Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

St Patrick's College
Francis Street, Strathfield

Prepared for
St Patrick's College

Project 86967.00
January 2020

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

	Signature	Date
Author		13 January 2020
Reviewer		13 January 2020

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Report on Geotechnical Investigation
St Patrick's College
Francis Street, Strathfield

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed science and learning centre at St Patrick's College, Francis Street, Strathfield. The investigation was commissioned in an email dated 16 October 2019 by Andrew Simpson of SDA Structures Pty Ltd on behalf of St Patrick's College and was undertaken in accordance with Douglas Partners' proposal SYD191058.P.001.Rev0 dated 5/10/19.

It is understood that the proposed development is to include the construction of a new four-storey science and learning centre building over a one level basement.

The investigation included the drilling of three cored and six auger drilled boreholes, the installation of one groundwater well and laboratory testing of selected samples. Details of the field work are presented in this report, together with comments and recommendations relevant to design and construction.

2. Site Description

St Patrick's College is located on a near-rectangular block bounded by Shortland Avenue to the north, Fraser Street to the east, Francis Street to the west and the Australian Catholic University to the south. Several residential properties towards the north-eastern corner of the school are also included within the block. The development area is located towards the south-eastern portion of the school along Fraser Street and is currently occupied by five basketball / tennis courts.

The site is located towards the top of a hill that slopes down to the north and changes in elevation from about RL 28 m AHD at the southern end of the site to about RL 20 m AHD at the north-eastern corner of the site. The development area is generally flat with an RL of approximately 26 m AHD. There are a number of terraced areas including a playing field and the tennis/basketball courts on the site that have been formed during previous developments.

The *Sydney 1:100 000 Geological Series Sheet* indicates that the site is underlain by Ashfield Shale which typically comprises a residual clay profile overlying variably weathered dark grey shale, laminite and siltstone. The site is also near a boundary of Hawkesbury Sandstone which underlies the Ashfield shale and typically comprises medium to coarse grained quartz sandstone with minor shale and laminite lenses. An extract from the geological map overlain by 2 m surface contours is shown in Figure 1.

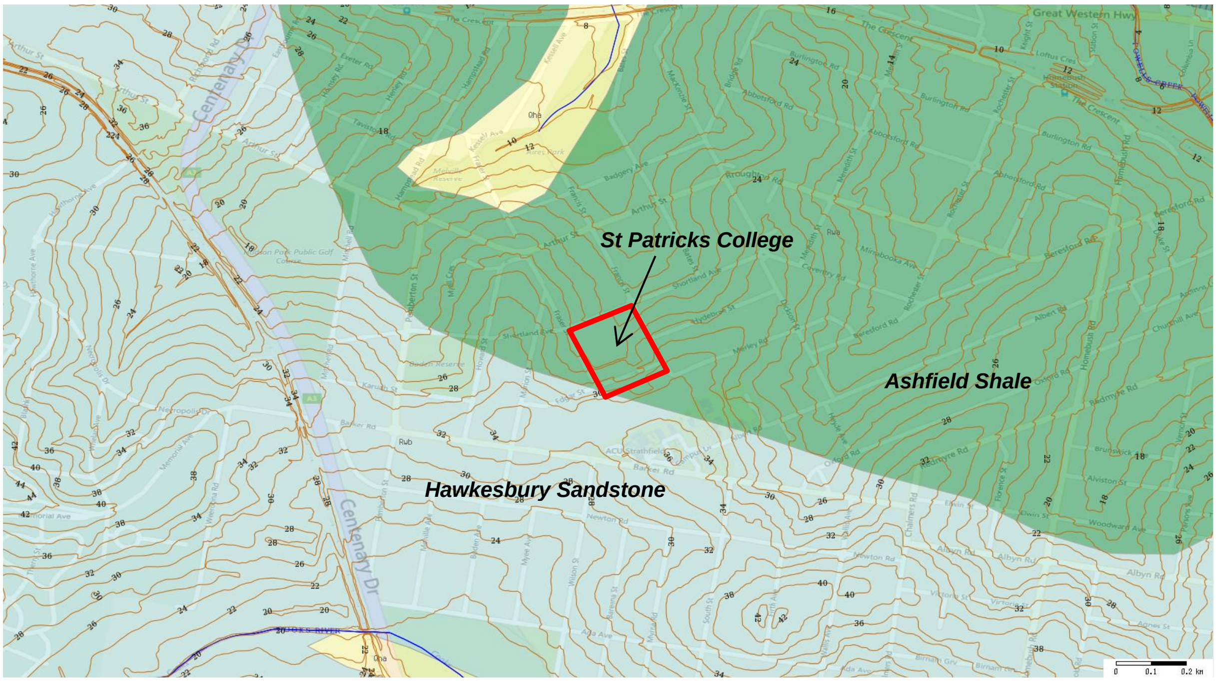


Figure 1: Extract from geological map overlain by 2 m surface contours

3. Field Work Methods

The field work was carried out on 24, 25 and 29 October 2019 and included:

