
Report on Geotechnical Investigation

Ross Street Teaching and Learning Hub

**Corner Parramatta Road and Western
Avenue, Camperdown**

Prepared for The University of Sydney

Project 225008.00

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

Signature

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Report on geotechnical investigation

Ross Street Teaching and Learning Hub

Corner Parramatta Road and Western Avenue, Camperdown

1. Introduction

This report presents the results of a geotechnical investigation undertaken at University of Sydney, Camperdown campus for the proposed Teaching and Learning Hub (A01 Ross Street Development). The investigation was commissioned in an email dated 29 September 2023 by Laura MacMahon from the University of Sydney Infrastructure and was generally undertaken in accordance with Douglas Partners Pty Ltd (Douglas) proposal 225008.P.001.Rev1 dated 25 September 2023. It should be noted that modifications made to the design have been considered over the course of the assessment phase for the proposed works.

It is understood that the project will include the development of a new building. The investigation was required to support the initial master planning design. It is understood the proposed development will comprise a five storey building with single level basement.

This report considers the following Planning Secretary's Geotechnical Assessment Requirements (SEARs, issued 10 July 2023):

- Ground Conditions (SEARs item 13): ***"Assess potential impacts on soil resources and related infrastructure and riparian lands on and near the site, including soil erosion, salinity and acid sulfate soils."*** This report considers soil and rock conditions of the site as relevant to the proposed development. Data and comments relating to this item are provided in Sections 4 to 9; and
- Water Conditions (SEARs item 13): ***"Provide a Surface and Groundwater Impact Assessment that assesses potential impacts on surface water resources including related infrastructure, hydrology, dependent ecosystems, drainage lines, downstream assets and watercourses groundwater resources in accordance with the Groundwater Guidelines."*** This report does not address the surface water assessment. Data and comments in relation to groundwater with respect to the proposed development are provided in Sections 4 to 9.

This investigation included the drilling of six boreholes, installation of two groundwater monitoring wells, in situ testing and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on design and construction practice, for the current proposed development. The investigation was undertaken in conjunction with a preliminary contamination assessment (PSI) of the site which is reported separately in Douglas Report 225008.01.R.001.Rev0 dated August 2024.

This Geotechnical Investigation Report has been prepared for the University of Sydney (the applicant), and to support the preparation of a State Significant Development Application (SSD-57838709) to the Department of Planning and Environment (DPE).

2. Project Understanding

Within the University of Sydney campus, Douglas understand that the proposed development comprises the following:

- The construction of a new five-storey building with single level basement;
- The basement level is understood to have a finished floor level of RL 21 m AHD, where maximum basement excavation depths will be approximately 4.5 m. Further excavation will likely be required for footings, service pits, lift pits etc.; and
- The proposed building will also interface with the existing A02 Faculty of Arts and Social Sciences Building (SSB). It is proposed there will be a new pedestrian accessway between the two buildings which connects through to Parramatta Road.

3. Site Description

The proposed Teaching and Learning hub is located at the corner of Parramatta Road and Western Avenue, within the University of Sydney's Camperdown Campus. The site is a primary gateway to the University, adjoining Western Avenue, Science Road, and Parramatta Road. The site is identified Lot 1 DP1171804. The overall site is rectangular shaped area of 1,273 m² and is bound by Parramatta Road to the north, the SSB Building and Agriculture Lane to the east, Science Road to the south, and Western Avenue to the west. An aerial photograph of the site detailing the approximate development footprint is shown on Figure 1 below.

The ground surface across the site gently slopes in a west to south-west direction, with levels typically ranging between about RL 27.5 m and RL 23.5 m AHD, with an average overall slope of about four degrees.

The site is currently occupied by numerous temporary single storey demountable buildings (Demountable Village). The site was mainly surfaced with asphaltic concrete and garden beds.



Figure 1: Aerial view of the proposed site (Source: University of Sydney, 2024)

4. Regional Mapping

4.1 Geology

The Geological Survey of NSW Sydney 1:100,000 Geology Sheet 9130 for Sydney indicates that the site is underlain by Ashfield Shale. The Ashfield Shale typically comprises black to dark grey shale and laminite (interlaminated siltstone and sandstone). The predominantly shaly rock is typically closely bedded and contains an orthogonal pair of steeply dipping (70° to 90°) joint sets typically striking NNE and ESE and spaced at 0.5 m to 5 m. Randomly oriented, 30° to 45° dipping slickensided joints are also ubiquitous.

The results of the recent field work for the present investigation were consistent with the published geological mapping.

4.2 Soil Landscape

Reference to the Sydney 1:100,000 Soils Landscape Sheet indicates that bedrock at the site is overlain by residual soils of the Blacktown group. These typically comprise shallow to moderately deep, moderately reactive clay soils. The results of the field work indicated that filling is present across much of the site, with natural clay soils present between the filling and bedrock, at borehole locations.

4.3 Hydrogeology

There are two registered groundwater wells noted within a 50 m radius of the site. GW116421 and GW116424 recorded standing water levels in the range of 2.9 m to 3.2 m. The nearest surface water body receptor is Orphan School Creek located approximately 600 m to the north-west which discharges into Johnston's Bay. Based on the geology and topography, surface water and groundwater are expected to flow west to south-west of the site.

The geology and topography of the site suggests that the regional groundwater table is in the underlying rock. Ephemeral seepage from perched water would be expected from along the top of clay and bedrock and through joints and bedding planes within the rock itself. Seepage volume would be expected to be low and vary with climatic events.

4.4 Groundwater Dependant Ecosystems (GDEs)

A review of the Bureau of Meteorology Groundwater Dependant Ecosystems Atlas indicates that there are no aquatic, subterranean or terrestrial GDEs within 1 km of the site. The closest GDE to the site is approximately 5 km east to southeast which comprises a low potential for terrestrial GDE (South Coast – Gorges River, Eastern Suburbs Banksia Scrub).

4.5 Acid Sulphate Soils

Reference to the 1:25,000 Acid Sulfate Soils (ASS) Risk map indicates that the site is within an area of no known occurrence of acid sulfate soils. The nearest mapped 'high probability of occurrence' of ASS is in "Canal Reserve", which is approximately 1.1 km north-west of the site. Given the elevation (RL 24 m) and the known geology of the site, it is expected that acid sulfate soils are not present on the site.

The site is also mapped as being Class 5 with reference to the Sydney Local Environmental Plan 2012 Acid Sulfate Soil maps. Reference to the NSW Planning and Environmental portal, indicates that acid sulfate soils are not typically found in Class 5 category areas.

Additionally, acid sulfate soils typically do not form above RL 5 m.

4.6 Salinity

Regional mapping of salinity potential in Western Sydney was undertaken in 2002 by the former Department of Infrastructure, Planning and Natural Resources, now the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW). The site is located outside the mapped area of salinity potential.

5. Field Work

5.1 Field Work Methods

The field investigations were carried out from 6 to 9 November 2023, and 24 November which included a combined six geotechnical and environmental boreholes (Bores 101 – 106). Ground Penetrating Radar (GPR) and electronic scanning for buried services were carried out prior to drilling.

Non-destructive drilling (NDD) methods were carried out at Bores 101, 104 and 106. Coring was initially undertaken using a 150 mm diameter 'Diacore' barrel to penetrate through the asphaltic concrete and concrete surface at each test location. Disturbed sampling was carried out at various depth intervals using a hand auger. The initial augering of boreholes were taken to termination depths of between 1.35 m and 1.8 m. Bores 101 and 104 were then cased and continued into the underlying rock using diamond NMLC core drilling techniques to obtain continuous core samples of the bedrock, using a hand portable tight-access 'Proline' drilling rig.

Three boreholes (Bores 102, 103 and 105) were drilled using a track-mounted drilling rig. Bores 102 and 103 were drilled using solid flight augers and rotary wash-boring to termination depths in the range of 2.5 m and 5.65 m. Standard Penetration Testing (SPTs) was carried out at regular intervals (in Bores 102 and 103) to assess the *in-situ* strength of the soil material. Soil samples were recovered from SPT split tubes for subsequent laboratory testing. Bores 102 and 103 were then continued into the underlying rock using NMLC diamond core drilling techniques to obtain continuous core samples of the rock.

Following the completion of drilling, groundwater monitoring wells were installed in Bores 101 and 103 to depths of 7.2 m and 8.9 m, respectively. The wells were constructed using 50 mm diameter, machine slotted, Class 18 uPVC with a filter zone. Details for both wells are shown in Appendix C. The wells were developed / purged (14 November 2023) of the drilling fluids using a twister pump and left to recharge. A follow-up visit was undertaken on 20 November 2023 to obtain groundwater levels and water samples.

A follow-up visit was undertaken 22 February 2024 to obtain groundwater levels at each standpipe location and to perform rising head and falling head permeability tests, which involve either artificially dropping (e.g., by pumping) or increasing (e.g., by adding water) water levels within the standpipe and measuring the time for water levels to return to near original levels.

All boreholes were backfilled with spoil upon completion and reinstated with fill, or concrete (where required). Bores 101 and 103 wells were completed with a flush mount "Gatic" cover. The locations of the boreholes are shown on Drawing 1 in Appendix B.

The coordinates and surface levels at the test locations were determined using a dGPS which is typically accurate to within 0.1 m.

5.2 Field Work Results

Details of the subsurface conditions encountered are given in the borehole logs in Appendix C. Notes explain descriptive terms and classification methods used are given in Appendix C.

Based on the results of the site investigation, the sequence of subsurface materials encountered at the site, in increasing depth order, is summarised below.

- FILL: sandy gravel, clay and sand fill, with inclusions of building rubble, ripped sandstone and pavement materials (i.e., asphalt and concrete) to depths of up to 0.35 m to 1.5 m; underlain by;
- RESIDUAL CLAY: pale grey mottled yellow / orange, high plasticity, stiff to very stiff residual clay, with inclusions of ironstone gravel to depths in the range of 1.35 m to 4.5 m; overlying

- **BEDROCK:** very low to low strength siltstone encountered in Bores 101 to 104 to depths in the range of 1.5 m to 5.5 m, then medium and high strength interlaminated siltstone and sandstone, to the depth of investigation.

Rock structure encountered included steeply dipping (45° to 90°) planar joints and shallow bedding planes.

5.3 Groundwater investigation

No free groundwater was encountered during auger drilling through the soil profile of the boreholes. The use of water for rotary drilling and coring prevented observation of groundwater within the rock at Bores 101 – 104. No major water loss was noted during rock drilling.

Two groundwater monitoring wells were installed as part of the geotechnical investigation:

- One in Borehole 101, screened in residual soil and bedrock comprising highly fractured to fractured siltstone from 1.6 to 7.5 m; and
- One in Borehole 103, screened in residual soil and bedrock comprising highly fractured to fractured siltstone from 1.1 to 8.9 m.

5.3.1 Groundwater levels

A summary of the measured groundwater levels within the site is provided in Table 1 below.

Table 1: Groundwater levels - manual measurements

Well ID	Surface (m AHD)	Screen depth (m bgl)	Depth to groundwater (m bgl)		Groundwater elevation (m AHD)	
			Nov-23	Feb-24	Nov-23	Feb-24
BH101	25.3	1.6 – 7.5	2.5	2.5	22.8	22.8
BH103	26.0	1.1 – 8.9	2.7	2.7	23.3	23.3

Water levels in Bores 101 and 103 were recorded between 2.5 m and 2.7 m (RL 22.8 to RL 23.3) which was close to the top of rock or within the upper lower strength rock and could be associated with perched seepage close to the rock surface. Seepage from perched groundwater is, however, expected to occur along the soil and rock interface and may also occur through fractured zones and joints in the rock. Seepage is likely to increase following periods of extended wet weather, and may be greater than typical sites in Sydney due to the proximity to former (buried) creek lines.

