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Report on
Geotechnical Investigation

Wilkinson House Redevelopment
167 Forbes Street, Darlinghurst

Prepared for
SCEGGS c/-Sandrick Project Directions Pty Ltd

Project 86514.03
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Integrated Practical Solutions

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

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Table of Contents

Page

Report on Geotechnical Investigation
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1. Introduction

This report presents the results of a geotechnical investigation undertaken for the redevelopment of Wilkinson House at 167 Forbes Street, Darlinghurst. The investigation was commissioned in an email dated 27 September 2021 by Warwick Smith of Sandrick Project Directions Pty Ltd on behalf of Sydney Church of England Girls Grammar School (SCEGGS) and was undertaken in accordance with Douglas Partners' proposal 86514.03.P.001 dated 24 September 2021.

It is understood that the proposed development is to include the adaptive reuse of Wilkinson House, including alteration and additions, and the retention of the external façade and internal foyer.. Reconstruction of the building will be carried out internally and include the extension of the lower ground floor across to the southern half of the building footprint. Geotechnical investigation is understood to be required to inform the design and planning process as well as for SSDA submission.

The investigation included the drilling of one cored borehole, and laboratory testing of selected rock core samples. Previous geotechnical investigations were carried out across the wider SCEGGS site by Douglas Partners (DP) in July 1994 and April 2008. Details of the field work investigation is presented in this report, together with the results of selected boreholes from the previous investigations and comments and recommendations relevant to design and construction.

2. Previous Investigations

In June 1994, DP carried out a geotechnical investigation for the sports building which is located directly to the south of Wilkinson House. This investigation comprised six boreholes drilled to depths of up to 8.5 m below the existing surface levels to obtain detailed information on the soil and rock stratigraphy.

In April 2008, DP carried out a geotechnical investigation for the Science and Technology Building which is located directly to the west of Wilkinson House. This investigation comprised five boreholes drilled to depths of up to 10.0 m below the existing surface levels and three test pits to obtain detailed information on the soil and rock stratigraphy.

Two boreholes (BH4 and BH5) from the 1994 investigation and one borehole (BH101) from the 2008 investigation have been selected for inclusion in this report given their proximity to Wilkinson House. The locations of the selected boreholes of the previous investigations are shown on Drawing 1 in Appendix B. The subsurface conditions encountered within these boreholes are presented in the borehole logs in Appendix D.

In January 2011 DP carried out geotechnical inspections of the rock faces exposed in the basement excavation for the Science and Technology Building, including the eastern basement rockface (along the western boundary of Wilkinson House) on 28 January 2011. The findings of this inspection have been included in this report. Site photographs of the western boundary wall from within the adjacent basement excavation, taken on 28 January 2011 have been included on Drawing 2 in Appendix B.

3. Site Description

SCEGGS is located in an intensely developed residential and commercial area of Darlinghurst about 1 km from the Sydney Central Business District. Overall, the site occupies an irregular shaped area measuring about 150 m x 60 m and is currently occupied by many school buildings which range in age from relatively recent to in excess of 100 years old. Wilkinson House is located on the corner of Forbes Street and St Peters Street in the north-eastern corner of the broader SCEGGS site.

The ground surface profile across Wilkinson House generally falls to the north-west at about 6-8 degrees from about RL 33.3 m to about RL 29.4 m AHD

4. Regional Geology and Published Data

The 1:100 000 Series Geological Sheet for Sydney indicates that the site is underlain by Hawkesbury Sandstone. This geological formation usually comprises medium to coarse grained quartz sandstone with minor shale lenses. Previous investigations on the site confirm the geological mapping with Hawkesbury Sandstone at shallow depths below the surface. Sandstone outcrop is exposed at several locations along Forbes Street including in a cutting which has since been removed to allow for the construction of the existing sports hall.

Data supplied by the NSW Department of Environment and Climate Change, based on published 1:25 000 Acid Sulfate Soil Risk Mapping, 1994-1998, indicates that the site is located within an area with an unknown probability of occurrence of ASS. Reference to the City of Sydney Local Environmental Plan Acid Sulfate Soils Map Sheet ASS_022 indicates that the site is located within a Class 5 area (i.e. an area where acid sulfate soils are not typically found below the natural ground surface).

The site is also within an unmapped area of salinity potential, however given the mapped and previously observed geology, the site is considered to have a very low salinity potential.

5. Field Work Methods

The field work for the current investigation included the drilling of one rock-cored borehole (BH201) to a depth of about 4.5 m using hand operated equipment. Diatube coring techniques were used to obtain continuous core samples of the bedrock. Following completion of drilling the borehole was spoon tested to identify the presence and thickness of the defects within the bedrock to a depth of about 2 m. The location of the borehole is shown on Drawing 1 in Appendix B.

6. Field Work Results

The subsurface conditions encountered during the investigation are presented in the borehole log in Appendix C. Notes defining descriptive terms and classification methods are included in Appendix A.

The materials encountered within the borehole BH201 included a 100 mm thick concrete slab underlain by sandy clay fill, with sandstone gravel, to a depth of between 0.25 m followed by sandstone bedrock. The sandstone bedrock was generally of high strength and unbroken to the termination depth of the borehole at about 4.5 m.

A site walkover was also conducted within the adjacent basement carpark to the west. The walls of the basement carpark exposed medium to high strength sandstone bedrock which had been generally left unsupported and exposed across the majority of the approximately 7 m deep basement excavation.

The use of drilling water during the core drilling of BH201 precluded the observation of groundwater within the borehole. Very little to no groundwater seepage was observed within the adjacent basement carpark down to about RL 22.2m AHD.

7. Laboratory Testing

A total of 9 samples were tested for axial point load strength index (Is_{50}). The results ranged between 0.7 MPa and 2.4 MPa, which correspond, to medium and high strength rock, respectively. The individual results are shown on the borehole log in Appendix C at the relevant depths.

