GROUNDED
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Acid Sulfate Soil Management Plan

Ross Street Teaching and Learning Hub

Corner Parramatta Road and Western Avenue, Camperdown

Prepared for The University of Sydney

Project 225008.00

14 February 2025

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Document History

Details

Project No.	225008.00
Document Title	Acid Sulfate Soil Management Plan
Site Address	Corner Parramatta Road and Western Avenue, Camperdown
Report Prepared For	The University of Sydney
Filename	225008.00.R.002.Rev2

Status and Review

Status	Prepared by	Reviewed by	Date issued
Revision 0	David Smith	Paul Gorman	12 April 2024
Revision 1	David Smith	Paul Gorman	31 October 2024
Revision 2	David Smith	Paul Gorman	14 February 2025

Distribution of Copies

Status	Issued to
Revision 0	Nora Babik, The University of Sydney
Revision 1	Nora Babik, The University of Sydney
Revision 2	Nora Babik, The University of Sydney

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		Date
Author		14 February 2025
Reviewer	P. Gorman	14 February 2025

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Report on Acid Sulfate Soil Management Plan
Ross Street Teaching and Learning Hub
Corner Parramatta Road and Western Avenue, Camperdown

1. Introduction

Douglas Partners Pty Ltd (Douglas) has been engaged by the University of Sydney to complete this acid sulfate soil management plan (ASSMP) for the Ross Street teaching and learning hub at the Corner Parramatta Road and Western Avenue, Camperdown (the site). This report has been prepared for the University of Sydney (the applicant), to support the preparation of a State Significant Development Application (SSD-57838709) to the Department of Planning and Environment (DPE).

It is understood that the proposed development comprises the construction of a five-storey building with single level basement. A geotechnical investigation was carried out between 6 and 9 November 2023 by Douglas (refer Section 4). The investigation included the drilling of six boreholes and installation of two groundwater wells. The details of the field work are presented in this report, in Section 4.

The site is located in an area classified as Class 5 on the Sydney Local Environmental Plan 2012 Acid Sulphate Soil Map. Acid Sulphate Soils (ASS) are not typically found in Class 5 areas. Furthermore, the site is located at a minimum elevation of approximately RL 23.5 m AHD, which suggests that ASS is unlikely.

On this basis, the ASSMP is not prepared to manage known ASS, but is intended to provide a methodology to address contingent finds of ASS (low probability) through observations noted in Section 6.

The purpose of this ASSMP is to:

- Outline the procedures for the identification of ASS;
- Outline the procedures for the appropriate management / mitigation of potential environmental impacts that may result from the disturbance of ASS (if found);
- Outline the procedures for the on-site treatment of ASS (if found);
- Outline the procedures for the off-site disposal of ASS (if found) at a licensed facility;
- Provide a monitoring program for validating the effectiveness of the management process; and
- Provide emergency response procedures for potential environmental threats which could occur during ASS management (if found).

This report must be read in conjunction with all appendices including the notes provided in Appendix A.

2. Site information

Site Address	Corner Parramatta Road and Western Avenue, Camperdown
Legal Description	Part of Lot 1 Deposited Plan 1171804
Approximate Area	1,273 m^2
Zoning	Zone SP2 Educational Establishment
Local Council Area	Council of the City of Sydney
Current Use	University – Demountable Village, teaching facilities
Surrounding Uses	North – Parramatta Road, then commercial / industrial buildings East – USYD educational buildings South – Science Road then a sporting oval West – Western Avenue then USYD educational buildings

A plan depicting the property and site boundaries and locality map is included as Drawing 1, Appendix B.

3. Environmental setting

3.1 Geology

The Geological Survey of NSW Sydney 1:100,000 Geology Sheet 9130 for Sydney indicates that the site is underlain by Ashfield Shale, part of the Wianamatta Group of rocks comprising four siltstone and laminite subgroups. 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 geotechnical investigation were consistent with the published geological mapping.

3.2 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. ASS are not typically associated with residual soil profiles (refer Section 5.1).

3.3 Hydrogeology

There are two registered groundwater wells noted within a 50 m radius of the site. GW116421 to GW116424 recorded standing water levels in the range of 2.9 m to 3.2 m bgl. 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 to the 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 bedrock and through joints and bedding planes within the rock itself. Seepage volume would be expected to be low and vary with climatic events.

3.4 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).

3.5 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 ASS 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, ASS typically do not form above RL 5 m AHD.

4. Geotechnical Investigation

The recent field work for the geotechnical investigation (Douglas Report 225008.00.R.001.Rev2 dated February 2025) was conducted between 6 to 9 November 2024 and 24 November 2024 in the presence of a geotechnical engineer from Douglas. 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). Boreholes were drilled to termination depths in the range of 1.35 m and 9.7 m.

The logs for the three boreholes are attached in Appendix C. The logs should be read in conjunction with the attached explanatory notes that define classification methods and terms used to describe the soils and rock, in Appendix A. In summary, the subsurface profile encountered comprised the following:

- 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 bgl; underlain by;
- RESIDUAL: pale grey mottled yellow / orange, high plasticity, residual clay, with inclusions of ironstone gravel to depths in the range of 1.35 m to 4.5 m bgl; overlying; and

- 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.

Two groundwater monitoring wells were installed in Bores 101 and 103, following the completion of drilling. The wells were constructed using a 50 mm diameter, machine slotted, Class 19 uPVC. The wells were completed with a flush mount 'Gatic' cover. Groundwater has been reported at depths of between 2.5 m and 2.7 m below surface in monitoring wells (Bores 101 and 103) installed during the recent investigation. Construction details of the wells and initial water level readings are included in the attached borehole logs in Appendix C.

5. Acid Sulfate Soils Background and Guidelines

5.1 Background

ASS is naturally occurring sediment containing iron sulfides, primarily pyrite, commonly deposited in alluvial and estuarine environments. The occurrence of ASS is associated with areas or regions that have previously been or are currently estuarine environments. Due to changes in sea level or geomorphologic changes to the coastal systems, these sediments are often overlain by terrestrial sediments. The subsurface profile identified at the site (refer Section 4) is residual and not consistent with the estuarine environments described above.

When ASS is exposed to air (e.g., due to excavation or dewatering), the oxygen reacts with iron sulfides in the sediment, producing sulfuric acid. This acid can be produced in large quantities and is highly mobile in water. The process can also release iron and other metals present in the soils. The sulfuric acid (and metals) can drain into waterways causing severe short and long term socio-economic and environmental impacts, including damage to man-made structures and natural ecosystems.

ASS can either be classified as actual acid sulfate soils (AASS) that have already reacted with oxygen to produce acid, or potential acid sulfate soils (PASS). PASS are soils containing iron sulfide that have not been exposed to oxygen (e.g., soils below the water table). PASS therefore have not produced sulfuric acid but have the potential to do so if exposure to oxygen occurs.

The environmental impacts that may result from the disturbance of ASS, from construction activities include:

- Uncontrolled surface runoff in areas of exposed AASS, causing the release of acid into the environment;
- Changes to surface run-off patterns promoting the release of acid into the environment;
- Leaching of acid into the environment at treatment sites; and
- Exposure of PASS to the air, or in new drains thus causing increased oxidisation and increased release of acid into the environment.

ASS can also affect human health, including eye irritation and dermatitis from short term exposure of sensitive individuals. Long term exposure to untreated ASS and mobilised metals can have more severe effects on some individuals.

5.2 Guidelines

This ASSMP has been devised broadly in accordance with the following publications:

- NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC), 1998. *Acid Sulfate Soil Manual* (ASSMAC, 1998);
- NSW Environmental Protection Authority (EPA), 2014. *Waste Classification Guidelines* (EPA, 2014);
- Ahern CR, McElnea AE, Sullivan LA (2004). *Acid Sulfate Soils Laboratory Methods Guidelines Version 2.1,* Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia (Ahern et al, 2004) (this guideline supersedes the laboratory section of ASSMAC, 1998);
- Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M., (2014). *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government*; and
- National Acid Sulfate Soils Guidance, 2018. *National Acid sulfate soils sampling and identification methods manual.*

5.3 Testing Methods

5.3.1 pH Field Test Method

This test comprises the following:

- Preparation of a one volumetric part soil: five volumetric parts distilled water solution in a glass or plastic vial (e.g., 5 g soil to 25 mL water);
- Allow approximately 10 minutes for solution to equilibrate; and
- Measure pH using a pH meter that has been calibrated as per the manufacturer's instructions.

5.3.2 pHfox Test Method

This test comprises the following:

- Prepare a 30% solution of hydrogen peroxide (H_2O_2) to a pH of between pH 4.5 and pH 5.5. If the pH of the peroxide is less than 4.5 adjust the pH by adding a few drops of 0.1M sodium hydroxide (NaOH) until the pH is between 4.5 and 5.5;
- Place approximately 5 g of soil into a small plastic / glass heat resistant test tube or beaker;
- Add approximately 2 mL of above H_2O_2 solution and stir, additional H_2O_2 can be added a few drops at a time until the reaction slows to virtual completion;
- A small amount of deionised water can be used to cool the reaction;
- Allow up to approximately 20 minutes for initial reaction to occur, during which time close supervision will be required to prevent overflow and loss of sample;
- Add deionised water to make up a volume of approximately 20 mL; and

- Record the pH using a pH meter that has been calibrated as per the manufacturer's instructions along with the assessed strength of reaction. Note that a strong reaction comprises effervescence, smoke or steam and a possible colour change. If a grey bubbling / frothy reaction occurs instead of effervescence, then this may be characteristic of an organic reaction with the hydroxide rather than pyritic oxidation. Such an organic reaction should be recorded as "F" (after the reaction number).

5.4 Laboratory Testing Method

All laboratory analysis should be undertaken by a NATA accredited laboratory. There are two methods normally used to assess ASS, namely the suspension peroxide oxidation combined acidity and sulphate (SPOCAS) method and the full chromium reducible sulphur (S_{Cr}) suite method.

The SPOCAS method can be impacted by organic matter, which can increase the recorded net acidity (and thus over-estimate the required liming rate), especially based on the sulfur trail. Given the expected presence of organic matter at the site, the S_{CR} method is generally considered to be the most appropriate test for the site.

5.5 Assessment of ASS Presence or Absence

5.5.1 Field Screening

Field screening indicators do not form part of the assessment criteria as such but can be used to provide an indication of the ASS status and to assist in selecting samples for laboratory testing.