It should be noted that groundwater levels are transient and vary over time due to seasonal, climatic and other factors.

5.3.2 Hydraulic conductivity testing

Rising and falling head (slug) hydraulic conductivity tests were carried out at the monitoring wells on 22 February 2024. The tests were undertaken by lowering a solid cylinder (slug) in the wells to displace a volume of water (rising head test) while monitoring water level recovery using a data logger. The slug was then removed from the well (falling head test) and recovery was again monitored.

Hydraulic conductivity tests were analysed using the Hvorslev (1951) solution for slug testing interpretation. Results are presented in Table 2. The detailed results of the tests are attached in Appendix E.

Table 2: Interpreted hydraulic conductivity results

Well ID	Falling head test k (m/s)	Rising head test k (m/s)	Average (m/s)
BH101	4×10^{-7}	2×10^{-7}	3×10^{-7}
BH103	1×10^{-6}	2×10^{-6}	2×10^{-6}

Notes to Table 2:

k: hydraulic conductivity

6. Laboratory Testing

6.1 Soil

Laboratory testing on soil samples was undertaken to determine soil salinity and aggressiveness for exposure classification of buried concrete and steel elements. The results of the chemical and geotechnical laboratory testing are presented in Table 3. The detailed laboratory test reports are given in Appendix D.

Table 3: Summary of Laboratory Results

BH ID	Depth (m)	Material ⁽¹⁾	pH	EC ($\mu\text{s}/\text{cm}$)	Cl (mg/kg)	SO ₄ (mg/kg)	Resistivity (ohm.cm) ⁽²⁾	ESP (%)
BH106	0.25-0.35	Fill / Gravel	7.6	34	<10	20	29,412	2
BH106	0.35-0.6	Clay	5.3	30	10	10	33,333	4
BH106	1-1.1	Clay	4.7	55	26	62	18,182	14

Notes to Table 3:

(1) Soil condition B – low permeability soils or all soils above groundwater (Refer to Table 6.4.2 (C) and 6.5.2 (C) in AS2159-2009)

(2) Calculated Resistivity by inversion of EC(1:5) = $(1/\text{EC}) \times (1 \times 10^6)$

EC = Electrical conductivity;

Cl = Chloride ion concentration;

SO₄ = Sulphate ion concentration

ESP – exchangeable Sodium Percentage

“ – ” denotes not analysed

6.2 Rock

Selected samples of the rock core obtained from Bores 101 – 104 were tested in the laboratory to determine the Point Load Strength Index ($Is_{(50)}$) values to assist with the rock strength classification. The results of the testing are shown on the borehole logs at the corresponding depths.

The $Is_{(50)}$ values for the rock have been used to estimate the Unconfined Compressive Strength (UCS) based on a UCS: $Is_{(50)}$ ratio of 20:1. It is noted that point load tests are not readily carried out on very low strength rock or highly fractured rock and hence strength classification of the weaker rock is based on visual / tactile assessments of the rock core.

The $Is_{(50)}$ values of the rock cores from the investigation typically ranged from 0.2 MPa to 2.2 MPa, corresponding to a very low to high strength classification (inferred UCS ranging from 4 MPa to 44 MPa).

7. Proposed Development

It is understood that the proposed development comprises demolition of the existing structures and the construction of five storey building with single level basement. It is understood that that proposed building will be designed for a drained basement.

It is understood that the proposed basement level will have a finished floor level of approximately RL 21 (AHD) where excavation depths of up to 4.5 m are expected. Further excavation will be required for slab and subfloor drainage (where required). Locally deeper excavations will be required for lift cores and footings.

During excavation of the proposed basement, excavations are likely to be near or adjacent to property boundaries and existing services, infrastructure and / or structures.

The proposed building will also interface with the existing A02 Faculty of Arts and Social Sciences Building (SSB). It is proposed there will be a new pedestrian accessway between the two buildings which connects through to Parramatta Road. Other options to be explored includes enabling better vehicle drop off and realigning Science Road.

8. Geotechnical Model

The investigated subsurface profile can be grouped into six geotechnical units based on the general stratigraphy outlined in Section 5.2.

The interpreted depths and RLs at the top of the various units at each test location, shown in Table 4, are based on the geotechnical logs carried out during the investigations.

The rock encountered in the boreholes has been classified in accordance with Pells et al (2019) "Classification of Sandstone and Shale in the Sydney Region: A Forty Year Review" Aust. Geomechanics Journal, June, 2019. There are five classes of rock (I to V) based on strength, fracturing and the amount of defects such as sheared zones and clay seams. Class I rock is the

best quality (high strength with very few defects) while Class V represents the lowest quality rock (very low strength and / or numerous defects) in the classification system.

Table 4: Summary of Geotechnical Model

Unit	Material	Depth [m] {Reduced Level (m AHD) to Top of Each Unit}					
		BH101	BH102	BH103	BH104	BH105	BH106
1	Fill	0.0 (25.3)	0.0 (24.2)	0.0 (26.0)	0.0 (25.9)	0.0 (25.4)	0.0 (24.4)
2	Residual Clay	1.1 (24.2)	1.1 (23.3)	1.0 (25.0)	1.5 (24.4)	0.8 (24.6)	0.35 (24.0)
3	Class V Siltstone	2.0 (23.3)	4.5 ⁽²⁾ (19.7) ⁽²⁾	3.0 (23.0)	N.E.	N.E.	N.E.
4	Class IV Interlaminated Siltstone and Sandstone	2.2 (23.1)	5.5 (18.7)	4.0 (20.4)	2.6 (23.3)	N.E.	N.E.
5	Class III Interlaminated Siltstone and Sandstone	3.9 (21.4)	N.E.	5.5 (20.5)	3.9 (22.0)	N.E.	N.E.
6	Class III/II Interlaminated Siltstone and Sandstone	6.0 (19.3)	6.7 (17.5)	7.0 (19.0)	4.7 (21.2)	N.E.	N.E.

Notes to Table 4:

(1) N.E. = Not Encountered (BH105 terminated at 2.5 m and BH106 terminated at 1.35 m).

(2) Depth / RL to top of very low to low strength laminite inferred from SPT refusal depth.

Geotechnical cross-sections (Section A-A' and B-B') showing the interpreted subsurface profile is provided on Drawing 2 and 3 in Appendix B. The sections show the interpreted geotechnical divisions of the underlying fill, soil and rock, together with the current ground surface, and proposed basement level. It should be noted that the interpreted unit boundaries shown on the section are accurate at the borehole locations only. Reference should be made to the borehole logs for more detailed information and descriptions of the soil and rock materials.

Water levels in Bores 101 and 103 were recorded between 2.5 m and 2.7 m (RL 22.8 to RL 23.3) which was close to the top of rock or within the upper lower strength rock and could be associated with perched seepage close to the rock surface.

9. Comments

9.1 Excavation Conditions

It is understood the basement level is planned at RL 21. Excavations are expected to encounter concrete structures, fill, clay soils (Units 1 and 2), Class V and IV Siltstone (Units 3 and 4) and some Class III (or better) Siltstone (e.g., near the Borehole 104 location). Based on the conditions encountered in the bores, it is expected that excavating Units 1 and 2 should be readily achievable by hydraulic excavator. Excavation of the weathered rock (Unit 3) should be achievable with a

toothed bucket, assisted by light rock-breaking using hydraulic rock hammers. Excavation of medium and high strength rock (Units 4-6), where encountered, may require medium to heavy rock breaking and ripping equipment.

The use of rock breaking equipment will generally cause dust, noise and vibration that has the potential to affect adjacent sensitive infrastructure (i.e., nearby underground services, or buildings, etc) as well as pedestrians and occupants of nearby buildings.

Based on the current groundwater information, it is anticipated that seepage will generally occur from along the clay / rock interface and from bedding planes within the bedrock, where exposed. Seepage volumes are expected to be low but will vary with rainfall. During construction, any seepage should be readily controlled by the use of sump and pumps (or tremie pipes in pile excavations).

9.2 Trafficability

The exposed surface after excavation is expected to comprise either clay and / or siltstone. Both of these materials quickly deteriorate when they become wet and therefore do not provide a good working surface. Working platforms should be provided over the clay and shale and could comprise granular materials such as DGB, recycled concrete or ripped sandstone.

9.3 Disposal of Excavated Material

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the *Waste Classification Guidelines* (EPA, 2014) and recommendations carried out in Douglas' contamination report 225008.01.R.001.Rev0 dated August 2024

9.4 Dilapidation Surveys

Dilapidation surveys (existing building condition) should be carried out on surrounding buildings close to the existing basement as well as footpaths, roads and any critical services adjacent to the site boundaries. The dilapidation surveys should be undertaken before commencement of any excavation work in order to document any existing defects so that any claims for damage due to construction related activities can be accurately assessed.

9.5 Ground-borne Vibration

During demolition, it will be necessary to use appropriate methods and equipment to keep ground-borne vibration at adjacent buildings and structures within acceptable limits. It is expected that vibrations due to excavation in soil and weathered rock on this site will be minor. For buildings, the level of acceptable vibration is dependent on various factors including the type of structure (e.g., reinforced concrete or brick structures etc.), its structural condition, the frequency range of vibration produced by the construction equipment, the natural frequency of the structure and the vibration transmitting medium.

Ground-borne vibration can be strongly perceptible to humans at levels above 2.5 mm/s vector sum peak particle velocity (VSPPV). This is generally much lower than the vibration levels required to cause structural damage to buildings. The Australian Standard AS2670.2-1990 "Evaluation of human exposure to whole-body vibrations – continuous and shock induced

vibrations in buildings (1-80 Hz)" indicates an acceptable day time limit of 8 mm/s VSPPV for human comfort.

Based on the experience of Douglas in Sydney and reference to AS2670.2, it is suggested that a maximum component PPVi of 8 mm/s be employed at this site for the adjacent buildings which are in good condition in order to reduce the risk of architectural damage and to address human comfort levels. This vibration limit should be reduced to a maximum component PPVi of 3 mm/s in the vicinity of the sensitive structures or buildings with sensitive equipment therein. The vibration limit is applicable at the foundation level of existing buildings / structures and may need to be modified following review of dilapidation surveys, vibration trials and / or proposed plant.

As the magnitude of vibration transmission is site specific, it is recommended that a vibration trial be undertaken at the commencement of demolition. The trial may indicate that smaller or different types of equipment should be used.

9.6 Groundwater

It is understood that that proposed building will be designed with a long-term drained basement.

Groundwater has been reported at depths of between 2.5 m and 2.7 m below surface in the monitoring wells installed during the recent investigation. These readings are likely to represent ephemeral 'perched' water, which is commonly present at the soil / rock interface after periods of prolonged wet weather or due to anthropogenic influences such as diverted stormwater runoff, leaked water services and irrigation. Some seepage may also migrate through defects with the rock.

During construction, it is anticipated that seepage into the excavation should be readily controlled by temporary perimeter drains, connected to a "sump-and-pump" system. A permanently drained basement, if approved by the Department of Climate Change, Energy, the Environment and Water (DCCEEW), will require permanent sub-floor drainage below the basement floor slab to direct seepage to a pump out system and into the stormwater drainage system. Approval will probably be required by Council to allow disposal to the stormwater system. Alternatively, if there are Sydney Water assets nearby, approval from Sydney Water could be obtained.

A Dewatering Management Plan may be required for submission to DCCEEW to support the response to the SEARs and obtain approval/license for dewatering. The (water access) licencing requirement for both the construction dewatering and the permanent dewatering during the operational phase of the building will depend on the groundwater inflow volume, which can be estimated from groundwater modelling. If the volume is less than 3 ML per year, an exemption from requiring a Water Access Licence (WAL) can be applied.