8. Geotechnical Model

The geotechnical model for the site comprises surface fill, underlain by sandstone bedrock of medium to high strength, occurring at relatively shallow depths. Some weathered bands of very low and low strength were encountered within the upper bedrock profile of the previous boreholes. Table 1 summarises the levels at which different materials were encountered in the boreholes.

Table 1: Summary of Inferred Material Strata Depths and Levels

Stratum	Depth and RL of Top of Stratum m / (m, AHD)			
	BH201	BH4	BH05	BH101
Fill (Surface)	**0** (30.8)	**0** (33.2)	**0** (30.3)	**0** (28.2)
M Sandstone with VL-L Bands	NA	NA	**0.3** (30.0)	**0.6** (27.6)
M-H Sandstone	**0.3** (30.5)	**0.3** (32.9)	**1.8** (28.5)	**1.5** (26.7)
Base of Borehole	**4.5** (26.3)	**3.5** (29.7)	**4.0** (26.3)	**10.0** (18.2)

Notes: NE = not encountered; VL = Very Low Strength, L = Low Strength, M = Medium Strength, H = High Strength

The regional groundwater table is likely to be well below the bedrock surface. Some seepage along the rock surface and through joints or partings within the rock should be expected following extended periods of rainfall.

9. Proposed Development

The proposed development is to include the adaptive reuse of Wilkinson House, including alteration and additions, and the retention of the external façade and internal foyer.. Reconstruction of the building will be carried out internally and includes the extension of the lower ground floor across to the southern half of the building footprint. It is understood that temporary support for the brick façade will be provided during construction. The structure of the building is expected to comprise a reinforced concrete framed structure that will support the façade in the long term.

The lower ground floor is proposed to have a finished floor level of RL 29.68 m and is proposed to be connected to the Centenary Sports Hall directly to the south of Wilkinson House. Although it is unclear at this stage what the ground levels are below the timber flooring of the existing building, it is expected that some excavation to depths of between 1 m and 2.5 m will be required to facilitate construction of the lower ground floor slab.

10. Comments

10.1 Excavation

The construction of the proposed basement may require excavation of up to about 2.5m in depth. It is expected that only surficial fill soils will be encountered and that the majority of the excavation will be within medium to high strength sandstone bedrock.

Excavation in medium strength and stronger sandstone will require heavy ripping equipment, rock saws and/or rock hammers for effective removal. The fresh sandstone may include rock with an unconfined compressive strength (UCS) in excess of 50 MPa and earthworks contractors should form their own opinion on productivity based on the borehole logs and core photographs.

Excavation should be carried out with due consideration of the proximity to the existing brick façade to be retained. Rock sawing along the excavation boundaries is likely to be required.

Vibrations at the foundation level of the brick façade are suggested to be limited to a component vector sum peak particle velocity (VSPPI) of 3 mm/s to protect the architectural features and considering the heritage listing of the brick façade. Higher vibration limits may be possible where some architectural damage requiring rectification is considered acceptable or allowed for. Further advice on vibration limits should be sought from a structural engineer following a detailed condition assessment of the existing brick façade. A vibration trial and monitoring should be carried out to confirm that the size of the machinery proposed to be used is suitable. Given the proximity of the excavation to the existing façade, rock sawing and milling will be required to limit vibration. Only small rock hammers should be used subject to a vibration trial.

10.2 Excavation Support and Underpinning

It is expected that the brick façade that extends around the perimeter of the proposed excavation is probably founded on sandstone bedrock and therefore there will be no soils that will require support. However, if any portion of the brick facade is found to be founded on the upper soil profile it is expected that these sections will require underpinning down to the sandstone bedrock.

It is recommended that a series of test pits be completed adjacent to the base of the brick façade along the perimeter of the proposed excavation when excavation commences to confirm whether underpinning is required. Site photographs of the adjoining basement excavation on 28 January 2011 (included on Drawing 2 in Appendix B) confirms that the western wall of the brick façade is founded on medium to high strength sandstone bedrock.

If underpinning is required, it will have to be done in short panels no greater than about 1 m lengths by excavating under the footings and providing temporary support until concrete blade walls can be installed from the underside of the footing down to competent bedrock.

Vertical cuts in the medium strength or better sandstone will be feasible, pending a stability assessment by a geotechnical professional during excavation. Where steeply dipping joints intersect the excavation faces at unfavourable orientations, stabilisation methods including the installation of rock bolts with or without the application of shotcrete will be required.

To determine the requirement for rock bolts and shotcrete, it is recommended that inspections of the excavation faces be undertaken by an experienced geotechnical engineer or engineering geologist at regular intervals, say 1 m depth of excavation, during construction.

10.3 Excavation Along Western Boundary

Excavation along the western brick façade is complicated by the existing unsupported cuts in the sandstone of the adjacent basement to the west. Excavation for the proposed lower ground floor will leave a slender ‘blade’ of sandstone to support the existing brick façade within a portion of this elevation. It is possible that there may be natural defects within the bedrock which could cause shear failure of this blade of sandstone and it will also require structural support to prevent buckling failure.

The risk of failure increases with the slenderness (height to width ratio) of the sandstone left in place. It is recommended that height to width ratio of no greater than 1:1 be left unsupported in the short term.

Based on the levels of the sandstone bedrock shown in Drawing 2 it appears that the northern portion of the brick façade is founded either below or less than 0.5 m above the proposed BEL of 29.5 m. The southern 7-8 m however of this wall appears to be founded between 1 m to 2 m above the proposed BEL and this portion will require structural support.

A suitable support system would include reinforced concrete walls installed on either side of the ‘blade’ of sandstone, dowelled or bolted together (through the sandstone). The outside wall will likely need to be installed prior to excavation internally. A sketch of the suggested system is provided in Figure 1 below and would need to be designed by a structural engineer.