- The drilling of seven auger drilled boreholes (BH1 to BH7) to depths of between 1.4 m and 4.4 m using a bobcat mounted drilling rig;
- Standard penetration tests (SPTs) were carried out at regular intervals and soil samples were collected for laboratory testing in the auger drilled section of each borehole;
- Boreholes BH1, BH3 and BH5 were then extended by NMLC diamond core drilling techniques to depths of between 5.5 m and 7.2 m to obtain continuous core samples of the bedrock; and
- One borehole (BH5) was converted into a groundwater monitoring well by installing Class 18 uPVC screen and casing.

The easting, northing and reduced level (RL) of the ground surface relative to Australian Height Datum (AHD) and MGA94 at each test location were measured using dGPS equipment (accurate to about ± 0.1 m).

The locations of the boreholes are shown on Drawing 1 in Appendix B and the borehole coordinates are shown on the borehole logs in Appendix C.

4. Field Work Results

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

The boreholes encountered:

- FILL – clay, gravel and sand in varying proportions to depths of between 0.2 m and 2.8 m. A concrete slab with a thickness of 120 mm was encountered in all boreholes drilled in the existing tennis/basketball courts (BH1 to BH6);
- RESIDUAL SOIL – generally stiff to hard clay/sandy clay with varying proportions of ironstone gravel to depths of between 1.1 m and 4.4 m in all boreholes; and
- BEDROCK – generally very low to low strength siltstone from depths of between 1.1 m and 4.4 m in boreholes BH1 to BH7, becoming medium and high strength with depth. In borehole BH1 rock was not encountered until a depth of 4.4 m and was of medium to high strength.

Table 1 summarises the depths/levels at which different materials were encountered in the boreholes. The rock classifications refer to a system developed by Pells, Douglas et al (1978) which classifies rock on the basis of strength, fracturing and defects. Class V rock is typically very low strength and fractured whereas Class I rock is typically high strength and unbroken. Lower classifications may, however, contain strong rock with significant defects and/or fracturing.

Table 1: Summary of Inferred Material Strata Levels

Stratum	Depth and RL of Top of Stratum m / (m, AHD)								
	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8	BH9
Fill (Surface)	**0** (26.0)	**0** (26.3)	**0** (26.2)	**0** (26.0)	**0** (26.1)	**0** (26.2)	**0** (22.8)	**0** (28.4)	**0** (27.2)
Stiff to Hard Residual Clay	**2.8** (23.2)	**0.6** (25.7)	**0.5** (25.7)	**1.0** (25.0)	**0.2** (25.9)	**0.5** (25.7)	**0.7** (22.1)	**0.6** (27.8)	**0.8** (26.4)
Class V Siltstone	NE	**1.1** (25.2)	**2.4** (23.8)	NE	NE	**2.1** (24.1)	NE	NE	NE
Class IV Siltstone	**4.4** (21.6)	NE	NE	**3.1** (22.9)	**2.8** (23.3)	NE	**1.0** (21.8)	NE	NE
Class III Siltstone	**5.0** (21.0)	NE	**4.9** (21.3)	NE	**3.9** (22.2)	NE	NE	NE	NE
Base of Borehole	**7.2** (18.8)	**1.5** (24.8)	**5.5** (20.8)	**4.0** (22.0)	**5.9** (20.2)	**4.1** (22.1)	**1.4** (21.4)	**0.8** (27.6)	**1.0** (26.2)

Notes: NE = not encountered

Groundwater seepage was not observed during auger drilling in any of the boreholes. The use of drilling fluid during coring prevented further observations with depth. The water level in the groundwater well at BH5 was measured on 7 November 2019 and was found to be at a depth of 1.9 m (RL 24.2 m AHD). It is noted that this is likely to be perched seepage rather than the regional groundwater table which is likely to be much deeper.