Since this project is a State significant development, there is also no requirement for a water use approval, a water management work approval (including the water supply work approval) or an activity approval (other than an aquifer interference approval), in accordance with Environmental Planning and Assessment Act 1979 No. 203.

Based on the preliminary estimates, it is expected that inflows would be below 3 ML per year, however, it is expected that detailed groundwater inflow analysis will be required to predict water inflow volume into the basement more accurately, and to assess the associated impact on neighbours' structures and infrastructure, existing groundwater users and the environment.

The design of a drained basement will need to make provision for sub-floor drainage below the basement floor level to prevent hydrostatic pressures developing on the underside of the basement slab (and walls), and to direct seepage to the drainage system. This could comprise a minimum 100 mm thick, durable, open-graded, crushed rock with subsurface drains and sumps. Previous experience in the area is that seepage will likely contain relatively high levels of soluble iron that will form a precipitate in the form of a gelatinous 'sludge' when exposed to oxygen. This 'sludge' has the potential to block sub-slab (gravel) drains and damage pumps. Therefore, detailing of sub-floor drains, sumps and pumps should incorporate provision for regular maintenance such as flushing and 'rodding' of drains and / or "baffle" pits if a drained basement is considered.

It is imperative that excavations for drainage trenches and sumps are not located within the zone of influence of foundations.

Groundwater entering excavations and post-construction accumulation of groundwater below the basement floor will need to be disposed of in accordance with the Protection of the Environment Operations Act 1997 (POEO Act). Ultimately, this requires that any water discharged into the natural environment should comply with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agricultural and Resource Management Council of Australia and New Zealand, October 2000.

The above water quality guideline criteria include trigger values for pH, turbidity, nutrients, dissolved oxygen and faecal coliforms (unlikely to be present in excavation water). An appropriate strategy would be to carry out testing of groundwater samples during construction to assess its compliance with the ANZECC water quality guidelines. If the tested water quality complies with the guidelines, it can normally be pumped directly into the stormwater system, subject to regulatory and Council approvals. Alternatively, the pumped groundwater would require on-site treatment such as sedimentation and dosing to improve the quality of water to a sufficient level to comply with the ANZECC requirements before disposal into stormwater, again subject to appropriate approvals.

9.7 Excavation Support

Battering of the sides of the excavation is unlikely to be feasible where close to boundaries, services or existing buildings with shallow footings etc. Batter slopes could be possible away from these locations but may be restricted.

9.7.1 Batter Slopes

Suggested temporary and permanent batter slopes for unsupported excavations up to a maximum height of 3 m, above the water table and without surcharge loads, are shown in Table 5. Batter slopes higher than 3 m will require analysis of each slope. If surcharge loads are applied near the crest of the slope, then analysis will be required and probably flatter batters or support may be required.

Table 5: Recommended Batter Slopes for Exposed Material

Material	Excavation Height (m)	Maximum Temporary Batter Slope (H : V)	Maximum Permanent Batter Slope (H : V)
Unit 1: Fill	< 3	1.5 : 1	2.5 : 1 ⁽¹⁾
Unit 2: Residual Clay ⁽²⁾	<3	1 : 1	2 : 1 ⁽¹⁾
Unit 3 and 4: Siltstone (Class V) and Interlaminated Siltstone/Sandstone (Class IV)	< 3	0.75 : 1	1 : 1 ⁽³⁾

Notes to Table 5:

- (1) Permanent batters in fill and soil may need to be reduced to 3H: 1V to facilitate maintenance of grassed slopes, if required.
- (2) Very stiff to hard clays are often fissured. Flatter slopes may be necessary in such clays and measures such as topsoiling and vegetating may also be necessary to resist erosion.
- (3) Subject to jointing assessment by experienced Geotechnical Engineer / Engineering Geologist

Temporary batters should be protected in the short term from erosion caused by heavy rain. Shotcrete with dowels and weepholes or strip drains may be considered to protect the slope face. Any temporary slopes should be inspected for signs of instability on a regular basis by a geotechnical engineer. Steeper slopes reinforced with soil nails and a structural facing may be considered where there are space constraints.

Shale / siltstone / laminite is expected to deteriorate and breakdown if left exposed to weather. Any rock faces exposed over the long term should be covered with mesh reinforced shotcrete pinned to the face with dowels.

9.7.2 Retaining / Shoring Systems

Where temporary batter slopes cannot be adopted, excavations will require temporary support through construction of an anchored, propped, or cantilevered pile shoring walls using soldier piles with infill panels or contiguous piles. Permanent support should be provided by the building structure.

Design pressures for retaining walls should take into account the requirement to limit movement of the surrounding ground and adjacent structures and to ensure an adequate factor of safety is maintained against failure (for temporary and permanent retaining walls).

The design of cantilevered shoring systems (or shoring systems with one row of restraints i.e., ground anchors or props) may be based on a triangular earth pressure distribution using the parameters presented in Table 6. 'Active' earth pressure coefficient (K_a) values may be used where some wall movement is acceptable. 'At rest' earth pressure coefficient (K_o) values should be used where wall movement needs to be limited (i.e., adjacent to existing structures or utilities). Note that cantilevered walls are generally associated with relatively high lateral deflections or movements in towards the excavation and should not be used where wall movement needs to be limited or for the support of excavations more than 3 m deep.

Table 6: Recommended Design Parameters for Shoring Systems

Unit	Material	Unit Weight (kN/m ³)	Earth Pressure Coefficient			Effective Cohesion c' (kPa)	Effective Friction Angle (Degrees)
			Active (Ka)	At Rest (Ko)	Passive (Kp)		
1	Filling	20	0.4	0.6	-	2	25
2	Residual Soil	20	0.3	0.45	3.3	5	25
3	Class IV/V siltstone, or interbedded siltstone and sandstone	21	0.2	0.3	400 [^]	10	28
3	Class III interbedded siltstone and sandstone (or better)	22	0*	0*	2000 [^]	20	28

Notes to Table 6:

The values above assume a level surface behind the wall.

* It is assumed that the rock mass is free of adverse dipping joints and seams.

[^] Kp is given as ultimate passive pressure

The design of the shoring should allow for all surcharge loads applied as a rectangular earth pressure distribution, including building footings, inclined slopes behind the wall, traffic, site sheds, and construction related loads.

The earth pressure loading described above does not include either earthquake loads or hydrostatic pressures. Unless positive drainage measures are incorporated to prevent water pressure build-up behind the walls, full hydrostatic head should be allowed for in design.

Detailed design of shoring wall should be undertaken using a computer program such as WALLAP, FLAC or PLAXIS to model soil-structure interactions during different phases of construction.

Passive resistance for piles founded in rock below the base of the bulk excavation (including allowance for services or footings) may be based on an ultimate passive pressure equal to the values indicated in Table 6 above. A factor of safety must be applied to these ultimate values to limit wall movement that is required to mobilise the passive resistance. The top 0.5 m of the rock socket below bulk excavation level should be ignored due to possible disturbance (i.e., over excavation) and tolerance effects. The minimum socket depth should be equal to the greater of one pile diameter or 1.0 m below the lowest level of any nearby excavation (including any detailed excavations), but subject to analysis. This is also relevant where anchors are installed (or toe anchors, just prior to fully exposing the toe of the pile). Staged excavation and inspection by a suitably qualified geotechnical engineer will therefore be required to confirm that the rock in front of the piles is not adversely affected by discontinuities, especially where passive resistance is relied upon.

9.7.3 Ground Anchors

Pre-stressed ground anchors, rockbolts and dowels (support elements) can be used to laterally support existing walls, new shoring, underpinning works or unstable rock masses. These support elements should be bonded into the stronger rock, inclined as required, but preferably not steeper than 30° below the horizontal. Table 7 provides allowable bond stresses for estimating purposes.

Table 7: Allowable Bond Stress for Ground Anchor Design

Material Description	Allowable Bond Stress (kPa)
Class V siltstone or Class IV interlaminated siltstone and sandstone	70
Class III interlaminated siltstone and sandstone	150

These values should be confirmed by pull-out tests, carried out prior to installation of support elements. Ultimately, it is the anchoring contractor's responsibility to ensure that the correct design values (specific to the support system and method of installation) are used and that the support element holes are carefully cleaned prior to grouting.

The parameters given in Table 7 assume that the drilled holes are clean and adequately flushed. The anchors should be bonded behind an imaginary line drawn up at 45 degrees from the base of the excavation, and "lift-off" tests should be carried out to confirm the anchor capacities.

After support elements have been installed, it is recommended that they are tested to 125% of their nominal working load. Where stress relief or further unavoidable movement of the shoring is expected, it is recommended that the support elements are locked-off at a lower value, as required to accommodate the additional movement and subsequent increase in stress in the support elements. Checks should be carried out to confirm that the load in the support elements is maintained and that losses due to creep or other causes do not occur.

Care should be exercised to ensure that anchors are installed progressively during excavation and stressed prior to excavation of the next drop to ensure that stability is maintained at all times.

The use of permanent anchors, if required, would need careful attention to corrosion protection for which geotechnical advice should be sought.

9.8 Foundations

The most appropriate type of foundation system for the building will depend on the magnitude of the proposed column loads and ground profile below the building footprint. Boreholes within the building area suggest bedrock depths will be variable and will be encountered within about 2 m to 4.5 m of the existing surface, with the depth to rock increasing in a south-easterly direction.

In all cases, structural loads should be transferred to a uniform founding stratum. Given that that rock will be exposed in some parts the entire building should be uniformly founded on rock. Pad footings may be suitable where rock is exposed or shallow below the basement, however piles may be required where rock is deeper, for example near BH102.

Bored piles may be considered however the potential for collapse of the filling overlying the bedrock may occur. Bored piles with temporary casing to support the filling could be considered. Continuous Flight Auger (CFA) piles could be a suitable option to avoid problems associated with collapsing filling and groundwater inflows. Large piling rigs with high torque capacity will be required to penetrate the medium and high strength bedrock. The piling contractor should be made aware of the ground conditions and should make their own assessment on the type of equipment required to carry out the piling works.

Table 8: Recommended Design Parameters for Foundation Design (after Pells et al')

Unit / Founding Stratum	Allowable Pressure (Serviceability)		Ultimate Pressure (Ultimate)		Field Young's Modulus, E (MPa)
	End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	End Bearing (kPa) ⁽²⁾	Shaft Adhesion (Compression) (kPa)	
Unit 3: Class V Siltstone	700	50	2,000	100	70
Unit 4: Class IV Interlaminated siltstone and Sandstone	1,000	100	3,000	200	100
Unit 5: Class III Interlaminated siltstone and Sandstone (or better)	3,500	300	10,000	600	200

Notes to Table 8:

(1) Design Values for Foundations on Sandstone and Shale in the Sydney Region, Pells Mostyn and Walker. Australian Geomechanics December 1998.

(2) Ultimate values occur at large settlements, typically >5% of minimum footing dimension

Foundations proportioned on the basis of the allowable bearing pressure in Table 8 would be expected to experience total settlements of less than 1% of the footing width under the applied working load, with differential settlements between adjacent columns expected to be less than half of this value.

Footings designed using ultimate values and Limit State Design will need to consider serviceability which usually governs the design in this case. For pile design, a basic geotechnical strength reduction factor, ϕ_{gb} , of about 0.4 (or possibly higher) calculated from Table 4.3.2 (A, B, and C) of AS2159-2009: Piling Design and Installation, is considered feasible. However, the structural engineer will need to make their own assessment with the final (ϕ_{gb}) number being dependent on the design and installation method (and associated risk rating) adopted by the structural engineer.