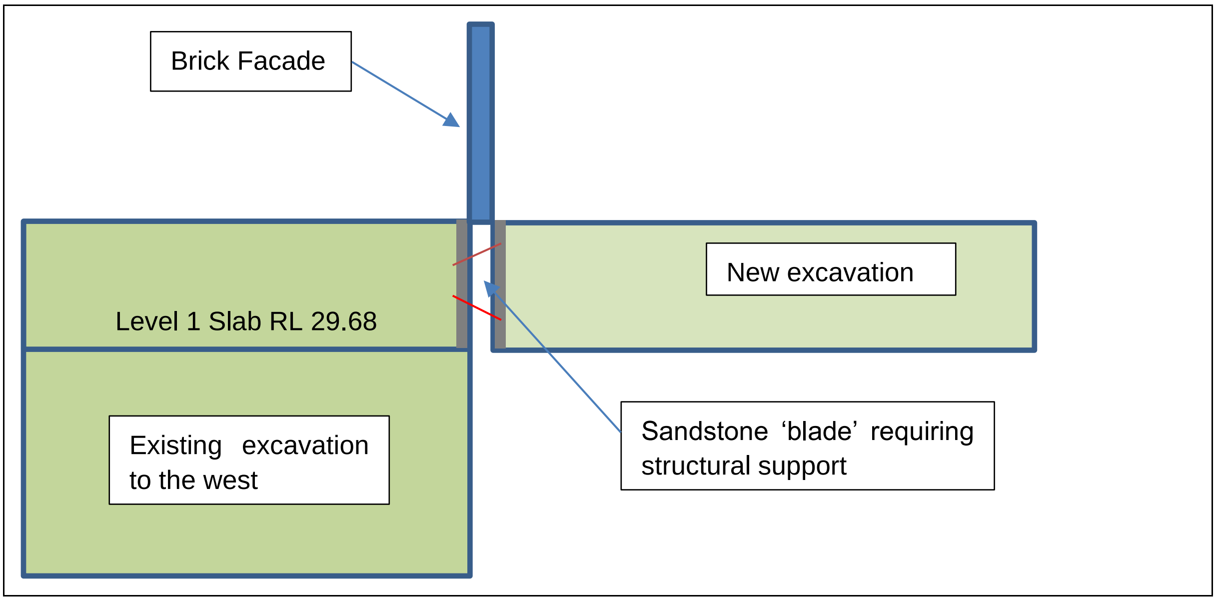

Figure 1 –Potential Sandstone 'Blade' Along Western Boundary

10.4 Groundwater

The regional groundwater table is expected to be well below the bedrock surface. Seepage or perched groundwater would be expected along strata boundaries and through joints or partings within the rock. Seepage may also occur along the soil-rock interface.

Drainage measures will need to be provided in subsurface structures to allow seepage water to flow around the structures rather than exert hydrostatic pressures against them. Conventional drainage that ultimately diverts water into the local stormwater system should be suitable for this purpose.

10.5 Foundations

The foundation material underlying Wilkinson House will mostly comprise medium to high strength sandstone with the possibility of some minor low or very low strength bands. Spread footings (pad or strip) founded on this material are considered to be suitable footing types.

The medium to high strength sandstone is generally considered suitable for an allowable bearing pressure of 6000 kPa if spoon testing is undertaken in at least half of the footing excavations during construction.

It is noted that the adjacent basement excavation to the west is about 7 m deeper than the proposed lower ground floor level within Wilkinson House. It is recommended that any footings founded within a 1:1 zone of influence of the adjacent basement excavation should be designed based on a reduced bearing capacity of 3,500 kPa. Given that about half of the building footprint is within the zone of influence of the adjacent basement excavation, it is suggested that a maximum allowable bearing pressure of 3.5 MPa be adopted for all the footings to remove the requirement for any spoon testing.

The total settlement of a footing designed using the allowable parameters provided in this report should be less than 1% of the footing width upon application of the design load.

All footings should be inspected by an experienced geotechnical professional during construction to check the adequacy of the foundation materials. Spoon testing of at least half of footings will be required for design bearing pressures greater than 3500 kPa.

10.6 Seismicity

A Hazard Factor (*Z*) of 0.08 would be appropriate for the development site in accordance with Australian Standard AS 1170.4 – 2007 *Structural design actions – Part 4: Earthquake actions in Australia*. The classification of the site for earthquake loading is Class B_e – Rock on the basis that the foundations would be founded on rock at shallow depth and the rock near the surface is considered to have an unconfined compressive strength of generally less than 50 MPa.

10.7 Salinity and Acid Sulfate Soils

Based on the published data provided in Section 4, the encountered shallow bedrock profile and the RL of the site, there is a very low risk of highly saline soils or acid sulfate soils on the site and hence further assessment and management plans are not required for the proposed development.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at 167 Forbes Street, Darlinghurst in accordance with DP's proposal 86514.03.P.001 dated 24 September 2021 and acceptance received from Sandrick Project Directions Pty Ltd on Behalf of SCEGGS. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of 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 DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP 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 DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP 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 groundwater 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. DP 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 DP. This is because this report has been written as advice and opinion rather than instructions for construction.

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

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

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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.

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.

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.

Soil Descriptions

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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.