5. Laboratory Testing

5.1 Rock

A total of 8 samples were tested for axial point load strength index (Is_{50}). The results ranged between 0.18 MPa and 1.39 MPa which correspond to low strength and high strength rock, respectively. The individual results are shown on the relevant borehole logs in Appendix C.

5.2 Soil

Two samples were sent to a NATA accredited analytical laboratory and were analysed to assess the exposure classification to steel and concrete below ground. The results are summarised in Table 2 and the detailed results are included in Appendix D.

Table 2: Analytical Results for Aggressivity in Soil and Groundwater

Sample/Depth (m)	Stratum	pH (pH units)	EC (µS/cm)	Cl^- (mg/kg)	SO_4^{2-} (mg/kg)
BH1/2.0	Fill	8.4	230	<10	150
BH6/1.5-1.95	Residual Soil	9.0	79	26	<10
BH5/-	Groundwater	7.6	2700	380	140

Notes: EC = electrical conductivity; Cl^- = chloride ion; SO_4^{2-} = sulphate ion

Two samples were also tested for Atterberg limits. The results are summarised in Table 3 and the detailed results are included in Appendix D.

Table 3: Results for Atterberg Limits in Soil

Sample/Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Field Moisture (%)
BH1/2.5-2.95	43	22	21	20.8
BH4/2.5-2.95	42	21	21	20.3

6. Geotechnical Model

The development area is underlain by varying depths of fill, typically deeper at the northern end, where ground levels are likely to have been raised to create a level platform for the existing tennis/basketball courts. The residual clays are derived from weathering of the Ashfield Shale and are therefore expected to be of medium to high plasticity and moderately to highly reactive. The laboratory testing confirms this.

The clays are underlain by a weathered Ashfield Shale profile which is initially very low to low strength siltstone (with some higher strength bands) at depths of between 1.1 m and 4.4 m (Class V and Class IV in Table 1). The siltstone increases to medium to high strength at depths of between 3.9 m and 5.0 m (Class III in Table 1) and was observed to the termination depths of the cored boreholes (BH1, BH3 and BH5) between 5.5 m and 7.2 m.

Groundwater was encountered at a depth of 1.9 m (RL 24.2 m AHD) in the monitoring well, however, is considered to be perched seepage rather than the regional groundwater table. The groundwater table is likely to be well below the bedrock surface. Seepage near the rock surface and through joints/partings within the bedrock would be expected to occur.

7. Proposed Development

It is understood that the development is likely to include the construction of a new four-storey building over a one level basement. It is understood that the single level basement will cover the majority of the existing tennis/basketball court area (approximately 2500 m^2), while the four-storey building is proposed above the central/eastern portion (approximately 1000 m^2) of the new basement. New bleacher seats are also proposed to be constructed to the north of the new building to replace the existing bleachers that face the oval.

Based on the finished floor level of RL 24.1 m AHD of the basement floor slab it is expected that bulk excavation of about 2.5 m will be required for the construction of the basement floor slab. Deeper excavation is likely to be required for the footings, service trenches, lift pits etc.

The geotechnical issues considered relevant to the proposed development include excavation, excavation support, groundwater and foundations. Comments on site classification, pavements, aggressivity and seismicity are also provided.

8. Comments

8.1 Excavation

Excavation for the proposed development is expected to extend through fill, residual soils and in some areas Class V siltstone. Excavation of the fill, residual soil and weathered rock encountered in the boreholes should be readily achievable using conventional earthmoving equipment such as excavators. Depending on the excavation depth, low strength and stronger shale may be encountered which will likely require ripping or hammering for bulk and detailed excavation.

Vibrations associated with shallow excavations are unlikely to be an issue due to the weathered nature of the rock profile. However, in the event that advice on vibration limits is required we would recommend that vibrations be limited to a peak component particle velocity (PPVi) of 8 mm/s at the foundation level of any adjacent modern buildings and 5 mm/s for heritage or sensitive structures.

8.2 Excavation Support

Vertical excavations in fill, residual clay and very low to low strength siltstone bedrock are not expected to be stable and will require both temporary and permanent lateral support during and after excavation. A bored soldier pile shoring wall with shotcrete infill panels would be suitable for the site. Typically, soldier piles are installed at a spacing of approximately 2 m to 2.5 m centre to centre, however, closer spaced piles may be required to reduce wall movements, or prevent collapse of infill materials, where pavements, structures or services are located in close proximity to the excavation.

Where space permits, temporary batters of 1(H):1(V) could also be used to support the sides of excavations in these materials for cuts up to 3 m deep.