All foundations should be inspected by a geotechnical engineer or engineering geologist prior to placing concrete. Depending on the applied bearing pressure required, spoon testing and cored bores may be required in line with the recommendations in Pells et al. If weak seams or defects are encountered below the foundation base, the excavation may need to be deepened until suitable founding material is reached, or re-sized, based on a reduced allowable bearing pressure.

9.9 Seismic Design

In accordance with the Earthquake Loading Standard, AS1170.4, 2007, the site has a hazard factor (z) of 0.08 and a site sub-soil class of shallow soil (C_e).

9.10 Pavements

The design of pavements will depend on the type of subgrade material. If pavements are to be placed over the natural clay, some subgrade replacement or treatment may be required to provide a suitable subgrade for the pavement construction. Based on experience in the region with similar clay soils, it is recommended that a design CBR of 3% be adopted for any pavement design at the site. This design CBR assumes that the subgrade is appropriately prepared, and that adequate surface and subsurface drainage is provided and maintained.

If pavements are to be constructed on controlled filling, testing of the subgrade material will be required to determine the design CBR for pavement design.

9.11 Aggressivity

The results of the aggressivity testing compared to the values presented in AS2159 (2009) "Piling – Design and installation" indicate that the soil conditions are 'moderate' for buried concrete and 'non-aggressive' for buried steel. Recommendations are presented in AS2159 for appropriate minimum concrete strengths and minimum cover to reinforcing steel for various exposure classifications.

9.12 Salinity

The site is outside of the Salinity Potential in Western Sydney mapping and is not in an area generally associated with saline soils. Some layers within the Blacktown Residual landscape are associated with localised salinity but are not considered likely to be present in significant volumes on this site. Notwithstanding the aforementioned, soil salinity is typically assessed with respect to electrical conductivity of a 1:5 (soil:water) extract ($EC_{1:5}$). This value can be converted to EC_e (electrical conductivity of a saturated extract) by multiplication with a factor dependent of soil texture ranging from 6 for heavy clays to 17 for sands. Richards (1954, Ref 4) and Hazelton and Murphy (1992, Ref 5) classify soil salinity on the basis of EC_e . Based on the testing undertaken, and using a multiplication factor of 8 (for conservatism) the results indicate that non-saline conditions can generally be expected across the site. Based on the aforementioned, a salinity management plan is considered unnecessary for the site.

9.13 Erosion

The results of the ESP testing (refer to Table 3) indicate that the samples tested have ESPs range from 'non-sodic' to 'highly sodic'.

The existing fill and clay soils may have exhibited some erosion characteristics; however, the proposed works will largely comprise of paved surfaces over the existing ground surface and are not expected to expose soils to erosion conditions. Batters should consider erosion protection in their design, in the short-term and long-term.

9.14 Acid Sulfate Soils

No ASS testing has been carried out as part of this investigation. This section of the report provides only preliminary comments on observed geological and topographical indicators at the site.

In general, ASS are predominately formed with Holocene-aged (i.e., less than approximately 10,000 years old) marine deposits, typically below RL 5.

The site elevation is around RL 27.5 to RL 23.5 (AHD), and the published geology indicates the natural soils at the site are residual in origin (Blacktown residual landscape). No physical indicators of ASS (i.e., presence of jarosite, degradation of concrete, etc) were observed at the site.

Given the above, management of ASS is considered not likely.

9.15 Geotechnical Considerations Relating to Sydney Water

It is understood Sydney Water assets may also present within the site. Sydney Water requires Specialist Engineering Assessments (SEA) to be undertaken to demonstrate that there will be no adverse impact or nominate protective measures to prevent adverse impact to Sydney Water assets. The process is relatively detailed and is described in the Sydney Water Procedure – Specialist Engineering Assessment, together with the selected assets of concern to Sydney Water.

Once the assets have been identified, an SEA would generally be required if these assets are located within the zone of influence (ZOI) defined in the Sydney Water Technical Guidelines “Building over and adjacent to pipe assets.” Reference should be made to that document for further details, but this includes:

- Applied temporary or permanent loads above a line drawn up at 1H:1V from the base of the Sydney Water asset, or asset encasement; and
- New tanks, excavations, or temporary anchors, within the offset distances given in the technical guidelines, or above the groundwater drawdown zone of dewatered excavations.

10. Further Geotechnical Input

Below is a summary of the recommended additional works that should be carried out:

For SSDA

- Groundwater impact assessment (in response to SEARs) based on final design decisions around retaining/shoring wall systems, basement geometry and based on the proposed drained basement. This will require an inflow assessment and review of potential impacts given the inflows, based on a single fixed design. It is possible that additional wells may be required following review, once the existing structures are demolished.

Pre-Construction

- Dilapidation surveys;
- It is recommended that in order to confirm with DPE / Water NSW requirements, an additional well should be installed and wholly sealed off in deeper rock mass to provide confidence in the groundwater levels;
- Monitoring of groundwater levels to allow for accurate assessment and monitoring of the water table level;
- A dewatering management plan (DMP) capturing the above and management and monitoring methods required during construction to ensure compliance with SSDA conditions. A highly detailed DMP may be required to satisfy City of Sydney Council requirements;
- Further geotechnical investigation may be required on site once final details of the proposed development are known;
- For pavement design, shallow boreholes with bulk sampling should be carried out to assess the CBR of the proposed subgrade once bulk earthworks is complete; and
- Review of information and further assessment of existing foundations.

During Construction

- Waste Classification of all material to be excavated and transported off site;
- Shoring pile inspections and anchor installation and testing inspections;
- Footing / pile inspections during construction;
- Groundwater monitoring, if required; and
- Vibration Monitoring.

It is recommended that a meeting be held after the initial design has been completed to confirm that these recommendations have been interpreted correctly.

11. Limitations

Douglas has prepared this report for this project at Corner Parramatta Road and Western Avenue, Camperdown in accordance with Douglas's proposal dated 25 September 2023 and acceptance received from Nora Babik dated 29 September 2023. The work was carried out under Douglas' Conditions of Engagement. This report is provided for the exclusive use of The University of Sydney for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and / or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and / or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas' field testing has been completed.

Douglas' advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by Douglas in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and / or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by Douglas. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope of work for this investigation / report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of fill of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such fill may contain contaminants and hazardous building materials.

Appendix A

About this Report

Introduction

These notes have been provided to amplify Douglas' report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

Douglas' reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Engagement Terms for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather

changes. They may not be the same at the time of construction as are indicated in the report; and

- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, Douglas will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, Douglas cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, Douglas will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, Douglas requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. Douglas would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

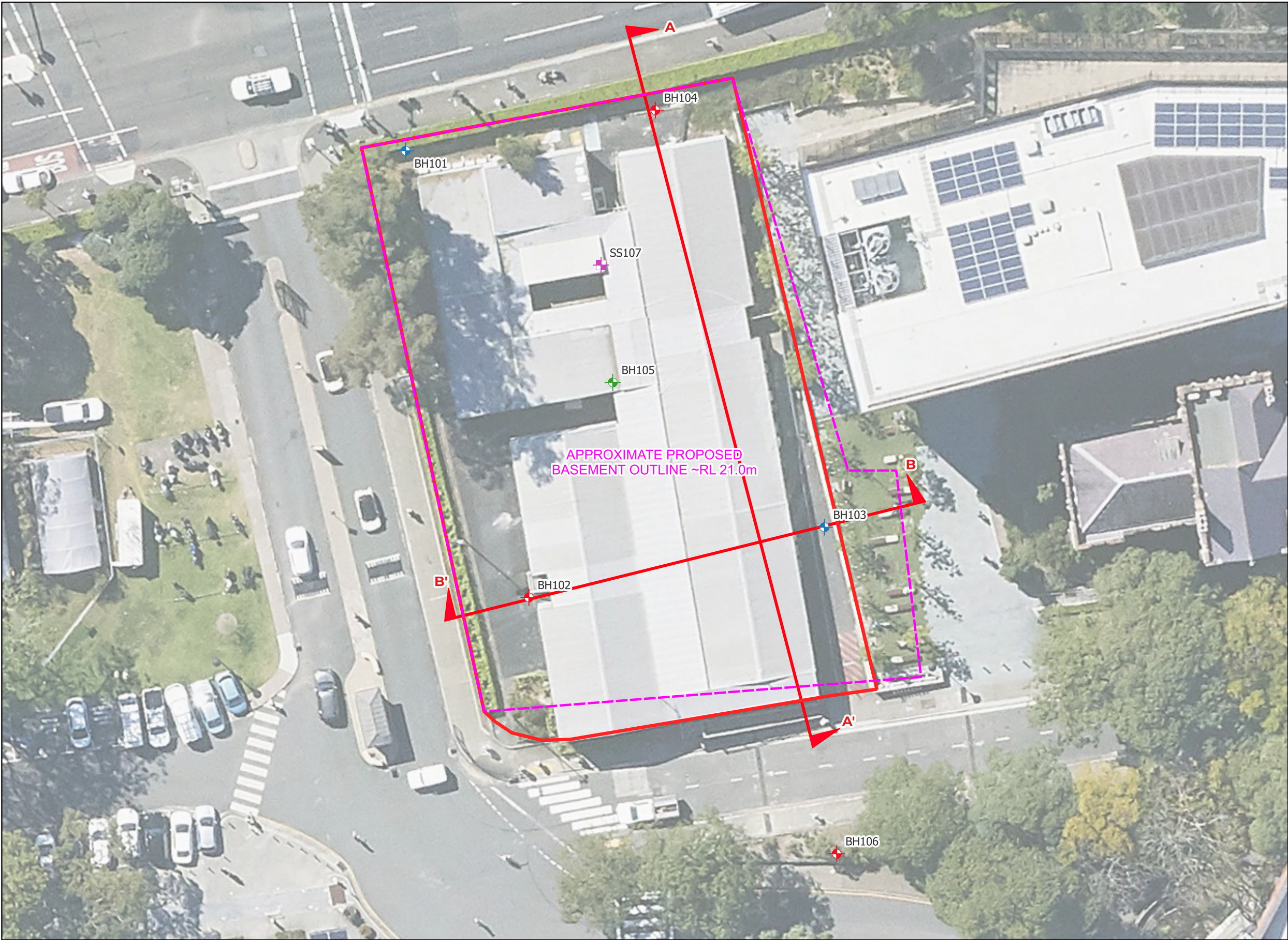
Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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Appendix B