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 with 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 with 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 with 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:

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

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

Douglas Partners

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

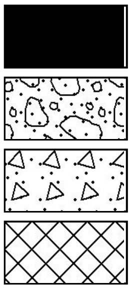
Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

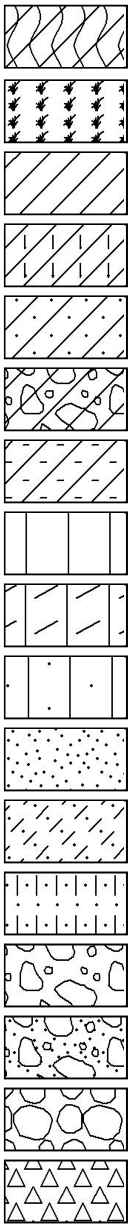
Graphic Symbols for Soil and Rock

General



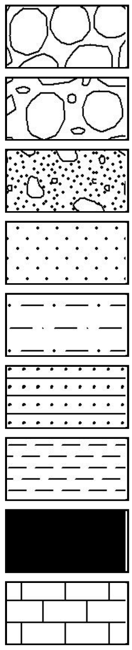
- Asphalt
- Road base
- Concrete
- Filling

Soils



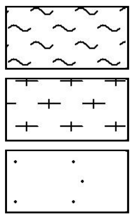
- Topsoil
- Peat
- Clay
- Silty clay
- Sandy clay
- Gravelly clay
- Shaly clay
- Silt
- Clayey silt
- Sandy silt
- Sand
- Clayey sand
- Silty sand
- Gravel
- Sandy gravel
- Cobbles, boulders
- Talus

Sedimentary Rocks



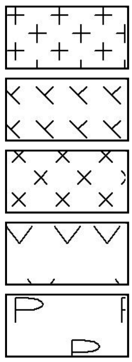
- Boulder conglomerate
- Conglomerate
- Conglomeratic sandstone
- Sandstone
- Siltstone
- Laminite
- Mudstone, claystone, shale
- Coal
- Limestone

Metamorphic Rocks



- Slate, phyllite, schist
- Gneiss
- Quartzite

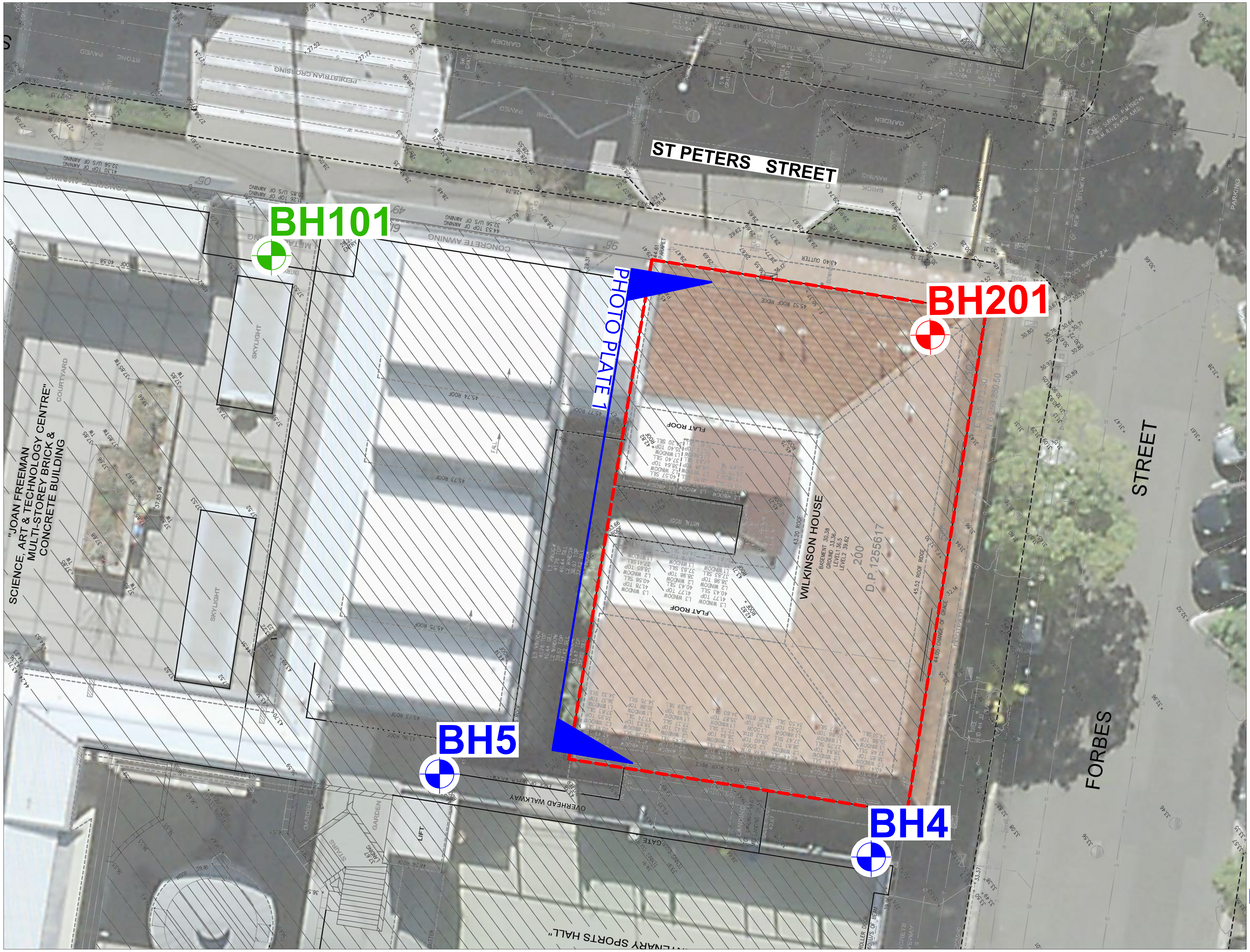
Igneous Rocks

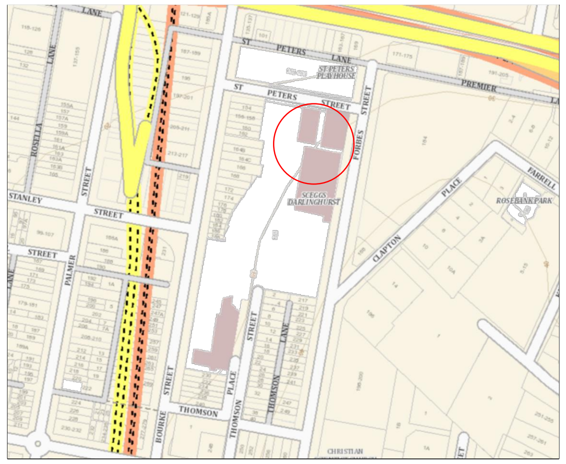


- Granite
- Dolerite, basalt, andesite
- Dacite, epidote
- Tuff, breccia
- Porphyry