Excavations retained either temporarily or permanently will be subjected to earth pressures. Table 4 outlines material and strength parameters that could be used for the design of excavation support structures.

Table 4: Material and Strength Parameters for Excavation Support Structures

Material	Bulk Density (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Ultimate Passive Earth Pressure (kPa)
Fill	20	0.4	0.6	-
Residual Soil	20	0.3	0.45	150[1]
Class V/IV Siltstone	22	0.2	0.3	500[1]
Class III Siltstone	23	0.1	0.15	2000[1]

Notes: [1]Only below bulk/detailed excavation level

The lateral earth pressure distribution for a wall propped by slabs at the top and bottom could be assumed to be trapezoidal; the maximum lateral earth pressure acting over the central 60% of the wall, decreasing to zero at the top and base. The lateral earth pressure distribution for a cantilevered wall could be assumed to be triangular. Cantilevered walls should not be used to support adjacent structures.

'Active' earth pressure coefficient (K_a) values may be used for walls where some wall movement is acceptable, and 'at rest' earth pressure (K_o) values should be used where the wall movement needs to be reduced (i.e. adjacent to existing structures or utilities).

Lateral pressures due to surcharge loads from adjacent buildings, existing road corridors, sloping ground surfaces and construction machinery should be included where relevant. Hydrostatic pressure acting on the shoring walls should also be included in the design where adequate drainage is not provided behind the full height of the walls.

8.3 Groundwater

Water was encountered in the monitoring well installed as a part of the investigation in borehole BH5, however the regional groundwater table is expected to be well below the bedrock surface. Seepage should be expected through the fill and rock, and along strata boundaries. The rate of seepage is likely to vary with climatic conditions.

The subsurface conditions encountered in the boreholes indicate that seepage can probably be controlled using a sub-floor drainage and collection system in the basement level. A pump or gravity drainage system (if possible) will be required to periodically remove stored water from the lowest part of any basements. A pump may also be needed to remove seepage from footing/pile excavations prior to the placement of concrete.

8.4 Foundations

8.4.1 Site Classification

As parts of the site contain fill thicker than 0.4 m, the site is classified as Class P when assessed in accordance with Australian Standard AS2870 – 2011 *Residential slabs and footings*. However, where the filling is stripped during the bulk excavation, the site may be reclassified as Class M. Differential movements between structures founded in bedrock and structures founded in the clays could occur and it may be prudent to found all structures within bedrock. The presence of trees should also be taken into account when assessing soil reactivity.

8.4.2 Spread Footings

Based on the finished surface level of RL 24.1 m AHD for the proposed basement floor slab, Class V or IV siltstone should be exposed at or close to the design foundation level. Spread footings on Class V or IV siltstone could therefore be used to support the new structure. Some allowance should be made for deepening of footings toward the northern portion of the basement to encounter the siltstone bedrock. The support of column loads within the north-eastern portion of the basement in the vicinity of BH1, and more substantial column loads elsewhere, may require the use of piles to be founded within the bedrock profile.

Where applicable, spread footings could be designed using the parameters outlined in Table 5.

Table 5: Allowable Footing Design Parameters for Spread Footings

Material	Allowable Bearing Pressure (kPa)
Existing Fill	0
Residual Clay	200
Class V Siltstone	700
Class IV Siltstone	1000
Class III Siltstone	3500

Settlement of a spread footing is dependent on the loads applied to the footing and the foundation conditions below the footing. The total settlement of a spread footing designed using the parameters provided in this report may be in the order of 1% of the width of the footing upon application of the working load. Differential settlements between footings may be in the order of 50% of the value of total settlement.

Spread footings will not be able to be used within the zone of influence of any existing batters, retaining walls or existing/proposed excavations. The zone of influence can be described as a line drawn up at 2(H):1(V) from the base of the batter/wall.

All spread footing excavations should be inspected by an experienced geotechnical professional to check the adequacy of the foundation material.

8.4.3 Piles

Bored piles could be used to support the new structure and could be designed using the parameters provided in Table 6.

Table 6: Design Parameters for Bored Piles

Material	Allowable End-Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)[1]	Ultimate End-Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa)[1]	Young's Modulus (MPa)
Class V Siltstone	700	50	1,500	100	75
Class IV Siltstone	1,000	100	3,000	150	150
Class III Siltstone	3,500	350	10,000	700	500

Notes: [1]Pile sockets should be clean and roughened to achieve these shaft adhesion values

It should be noted that the serviceability limit-state is likely to govern the design of the piles and the ultimate bearing pressures provided in Table 6 are unlikely to be able to be achieved in practice. An appropriate geotechnical strength reduction factor should be applied when using the limit-state approach as outlined in AS 2159 – 2009 *Piling – Design and installation*. An initial value of 0.4 could be assumed in the first instance.