Field screening is indicative only and can give false positive and false negative indications of the presence of ASS. False positives can be caused by organic matter, which often "froths" during oxidation. False negatives can be caused by shells in the soil. Indicators of ASS from field screening comprise:

- Field pH is less than or equal to pH 4;
- pH_{fox} is less than 3.5;
- A decrease of more than 1 pH unit from the field pH to the pH_{fox};
- Bubbling, production of heat or release of sulphur odours during pH_{fox} testing; and
- Change in colour from grey to brown tones during oxidation.

5.5.2 Laboratory Analysis for ASS Assessment

Laboratory analysis to assess for ASS generally comprises suspension peroxide oxidation combined acidity and sulphate (SPOCAS) or Chromium Reducible Sulphur Full Suite. SPOCAS analysis is better in soils with jarosite and other visible ASS minerals. The full chromium suite is less subject to false positives caused by organic matter.

The results from this testing can be used to determining the need for management of ASS in accordance with Table 1.

Table 1: Action criteria for ASS Management (ASSMAC 1998)

Material Type	Potential + Actual Acidity / Net Acidity	
	Equivalent Acidity	Equivalent Sulfur
	(mol H+/tonne)^	(% S)^
ASSMAC Action Criteria for disturbance of 1 – 1000 tonnes		
coarse textured material i.e., sands to loamy sands	18	0.03
medium textured material i.e., sandy loams to light clay	36	0.06
fine textured material i.e., medium to heavy clays and silty clay	62	0.1
ASSMAC Action Criteria for disturbance of more than 1000 tonnes		
All textures	18	0.03

Notes to table:

^ Oven-dry basis

6. Identification of ASS

As mentioned in Sections 1, 3.5 and 5.1 the potential for ASS to be encountered during basement excavation at the site is very low, as the profile at the site has currently been identified as fill over residual soils, then shallow sandstone bedrock. However, if by chance the following circumstances are observed during the basement excavation:

- The presence of a sulphur odour;
- The presence of alluvial / estuarine soils; or
- Soil with pH less than 4.

then the following identification processes will be implemented:

- Field screening by an Environmental Consultant, as per Section 5.3;
- Laboratory analysis as per Section 5.4, with samples selected by the Environmental Consultant; and
- Comparison of the results against the indicators and Action Criteria listed in Sections 5.5.1 and 5.5.2.

If the assessment shows the presence of PASS or AASS, then the management protocols outlined in Section 7 will be enacted.

7. Management Strategy

7.1 Further Assessment of Potential Non-ASS Material

Known or potential ASS may be temporality stored in stockpile pads (see Section 7.2.1) or in lined skip bins (if in small quantities) so that the soil can be tested as 'batches' prior to treatment. The stockpile/s should be placed in an area with a low permeability base lining (e.g., plastic layer and compacted clay layer) and lime guard layer, bunding and leachate collection system to prevent any impact on the environment in the scenario that the material is ASS / PASS.

Testing should be undertaken in accordance with Section 5. Possible overtreatment of soils may be avoided with pre-treatment testing. It is noted that the fastest turnaround of results for S_{Cr} testing is typically three days from receipt of the sample at the laboratory (with the timing generally commencing from the morning after the samples are received by the laboratory), and this timing may not always be available from the laboratory.

Testing for ASS should be undertaken by the environmental consultant, and the final sampling density will depend on the volume and type of soil. It is anticipated that the following general sampling densities will apply (exact densities will be determined based on the risk of ASS being present and the proposed re-use or disposal of the material):

- Field and oxidised pH screening tests: one sample per 25 m3 or a minimum of ten samples per material type; and
- Laboratory analysis for ASS: one sample per 100 m3, at least one sample per material type or a minimum of three samples.

The results will be compared with the indicators and Action Criteria (Section 5) to determine if treatment / management is required.

If the material is determined to be ASS, it should be managed and treated as per the below sections. It is noted that if these materials are found to be ASS, they will not be able to be classified as PASS for direct off-site disposal without treatment based on an expected time lapse of more than 16 hours between excavation and receipt of materials at the disposal point.

If the material is found not to be ASS, then further management or treatment for ASS will not be required and it can be re-used or disposed. Off-site disposal will require appropriate assessment in accordance with the POEO Act 1997.

7.2 Soil Contingency Plan - On-Site Treatment

This strategy comprises on-site treatment and can be applied to all materials containing ASS. On-site neutralisation, management, monitoring and validation of ASS should be undertaken as required using the methodology given below. Following on-site treatment, the material could be re-used on site or be disposed off-site to an appropriately licensed waste facility.

7.2.1 Prior to Excavation

On-site treatment will require preparation of a Treatment Area(s), Stockpiling Area(s) and Leachate Collection Area(s). During construction planning, sufficient land should be allowed for the placement of treatment areas. The leachate collection location, lining and construction should be similarly pre-planned. Figure 1 shows a cross section of a typical treatment pad.

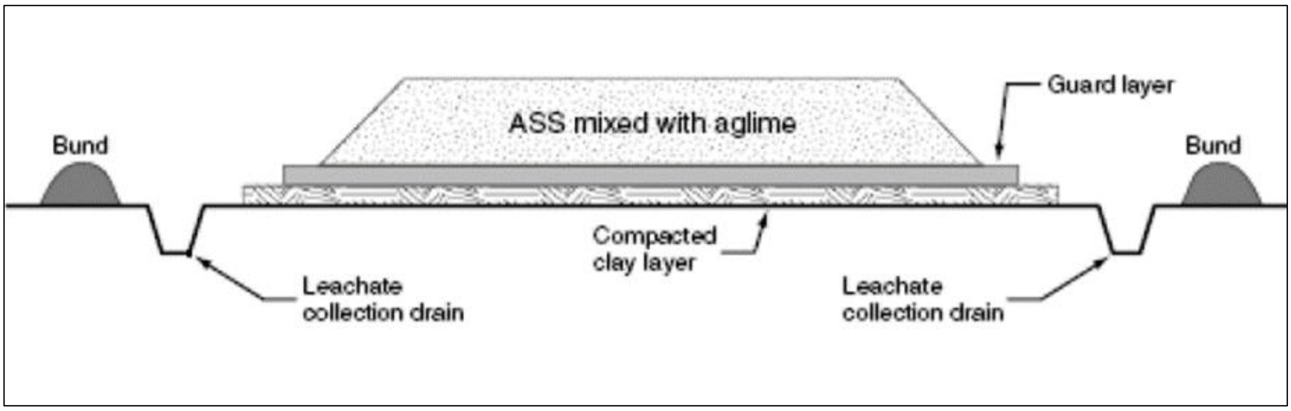

Figure 1: Schematic cross section of a typical treatment pad, including clay layer, guard layer, leachate collection system and containment with bunding[1]

These areas should be prepared as follows:

- Prepare a treatment pad and (if required) stockpile pad of appropriate area for the volume of soil to be treated / stored. The pad should be prepared on relatively level or gently sloping ground to minimise the risk of any potential instability issues, with a natural (or shaped) fall to a local drainage sump. The treatment area should be located as far as practical from any potential ecological receptors;
- Lining of the surface of the pad with selected compacted clay (at least two layers to a combined compacted thickness of 0.5 m) or a geosynthetic liner as approved by the environmental consultant. A concrete pad may also be suitable; however, it is unlikely to be preferred for the site and would be subject to the approval of the environmental consultant;
- Apply a guard layer of fine agricultural lime ('ag lime') over the compacted clay or geosynthetic liner, to neutralise downward seepage. This guard layer of lime should be applied at a minimum rate of 20% of the required liming rate per m^2 of surface area. The guard layer should be re-applied following removal of treated soils and prior to addition of untreated ASS; and
- Liming pads should be bunded and a circumference drain excavated to collect and contain leachate. The drain and inner bund slopes should be lined with impermeable material and covered with a layer of fine lime applied to neutralise any possible leachate migrating from the stockpiled material. The drain should direct water into an appropriately sized detention basin, the base of which has been prepared in the same manner as the liming pad. Alternatively, water from the drain can be pumped into on-site tanks for storage, testing and treatment.

If small quantities of ASS are to be excavated at any one time, then the use of a properly sealed skip bin may be appropriate instead of treatment pad. Any leachate drainage from the skip bin

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[1] Figure reproduced from Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M., 2014. *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines*. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government. (Dear et al, 2014).

should be avoided, or otherwise will need to be contained (through bunding) and treated as necessary.

7.2.2 Treatment Process

The process for the treatment of ASS is as follows:

- Prepare a treatment / stockpiling pad in accordance with Section 7.2.1;
- Segregate any non-ASS overburden (fill from the area containing ASS if material types can easily be separated during works;
- Transport ASS material requiring treatment to the treatment area;
- Manage ASS during stockpiling and treatment to minimise dust and leachate generation (e.g., by covering, or lightly conditioning with water). If wet weather prevails, stop works and cover the stockpiled material with a plastic sheet to reduce the formation of leachate;
- Spread the ASS onto the guard layer in 0.2 to 0.3 m thick layers, leaving a 1 m flat area between the toe of the spread soil and the containment bund or drain. When spreading the first soil layer, care should be taken not to churn up the lime guard layer;
- Let the ASS dry to facilitate lime mixing (if too wet, then adequate mixing of lime cannot be achieved);
- Apply ag lime (refer to Section 7.2.3) to the stockpiled soil, at the calculated liming rate calculation Section 7.2.4) and harrow / mix thoroughly prior to spreading the next layer;
- Continue the spreading / liming / mixing cycle. This can be done one layer at a time, or with multiple ASS layers placed on top of each other;
- Assess the success of the treatment using verification testing in accordance with Section 7.2.5. Samples will need to be collected from all layers, which is likely to require use of plant for sampling. The verification testing has two components: field pH screening (including peroxide pH testing) and laboratory analysis. It is anticipated that laboratory analysis will only be undertaken after the field screening results have passed;
- If verification sampling indicates that additional neutralisation is required, add additional lime (at an appropriate liming rate) and mix as described above;
- When verification testing indicates that lime neutralisation is complete, then the stockpiled soil may be removed from the treatment pad;
- Re-use the treated ASS on-site or undertake waste classification assessment and dispose off-site in accordance with Sections 7.2.6 and 7.2.7; and
- Management of leachate water in accordance with Section 7.3.

7.2.3 Neutralising Materials for Soils

Agricultural lime (Calcium Carbonate - $CaCO_3$), commonly known as ag lime, is the preferred neutralisation material for the management of ASS, as this material is usually the cheapest and most readily available product for acid neutralisation. Furthermore, ag lime is slightly alkaline (pH of 8.5 to 9), non-corrosive, of low solubility and does not present handling problems. The ag lime should consist of finely ground (at least <1 mm) calcium carbonate or calcite (limestone or marble).