Appendix B

Drawings





Locality Plan

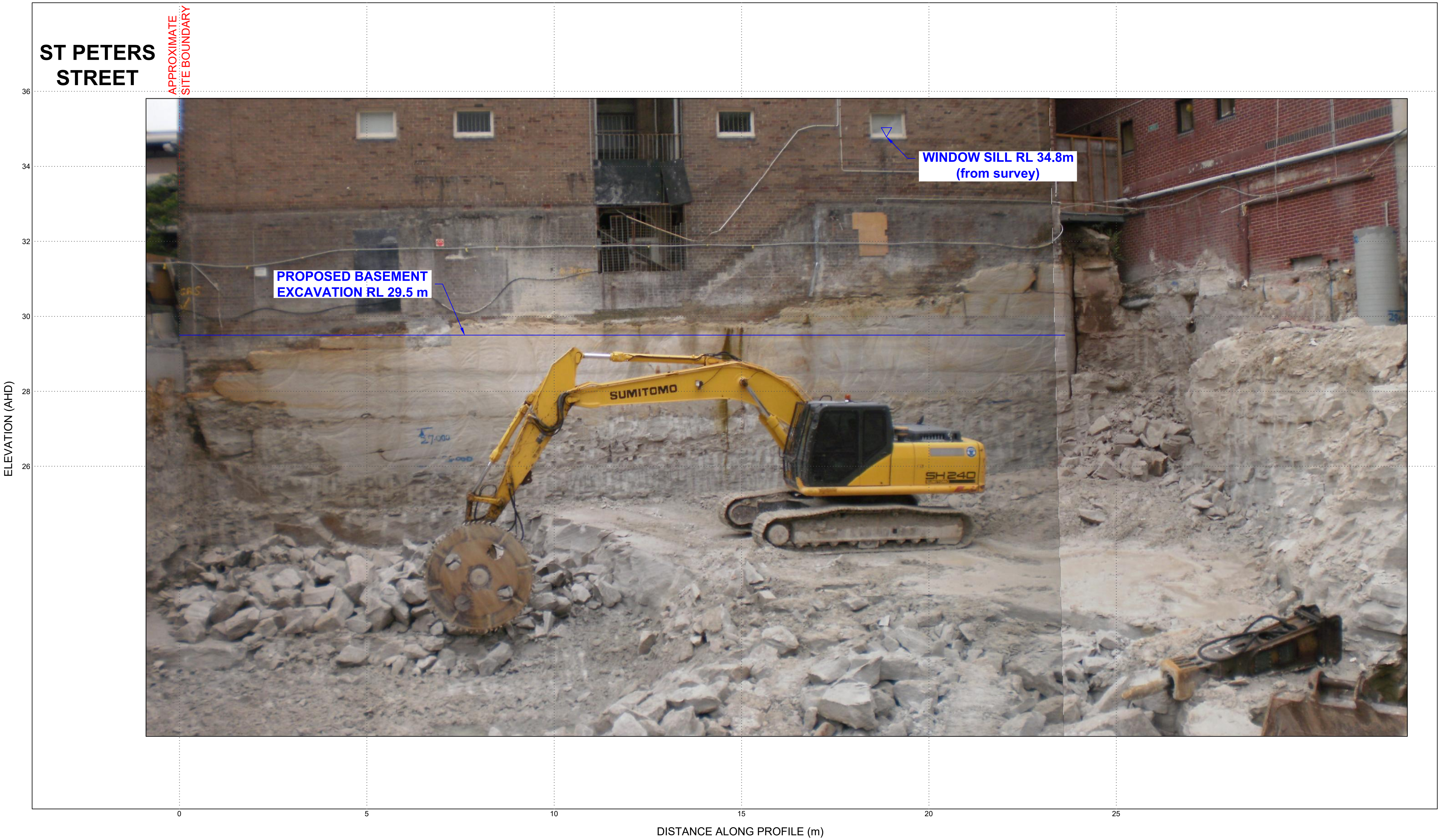
LEGEND

- View of Photo Plate 1 (Refer to D.002)
- Approximate Site Boundary
- Approximate Current Borehole Location
- Approximate Selected Borehole Location (DP45427, March 2008)
- Approximate Selected Borehole Location (DP20080, July 1994)

NOTE:
1: Base image from MetroMap (Dated 30.07.2021)
2: Base Survey Plan from Rygate & Company Pty Ltd, Reference No. 79584 (Dated 12.04.2021)

0 1 2 4 6 8 10 15 20 30m
1:300 @ A3

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Sandrick Project Directions Pty Ltd	TITLE: **Test Location Plan**	PROJECT No: 86514.03
	OFFICE: Sydney / DRAWN BY: MG	**Wilkinson House Redevelopment**	DRAWING No: 1
	SCALE: 1:300 @ A3 / DATE: 12.10.2021	**167 Forbes Street, Darlinghurst**	REVISION: 0



NOTE:

1: Base image from rock face inspection by Douglas Partners Pty Ltd (Dated 28.01.2011)