Settlement of a pile is dependent on the loads applied to the pile and the foundation conditions below the pile toe and within the socket zone. The total settlement of a pile designed using the allowable parameters provided in this report may be in the order of 1% of the diameter of the pile. Differential settlements between piles may be in the order of 50% of the value of total settlement. Serviceability analysis should be undertaken when using the ultimate (limit-state) parameters.

All bored pile excavations should be inspected by an experienced geotechnical professional to check the adequacy of the foundation material and the socket roughness/cleanliness.

8.5 Pavements

On the basis of the subsurface conditions encountered on the site and our previous experience in the area, it is recommended that a design subgrade CBR of 3% be adopted for the clayey residual soils.

8.6 Aggressivity

The laboratory test results indicate that the soil and groundwater conditions are non-aggressive to concrete and mildly to moderately aggressive steel as outlined in Australian Standard AS 2159 – 2009 *Piling – Design and installation*.

8.7 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 site sub-soil class would be Class C_e.

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for the project at St Patrick's College at Francis Street Strathfield, in accordance with DPs proposal dated 5 October 2019 and subsequent acceptance received from the client. The report is provided for the use of St Patrick's College for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party.

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

DPs advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

This report must be read in conjunction with all of the attached notes 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 given 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 contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

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

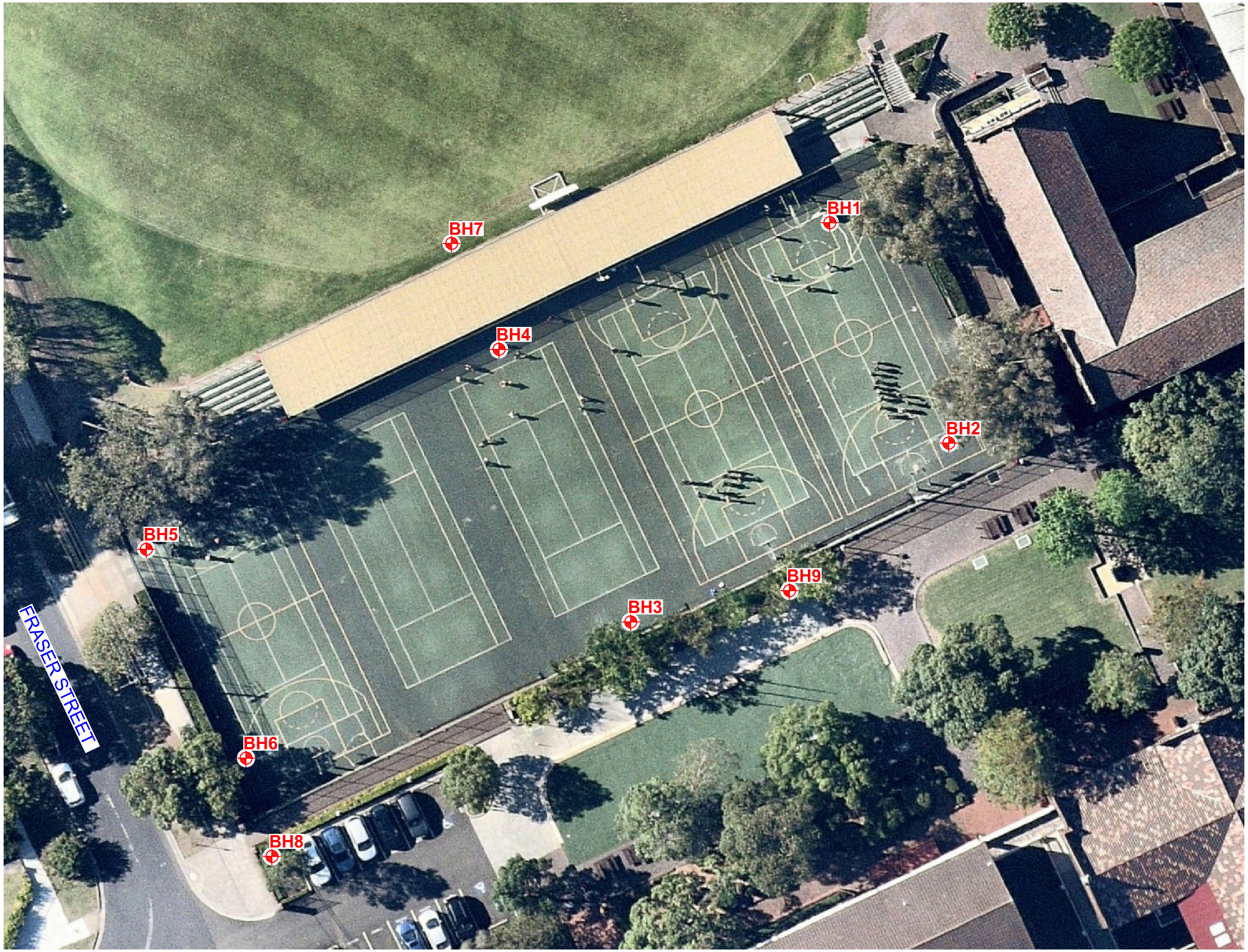
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate 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.