Drawings



Site Location

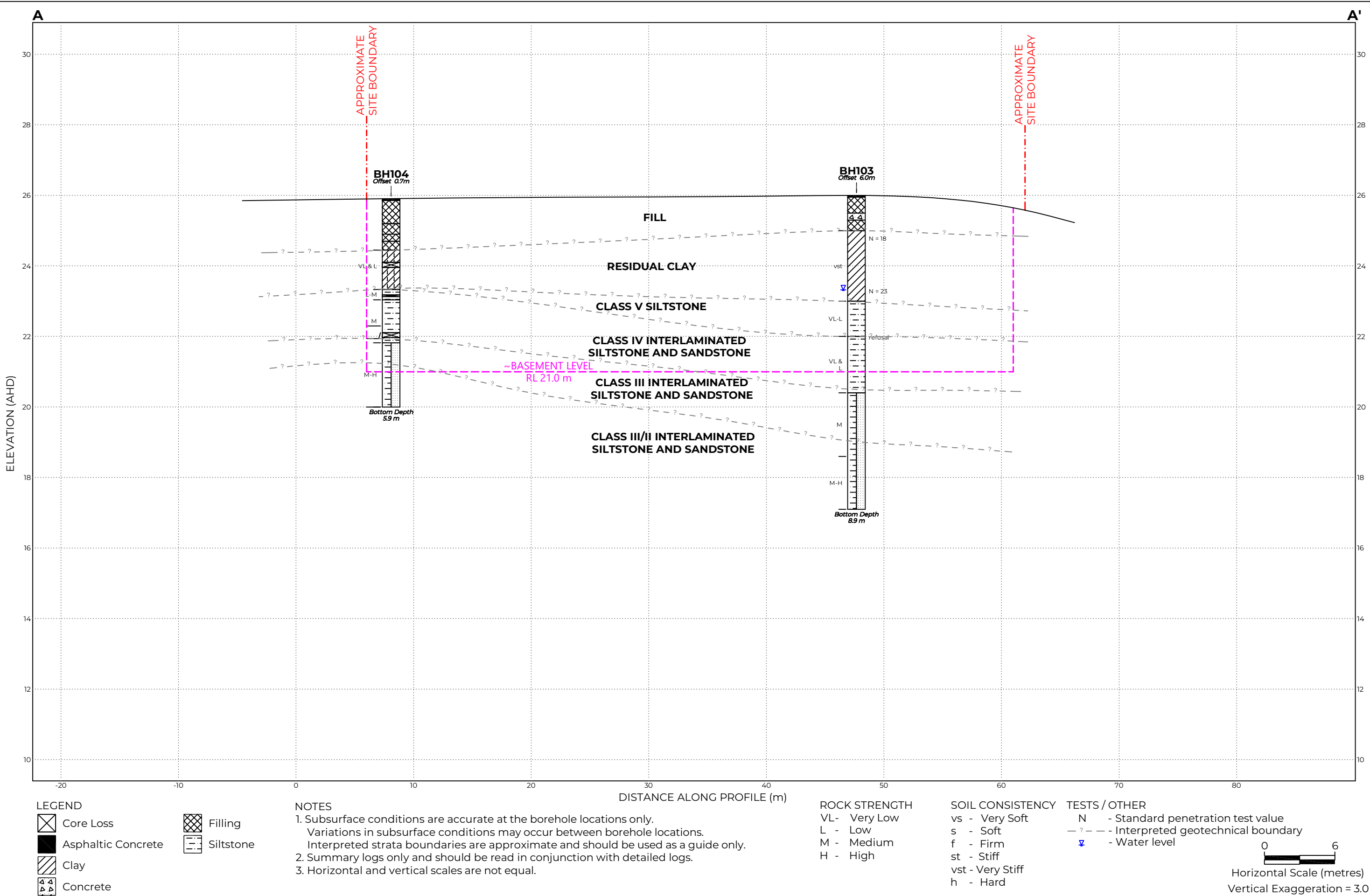
LEGEND

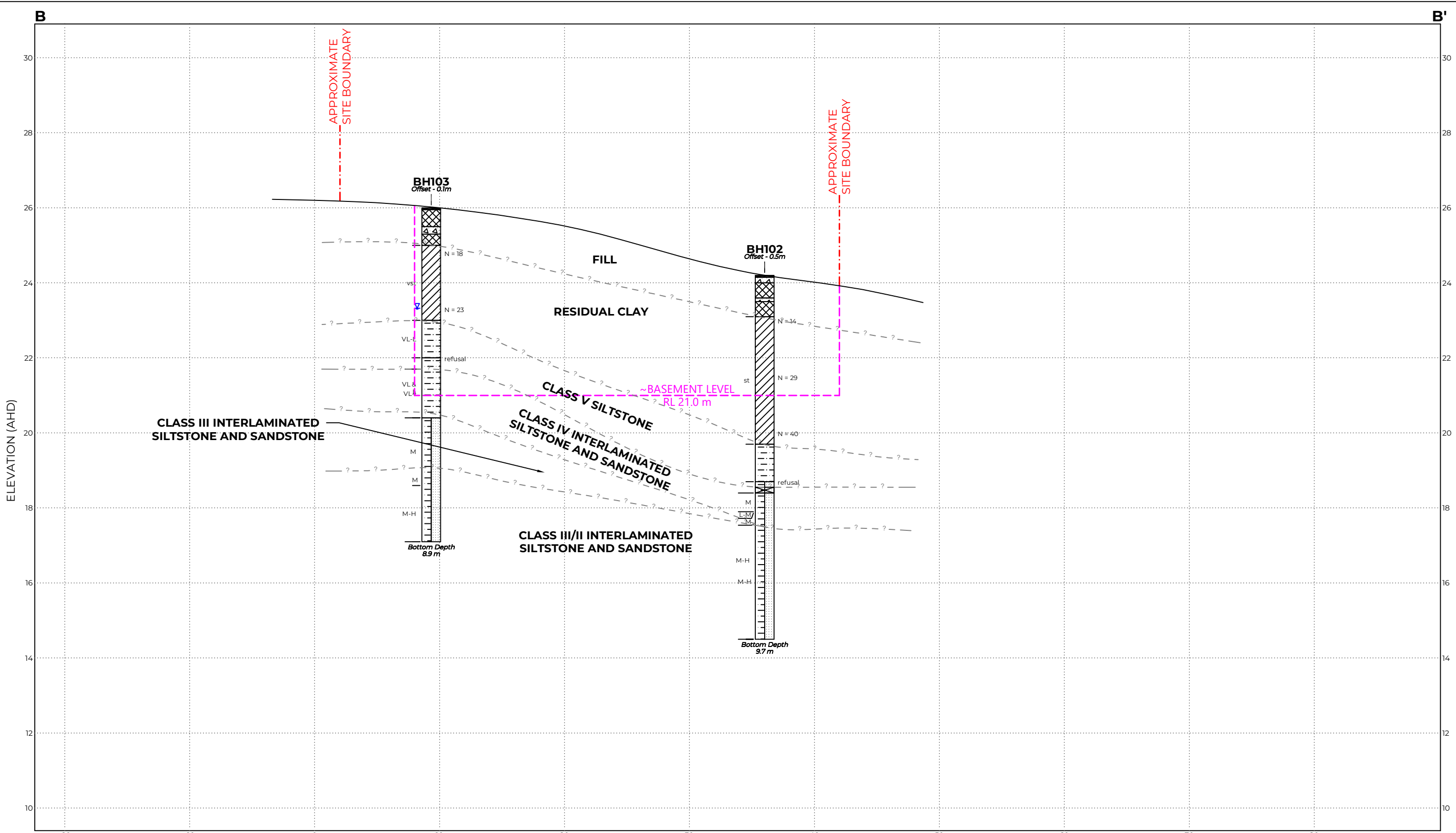
- Borehole / Groundwater Well (Geotechnical and Contamination)
- Borehole (Geotechnical and Contamination)
- Borehole (Contamination)
- Surface Sample (Contamination)
- Site Boundary
- Cross Section Line

0 5 10 15 20 m

NOTE:
1:Base image from Metromap (Dated 20.09.2024)

	CLIENT: The University of Sydney		TITLE: Test Location Plan USYD Ross Street Teaching & Learning Hub Corner of Parramatta Road and Western Avenue, Camperdown		Project: 225008.00
	OFFICE: Sydney	DRAWN BY: EC/MN			DRAWING No: 1
	SCALE: 1:350 @A3	DATE: 21.01.2025			REVISION: 1





LEGEND

- | | | | |
|--|--------------------|--|-----------|
| | Core Loss | | Filling |
| | Asphaltic Concrete | | Siltstone |
| | Clay | | |
| | Concrete | | |

NOTES

- Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
- Summary logs only and should be read in conjunction with detailed logs.
- Horizontal and vertical scales are not equal.

ROCK STRENGTH

- VL- Very Low
L - Low
M - Medium
H - High

SOIL CONSISTENCY

- vs - Very Soft
s - Soft
f - Firm
st - Stiff
vst - Very Stiff
h - Hard

TESTS / OTHER

- N - Standard penetration test value
- ? - - Interpreted geotechnical boundary
v - Water level

0 6
Horizontal Scale (metres)
Vertical Exaggeration = 3.0



CLIENT: The University of Sydney	
OFFICE: Sydney	DRAWN BY: EC
SCALE: 1:300 (H) 1:100 (V) @ A3	DATE: 21.01.2025

TITLE: **Interpreted Geotechnical Cross-Section B-B'**
USYD Ross St Teaching & Learning Hub
Corner of Parramatta Road and Western Avenue, Camperdown

PROJECT No:	225008.00
DRAWING No:	3
REVISION:	1

Appendix C

Terminology, Symbols and Abbreviations

Soil Descriptions

Rock Descriptions

Sampling, Testing and Excavation Methodology

Results of the Investigation



Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests /

Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

The soil group symbol classifications are given as follows based on two major soil divisions:

- Coarse-grained soils
- Fine-grained soils

Major Divisions				Description	
				Group Symbol*	Typical Name
COARSE-GRAINED SOILS	More than 65% by dry mass, (excluding that larger than 63 mm) is greater than 0.075 mm	GRAVEL	More than 50% of coarse grains are greater than 2.36 mm	GW	Well graded gravels and gravel-sand mixtures, little or no fines.
				GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.
				GM	Silty gravels, gravel-sand-silt mixtures.
				GC	Clay gravels, gravel-sand-clay mixtures.
		SAND	More than 50% of coarse grains are less than 2.36 mm	SW	Well graded sands and gravelly sands, little or no fines.
				SP	Poorly graded sands and gravelly sands, little or no fines.
		SANDY SOILS		SM	Silty sand, sand-silt mixtures.
				SC	Clayey sands, sand-clay mixtures.

* For coarse grained soils where the fines content is between 5% and 12%, the soil shall be given a dual classification eg GP-GM.

FINE-GRAINED SOILS	More than 35% by dry mass, (excluding that larger than 63 mm) is less than 0.075 mm	Liquid Limit less than 35%	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity
		35% <LL< 50%	CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Liquid Limit greater than 50%	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity.
			Pt	Peat muck and other highly organic soils.

Soil Descriptions

Douglas Partners



Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 - 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 - 30%	Clay with sand
Trace	0 - 15%	Clay, trace sand

In coarse grained soils (>65% coarse)

- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand, trace clay

In coarse grained soils (>65% coarse)

- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand, trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.



Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;

- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
Soil tends to stick together.
Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w < PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL' (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w > PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈ LL' (i.e. near the liquid limit).
- 'Wet' or 'w > LL' (i.e. wet of the liquid limit).



Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $IS_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Abbreviation	Unconfined Compressive Strength MPa	Point Load Index * $IS_{(50)}$ MPa
Very low	VL	0.6 - 2	0.03 - 0.1
Low	L	2 - 6	0.1 - 0.3
Medium	M	6 - 20	0.3 - 1.0
High	H	20 - 60	1 - 3
Very high	VH	60 - 200	3 - 10
Extremely high	EH	>200	>10

* Assumes a ratio of 20:1 for UCS to $IS_{(50)}$. It should be noted that the UCS to $IS_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
<i>Note: If HW and MW cannot be differentiated use DW (see below)</i>		
Distinctly weathered	DW	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 weathered products in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} > 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners



Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General



Asphalt



Road base



Concrete



Filling

Soils



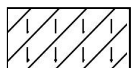
Topsoil



Peat



Clay



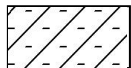
Silty clay



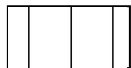
Sandy clay



Gravelly clay



Shaly clay



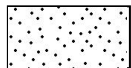
Silt



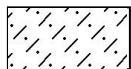
Clayey silt



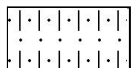
Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

Sedimentary Rocks



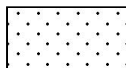
Boulder conglomerate



Conglomerate



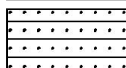
Conglomeratic sandstone



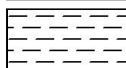
Sandstone



Siltstone



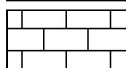
Laminite



Mudstone, claystone, shale

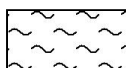


Coal

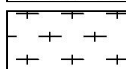


Limestone

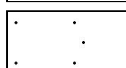
Metamorphic Rocks



Slate, phyllite, schist

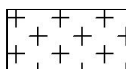


Gneiss



Quartzite

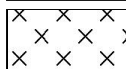
Igneous Rocks



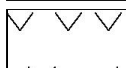
Granite



Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 25.3 AHD
EASTING: 332126
NORTHING: 6249087
DIP/AZIMUTH: 90°/-

BORE No: BH101
PROJECT No: 225008.00
DATE: 7/11/2023
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
25	0.05	ASPHALTIC CONCRETE: 50mm thick, dark grey CONCRETE: 100mm thick, pale grey FILL/Sandy GRAVEL: subangular concrete and igneous gravel up to 45mm, pale brown, fine to medium sand, trace silt, trace building rubble (bricks), dry																			PID - <1ppm
																				E*	
	1	CLAY CH: high plasticity, pale grey mottled yellow, with iron indurated gravel of medium strength, trace rootlets, w<PL, residual Below 1.50m: possibly extremely weathered material																			PID - <1ppm
																					PID - <1ppm
2	2.02	SILTSTONE: red-brown, pale grey and grey, very low and low strength, highly weathered, highly fractured, fragmented with occasional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale Below 3.0m: slightly fractured																C	100		pp = 450-500
23	2.2																	C	87	77	
3																					
4	3.91	SILTSTONE: dark grey, moderately to highly weathered, medium to high strength, 10% sandstone laminations, slightly fractured, Ashfield Shale																			PL(A) = 0.3

RIG: Proline Drill **DRILLER:** BB **LOGGED:** HS **CASING:** HW to 1.79m

TYPE OF BORING: Dia-tube to 0.18m, hand auger to 1.80m, NMLC Coring to 6.0m.

WATER OBSERVATIONS: No groundwater observed during hand augering.

REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum. *Replicate sample BD1/20231107 taken from 0.2-0.4 m. Refer to well logs for monitoring well construction details.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 25.3 AHD
EASTING: 332126
NORTHING: 6249087
DIP/AZIMUTH: 90°/--

BORE No: BH101
PROJECT No: 225008.00
DATE: 7/11/2023
SHEET 2 OF 2

[illegible]

RIG: Proline Drill

DRILLER: BB

LOGGED: HS

CASING: HW to 1.79m

TYPE OF BORING: Dia-tube to 0.18m, hand auger to 1.80m, NMLC Coring to 6.0m.

WATER OBSERVATIONS: No groundwater observed during hand augering.

REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum. *Replicate sample BD1/20231107 taken from 0.2--0.4 m. Refer to well logs for monitoring well construction details.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



Douglas Partners
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BORE: BH101 PROJECT: 225008.00 NOVEMBER 2023



Project No: 225008.00
BH ID: BH101
Depth: 1.86 - 6.06m
Core Box No.: 1

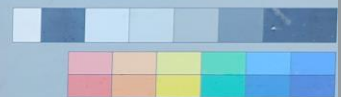


1.86 – 6.00m

BORE: BH101 PROJECT: 225008.00 NOVEMBER 2023



Project No: 225008.00
BH ID: BH101
Depth: 6.00 - 7.54m
Core Box No.: 2



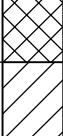
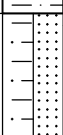
6.00 - 7.54m

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 25.3 AHD
EASTING: 332126
NORTHING: 6249087
DIP/AZIMUTH: 90°/-

BORE No: BH101
PROJECT No: 225008.00
DATE: 7/11/2023
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
25	0.05	ASPHALTIC CONCRETE: 50mm thick, dark grey		E*	0.2		PID - <1ppm		Concrete cap
	0.15	CONCRETE: 100mm thick, pale grey			0.4				Bentonite 0.1-0.3m
		FILL/Sandy GRAVEL: subangular concrete and igneous gravel up to 45mm, pale brown, fine to medium sand, trace silt, trace building rubble (bricks), dry			0.8		PID - <1ppm		Spoil 0.3-0.5m
					1.0				Blank pipe 0.0-1.2m
1	1.1	CLAY CH: high plasticity, pale grey mottled yellow, with iron indurated gravel of medium strength, trace rootlets, w<PL, residual		E	1.1		PID - <1ppm		Bentonite 0.5-1.6m
					1.3				
		Below 1.50m: possibly extremely weathered material			1.86				
					2.03		pp = 450-500		
2	2.02	SILTSTONE: red-brown, pale grey and grey, very low and low strength, highly weathered, highly fractured, fragmented with occasional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale		C	2.03				
	2.2				2.5				
		Below 3.0m: slightly fractured			3.03		PL(A) = 0.3		
					3.95				
	3.91	SILTSTONE: dark grey, moderately to highly weathered, medium to high strength, 10% sandstone laminations, slightly fractured, Ashfield Shale		C	4.02		PL(A) = 0.7		
4									
									Machine slotted PVC screen 1.2-7.54m Gravel 1.6-7.2m

RIG: Proline Drill

DRILLER: BB

LOGGED: HS

CASING: HW to 1.79m

TYPE OF BORING: Dia-tube to 0.18m, hand auger to 1.80m, NMLC Coring to 6.0m.

WATER OBSERVATIONS: No groundwater observed during hand augering.

REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum. *Replicate sample BD1/20231107 taken from 0.2--0.4 m. Refer to well logs for monitoring well construction details.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 25.3 AHD
EASTING: 332126
NORTHING: 6249087
DIP/AZIMUTH: 90°/--

BORE No: BH101
PROJECT No: 225008.00
DATE: 7/11/2023
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample			
20		SILTSTONE: dark grey, moderately to highly weathered, medium to high strength, 10% sandstone laminations, slightly fractured, Ashfield Shale <i>(continued)</i>		C	5.07 5.15		PL(A) = 1		
6		Below 6.0m: slightly weathered, 20% sandstone laminations		C	6.06		PL(A) = 0.9	6	
19					6.65				
7				C	7.07		PL(A) = 1.5	7	
18									
7.54		Bore discontinued at 7.54m Target depth reached			7.54				
8									
17									
9									
16									

RIG: Proline Drill

DRILLER: BB

LOGGED: HS

CASING: HW to 1.79m

TYPE OF BORING: Dia-tube to 0.18m, hand auger to 1.80m, NMLC Coring to 6.0m.

WATER OBSERVATIONS: No groundwater observed during hand augering.

REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum. *Replicate sample BD1/20231107 taken from 0.2--0.4 m. Refer to well logs for monitoring well construction details.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U _s	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W _s	Water seep
E	Environmental sample	W _l	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test ls(50) (MPa)
		PL(D)	Point load diametral test ls(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 24.2 AHD
EASTING: 332137
NORTHING: 6249047
DIP/AZIMUTH: 90°/--

BORE No: BH102
PROJECT No: 225008.00
DATE: 9/11/2023
SHEET 1 OF 2

[illegible]

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BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 24.2 AHD
EASTING: 332137
NORTHING: 6249047
DIP/AZIMUTH: 90°/-

BORE No: BH102
PROJECT No: 225008.00
DATE: 9/11/2023
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
	19	SILTSTONE: grey and dark grey, inferred highly weathered with bands of extremely weathered material <i>(continued)</i>																			
	5.5	INTERLAMINATED SILTSTONE AND SANDSTONE: 50% dark grey siltstone with 50% irregular and disturbed pale grey sandstone beds and laminations, medium to high strength, slightly weathered, thinly laminated, fractured, Ashfield Shale																S			10/50 refusal No recovery PL(A) = 0.5
	5.8																				
	6																				
	18																				
	7	Below 6.64m: fresh, slightly fractured																			
	17																	C	95	81	PL(A) = 1.1
	8																				PL(A) = 2.2
	16																				
	9																				PL(A) = 0.8
	15																	C	100	97	PL(A) = 1
	9.7	Bore discontinued at 9.7m Target depth reached																			

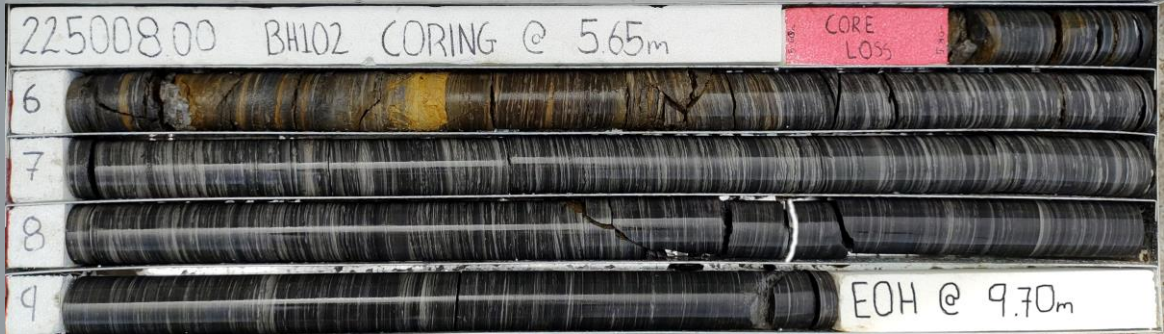
RIG: Massenza MI3 **DRILLER:** ML **LOGGED:** HS **CASING:** HW to 5.60m.
TYPE OF BORING: Solid flight auger to 5.65m, NMLC to 9.70m.
WATER OBSERVATIONS: No free groundwater observed during augering
REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BORE: BH102 PROJECT: 225008.00 NOVEMBER 2023



Project No: 225008.00
BH ID: BH102
Depth: 5.65 - 9.70m
Core Box No.: 1



5.95 - 9.70m

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 26.0 AHD
EASTING: 332163
NORTHING: 6249053
DIP/AZIMUTH: 90°/--

BORE No: BH103
PROJECT No: 225008.00
DATE: 8/11/2023
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing							
			EW	HW	MW	SW		FS	FR	Ex Low	Very Low	Low		Medium	High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %
28	0.05	ASPHALTIC CONCRETE: 50mm thick, dark grey																									
		FILL/Sandy GRAVEL: subangular concrete and igneous gravel up to 45mm, pale brown, with fine grained sand, trace silt, trace building rubble (bricks), dry																									
	0.5	REINFORCED CONCRETE: 200m thick																									
	0.7	FILL/Clayey GRAVEL: subangular igneous gravel up to 20mm, pale brown, with medium plasticity clay, with fine to medium sand																									
25	1.0	CLAY CH: high plasticity, pale grey mottled yellow, with medium strength ironstone bands, trace rootlets, w<PL, very stiff, residual																									
																					</						


Douglas Partners
 Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 26.0 AHD
EASTING: 332163
NORTHING: 6249053
DIP/AZIMUTH: 90°/-

BORE No: BH103
PROJECT No: 225008.00
DATE: 8/11/2023
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
21		SILTSTONE: red-brown, pale grey, and grey, very low and low strength, highly weathered, highly fractured, fragmented with occasional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale (continued)																			
5.6		INTERLAMINATED SILTSTONE AND SANDSTONE: 60% dark grey siltstone with 40% irregular pale grey sandstone beds and laminations, medium strength, moderately to slightly weathered, thinly laminated, fractured, Ashfield Shale																C	100	72	PL(A) = 0.3
20	6																	C	100	69	
19	7	Below 7.13m: slightly weathered to fresh																			PL(A) = 1
18	8																				
8.9		Bore discontinued at 8.9m Target depth reached																			
17	9																				

RIG: Massenza MI3

DRILLER: ML

LOGGED: HS

CASING: HW to 4.30m.