2: Image approximately to scale only, with reference rockface survey marks and window sill RL from Survey Plan by Rygate & Company Pty Ltd, Reference No. 79584 (Dated 12.04.2021)

0 1 2 3 4 5 7.5 10m
1:100 @ A3
Approx. Scale (metres)

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Sandrick Project Directions Pty Ltd	TITLE: **Photo Plate 1 - Excavation Adjacent to Wilkinson House (Western Boundary)**	PROJECT No: 86514.03
	OFFICE: Sydney / DRAWN BY: AH	**Wilkinson House Redevelopment**	DRAWING No: 2
	SCALE: Approx. 1:100 @A3 / DATE: 12.10.2021	**167 Forbes Street, Darlinghurst**	REVISION: 0

Appendix C

Current Field Work Results

BOREHOLE LOG

CLIENT: Sandrick Project Directions Pty Ltd
PROJECT: Wilkinson House Redevelopment
LOCATION: 167 Forbes St, Darlinghurst

SURFACE LEVEL: 30.80 AHD
EASTING: 335270
NORTHING: 6250226
DIP/AZIMUTH: 90°/--

BORE No: BH201
PROJECT No: 86514.03
DATE: 29/9/2021
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.1	CONCRETE: 100mm thick					
0.25	FILL/Sandy CLAY: low plasticity, grey-brown, coarse sand, trace fine to medium sandstone gravel, w~PL		D			
	SANDSTONE: fine to medium grained, pale grey with orange red iron staining, with grey siltstone laminations, bedding dippping 0-20 degrees, high strength, slightly weathered to fresh, unbroken, Hawkesbury Sandstone	0.47m: B, 0-5°, pl, ro, cln	C	100	100	PL(A) = 2.4 PL(A) = 1.4
		1.13m: B, 20°, pl, ro, cln 1.68m: B, 15°, pl, ro, cly vn 1.75m: Ds, 10mm	C	100	93	PL(A) = 1.4 PL(A) = 1.4
	From 2.9-3.15m: medium strength	2.51m: B, 0-5°, pl, ro, cly vn 2.91m: B, 15° degrees, pl, ro, cly vn	C	100	100	PL(A) = 1.2 PL(A) = 0.7 PL(A) = 0.9
4.47		3.73m: B, 15° degrees, pl, ro, cln	C	100	100	PL(A) = 1.7 PL(A) = 2.2
	Bore discontinued at 4.47m					

RIG: Hand equipment **DRILLER:** A1 Concrete **LOGGED:** RAS **CASING:** Uncased
TYPE OF BORING: 0-0.1m diatube 200mm diameter, 0.1m-0.25m hand excavation, 0.25m-4.47m diatube 75mm diameter.
WATER OBSERVATIONS: Obscured by drilling water
REMARKS: Spoon test conducted to verify discontinuities to a depth of 2.0m.

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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BORE: BH201 PROJECT: DARLINGHURST SEPTEMBER 2021

0.25m – 4.00m

BORE: BH201 PROJECT: DARLINGHURST SEPTEMBER 2021

4.00 – 4.47m

Appendix D

Previous Field Work Results

TEST BORE REPORT

BORE No: 4

CLIENT: TIERNEY & PARTNERS PTY LTD
PROJECT No: 20080
DATE: 29.6.94

PROJECT: PROPOSED SPORTS HALL
SURFACE LEVEL: 33.2
SHEET 1 **OF** 1

LOCATION: SCEGGS DARLINGHURST
DIP OF HOLE: 90°
AZIMUTH: –

Depth (m)	Description of Strata	Graphic Log	Discontinuities (B – Bedding, J – Joint, S – Shear, D – Drill Break)	Sample Type	Core Rec. %	RQD %	Test Results & Comments
0–0.25	FILLING – topsoil and sandstone rubble						
0.25–3.5	SANDSTONE – medium strength, slightly weathered, fractured, grey, medium grained, sandstone with some slightly fractured lengths and a minor extremely low strength band – high strength from 3.2m		0.41m: B, 20°, rough 0.61m: B, 20°, rough 0.85m: B, 20°, rough 1.03m: B, 20°, rough 1.50m: B, 20° 1.67m: B, 20° 2.0m: B, 20° 2.55m: B, 20° 2.75m: J, irregular 2.99m: B, 20° 3.31m: B, 20°	C C C	100 100 100	100 70 75 70	PL_D=0.6MPa PL_D=0.4MPa PL_D=0.9MPa PL_D=1.5MPa
3.5	TEST BORE DISCONTINUED AT 3.5 METRES		Unless otherwise specified all defects are planar				

Degree of Weathering: EW, HW, MW, SW, FS, FR — Rock Strength: Ex Low, Very Low, Low, Medium, High, Very High, Ex High — Fracture Spacing (m): 0.01, 0.05, 0.10, 0.50, 1.00