It is generally preferable if an ag lime with a purity of 95% or better is used (i.e., NV >95, where NV is the neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine calcium carbonate which is designated NV = 100). The ag lime should be fine and dry, as texture and moisture can also decrease the effective neutralising value. Ag lime with a NV of 95% to 98% is usually used. There could be economic justification for using a less pure grade of ag lime, however, this would require a higher application rate. Potential cost savings from using less pure material may be offset by the corresponding increase in the transport and disposal costs.

Coarse grained calcite is not recommended, as one of the products of the neutralisation reaction is gypsum ($CaSO_4.2H_2O$) which has a relatively low solubility and tends to coat the reacting calcite grain, forming a partial barrier against further reaction.

Gypsum may also give off hydrogen sulfide if in reaction with acidic conditions and can itself result in the generation of sulfuric acid.

Dolomitic ag lime, or magnesium blend ag lime, should not be used as these materials impose environmental risks from overdosing with the potential to damage estuarine ecosystems.

An alternative neutralising material can be used subject to prior approval by a suitably qualified scientist or engineer.

7.2.4 Lime Application Rate

The laboratory test results from the previous investigation can be used to calculate the lime application rate.

It is noted that the acid production will vary both horizontally and vertically through the ASS profile due to the variability of natural systems and / or source of the soils used for filling. The liming rate to be calculated from the analytical results should therefore be considered as a “starting point”, and pH monitoring should be conducted during treatment to assess the progress of the neutralisation, and need for additional mixing and / or addition of ag lime. Material will only be considered to have been successfully treated when all soil has been validated in accordance with Section 7.2.5.

If an alternate neutralising product is used, a specific dosing rate will need to be calculated.

The required dosing rate for ag lime treatment should be calculated from the following formula:

$$\underline{\textit{Alkali Material Required (kg) per unit volume of soil } (m^3)} = \left(\frac{\%\,\text{S x } 623.7}{19.98}\right) \times \frac{100}{\text{ENV}\,(\%)} \times \text{D} \times \text{FOS}$$

Where:

- %S = net acidity (% S units). This value is obtained from the SPOCAS / chromium suite analytical results and should be the “worst case” result of the acid or sulfur trails of all samples;
- 623.7 = % S to mol H+/t;
- 19.98 = mol H+/t to kg CaCO3 /t;
- D = Bulk density of soil (as measured, or else assume 2 t/m3);

- FOS (factor of safety) = a minimum value of 1.5 needs to be adopted, although values of up to 2 can be suitable;
- ENV = Effective Neutralising Value (e.g., Approx. 95% for fine ag lime).

Notes:

- The ENV is calculated based on the molecular weight, particle size and purity of the neutralising agent and should be assessed for proposed materials in accordance with ASSMAC (1998); and
- The "worst case" of the acid or sulfur trail results should be used. Where the acid trail is used the mol H+/t should be converted to %S as per the formula given above.

Whilst the above formulas are provided, the environmental consultant will provide the liming rate based on the soil analysis results from the initial ASS investigation. For reference the WA Department of Environment Regulation also provides a calculator for liming rates at https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/67-lime-rate-calculations-for-neutralising-acid-sulfate-soils.

7.2.5 Validation Testing

Soil pH should be regularly monitored in the ASS treatment area during treatment. Soil pH will be used as a measure of the effectiveness of neutralisation, and the material will only be considered to be suitably treated when all validation results meet the acceptance criteria (as summarised in Table 2 below).

Table 2: Summary of Monitoring Frequencies and Criteria

Material	Test	Frequency	Acceptance Criteria
Treated Soil (validation testing)	Field test: pH	Between 1 sample / 25 m^3 to 1 sample / 100 m^3 OR a minimum of six samples / treatment batch (depending on homogeneity)	• Field pH (i.e., field pH in water) is ≥ 5.5 (and ≤ 8.5 for any materials to be re-used on site); • Peroxide pH (i.e., pH after forced oxidation) is ≥ 6.5; • pH_{KCL} is ≥ 6.5;and • Net acidity*** is < 0.
	Laboratory analysis: Chromium Suite Analytical Method**	Between 1 sample / 100 m^3 and 1 sample / 500 m^3 OR a minimum of 3 samples / batch	

Notes to Table:

* It is noted that the fastest turnaround of results for SPOCAS testing is a minimum of three days from receipt of the sample to the laboratory. This should be taken into account to ensure adequate on-site storage is available for treated and untreated ASS.
* *The Chromium Suite Method must include a complete acid / base accounting test method.
*** The net acidity is calculated from SPOCAS/ chromium suite analytical results as follows:
Net Acidity (%Sulfur) = (SCr) + TAA + SNAS – ANC / FF
Where, Spos or SCr is potential acidity (from SPOCAS suite or chromium suite)
s-TAA is actual acidity
SRAS or SNAS or is retained acidity (from SPOCAS suite or chromium suite)
ANC is acid neutralising capacity
FF is Fineness Factor of soils

7.2.6 Disposal of Treated ASS

Waste classification of treated ASS material to be disposed of off-site is to be conducted in accordance with EPA (2014) and the *Protection of the Environment Operations (POEO) Act* 1997 (the POEO Act 1997).

With regard to ASS, Part 4 (Acid Sulfate Soils) of EPA (2014) states that ASS must be treated (neutralised) prior to acceptance by a landfill. After treatment the soil should be chemically assessed in accordance with Part 1 of EPA (2014). This will determine whether any other contaminants are present in the material. When the classification has been established, the soil should be disposed of to a landfill that can lawfully accept that classification of waste.

Prior arrangements should be made with the landfill to ensure that it is licensed to accept the waste. The landfill should be informed that the ASS has been treated in accordance with the neutralising techniques outlined in an ASSMP produced in accordance with ASSMAC (1998) and that the waste has also been classified in accordance with EPA (2014).

It may also be possible to dispose of ASS directly to a licenced facility without treatment. Should the contractor propose to dispose of ASS at an appropriately licensed facility this is to be discussed with the environmental consultant prior to commencing works and this ASSMP updated accordingly (if necessary).

7.2.7 Contingency Plan for Surface Water and Groundwater Management

Water is the main mechanism by which acid and metals from oxidised ASS are mobilised and transported. Careful management of water is therefore paramount to effective management of potential adverse impacts from ASS.

The below sections provide strategies for management, assessment and disposal of water which has been in contact with the ASS. This could comprise water leaching from the ASS or surface water. The proposed works are not expected to require groundwater dewatering from the PASS zone.

7.2.8 Leachate and Surface Water Collection

All water that has been in contact with ASS / assumed ASS must be managed, assessed, treated and appropriately disposed of.

Water from the ASS treatment / storage area should be collected in the lined drains / detention basin constructed in accordance with Section 7.2.1, or in a tank. The stored water should not be in direct contact with ground or surface water, and should be stored away from overland flow paths. Any other water which may have come into contact with ASS should be collected in an on-site detention basin / tank.

All water which has the potential to come into contact with ASS requires management in accordance with the below sections.

7.2.9 Water Assessment

All water which has the potential to come into contact with ASS requires assessment (and if necessary, treatment) for the parameters listed in Table 3, below, as a minimum. This table also details the recommended monitoring frequencies and target thresholds.

Table 3: Suggested Water Monitoring Frequencies and Target Levels for Disposal to Stormwater

Test	Frequency	Target Level for Disposal to Stormwater
pH	• Field measurement: • During storage as required to allow timely treatment; • Immediately prior to disposal; and • Daily checks during discharge period.	• pH 6.5 – 8.5
Total Suspended Solids (TSS)	• Field measurement: • Immediately prior to disposal; and • As required based on visual observations; and • Visual assessment: • Daily during discharge period.	• water observed to be clear; • Turbidity <50 NTU
Oil and Grease	• Visual assessment: • Immediately prior to disposal; and • Daily checks during discharge period; and • Laboratory analysis: • As required based on visual observations.	• None observable • <10 mg/L
Iron (total and soluble)	• Laboratory analysis: • Immediately prior to disposal; and • Weekly checks during discharge period; and • As required based on visual observations; and • Visual assessment: • Daily during discharge	• ≤ 0.3 mg/L filterable iron • No obvious sign of iron staining / settlement

Test	Frequency	Target Level for Disposal to Stormwater
Metals (aluminium, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, zinc)	• Laboratory analysis: • One round of testing before first disposal; • If first round of testing exceeds target levels then further testing prior to disposal is required	• ANZG (2018) Trigger Levels for 95% Level of Protection for freshwater ecosystems
Contaminants of Concern (if encountered / identified during excavation although not anticipated)	• Laboratory analysis: • One round of testing before disposal for any water which has come into contact with contaminated / potentially contaminated soil or water	• As required, based on what contaminants of concern (e.g., in soil or groundwater) the water has potentially been impacted by. This may include, inter alia, TRH, BTEX, metals or VOC

7.2.1 Treatment

Treatment of water from construction sites is commonly required for pH and total suspended solids (TSS). Aeration and removal of TSS also generally decreases metal concentrations in the water. Standard industry treatment methods and commercial treatment products are suitable for the site and are likely to provide the most efficient treatment.

If a suitable treatment method for man-made contaminants in the water (e.g., oil and grease or metals) cannot be implemented, an alternate disposal method may be required (e.g., to trucking off-site to a liquid waste disposal facility or disposal to sewer in accordance with a specific Trade Waste Agreement which would need to be obtained from Sydney Water).

Due to its low solubility in water, ag lime is generally not suitable for the neutralisation of ASS leachate, which requires a product with a very quick reaction and high solubility. The most suitable neutralising agent for leachate and stockpile drainage water is slaked or quicklime (calcium hydroxide). This is made by treating burnt lime with water (slaking) and comes as a fine white powder. It has a typical NV of approximately 135. Due to its high alkalinity (pH of approximately 12.5 to 13) slaked or quicklime should not be allowed to come into contact with skin, or be inhaled.

7.2.2 Water Disposal

Water requiring off-site discharge should be disposed of in accordance with the POEO Act 1997, relevant guidelines, consents and licences. Consent for discharge should be obtained from the relevant authorities, where appropriate. The approval body for discharge into the stormwater system is the local Council. Once site water has been effectively treated and assessed to meet the discharge criteria, it can be discharged in accordance with the requirements of the development consent of the relevant consent authority.

8. Emergency Response Procedures

Construction activities which may cause potential environmental threats are summarised in Table 4 below, together with recommended "Emergency Response Procedures".

