURE THROUGH BEDDING OR WEAK PLANE
2= FRACTURE ALONG BEDDING
3= FRACTURE THROUGH ROCK MASS
4= FRACTURE INFLUENCED BY NATURAL DEFECT OR DRILLING
5= PARTIAL FRACTURE OR CHIP (INVALID RESULT)

TEST TYPE
A= AXIAL
D= DIAMETRAL
I= IRREGULAR
C= CUBE

MOISTURE CONDITION
W= WET
M= MOIST
D= DRY

ROCK TYPE
SS= SANDSTONE
ST= SILTSTONE
SH= SHALE
YS= CLAYSTONE
IG= IGNEOUS

Remarks:

Approved Signato[redacted]....

Technician: FV

Orlando Mendoza - Laboratory Manager

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
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Point Load Strength Index Report

Project: E25358.G03: 162 - 172 Lord Sheffield Circuit, Penrith
Project No.: 31380/5842D-L

Client: EI Australia Pty Ltd
Report No.: 21/3529

Address: Suite 6.01, 55 Miller Street, Pyrmont NSW 2009
Report Date: 29/11/2021

Test Method: AS4133.4.1
Page: 2 of 2

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

Date Samples Drilled / Taken: 12/11/21

Borehole No. 4

Depth	Test Type	Is(50) (Mpa)	Rock Type	Failure Type	Moisture
12.31	A	0.500	SS	3	D
12.63	A	1.300	SS	3	D
13.43	A	0.600	SS	3	D
14.50	A	0.370	SS	3	D
15.51	A	1.000	SS	3	D
16.56	A	0.730	SS	3	D
17.31	A	2.000	SS	3	D

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

Date Samples Drilled / Taken:

Borehole No.

Depth	Test Type	Is(50) (Mpa)	Rock Type	Failure Type	Moisture

FAILURE TYPE
1= FRACTURE THROUGH BEDDING OR WEAK PLANE
2= FRACTURE ALONG BEDDING
3= FRACTURE THROUGH ROCK MASS
4= FRACTURE INFLUENCED BY NATURAL DEFECT OR DRILLING
5= PARTIAL FRACTURE OR CHIP (INVALID RESULT)

TEST TYPE
A= AXIAL
D= DIAMETRAL
I= IRREGULAR
C= CUBE

MOISTURE CONDITION
W= WET
M= MOIST
D= DRY

ROCK TYPE
SS= SANDSTONE
ST= SILTSTONE
SH= SHALE
YS= CLAYSTONE
IG= IGNEOUS

Remarks:

Approved Signatory: [redacted]

Technician: FV

Orlando Mendoza - Laboratory Manager

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

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14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Point Load Strength Index Report

Project: E25358.G03.2 | 162 - 172 Lord Sheffield Circuit, Penrith
Client: El Australia P/L
Address: 6.01, 55 Miller St., Pyrmont
Test Method: AS 4133.4.1
Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

Project No.: 31380/5976D-L
Report No.: 22/0117
Report Date: 13/01/2022
Page: 1 of 1