RIG: PORTABLE
DRILLER: CHITTLEBURGH
LOGGED: PATEL
CASING: NW TO 0.5m

TYPE OF BORING: HAND AUGER TO 0.25m THEN NMLC CORING

WATER OBSERVATIONS: NO FREE GROUNDWATER OBSERVED

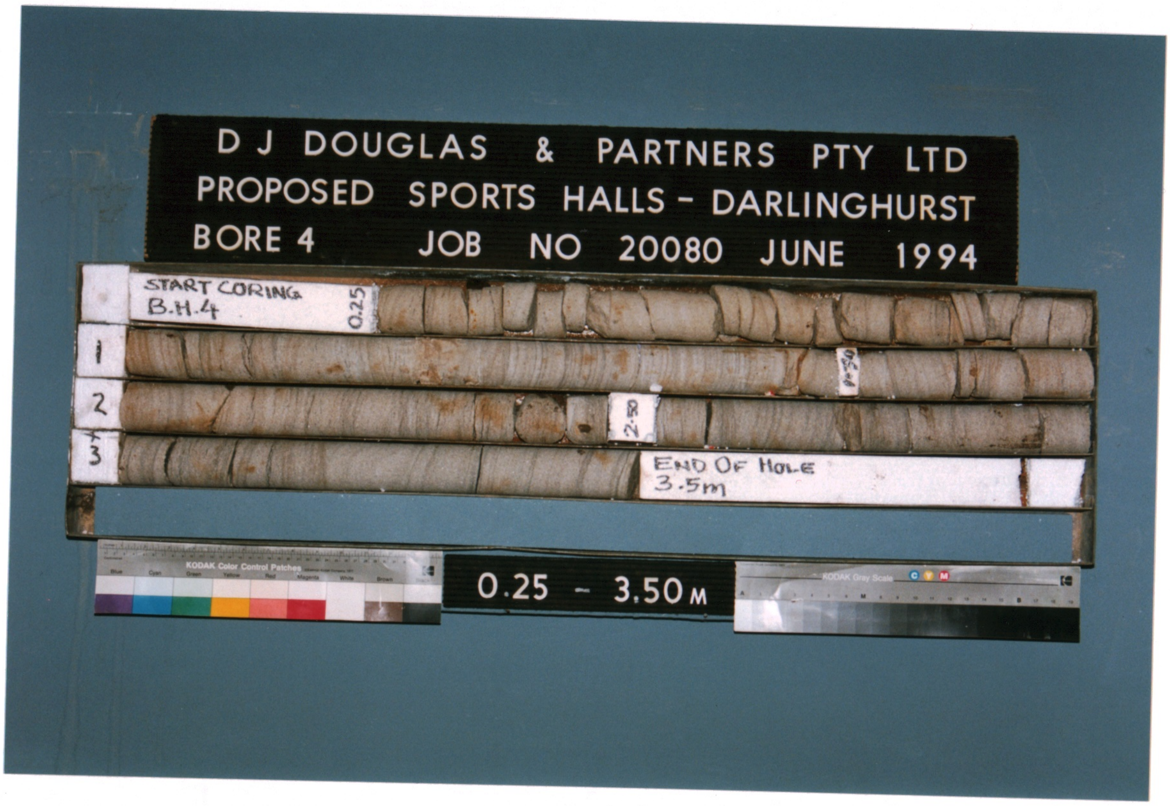
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A auger sample	PL point load strength I_s (50)MPa
B bulk sample	S standard penetration test
C core drilling	Ux x mm dia. tube
pp pocket penetrometer (kPa)	V Shear Vane (kPa)

CHECKED:
Initials: DFD
Date: 8.7.94

D.J. Douglas & Partners


D J DOUGLAS & PARTNERS PTY LTD
PROPOSED SPORTS HALLS - DARLINGHURST
BORE 4 JOB NO 20080 JUNE 1994
START CORING
B.H.4
0.25
1
2
3
END OF HOLE
3.5m
0.25 - 3.50 M
KODAK Color Control Patches
KODAK Gray Scale

TEST BORE REPORT

BORE No: 5

CLIENT: TIERNEY & PARTNERS PTY LTD **PROJECT No:** 20080 **DATE:** 28.6.94
PROJECT: PROPOSED SPORTS HALL **SURFACE LEVEL:** 30.3 **SHEET** 1 **OF** 1
LOCATION: SCEGGS DARLINGHURST **DIP OF HOLE:** 90° **AZIMUTH:** –

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)	Discontinuities (B – Bedding, J – Joint, S – Shear, D – Drill Break)	Fracture Spacing (m) (0.01 0.05 0.10 0.50 1.00)	Sample Type	Core Rec. %	RQD %	Test Results & Comments
0.10	CONCRETE									
0.32	FILLING – sandstone rubble and sandy clay									
1.0	SANDSTONE – medium strength, slightly weathered, fractured to slightly fractured, grey medium grained sandstone				– 0.58, 0.85, 0.91m: B, 20°, planar, rough		C	78	42	PL_D=0.4MPa
1.42	SANDSTONE – extremely low to very low strength, moderately weathered grey, fine to medium to coarse grained sandstone				CORE LOSS Probably due to extremely low strength material being washed away during drilling					
1.75					– 1.69m: J, 90°, planar, rough, ironstained					
4.0	SANDSTONE – high strength, slightly weathered, fractured grey medium to coarse grained sandstone with some clay bands to 20mm above 3m				– 1.73, 1.80, 1.88, 1.94m: B, 20°, planar, rough					PL_D=1.4MPa
							C	100	17	PL_D=0.7MPa
					– 2.92–2.94m: clay band – 3.05, 3.24, 3.85m: B, 20°, planar, rough		C	100	88	PL_D=1.7MPa
	TEST BORE DISCONTINUED AT 4.0 METRES									