Table 4: Contingency and Emergency Response Procedures

Construction Activity	Potential Environmental Threat	Emergency Response / Environmental Objective
Stockpiling / neutralisation of ASS	Stockpile washes or slips outside of bunded lime pad	• Inform site foreman and project manager / environmental representative; • Estimate volume of material breeching bund; • Conduct pH analysis of adjacent surface water (if potentially impacted); • Move breeched soil into a bunded limed pad; • Over-excavate contaminated area to 0.2 m depth, apply and mix lime at rate as for guard layers (20% of the required liming rate per m^2 of surface).
	Breach in stockpile containment bund	• Inform site foreman and project manager / environmental representative; • Close breach in bund; and • Conduct pH analysis of adjacent surface water (if potentially impacted).

For all construction incidents which pose an environmental threat, an incident report must be completed by the principal contractor / an environmental consultant in order that:

- The cause of the incident may be determined;
- Additional control measures may be implemented; and
- Work procedures modified (where appropriate) to reduce the likelihood of the incident re-occurring.

9. Responsibilities

The responsible party for the main issues relating to the ASSMP are presented in Table 5. This section does not cover responsibilities related to general construction site activities.

Table 5: Responsibilities

Issue	Responsibility	Verified by / Subject to the Approval of:-
Implementation of this ASSMP	Contractor	Principal Contractor
Monitoring	Contractor / Environmental Consultant	Principal Contractor / Environmental Consultant
Liaison with landfill operator	Contractor	Principal Contractor
Record keeping	Contractor	Principal Contractor / Environmental Consultant
Corrective action for non-compliance	Contractor	Principal Contractor / Environmental Consultant
Changes to ASSMP	Environmental Consultant	Principal Contractor

10. Reporting

ASSMAC does not require formal reporting of ASS management; however, it is important to keep records of any identified ASS, and subsequent implementation of this ASSMP, including any management and validation process to show compliance with the guidelines. The records should be provided to the Project Principal, and to the consent authority upon request. The records should include documentation of investigations, review / inspection for possible / suspected ASS material in any areas of excavation / dewatering, and details of any treatment / management and off-site disposal of ASS materials. This would include records showing that any treated materials were successfully validated.

11. Conclusion

ASS is not anticipated to be encountered during proposed excavation works. This ASSMP has been developed as a contingency plan to provide the method of management of ASS during basement excavation works, in the unlikely event that ASS is encountered. The management strategy is subject to review and updating, as required, depending on field and laboratory results from any further ASS investigation.

12. Limitations

Douglas Partners Pty Ltd (Douglas) has prepared this report for this project at the Corner Parramatta Road and Western Avenue, Camperdown in accordance with Douglas' proposal dated 225008.00.R.001.Rev1 and acceptance received from The University of Sydney dated 29 September 2023. The work was carried out under Douglas' Engagement Terms. 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 and environmental 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.

Appendix A

About this report

About this Report

Introduction

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

DP's 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 Conditions of Engagement 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, DP 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, DP 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, DP will be pleased to assist with investigations or advice to resolve the matter.

continued next page

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, DP 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. DP 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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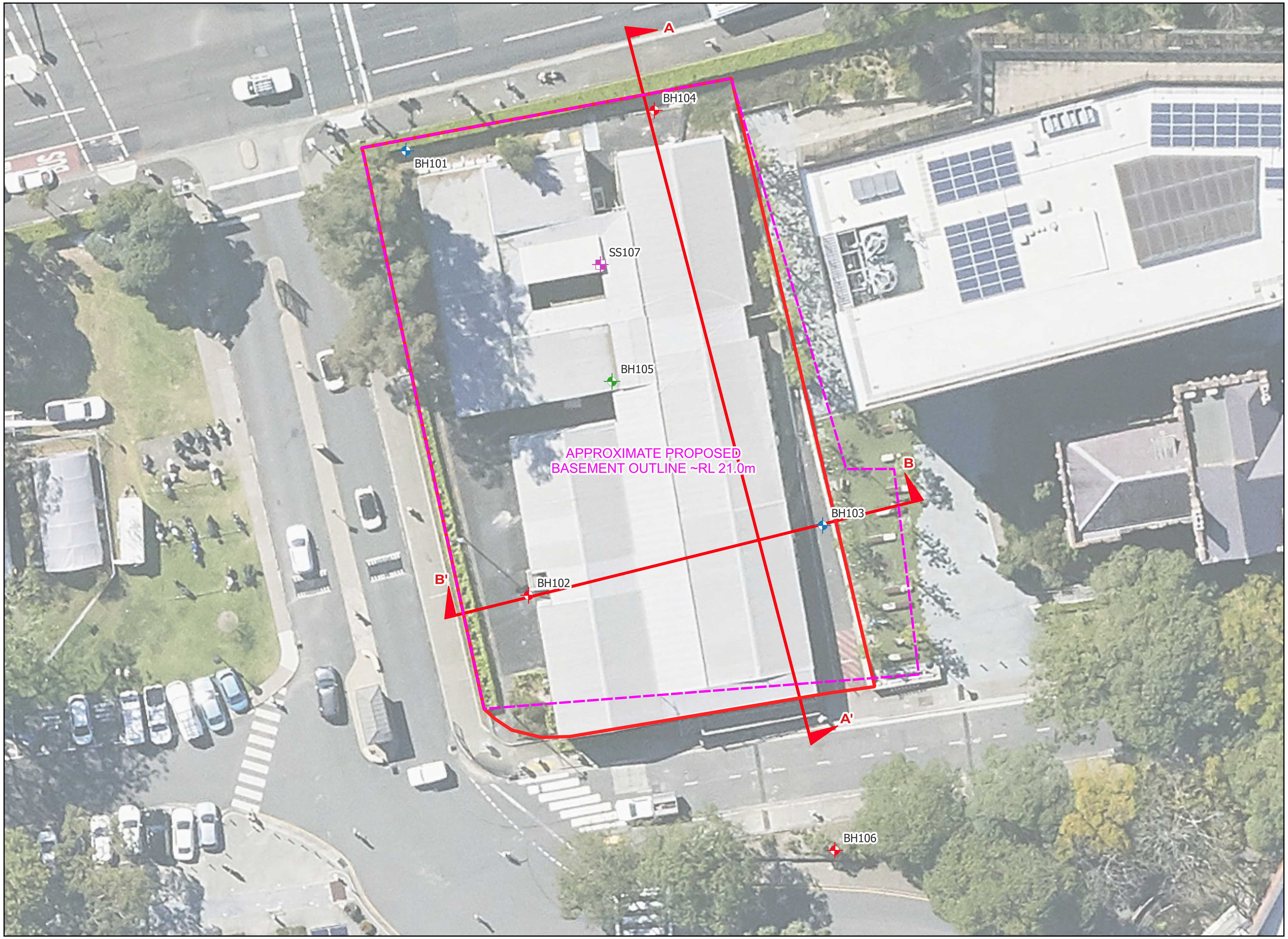
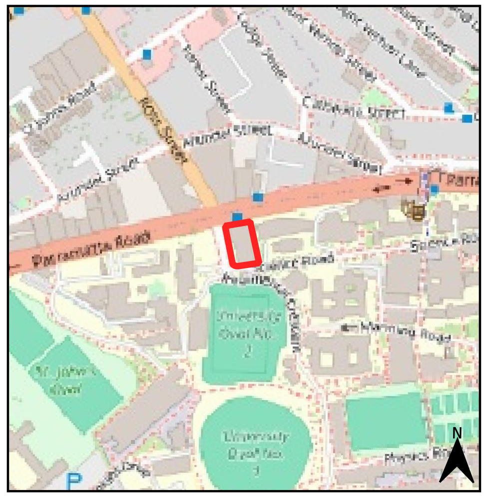
Appendix B

Drawings





Site Location

LEGEND

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

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

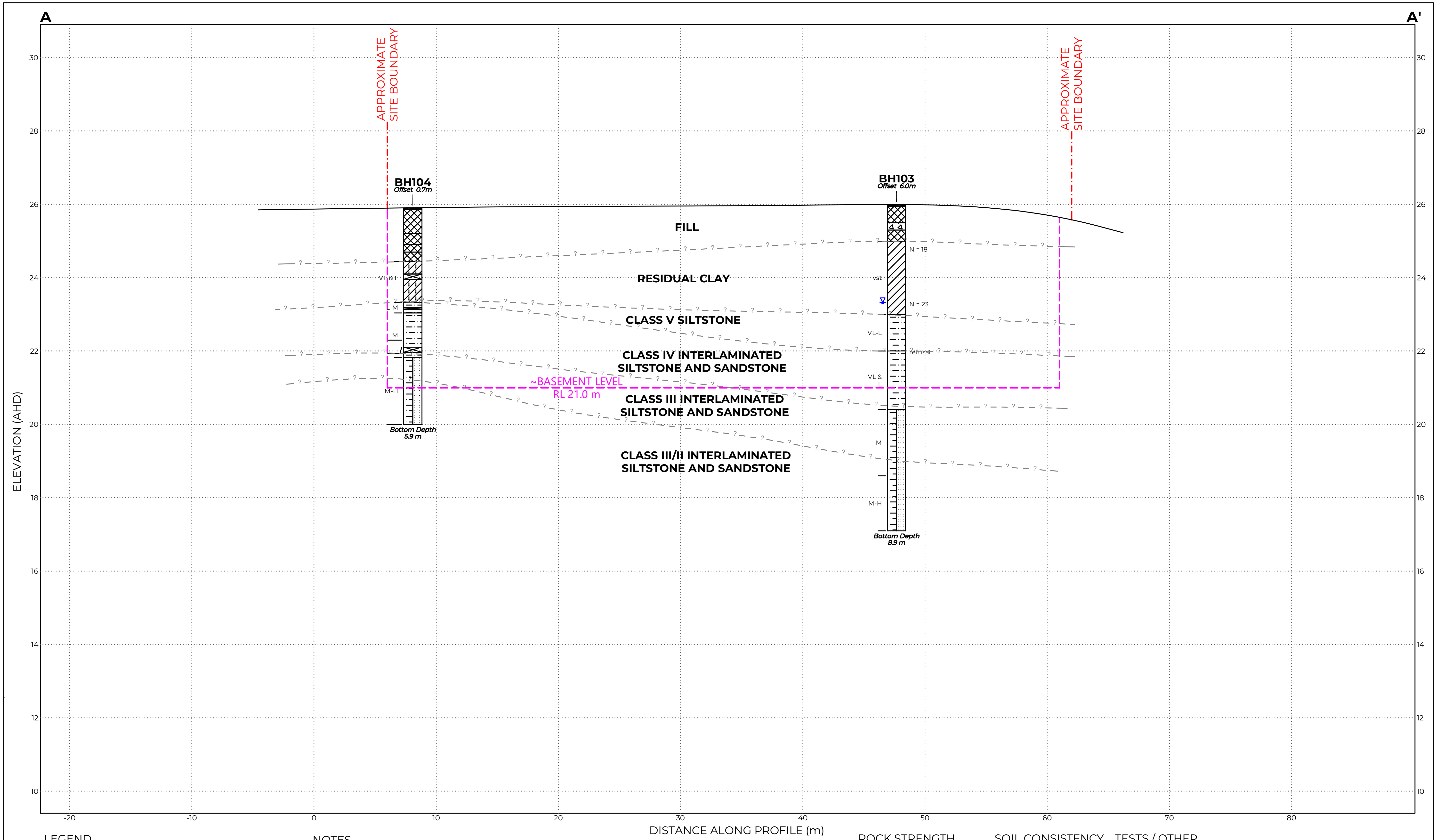
Douglas PARTNERS

CLIENT: The University of Sydney	
OFFICE: Sydney	DRAWN BY: EC/MN
SCALE: 1:350 @A3	DATE: 21.01.2025