TYPE OF BORING: Solid flight auger to 4.30, NMLC to 8.91m.

WATER OBSERVATIONS: No free groundwater observed during augering.

REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum. Refer to well logs for monitoring well construction details.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	SP	Standard penetration test
E	Environmental sample	WL	Water level	S	Shear vane (kPa)



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BORE: BH103 PROJECT: 225008.00 NOVEMBER 2023



Project No: 225008.00
BH ID: 84103
Depth: 4.30 - 8.90m
Core Box No.: 1



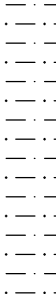
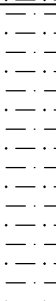
4.30 - 8.90m

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 26.0 AHD
EASTING: 332163
NORTHING: 6249053
DIP/AZIMUTH: 90°/--

BORE No: BH103
PROJECT No: 225008.00
DATE: 8/11/2023
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
26	0.05	ASPHALTIC CONCRETE: 50mm thick, dark grey							Concrete cap
		FILL/Sandy GRAVEL: subangular concrete and igneous gravel up to 45mm, pale brown, with fine grained sand, trace silt, trace building rubble (bricks), dry		E	0.2				Bentonite 0.1-0.3m
				A	0.3				
				E	0.4				
	0.5	REINFORCED CONCRETE: 200m thick			0.5				Spoil 0.3-0.5m
	0.7	FILL/Clayey GRAVEL: subangular igneous gravel up to 20mm, pale brown, with medium plasticity clay, with fine to medium sand		E	0.7		PID - <1ppm		Blank pipe 0.0-1.1m
				E	0.8				Bentonite 0.5-1.1m
25	1.0	CLAY CH: high plasticity, pale grey mottled yellow, with medium strength ironstone bands, trace rootlets, w<PL, very stiff, residual		S	1.0		pp = 350-450 7,8,10 N = 18	1	
					1.45				
				E	1.6		PID - <1ppm		
				E	1.7				
					1.8				
				E	1.9				
24	2.0				2.0			2	
					2.5		pp = 400-500 5,9,14 N = 23		
		Below 2.57m: possibly extremely weathered material		S	2.95			20-11-23	
23	3.0	SILTSTONE: pale grey, very low to low strength, Ashfield Shale						3	
					4.0		25/50 refusal Bouncing	4	
				S	4.05				
					4.3				
22	4.0	SILTSTONE: red-brown, pale grey, and grey, very low and low strength, highly weathered, highly fractured, fragmented with occasional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale		C					Gravel 1.1-7.9m (please check depth)


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BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 26.0 AHD
EASTING: 332163
NORTHING: 6249053
DIP/AZIMUTH: 90°/--

BORE No: BH103
PROJECT No: 225008.00
DATE: 8/11/2023
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
21		SILTSTONE: red-brown, pale grey, and grey, very low and low strength, highly weathered, highly fractured, fragmented with occasional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale (<i>continued</i>)		C					Machine slotted PVC screen 1.1-8.9m	
	5.6	INTERLAMINATED SILTSTONE AND SANDSTONE: 60% dark grey siltstone with 40% irregular pale grey sandstone beds and laminations, medium strength, moderately to slightly weathered, thinly laminated, fractured, Ashfield Shale			5.6 5.67		PL(A) = 0.3			
	6			C						
					6.87		PL(A) = 0.6			
	7	Below 7.13m: slightly weathered to fresh			7.0					
				C						
	8				7.95		PL(A) = 1			
									Sand 7.9-8.9m	
					8.75		PL(A) = 0.8			
	8.9	Bore discontinued at 8.9m Target depth reached			8.9				End cap	
	9									

RIG: Massenza MI3

DRILLER: ML

LOGGED: HS

CASING: HW to 4.30m.

TYPE OF BORING: Solid flight auger to 4.30, NMLC to 8.91m.

WATER OBSERVATIONS: No free groundwater observed during augering.

REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum. Refer to well logs for monitoring well construction details.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 25.9 AHD
EASTING: 332148
NORTHING: 6249090
DIP/AZIMUTH: 90°/--

BORE No: BH104
PROJECT No: 225008.00
DATE: 6/11/2023
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing							
			EW	HW	MW	SW		FS	FR	Ex Low	Very Low	Low		Medium	High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %
25	0.045	ASPHALTIC CONCRETE: 450 mm thick, dark grey																									
		FILL/Silty GRAVEL: dark grey, fine to coarse, subangular to angular igneous and shale gravel, trace concrete, wet, potential ash																									PID - <1ppm
	0.7	FILL/Silty CLAY: medium to high plasticity, grey-brown, trace potential ash, concrete and igneous and shale gravel, w~PL, sweet odour																					E				PID - <1ppm
	1.0	FILL/Silty CLAY: medium to high plasticity, grey-brown, trace shale gravel, w~PL																					E				PID - <1ppm
	1.2	FILL/Silty CLAY: medium to high plasticity, pale grey-grey, trace subangular to angular shale gravel, w~PL, possibly residual																					E				PID - <1ppm
24	1.45	Silty CLAY: pale grey and red-brown, some very low strength siltstone bands, residual/weathered rock																									
																							C	100	0		
	1.94																										
																							C	84	0		
	2.57	SILTSTONE: dark grey, very low strength																									
23	2.77																										
	2.86	SILTSTONE: dark grey, medium strength, slightly weathered, fractured, Ashfield Shale																									PL(A) = 0.4
																							C	88	92		
22	3.93																										
	4.08	INTERLAMINATED SILTSTONE AND SANDSTONE: 60% dark grey siltstone with 40% irregular pale grey sandstone beds and laminations, high strength, fresh and slightly weathered, fractured, Ashfield Shale																									PL(A) = 0.8
21																											
																											PL(A) = 1.1

RIG: Proline Drill **DRILLER:** BB **LOGGED:** HS **CASING:** HW to 1.45m
TYPE OF BORING: Dia-tube to 0.2m, hand auger to 1.50m, NMLC Coring to 5.90m.
WATER OBSERVATIONS: Fill saturated from recent rain.
REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum.

SAMPLING & IN SITU TESTING LEGEND			
A Auger sample	G Gas sample	PID Photo ionisation detector (ppm)	
BB Bulk sample	P Piston sample	PL(A) Point load axial test Is(50) (MPa)	
BLK Block sample	U Tube sample (x mm dia.)	PL(D) Point load diametral test Is(50) (MPa)	
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)	
D Disturbed sample	> Water seep	S Standard penetration test	
E Environmental sample	≡ Water level	V Shear vane (kPa)	

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 25.9 AHD
EASTING: 332148
NORTHING: 6249090
DIP/AZIMUTH: 90°/--

BORE No: BH104
PROJECT No: 225008.00
DATE: 6/11/2023
SHEET 2 OF 2

[illegible]

RIG: Proline Drill **DRILLER:** BB **LOGGED:** HS **CASING:** HW to 1.45m
TYPE OF BORING: Dia-tube to 0.2m, hand auger to 1.50m, NMLC Coring to 5.90m.
WATER OBSERVATIONS: Fill saturated from recent rain.
REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U _t	Tube sample (x mm dia.)
C	Core drilling	W _s	Water sample
D	Disturbed sample	W _{seep}	Water seep
E	Environmental sample	W _{level}	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



BORE: BH104 PROJECT: 225008.00 NOVEMBER 2023



Project No: 225008.00
BH ID: BH104
Depth: 1.50m - 5.90m
Core Box No.: 1



1.50 – 5.90m

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 25.4 AHD
EASTING: 332144
NORTHING: 6249066
DIP/AZIMUTH: 90°/--

BORE No: BH105
PROJECT No: 225008.00
DATE: 8/11/2023
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
25	0.1	ASPHALTIC CONCRETE: 100mm thick, dark grey								
		FILL/Sandy GRAVEL: subangular igneous gravel up to 45mm, pale brown, with fine to medium sand, trace silt, dry, apparently medium dense		E	0.2		PID - <1ppm			
				E	0.3					
				E	0.4					
				E	0.5					
				E	0.6					
				E	0.7					
	0.8	CLAY CH: high plasticity, pale grey mottled yellow, with medium strength iron indurated gravel, trace rootlets, w<PL, apparently stiff, residual		E	0.8		PID - <1ppm			
				E	0.9					
				E	1.0					
				E	1.1					
24			E	1.5		PID - <1ppm				
			E	1.6						
			E	1.7						
			E	1.8						
			E	1.9						
23										
22										
21										

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: USYD Ross Street Teaching & Learning Hub
LOCATION: Corner Parramatta Road and Western Avenue, Camperdown

SURFACE LEVEL: 24.4 AHD
EASTING: 332164
NORTHING: 6249024
DIP/AZIMUTH: 90°/--

BORE No: BH106
PROJECT No: 225008.00
DATE: 24/11/2023
SHEET 1 OF 1

[illegible]

RIG: Hand tools

DRILLER: LDS

LOGGED: LDS

CASING: Uncased

TYPE OF BORING: Hand tools to 0.35m, Hand auger to 1.35m.

WATER OBSERVATIONS: No free groundwater observed during augering.

REMARKS: Location coordinates are in GDA2020 Zone 56. Surface level is relative to Australian Height Datum.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



Appendix D

Laboratory Test Results

CERTIFICATE OF ANALYSIS 338754-A

Client Details

Client	Douglas Partners Pty Ltd
Attention	David Smith
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	<u>225008.01 Camperdown</u>
Number of Samples	Additional analysis
Date samples received	27/11/2023
Date completed instructions received	23/02/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	26/02/2024
Date of Issue	26/02/2024
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Hannah Nguyen, Metals Supervisor
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil				
Our Reference		338754-A-1	338754-A-2	338754-A-3
Your Reference	UNITS	BH106	BH106	BH106
Depth		0.25-0.35	0.35-0.6	1-1.1
Date Sampled		24/11/2023	24/11/2023	24/11/2023
Type of sample		Soil	Soil	Soil
Date prepared	-	26/02/2024	26/02/2024	26/02/2024
Date analysed	-	26/02/2024	26/02/2024	26/02/2024
pH 1:5 soil:water	pH Units	7.6	5.3	4.7
Electrical Conductivity 1:5 soil:water	µS/cm	34	30	55
Chloride, Cl 1:5 soil:water	mg/kg	<10	10	26
Sulphate, SO4 1:5 soil:water	mg/kg	20	10	62

ESP/CEC				
Our Reference		338754-A-1	338754-A-2	338754-A-3
Your Reference	UNITS	BH106	BH106	BH106
Depth		0.25-0.35	0.35-0.6	1-1.1
Date Sampled		24/11/2023	24/11/2023	24/11/2023
Type of sample		Soil	Soil	Soil
Date prepared	-	26/02/2024	26/02/2024	26/02/2024
Date analysed	-	26/02/2024	26/02/2024	26/02/2024
Exchangeable Ca	meq/100g	16	5.4	0.3
Exchangeable K	meq/100g	0.4	0.3	0.1
Exchangeable Mg	meq/100g	2.2	2.9	2.0
Exchangeable Na	meq/100g	0.3	0.3	0.4
Cation Exchange Capacity	meq/100g	19	9.0	2.8
ESP	%	2	4	14

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-OES analytical finish.