Appendix B

Drawing



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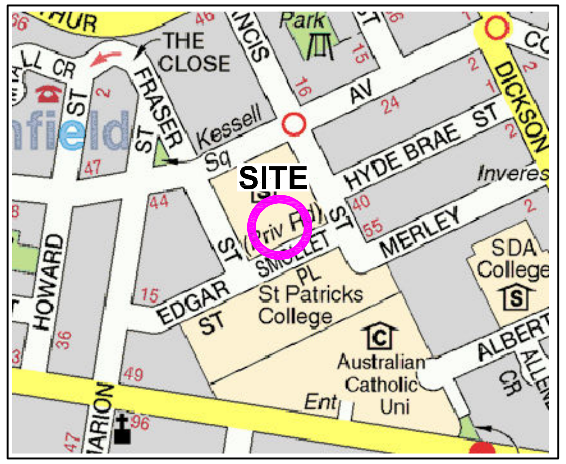

Locality Plan

NOTE:
1: Base image from Nearmap.com
(Dated 22.10.2019)
2: Test locations are approximate only and are shown with reference to existing features.

LEGEND

Borehle location

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CLIENT: St Patrick's College		TITLE: **Test Location Plan**	PROJECT No: 86967.00
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Science and Learning Centre**	DRAWING No: 1
SCALE: 1:400 @ A3	DATE: 6.11.2019	**Francis Street, STRATHFIELD**	REVISION: 0

Appendix C

Results of Field Work

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

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. 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	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

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

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

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	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

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;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Descriptions

Douglas Partners

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and 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 test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

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

* 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
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

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 some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

Douglas Partners

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General

- Asphalt
- Road base
- Concrete
- Filling

Soils

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

Sedimentary Rocks

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

Metamorphic Rocks

- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks

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

BOREHOLE LOG

CLIENT: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 26 AHD
EASTING: 321958.7
NORTHING: 6250153.7
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 86967.00
DATE: 24/10/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
26	0.12	CONCRETE: 120mm thick.		D			
	0.45	FILL/GRAVEL: fine to medium, subangular, dark grey, igneous, with fine to medium sand, moist.		D			
25	1.6	FILL/CLAY: low to medium plasticity, pale grey and brown mottled red, grey and dark grey, trace fine igneous and ironstone gravel, w~PL, apparently in a firm condition.		D			
				S			1,3,2 N = 5
24	1.9	FILL/GRAVEL: fine to medium, dark grey, igneous, dry, with fine to medium sand. 1.8m: with fine to medium sand.		D			
				D			
	2.1	(end of FILL/GRAVEL)					
	2.8	FILL/CLAY: medium plasticity, brown, trace fine subangular ironstone gravel, w~PL.		D			
				S			1,5,9 N = 14
23		FILL/SAND: fine to medium grained, yellow-brown, trace clay, dry, apparently in a loose condition.					
22	4.4	CLAY CI-CH: medium to high plasticity, pale grey, with iron indurated bands, w<PL, stiff to very stiff, residual. 4.0m: dark grey and red-brown, grading into weathered siltstone.		S			15,12,15/90 refusal bouncing
21		SILTSTONE: grey and brown with fine grained sandstone bands, medium to high strength, moderately weathered, highly fractured to fragmented, Ashfield Shale. 4.90m: dark grey and grey, fresh stained, fractured.	4.43-4.54m: B(x9), 0-5°,ro, un, cln 4.57m: Ds, 60mm 4.65-4.9m: B(x6), 0-5°, ro, un, fe stn 4.66-4.95m: J, un, ro, fe, stn 4.82-5.04m: J, 60-80°, ro, un, fe stn 5.07-5.31m: B(x7), 0-5°, ro, un, fe stn	C	100	10	PL(A) = 1.3
20			5.43-5.73m: B(x11), 0-10°, ro, un, cly vnr	C	100	0	
19	7.23		5.79-6.63m: B(x13), 0-10°, ro, un, cly <2mm 6.66m: Ds, 10mm 6.75m: Ds, 20mm 6.8-7.06m: B(x6), 0-5°, ro, un, cly vnr	C	100	18	PL(A) = 1.4 PL(A) = 0.87
		Bore discontinued at 7.23m					
18	8						
17	9						