Borehole / Sample No.	Depth (m)	Date Sampled	Date Tested	Test Type	Is (MPa)	$Is_{(50)}$ (MPa)	Rock Type	Failure Type	Moisture
BH2	11.17	07/01/2022	12/01/2022	A	1.2	1.3	TS	4	D
BH2	11.86	07/01/2022	12/01/2022	A	1.8	1.7	TS	3	D
BH2	12.53	07/01/2022	12/01/2022	A	3.5	3.4	TS	3	D
BH2	13.32	07/01/2022	12/01/2022	A	1.7	1.7	TS	3	D
BH2	14.31	07/01/2022	12/01/2022	A	3.2	3.1	TS	3	D
BH2	15.29	07/01/2022	12/01/2022	A	2.0	2.0	TS	3	D
BH2	16.70	07/01/2022	12/01/2022	A	0.81	0.82	TS	3	D
BH2	17.17	07/01/2022	12/01/2022	A	3.3	3.4	TS	3	D
BH5	12.85	07/01/2022	12/01/2022	A	0.29	0.31	TS	3	D
BH5	13.23	07/01/2022	12/01/2022	A	0.71	0.71	TS	3	D
BH5	14.47	07/01/2022	12/01/2022	A	1.4	1.5	TS	3	D
BH5	15.23	07/01/2022	12/01/2022	A	1.7	1.7	TS	3	D
BH5	16.54	07/01/2022	12/01/2022	A	1.1	1.1	TS	3	D
BH5	18.21	07/01/2022	12/01/2022	A	1.6	1.7	TS	3	D
BH6	14.26	07/01/2022	12/01/2022	A	0.032	0.032	TS	3	D
BH6	14.73	07/01/2022	12/01/2022	A	1.5	1.6	TS	3	D
BH6	15.10	07/01/2022	12/01/2022	A	0.51	0.53	TS	3	D
BH6	16.38	07/01/2022	12/01/2022	A	1.7	1.6	TS	3	D
BH6	17.13	07/01/2022	12/01/2022	A	1.6	1.6	TS	3	D
BH6	18.27	07/01/2022	12/01/2022	A	1.4	1.4	TS	3	D
BH6	19.62	07/01/2022	12/01/2022	A	2.3	2.4	TS	3	D
BH6	20.20	07/01/2022	12/01/2022	A	2.9	2.9	TS	3	D

Failure Type	Test Type	Moisure Condition	Rock Type
1 = Fracture through bedding or weak plane	A = Axial	W = Wet	SS = Sandstone
2 = Fracture along bedding	D = Diametrial	M = Moist	ST = Siltstone
3 = Fracture through rock mass	I = Irregular	D = Dry	SH = Shale
4 = Fracture influenced by natural defect or drilling	C = Cube		YS = Claystoane
5 = Partial fracture or chip (invalid result)			IG = Igneous

Remarks:

[redacted]

Approved Signatory.....

Technician: LS

Philip Ihnativ - Senior Geotechnician

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Daniel Duffy
Client	EI AUSTRALIA
Address	SUITE 6.01 55 MILLER STREET PYRMONT NSW 2009
Telephone	61 2 95160722
Facsimile	(Not specified)
Email	daniel.duffy@eiaustralia.com.au
Project	**E25358.G03 162-172 Lord Sheffield Circui**
Order Number	**E25358.G03**
Samples	3

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE226015 R0**
Date Received	18/11/2021
Date Reported	25/11/2021

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

[redacted]

Dong LIANG
Metals/Inorganics Team Leader

[redacted]

Shane MCDERMOTT
Inorganic/Metals Chemist

Soluble Anions (1:5) in Soil/Solids by Ion Chromatography [AN245] Tested: 23/11/2021

PARAMETER	UOM	LOR	BH1_3.0-3.45 SOIL - 18/11/2021 SE226015.001	BH3_6.0-6.45 SOIL - 18/11/2021 SE226015.002	BH4M_1.5-1.95 SOIL - 18/11/2021 SE226015.003
Chloride	mg/kg	0.25	**710**	**600**	**2000**
Sulfate	mg/kg	5	<5.0	**63**	**82**

pH in soil (1:5) [AN101] Tested: 23/11/2021

PARAMETER	UOM	LOR	BH1_3.0-3.45 SOIL - 18/11/2021 SE226015.001	BH3_6.0-6.45 SOIL - 18/11/2021 SE226015.002	BH4M_1.5-1.95 SOIL - 18/11/2021 SE226015.003
pH	pH Units	0.1	**6.3**	**8.0**	**4.7**