TITLE: **Test Location Plan**
USYD Ross Street Teaching & Learning Hub
Corner of Parramatta Road and Western Avenue, Camperdown

N

Project:	225008.00
DRAWING No:	1
REVISION:	1



LEGEND

- ☒ Core Loss
- ■ Asphaltic Concrete
- ▨ Clay
- Concrete
- Filling
- Siltstone

NOTES

1. 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.
2. Summary logs only and should be read in conjunction with detailed logs.
3. 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
▽ - Water level

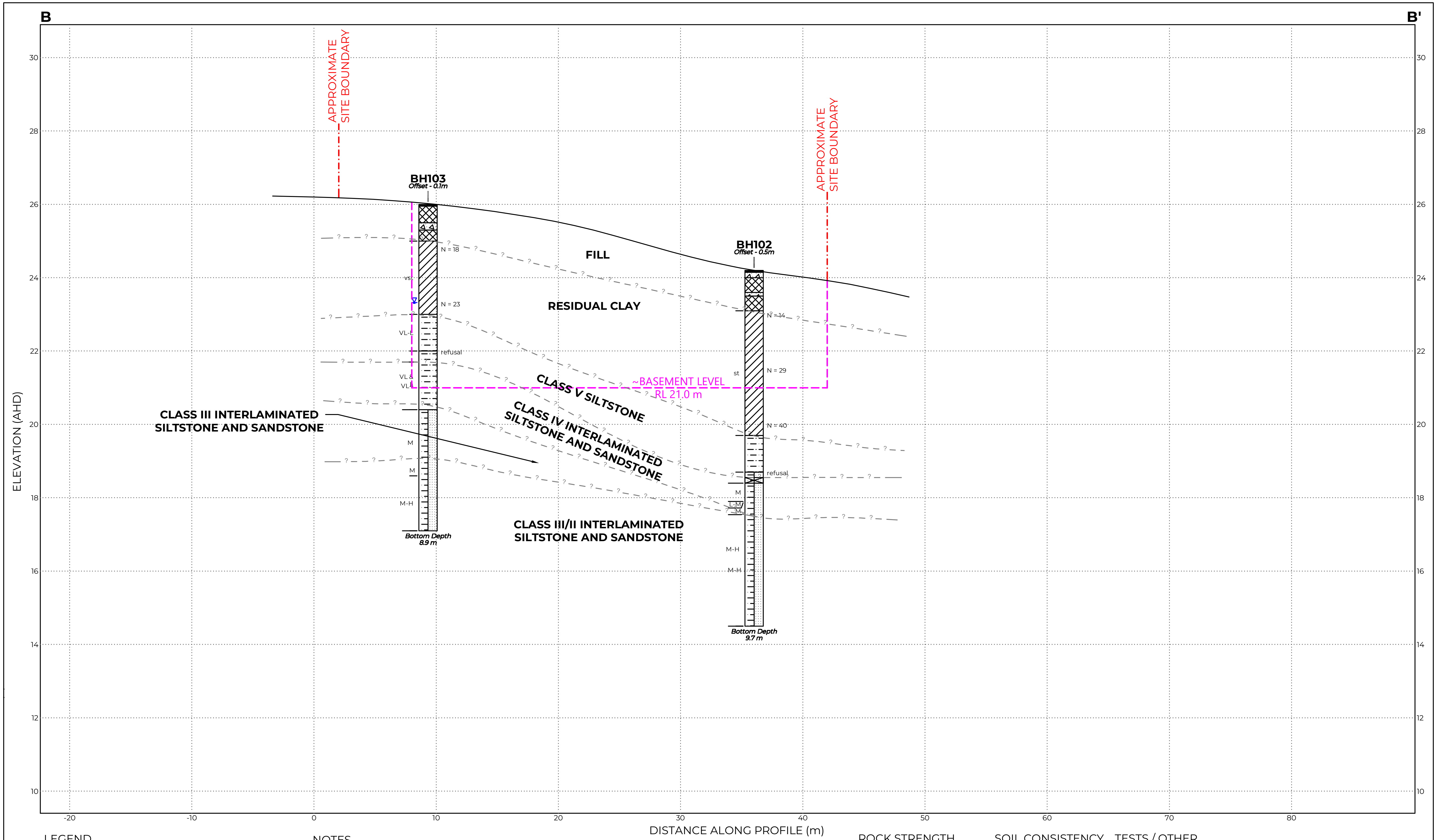
0 6
Horizontal Scale (metres)
Vertical Exaggeration = 3.0

Douglas
PARTNERS

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 A-A'**
USYD Ross St Teaching & Learning Hub
Corner of Parramatta Road and Western Avenue, Camperdown

PROJECT No:225008.00
DRAWING No: 2
REVISION: 1



LEGEND

- ☒ Core Loss
- ■ Asphaltic Concrete
- ▨ Clay
- Concrete
- ▦ Filling
- Siltstone

NOTES

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   Variations in subsurface conditions may occur between borehole locations.
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vs - Very Soft
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TESTS / OTHER

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

0 6
Horizontal Scale (metres)
Vertical Exaggeration = 3.0

Douglas
PARTNERS

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

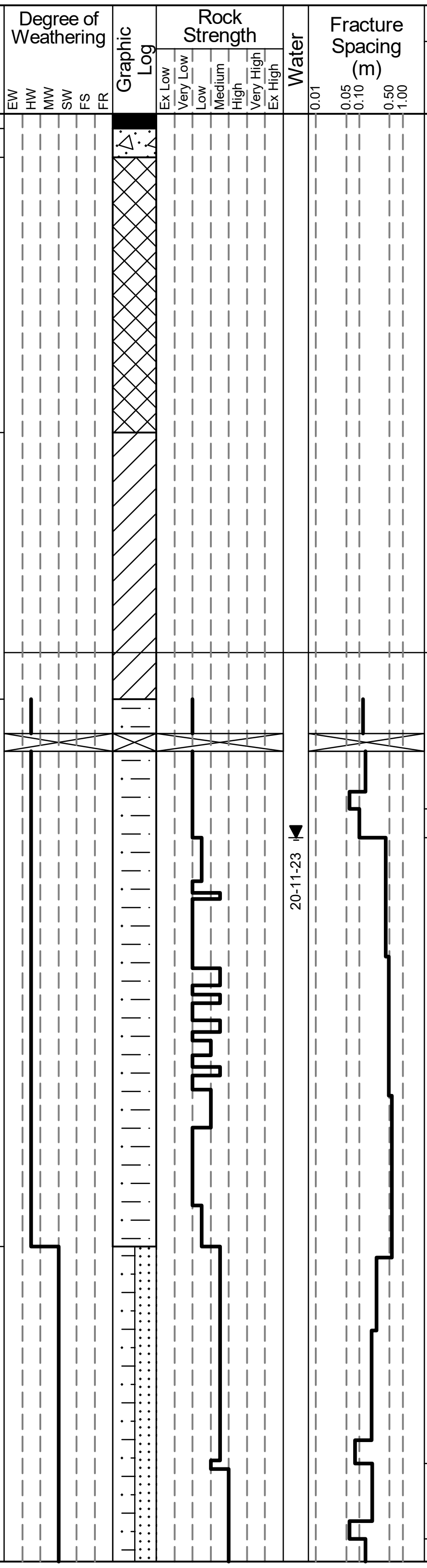
Results of the investigation

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	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	ASPHALTIC CONCRETE: 50mm thick, dark grey					
	0.15	CONCRETE: 100mm thick, pale grey					
25		FILL/Sandy GRAVEL: subangular concrete and igneous gravel up to 45mm, pale brown, fine to medium sand, trace silt, trace building rubble (bricks), dry		E*			PID - <1ppm
				E			PID - <1ppm
	1						
	1.1	CLAY CH: high plasticity, pale grey mottled yellow, with iron indurated gravel of medium strength, trace rootlets, w<PL, residual		E			PID - <1ppm
24		Below 1.50m: possibly extremely weathered material					
				C	100		pp = 450-500
	2						
	2.02	SILTSTONE: red-brown, pale grey and grey, very low and low strength, highly weathered, highly fractured, fragmented with occassional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale	2.14m: CORE LOSS: 60mm	C	87	77	
	2.2						
23			2.34m: 2.34-2.36m: B0°-5°, cly co, pl, sm x3 2.4m: 2.40-2.46m: B0°-5°, cly co, pl, sm x4 2.5m: 2.50-2.59M: B0°-5°, fe cly co, pl-ir, sm x5				
			2.91m: CZ (20mm)	C	100	81	
	3	Below 3.0m: slightly fractured					PL(A) = 0.3
22			3.39m: CS (20mm)				
	3.91	SILTSTONE: dark grey, moderately to highly weathered, medium to high strength, 10% sandstone laminations, slightly fractured, Ashfield Shale	3.95m: J85°, fe co, pl, ro				
	4						PL(A) = 0.7
21			4.2m: CS (10mm)				
			4.39m: J85°, fe co, pl, ro	C	100	88	
			4.58m: J55°, fe cly co, he 4.66m: CS (15mm)				
			4.86m: B0°, cly vn, pl, sm				

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_x	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)