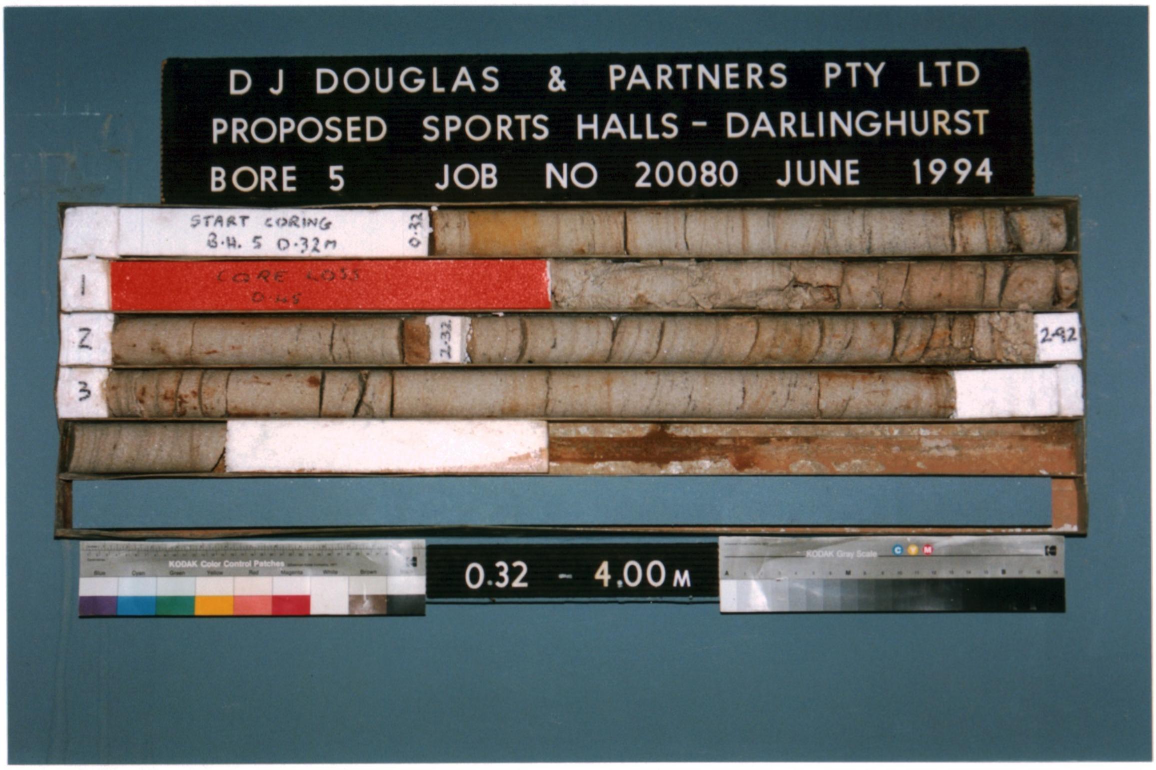
RIG: PORTABLE **DRILLER:** CHITTLEBURGH **LOGGED:** PATEL **CASING:** NW TO 0.5m
TYPE OF BORING: HAND AUGER TO 0.32m THEN NMLC CORING
WATER OBSERVATIONS: NO FREE GROUNDWATER OBSERVED
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A auger sample	PL point load strength I_s (50)MPa
B bulk sample	S standard penetration test
C core drilling	Ux x mm dia. tube
pp pocket penetrometer (kPa)	V Shear Vane (kPa)

CHECKED:
Initials: DFD
Date: 8.7.94

D.J. Douglas & Partners


D J DOUGLAS & PARTNERS PTY LTD
PROPOSED SPORTS HALLS - DARLINGHURST
BORE 5 JOB NO 20080 JUNE 1994
START CORING
B.H. 5 0.32M
0.32
1
2
2.32
2.92
3
0.32 - 4.00M

BOREHOLE LOG

CLIENT: SCEGGS Darlinghurst
PROJECT: Joan Freeman Building
LOCATION: St Peters Street, Darlinghurst

SURFACE LEVEL: 28.15
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 45427
DATE: 05 Mar 08
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Type	Core Rec. %	RQD %	Test Results & Comments
0.02	BITUMINOUS CONCRETE	Note: Unless otherwise stated, rock is fractured along rough, clay veneered, planar bedding or joints dipping 0°- 10°	A			
0.12	ROADBASE GRAVEL					
0.2	SLAG FILLING		A			
0.6	FILLING - light grey brown medium grained, sand filling with some gravel					
1.0	SANDSTONE - extremely low strength, light grey brown, medium grained sandstone		C	69	69	
1.24	SANDSTONE - medium and high strength, moderately weathered and fresh, slightly fractured, light grey and brown medium to coarse grained sandstone	1.24m: CORE LOSS: 110mm	C	100	87	PL(A) = 1.3MPa; PL(A) = 0.8MPa
2.47	SANDSTONE - high strength, fresh, slightly fractured, light grey medium to coarse grained sandstone	2.41m: B5°, 5mm				
2.85		2.85m: CORE LOSS: 350mm; 3.2m: J40°; 3.46m: B0°, 2mm clay; 4.16m: J30°, ironstained	C	88	87	PL(A) = 1.7MPa
4.2	SANDSTONE - medium strength, fresh, slightly fractured, light grey medium grained sandstone	4.9m: B0°, 5mm clayey sand				PL(A) = 0.7MPa
5.2	SANDSTONE - high strength, fresh, slightly fractured then unbroken, light grey medium to coarse grained sandstone	5.2m: B0°, 3mm clayey sand; 5.52m: J30°, ironstained				PL(A) = 1.4MPa
			C	100	99	PL(A) = 2MPa; PL(A) = 1.9MPa
			C	100	100	PL(A) = 1.7MPa; PL(A) = 1.4MPa
10.0	Bore discontinued at 10.0m					

RIG: Bobcat **DRILLER:** E Grima **LOGGED:** SI **CASING:** HW to 1.0m
TYPE OF BORING: Solid flight auger to 1.0m; NMLC-Coring to 10.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep; Water level

CHECKED
Initials:
Date:

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DOUGLAS PARTNERS PTY LTD
JOAN FREEMAN BUILDING — DARLINGHURST
BORE 101 PROJECT 45427 MAR 2008
Darlinghurst B/H101 45427 START 1.0 m
CORE LOSS 0.11
CORE LOSS 0.14
CORE LOSS 0.19
1.00 - 5.00M


DOUGLAS PARTNERS PTY LTD
JOAN FREEMAN BUILDING — DARLINGHURST
BORE 101 PROJECT 45427 MAR 2008
5.00 - 10.00M