Conductivity and TDS by Calculation - Soil [AN106] Tested: 23/11/2021

PARAMETER	UOM	LOR	BH1_3.0-3.45 SOIL - 18/11/2021 SE226015.001	BH3_6.0-6.45 SOIL - 18/11/2021 SE226015.002	BH4M_1.5-1.95 SOIL - 18/11/2021 SE226015.003
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	500	520	1200

Moisture Content [AN002] Tested: 23/11/2021

PARAMETER	UOM	LOR	BH1_3.0-3.45 SOIL - 18/11/2021 SE226015.001	BH3_6.0-6.45 SOIL - 18/11/2021 SE226015.002	BH4M_1.5-1.95 SOIL - 18/11/2021 SE226015.003
% Moisture	%w/w	1	**10.1**	**17.9**	**18.7**

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl2) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract of as received sample with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
***	Indicates that both * and ** apply.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

This document is issued by the Company under its General Conditions of Service accessible at www.sgs.com/en/Terms-and-Conditions.aspx. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client only. Any unauthorized alteration, forgery or

Appendix C – Vibration Limits

German Standard DIN 4150 – Part 3: 1999 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally considered to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, OR, maximum levels measured in (x) or (y) directions, in the plane of the uppermost floor), are summarised in **Table A** below.

It should be noted that peak vibration velocities higher than the minimum figures in **Table A** for low frequencies may be quite 'safe', depending on the frequency content of the vibration and the actual conditions of the structures.

It should also be noted that these levels are 'safe limits', up to which no damage due to vibration effects has been observed for the particular class of building. 'Damage' is defined by DIN 4150 to include even minor non-structural cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should damage be observed at vibration levels lower than the 'safe limits', then it may be attributed to other causes. DIN 4150 also states that when vibration levels higher than the 'safe limits' are present, it does not necessarily follow that damage will occur. Values given are only a broad guide.

Table A DIN 4150 – Structural Damage – Safe Limits for Building Vibration

Group	Type of Structure	Peak Vibration Velocity (mm/s)			
		At Foundation Level at a Frequency of:			Plane of Floor of Uppermost Storey
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 and 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note: For frequencies above 100 Hz, the higher values in the 50 Hz to 100 Hz column should be used.

Appendix D – Important Information

Important Information

SCOPE OF SERVICES

The geotechnical report ("the report") has been prepared in accordance with the scope of services as set out in the contract, or as otherwise agreed, between the Client And EI Australia ("EI"). The scope of work may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

EI has relied on data provided by the Client and other individuals and organizations, to prepare the report. Such data may include surveys, analyses, designs, maps and plans. EI has not verified the accuracy or completeness of the data except as stated in the report. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations ("conclusions") are based in whole or part on the data, EI will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to EI.

GEOTECHNICAL ENGINEERING

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared for a specific client, for a specific project and to meet specific needs, and may not be adequate for other clients or other purposes (e.g. a report prepared for a consulting civil engineer may not be adequate for a construction contractor). The report should not be used for other than its intended purpose without seeking additional geotechnical advice. Also, unless further geotechnical advice is obtained, the report cannot be used where the nature and/or details of the proposed development are changed.

LIMITATIONS OF SITE INVESTIGATION

The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model, and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation, the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies. The engineering logs are the subjective interpretation of subsurface conditions at a particular location and time, made by trained personnel. The actual interface between materials may be more gradual or abrupt than a report indicates.

SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions can be modified by changing natural forces or man-made influences. The report is based on conditions that existed at the time of subsurface exploration. Construction operations adjacent to the site, and natural events such as floods, or ground water fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. EI should be kept appraised of any such events, and should be consulted to determine if any additional tests are necessary.

VERIFICATION OF SITE CONDITIONS

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that EI be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of change of soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

REPRODUCTION OF REPORTS

 Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimize the likelihood of misinterpretation from logs.

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the Client and no other party. EI assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of EI or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

EI will not be liable to update or revise the report to take into account any events or emergent circumstances or fact occurring or becoming apparent after the date of the report.