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: 25.3 AHD
EASTING: 332126
NORTHING: 6249087
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BORE No: BH101
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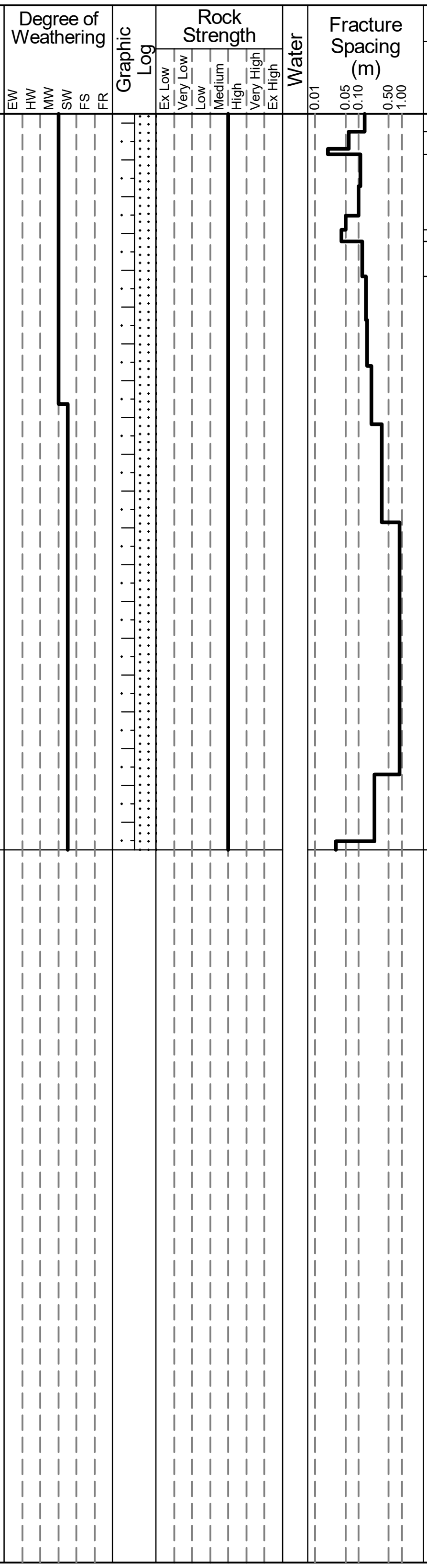
SHEET 2 OF 2



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		SILTSTONE: dark grey, moderately to highly weathered, medium to high strength, 10% sandstone laminations, slightly fractured, Ashfield Shale *(continued)*	4.92m: J45°, cly co, he 5.06m: B0°, fe cly co, pl, sm	C	100	88	PL(A) = 1
20	6	Below 6.0m: slightly weathered, 20% sandstone laminations	5.14m: B0°, fe co, pl, sm 5.35m: B0°, fe co, pl, sm 5.4m: J50°, he 5.44m: J70°, cly inf, cu, partially he 5.56m: J30°, fe stn, he 5.71m: CS (20mm) 5.87m: J80°-90°, fe cly inf, he 6.07m: J80°-90°, fe stn, he 6.41m: J30°, pl, fe stn, he	C	100	89	PL(A) = 0.9
19 18	7		6.7m: 6.7-6.9: B0°-10°, pl, fe stn x4 7.28m: J55°, fe stn, st, sm 7.51m: J30°, fe stn, st, sm	C	100	93	PL(A) = 1.5
17 16	7.54 8 9	Bore discontinued at 7.54m Target depth reached					

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_x	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)

Douglas Partners
Geotechnics | Environment | Groundwater

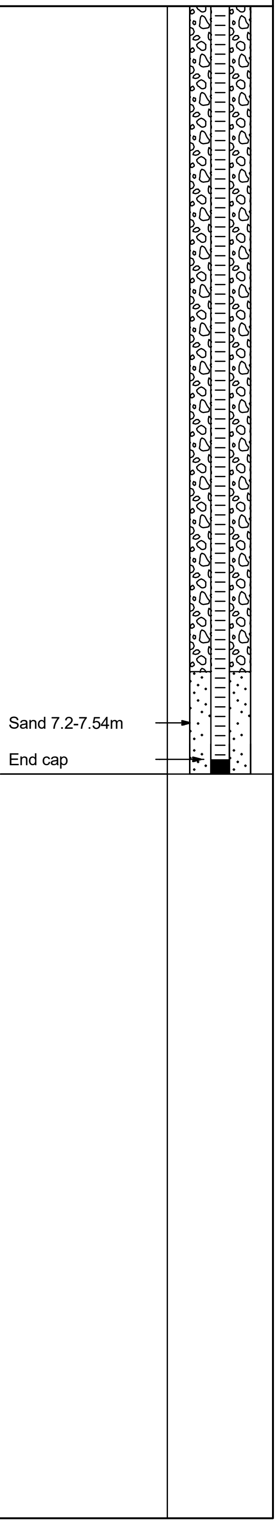
BOREHOLE LOG

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

SURFACE LEVEL: 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: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SILTSTONE: dark grey, moderately to highly weathered, medium to high strength, 10% sandstone laminations, slightly fractured, Ashfield Shale *(continued)*		C	5.07 5.15		PL(A) = 1		
20									
				C					
	6	Below 6.0m: slightly weathered, 20% sandstone laminations			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								8
17									
	9								9
16									



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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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

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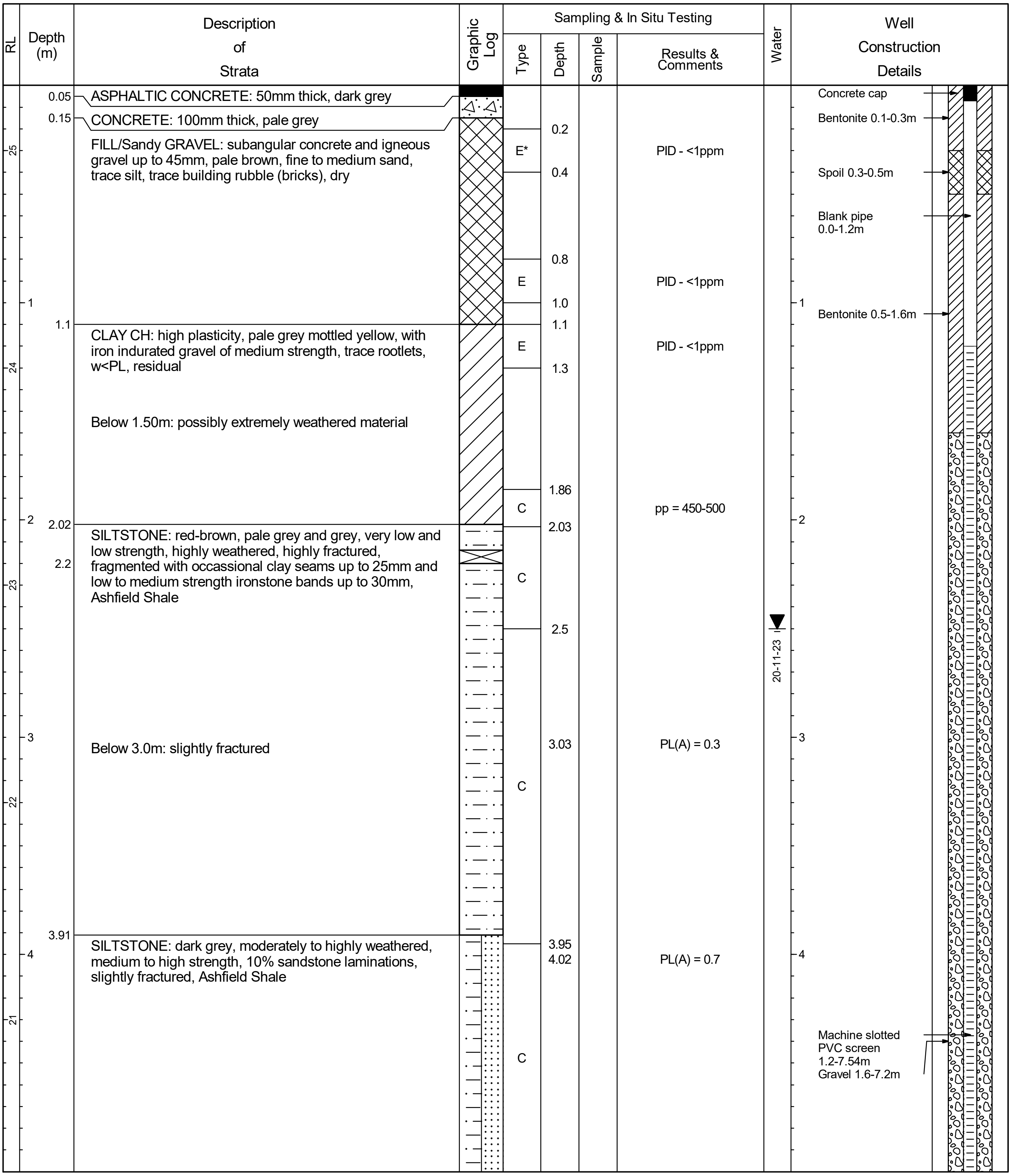

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	0.15	CONCRETE: 100mm thick, pale grey
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	1	
	1.1	CLAY CH: high plasticity, pale grey mottled yellow, with iron indurated gravel of medium strength, trace rootlets, w<PL, residual
24		Below 1.50m: possibly extremely weathered material
	2	
	2.02	SILTSTONE: red-brown, pale grey and grey, very low and low strength, highly weathered, highly fractured, fragmented with occassional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale
	2.2	
23		
	3	Below 3.0m: slightly fractured
22		
	3.91	SILTSTONE: dark grey, moderately to highly weathered, medium to high strength, 10% sandstone laminations, slightly fractured, Ashfield Shale
	4	
21		

Sampling & In Situ Testing

Type	Depth	Sample	Results & Comments
E*	0.2 0.4		PID - <1ppm
E	0.8 1.0		PID - <1ppm
E	1.1 1.3		PID - <1ppm
C	1.86		pp = 450-500
C	2.03 2.5		
C	3.03		PL(A) = 0.3
C	3.95 4.02		PL(A) = 0.7

Water: 20-11-23 (at approx. 2.5 m)

Well Construction Details

- Concrete cap
- Bentonite 0.1-0.3m
- Spoil 0.3-0.5m
- Blank pipe 0.0-1.2m
- Bentonite 0.5-1.6m
- 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_x	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)

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: 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

RL	Depth (m)	Description of Strata
	0.05	ASPHALTIC CONCRETE: 50mm thick, dark grey
24	0.2	CONCRETE: 150mm 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, apparently medium dense
	0.6	
	0.7	CONCRETE: 100mm thick, pale grey
	1	FILL/CLAY: medium plasticity, dark brown, with fine ironstone and igneous gravel, with building rubble (rubber, pvc), trace rootlets, w<PL
23	1.1	CLAY CH: high plasticity, pale grey mottled yellow, trace rootlets, w<PL, stiff, residual Below 1.40m: with medium strength ironstone bands up to 20mm thick
22	2	
21	3	
		Below 3.70m: possibly extremely weathered material
20	4	
	4.5	SILTSTONE: grey and dark grey, inferred highly weathered with bands of extremely weathred material