RIG: Bobcat **DRILLER:** JE **LOGGED:** RMM **CASING:** HW to 4.0m HQ to 4.0m
TYPE OF BORING: Diatube to 0.12m, Solid Flight Auger (TC-bit) to 4.00m, rotary (water) to 4.4m, NMLC to 7.23m
WATER OBSERVATIONS: No free groundwater observed while augering
REMARKS:

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: 1 PROJECT: STRATHFIELD OCTOBER 2019

4.40 – 7.23m

BOREHOLE LOG

CLIENT: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 26.3 AHD
EASTING: 321969.9
NORTHING: 6250132.6
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 86967.00
DATE: 29/10/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
26	0.1	CONCRETE: 120mm thick.		A	0.1				
	0.4	FILL/SAND: fine to coarse, dark grey with fine to coarse subangular igneous gravel, moist.		A	0.5				
	0.6	FILL/CLAY: low to medium plasticity, brown-dark brown with fine to medium sand and fine to coarse, subangular, igneous and ironstone gravel, w<PL.		A	1.0				
25	1.1	CLAY CI: medium plasticity, orange mottled red-brown, w<PL, stiff to very stiff, residual.		S	1.3–1.38		2,14,25/80 refusal bouncing		
				A	1.3				
	1.5	SILTSTONE: pale grey-grey, very low to low strength, Ashfield Shale. 1.3m: low strength.		S	1.5–1.55		11/50 refusal bouncing		
		Bore discontinued at 1.5m TC bit refusal							

RIG: Bobcat **DRILLER:** JE **LOGGED:** RK **CASING:** Uncased
TYPE OF BORING: Diatube to 0.12m, Solid Flight Auger (TC-bit) to 1.50m
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

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: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 26.2 AHD
EASTING: 321939.6
NORTHING: 6250116.4
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 86967.00
DATE: 25/10/2019
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
0.12	CONCRETE: 120mm thick.		A			
0.17	FILL/Sandy GRAVEL: fine to medium igneous, dark grey, sand is fine to medium, moist.		A			
0.5	FILL/Clayey SAND SC: fine to medium, brown-grey, moist.					
	Sandy CLAY SC: low to medium plasticity, grey-brown, sand is fine, w<PL hard, residual, grading into weathered siltstone.		A / S			26,25/100 refusal bouncing
2.0	2.0m: with red brown iron indurated bands, grading into weathered siltstone.	1.95m: CORE LOSS: 50mm	C	94	0	
2.44	SILTSTONE: brown and grey with some fine to medium grained sandstone laminations, very low strength, highly weathered, highly fractured, Ashfield Shale.	2.56m: B, 5-15°, ro co, clay <3mm 2.82-3.58m: B(x21), 0-15°, ro, un, fe stn, clay <3mm 3.67m: Cs, 40mm 3.87m: Ds, 130mm 4.12m: J, 0-70°, ir, un, clay, vnr 4.16m: Ds, 160mm 4.25-4.42m: J, 70°, ro, un, fe stn 4.40-4.57m: B(x4), 5-20°, ro, cn, fe, stn	C	100	20	PL(A) = 0.18
4.91	SILTSTONE: dark grey with fine grained sandstone laminations, low to medium strength, slightly weathered to fresh stained, slightly fractured, Ashfield Shale.	4.6m: Ds, 70mm 4.79m: B, 5-10°, ro, un, clay 10mm 4.86m: Ds, 30mm 5.06m: B, 0-5°, ro, un, clay 10mm 5.19-5.30m: J, 80-90°, ro, un, fe, stn				PL(A) = 0.4
5.45	Bore discontinued at 5.45m					