Client Reference: 225008.01 Camperdown

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			26/02/2024	[NT]	[NT]	[NT]	[NT]	26/02/2024	[NT]
Date analysed	-			26/02/2024	[NT]	[NT]	[NT]	[NT]	26/02/2024	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	100	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	99	[NT]

Client Reference: 225008.01 Camperdown

QUALITY CONTROL: ESP/CEC					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	338754-A-2
Date prepared	-			26/02/2024	1	26/02/2024	26/02/2024		26/02/2024	26/02/2024
Date analysed	-			26/02/2024	1	26/02/2024	26/02/2024		26/02/2024	26/02/2024
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	1	16	15	6	120	106
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	1	0.4	0.4	0	117	107
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	1	2.2	2.0	10	119	113
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	1	0.3	0.3	0	125	114
ESP	%	1	Metals-020	[NT]	1	2	2	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.	
Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2	

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

Samples received in good order: Holding time exceedance

Appendix E

Hydraulic Testing Results

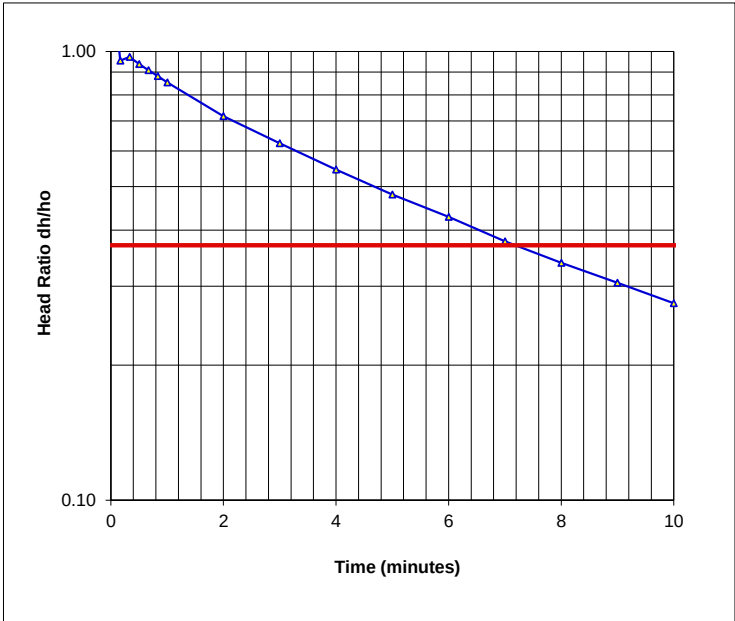
Permeability Testing - Rising Head Test Report

Client:	The University of Sydney	Project No:	225008.00
Project:	Proposed Teaching and Learning Hub	Test date:	22/02/2024
Location:	Ross Street, Camperdown	Tested by:	CC

Test Location		Test No.	
Description:	Standpipe in borehole	Easting:	332163 m
Material type:	Siltstone / sandstone	Northing:	6249053 m
		Surface Level:	26.0 m AHD

Details of Well Installation			
Effective diameter (2re)	76	mm	Depth to water before test
Borehole diameter (2R)	76	mm	Depth to water at start of test
Effective Length of well screen (Le)	6.3	m	Depth of top of gravel pack
			Depth of base of gravel pack

Test Results			
Time (min)	Depth (m)	Change in Head dH (m)	dH/Ho
0.0	1.60	1.00	1.538
0.2	1.98	0.62	0.954
0.3	1.97	0.63	0.973
0.5	1.99	0.61	0.938
0.7	2.01	0.59	0.908
0.8	2.03	0.57	0.881
1.0	2.05	0.55	0.854
2.0	2.13	0.47	0.718
3.0	2.19	0.41	0.625
4.0	2.25	0.35	0.546
5.0	2.29	0.31	0.480
6.0	2.32	0.28	0.428
7.0	2.35	0.25	0.377
8.0	2.38	0.22	0.338
9.0	2.40	0.20	0.305
10.00	2.42	0.18	0.275
15.00	2.48	0.12	0.177
20.00	2.55	0.05	0.081



To = 7.0 mins
420 secs

Theory:	Rising Head Permeability calculated using equation by Hvorslev $k = \frac{r^2 \ln(Le/R)}{2Le T_o}$ where r = radius of casing R = radius of well screen Le = length of well screen To = time taken to rise or fall to 37% of initial change
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Hydraulic Conductivity	k =	1E-06	m/sec	
	=	1.2E-01	m/day	

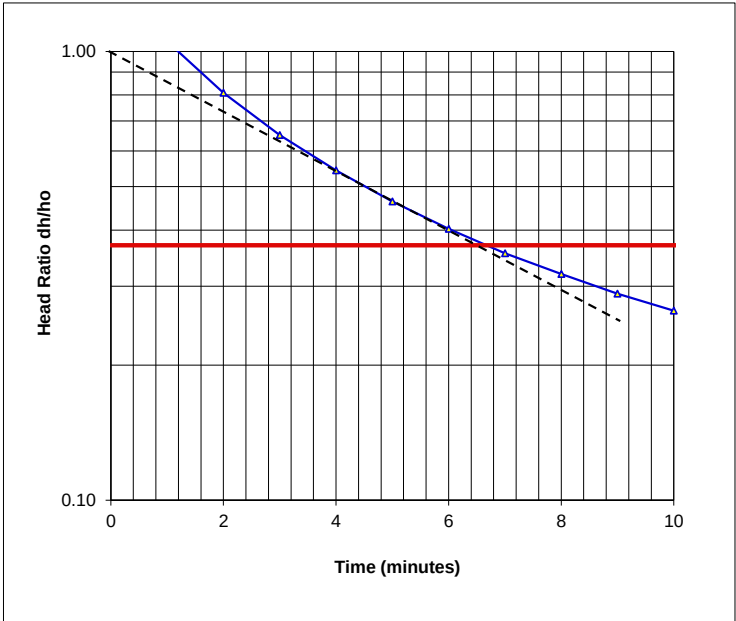
Permeability Testing - Rising Head Test Report

Client:	The University of Sydney	Project No:	225008.00
Project:	Proposed Teaching and Learning Hub	Test date:	22/02/2024
Location:	Ross Street, Camperdown	Tested by:	CC

Test Location		Test No.	BH103 - rising
Description:	Standpipe in borehole	Easting:	332163 m
Material type:	Siltstone / sandstone	Northing	6249053 m
		Surface Level:	26.0 m AHD

Details of Well Installation					
Effective diameter (2re)	76	mm	Depth to water before test	2.6	m
Borehole diameter (2R)	76	mm	Depth to water at start of test	3.6	m
Effective Length of well screen (Le)	6.3	m	Depth of top of gravel pack	1.1	m
			Depth of base of gravel pack	8.9	m

Test Results			
Time (min)	Depth (m)	Change in Head dH (m)	dH/Ho
0.0	3.60	1.00	1.538
0.2	3.68	0.92	1.420
0.3	3.74	0.86	1.321
0.5	3.79	0.81	1.240
0.7	3.84	0.76	1.170
0.8	3.88	0.72	1.110
1.0	3.92	0.68	1.053
2.0	4.07	0.53	0.809
3.0	4.18	0.42	0.651
4.0	4.25	0.35	0.543
5.0	4.30	0.30	0.464
6.0	4.34	0.26	0.403
7.0	4.37	0.23	0.355
8.0	4.39	0.21	0.319
9.0	4.41	0.19	0.289
10.00	4.43	0.17	0.265
15.00	4.48	0.12	0.183
20.00	4.49	0.11	0.172



To = 6.4 mins
384 secs

Theory:	Rising Head Permeability calculated using equation by Hvorslev $k = \frac{r^2 \ln(Le/R)}{2Le T_o}$ where r = radius of casing R = radius of well screen Le = length of well screen To = time taken to rise or fall to 37% of initial change
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Hydraulic Conductivity	k =	2E-06	m/sec	
	=	1.3E-01	m/day	

Permeability Testing - Rising Head Test Report

Client:	The University of Sydney	Project No:	225008.00
Project:	Proposed Teaching and Learning Hub	Test date:	22/02/2024
Location:	Ross Street, Camperdown	Tested by:	CC

Test Location		Test No.	
Description:	Standpipe in borehole	Easting:	332126 m
Material type:	Siltstone / sandstone	Northing:	6249087 m
		Surface Level:	25.3 m AHD

Details of Well Installation			
Effective diameter (2re)	76 mm	Depth to water before test	2.5 m
Borehole diameter (2R)	76 mm	Depth to water at start of test	1.5 m
Effective Length of well screen (Le)	5.0 m	Depth of top of gravel pack	1.6 m
		Depth of base of gravel pack	7.5 m

Test Results			
Time (min)	Depth (m)	Change in Head dH (m)	dH/Ho
0.0	1.50	1.00	1.667
0.2	1.92	0.58	0.963
0.3	1.80	0.70	1.170
0.5	1.96	0.54	0.907
0.7	1.94	0.56	0.933
0.8	1.95	0.55	0.923
1.0	1.95	0.55	0.912
2.0	1.98	0.52	0.865
3.0	2.00	0.50	0.827
4.0	2.02	0.48	0.796
5.0	2.04	0.46	0.767
6.0	2.06	0.44	0.741
7.0	2.07	0.43	0.718
8.0	2.08	0.42	0.696
9.0	2.09	0.41	0.675
10.00	2.11	0.39	0.655
15.00	2.16	0.34	0.567
20.00	2.21	0.29	0.489
25.00	2.24	0.26	0.433
35.00			

To = 31.0 mins
1860 secs

Theory:	Rising Head Permeability calculated using equation by Hvorslev $k = \frac{r^2 \ln(Le/R)}{2Le To}$ where r = radius of casing R = radius of well screen Le = length of well screen To = time taken to rise or fall to 37% of initial change
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Hydraulic Conductivity	k = 4E-07 m/sec	
	= 3.3E-02 m/day	

Permeability Testing - Rising Head Test Report

Client:	The University of Sydney	Project No:	225008.00
Project:	Proposed Teaching and Learning Hub	Test date:	22/02/2024
Location:	Ross Street, Camperdown	Tested by:	CC

Test Location		Test No. BH101 - rising	
Description:	Standpipe in borehole	Easting:	332126 m
Material type:	Siltstone / sandstone	Northing:	6249087 m
		Surface Level:	25.3 m AHD

Details of Well Installation			
Effective diameter (2re)	76 mm	Depth to water before test	2.5 m
Borehole diameter (2R)	76 mm	Depth to water at start of test	3.5 m
Effective Length of well screen (Le)	5.0 m	Depth of top of gravel pack	1.6 m
		Depth of base of gravel pack	7.5 m

Test Results			
Time (min)	Depth (m)	Change in Head dH (m)	dH/Ho
0.0	3.50	1.00	1.667
0.2	3.77	0.73	1.215
0.3	3.81	0.69	1.147
0.5	3.83	0.67	1.114
0.7	3.84	0.66	1.097
0.8	3.85	0.65	1.081
1.0	3.86	0.64	1.067
2.0	3.90	0.60	1.002
3.0	3.93	0.57	0.956
4.0	3.95	0.55	0.918
5.0	3.97	0.53	0.887
6.0	3.99	0.51	0.857
7.0	4.00	0.50	0.833
8.0	4.01	0.49	0.811
9.0	4.02	0.48	0.793
10.00	4.03	0.47	0.776
15.00	4.07	0.43	0.711
20.00	4.10	0.40	0.663
25.00	4.13	0.37	0.618
60.00			

To = 58.0 mins
3480 secs

Theory:	Rising Head Permeability calculated using equation by Hvorslev $k = \frac{[r^2 \ln(Le/R)]}{2Le To}$ where r = radius of casing R = radius of well screen Le = length of well screen To = time taken to rise or fall to 37% of initial change
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Hydraulic Conductivity	k = 2E-07 m/sec	
	= 1.7E-02 m/day	