Discontinuities: B - Bedding J - Joint S - Shear F - Fault

Sampling & In Situ Testing

Type	Test Results & Comments
E	
E	
E	PID - <1ppm
E	
E	
E	PID - <1ppm
E	
S	pp = 150-190 8,7,7 N = 14
E	
E	
E	PID - <1ppm
E	
S	pp = 300-370 7,12,17 N = 29
S	pp = 450-500 10,20,20 N = 40 Bouncing

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	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	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)

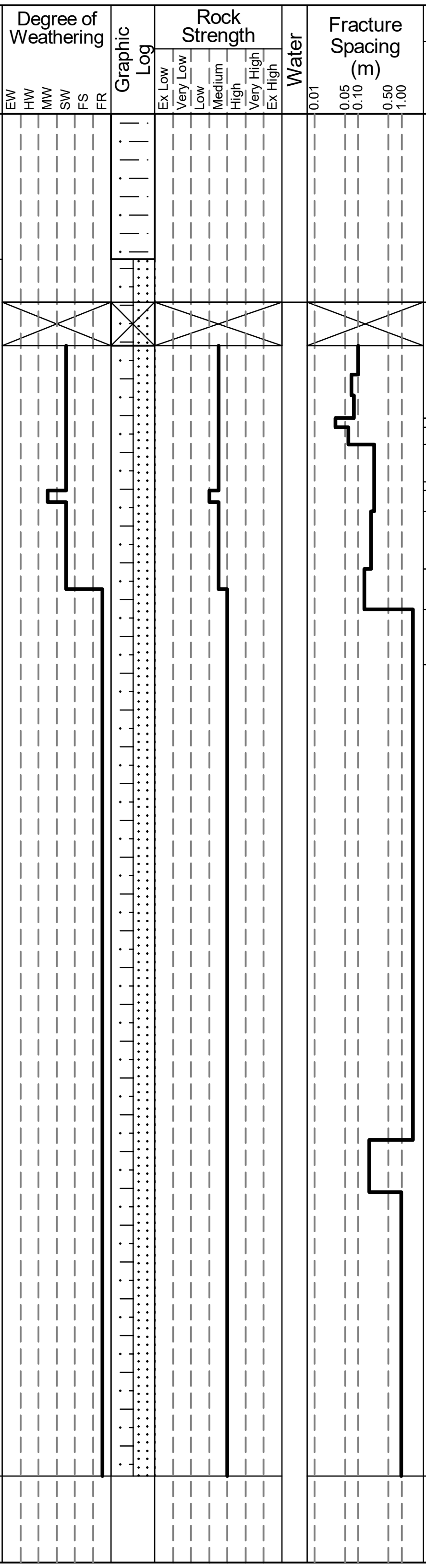
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

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

SURFACE LEVEL: 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	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
19		SILTSTONE: grey and dark grey, inferred highly weathered with bands of extremely weathred material *(continued)*					
	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
	5.8		5.65m: CORE LOSS: 150mm				PL(A) = 0.5
	6		5.9m: B0°, pl, sm, fe stn 5.97m: B10°, fe co, pl, sm 6.05m: J60°, fe cly co, st, sm 6.08m: J40°, fe cly co, pl, sm 6.14m: J40°, fe co, pl, sm 6.27m: J70°, pl, sm, fe stn 6.3m: CS, 40mm 6.37m: J70°, fe stn, he 6.57m: J45°, fe cly vn, pl, sm x2 6.71m: J20°, cln, pl, sm 6.9m: B10°, pl, sm, fe stn				
18		Below 6.64m: fresh, slightly fractured					PL(A) = 1.1
17	7			C	95	81	
16	8						PL(A) = 2.2
			8.54m: J45°, fe stn, st, sm 8.72m: J20°, cly vn, st, sm				PL(A) = 0.8
15	9			C	100	97	PL(A) = 1
	9.7	Bore discontinued at 9.7m Target depth reached	9.65m: J30°, pl, cly vn, sm				

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	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	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)

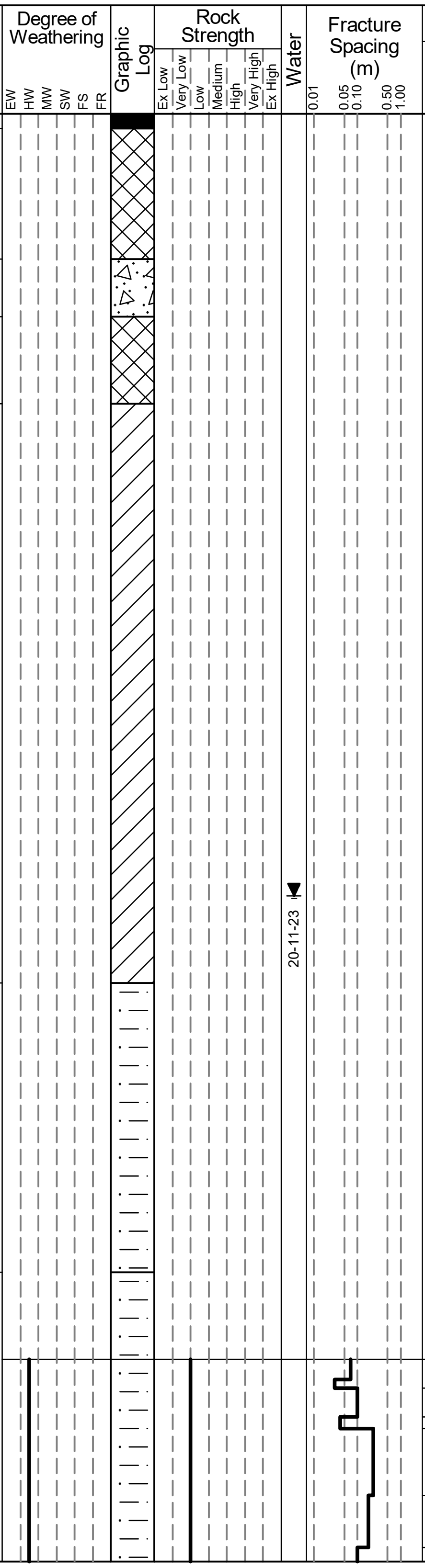
Douglas Partners
Geotechnics / Environment / Groundwater

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 1 OF 2



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
26	0.05	ASPHALTIC CONCRETE: 50mm thick, dark grey					
	0.5	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 A E			
	0.7	REINFORCED CONCRETE: 200m thick					
25	1 1.0	FILL/Clayey GRAVEL: subangular igneous gravel up to 20mm, pale brown, with medium plasticity clay, with fine to medium sand		E E			PID - <1ppm
		CLAY CH: high plasticity, pale grey mottled yellow, with medium strength ironstone bands, trace rootlets, w<PL, very stiff, residual		S			pp = 350-450 7,8,10 N = 18
				E E			PID - <1ppm
24	2			E			
		Below 2.57m: possibly extremely weathered material		S			pp = 400-500 5,9,14 N = 23
23	3 3.0	SILTSTONE: pale grey, very low to low strength, Ashfield Shale					
22	4 4.0			S			25/50 refusal Bouncing
		SILTSTONE: red-brown, pale grey, and grey, very low and low strength, highly weathered, highly fractured, fragmented with occassional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale	4.37m: CS, 20mm 4.4m: CS, 10mm 4.5m: CS, 15mm 4.54m: CS, 15mm 4.75m: J30°, pl, sm, fe stn 4.77m: CS, 10mm	C	100	72	

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_x	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)

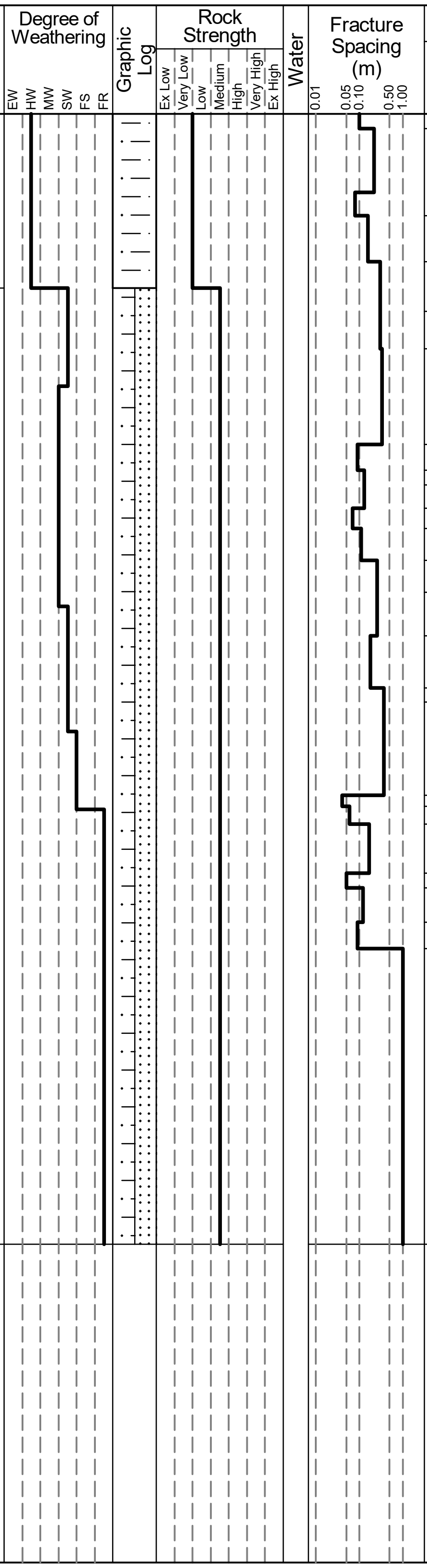
Douglas Partners
Geotechnics / Environment / Groundwater

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	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
21		SILTSTONE: red-brown, pale grey, and grey, very low and low strength, highly weathered, highly fractured, fragmented with occassional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale *(continued)*	4.95m: J50°, fe co, he 5.05m: B0°, fe cly co, pl, sm 5.27m: J45°, cly co, he 5.34m: J50°, fe cly co, pl, sm 5.35m: 5.35-5.51: DS, 160mm	C	100	72	
	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	5.51m: 5.51-5.55m: B0°, fe cly co, pl-ir, sm x2 5.68m: 5.68-5.77: B10°, pl, fe stn x2 5.81m: B15°, fe co, pl, sm 6.05m: 6.05-6.10: B0°-10°, pl, fe stn x2 6.14m: J20°, fe stn, pl, sm 6.23m: J55°-65°, fe co, un, sm 6.28m: B10°, pl, fe stn 6.36m: J40°-45°, cly vn, pl, sm 6.43m: J30°, fe cly co, ir, sm 6.54m: J80°-90°, fe cly co, un-ir, sm 6.65m: J80°-90°, un, fe stn 6.8m: J80°, fe cly co, partially he 6.98m: CS, 20mm	C	100	69	PL(A) = 0.3 PL(A) = 0.6
20	6						
19	7	Below 7.13m: slightly weathered to fresh	7.03m: 7.03-7.06: B0°-10°, pl, fe stn x2 7.35m: B15°-20°, cly vn, cu, sm 7.39m: B10°, cly vn, pl, sm 7.45m: J20°, fe stn, he 7.62m: J45°, fe co, ir, sm 7.67m: J15°, fe stn, he x2 7.79m: 7.79-7.85: J40°-60°, fe stn x4 7.88m: J45°, fe cly co, pl, sm	C	100	82	PL(A) = 1 PL(A) = 0.8
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_x	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)

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 1 OF 2

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

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_x	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)

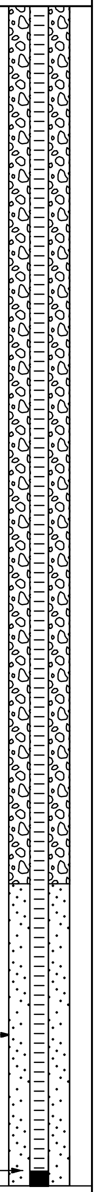
Douglas Partners
Geotechnics / Environment / Groundwater

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	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
21		SILTSTONE: red-brown, pale grey, and grey, very low and low strength, highly weathered, highly fractured, fragmented with occassional clay seams up to 25mm and low to medium strength ironstone bands up to 30mm, Ashfield Shale *(continued)*		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		
20	6			C					6
					6.87		PL(A) = 0.6		
19	7				7.0				7
		Below 7.13m: slightly weathered to fresh							
18	8			C	7.95		PL(A) = 1		8
									Sand 7.9-8.9m
					8.75		PL(A) = 0.8		
									End cap
	8.9	Bore discontinued at 8.9m Target depth reached			8.9				
17	9								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_x	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)

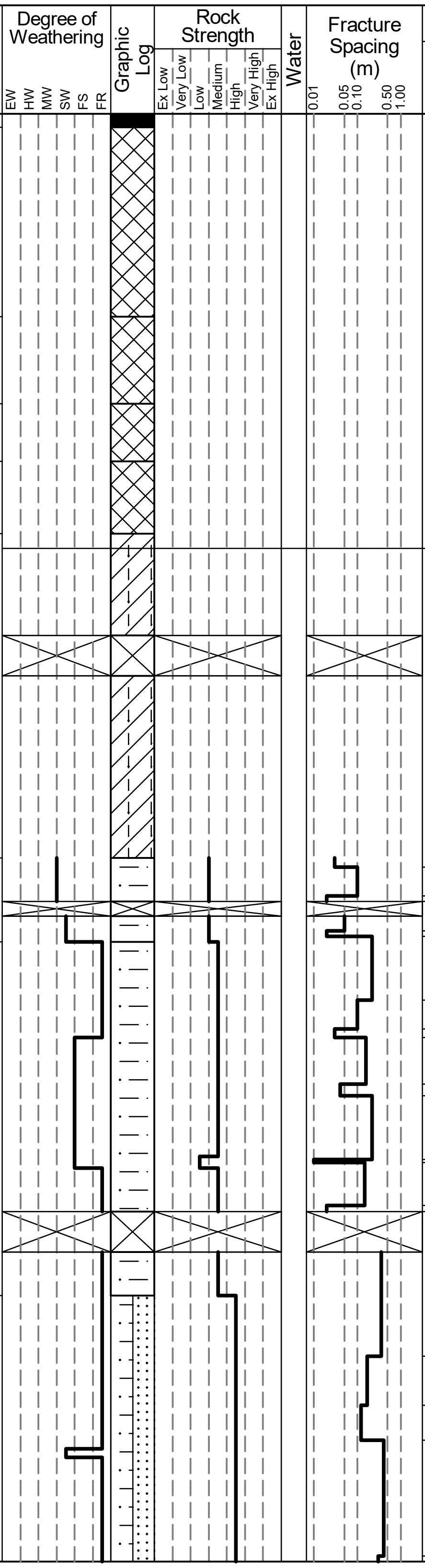
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

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

SURFACE LEVEL: 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	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
	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		E			PID - <1ppm
25	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 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
	1.45	Silty CLAY: pale grey and red-brown, some very low strength siltstone bands, residual/weathered rock		C	100	0	
24	1.94 2		1.8m: CORE LOSS: 140mm	C	84	0	
	2.57	SILTSTONE: dark grey, very low strength	2.57m: B5°, fe cly co, pl, sm 2.6m: 2.60-2.67: B0°-10°, fe cly co, pl-ir, sm x4				
	2.77		2.7m: CS (20mm) 2.72m: CORE LOSS: 50mm	C	88	92	PL(A) = 0.4
23	2.86 3	SILTSTONE: dark grey, medium strength, slightly weathered, fractured, Ashfield Shale	2.82m: B10°, cly co, pl, sm 2.84m: CS (20mm) 3.06m: J65°, he 3.16m: J45°, fe cly, pl, partially healed 3.19m: 3.19-3.24m: B0°-5°, cly co, pl, sm x4 3.35m: J20°, cly co, pl, sm 3.39m: 3.39-3.42m: B0°, cly vn, pl, sm	C	85	76	
22	3.93 4		3.61m: CS (10mm) 3.62m: B0°, fe cly co, pl, sm 3.77m: J40°, cly vn, pl, sm 3.79m: CORE LOSS: 140mm				PL(A) = 0.8
	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	4.29m: B0°, fe stn, st, sm 4.46m: B0-10°, fe co, pl, sm 4.58m: B0°, cly vn, pl, sm	C	100	93	PL(A) = 1.1
21							

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)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	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)

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: 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

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01 0.05 0.10 0.50 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
		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 *(continued)* 5.52m: sheared surface						4.98m: J60°, fe stn, ir, sm 5.28m: B0°, cly vn, pl, sm 5.45m: B10°, cly vn, pl, sm	C C	100 100	93 92	PL(A) = 1.2
20	5.9	Bore discontinued at 5.9m Target depth reached						5.88m: J45°, fe cly co, pl, sm				
	6											
19	7											
18	8											
17	9											
16												

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)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	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)

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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: 25.4 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 Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Sampling & In Situ Testing Results & Comments	Water	Well Construction Details
		ASPHALTIC CONCRETE: 100mm thick, dark grey	■						
	0.1	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 0.3				
				E	0.3 0.4		PID - <1ppm		
				E	0.4 0.5				
				E	0.5 0.6				
				E	0.7 0.8				
	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 0.9		PID - <1ppm		
				E	0.9 1.0				
				E	1.0 1.1				
				E	1.5 1.6				
				E	1.6 1.7		PID - <1ppm		
				E	1.7 1.8				
				E	1.8 1.9				
	2.5	Bore discontinued at 2.5m Target depth reached							

RIG: Massenza MI3 **DRILLER:** ML **LOGGED:** HS **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 2.50m.

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	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	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)

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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: 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

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
		CONCRETE: 150mm thick, pale grey							
	0.15	FILL/ ASPHALTIC CONCRETE AND GRAVEL		E	0.25 0.35		PID - <1ppm		
24	0.35	CLAY CH: medium to high plasticity, grey, w>PL, apparently in a stiff condition, residual		A/E	0.35 0.4		PID - <1ppm		
				A	0.8 0.9				
	1			E	1.0 1.1		PID - <1ppm		
		Below 1.2m: grey and orange, trace iron indurated gravel, becoming very stiff to hard		A	1.2 1.3				
23	1.35	Bore discontinued at 1.35m Target depth reached		A	1.35				
	2								
22									
	3								
21									
	4								
20									

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	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	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)

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Sampling Methods

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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

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.
		GRAVELLY SOILS		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

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.

Soil Descriptions

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.
Note: If HW and MW cannot be differentiated use DW (see below)		
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:

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

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

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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

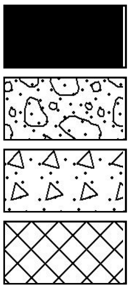
Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

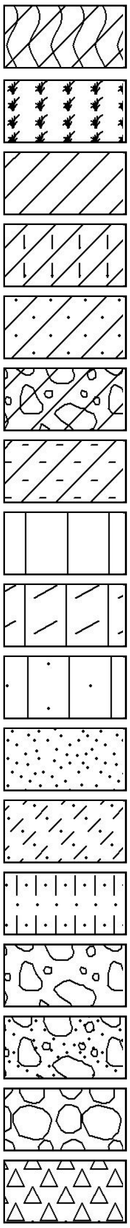
Graphic Symbols for Soil and Rock

General



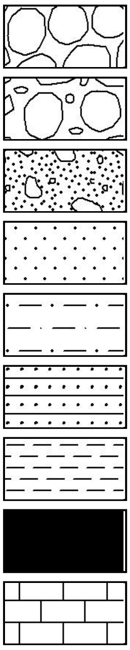
- Asphalt
- Road base
- Concrete
- Filling

Soils



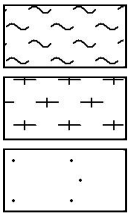
- Topsoil
- Peat
- Clay
- Silty clay
- Sandy clay
- Gravelly clay
- Shaly clay
- Silt
- Clayey silt
- Sandy silt
- Sand
- Clayey sand
- Silty sand
- Gravel
- Sandy gravel
- Cobbles, boulders
- Talus

Sedimentary Rocks



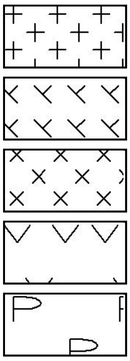
- Boulder conglomerate
- Conglomerate
- Conglomeratic sandstone
- Sandstone
- Siltstone
- Laminite
- Mudstone, claystone, shale
- Coal
- Limestone

Metamorphic Rocks



- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks



- Granite
- Dolerite, basalt, andesite
- Dacite, epidote
- Tuff, breccia
- Porphyry