RIG: Bobcat **DRILLER:** JE **LOGGED:** RMM **CASING:** HW to 1.0m HQ to 1.9m

TYPE OF BORING: Diatube to 0.12m, Solid Flight Auger (TC-bit) to 1.0m, rotary (water) to 1.95m, NMLC to 5.45m

WATER OBSERVATIONS: No free groundwater observed while augering

REMARKS:

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: 3 PROJECT: STRATHFIELD OCTOBER 2019

1.95 – 5.45m

BOREHOLE LOG

CLIENT: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 26 AHD
EASTING: 321927.1
NORTHING: 6250141.7
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 86967.00
DATE: 29/10/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water	Well Construction Details
26	0.1	CONCRETE: 120mm thick.	A	0.1				
	0.3	FILL/GRAVEL: fine to coarse, subangular, igneous, dark grey with fine to coarse sand, moist.	A	0.5				
		FILL/CLAY: medium to high plasticity, dark grey-grey with fine to coarse sand, w>PL.						
25	1.0	CLAY CI: medium plasticity, pale grey mottled yellow-brown, w<PL, stiff, residual.	A	1.0				
			S	1.0–1.45		2,5,8 N = 13		
24		1.80m: pale grey mottled red-brown, hard.	A	1.8				
		2.50m: with fine to medium subangular ironstone gravel.	S	2.5–2.95		8,15,16 N = 31		
23	3.1	SILTSTONE: dark grey-dark brown, very low to low strength, Ashfield Shale.	A	3.1				
22	4.0	Bore discontinued at 4.0m TC bit refusal	S	4.0–4.08		3/75 refusal bouncing		

RIG: Bobcat **DRILLER:** JE **LOGGED:** RK **CASING:** Uncased
TYPE OF BORING: Diatube to 0.12m, Solid Flight Auger (TC-bit) to 4.00m
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

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: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 26.1 AHD
EASTING: 321893.4
NORTHING: 6250123.3
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 86967.00
DATE: 25/10/2019
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)
0.12	CONCRETE: 120mm thick.	
0.17	FILL/GRAVEL: fine to medium, dark grey, igneous, with fine to medium sand, moist.	
	CLAY CI-CH: medium to high plasticity, grey mottled orange-red, with fine to medium, subangular ironstone gravel, w~PL, stiff, residual. 2.0m: w<PL, very stiff to hard.	
2.75	SILTSTONE: brown and grey with fine grained sandstone laminations, low to medium strength, highly weathered, highly fractured, Ashfield Shale.	2.93-3.25m: B(x9), 0-5°, ro, un, fe, stn 3.27-3.71m: J(x7), 30-80°, ro, un, fe, stn
3.36	SILTSTONE: grey-dark grey with fine grained sandstone laminations and beds, medium to high strength, slightly to moderately weathered, fractured to highly fractured, Ashfield Shale.	3.54m: Ds, 40mm 3.72-4.98m: B(x19), ro, un, fe, stn, Cly 0-10mm 4.5m: Ds, 20mm 4.89-5.08m: J, 80°, ro, pl, fe, stn 5.08m: Ds, 40mm 5.28-5.31m: B(x3), 0-10°, ro, un, fe, stn 5.38-5.78m: B(x14), 0-5°, ro, un, cly, vnr
5.89	Bore discontinued at 5.89m	

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
S			4,5,7 N = 12
S			5,30/140 refusal bouncing
C	100	0	PL(A) = 0.33
C	100	41	PL(A) = 1.2
C	100	15	PL(A) = 0.64

RIG: Bobcat **DRILLER:** JE **LOGGED:** RMM **CASING:** HW to 2.5m HQ to 2.9m
TYPE OF BORING: Diatube to 0.12m, Solid Flight Auger (TC-bit) to 2.5m, rotary (water) to 2.85m, NMLC to 5.89m
WATER OBSERVATIONS: No free groundwater observed while augering
REMARKS:

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: 5 PROJECT: STRATHFIELD OCTOBER 2019

2.85 – 5.89m

BOREHOLE LOG

CLIENT: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 26.1 AHD
EASTING: 321893.4
NORTHING: 6250123.3
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 86967.00
DATE: 25/10/2019
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Results & Comments	Well Construction Details
0.12	CONCRETE: 120mm thick.				Flush gatic cover
0.17	FILL/GRAVEL: fine to medium, dark grey, igneous, with fine to medium sand, moist.				Gravel
	CLAY CI-CH: medium to high plasticity, grey mottled orange-red, with fine to medium, subangular ironstone gravel, w~PL, stiff, residual.	S	1.0–1.45	4,5,7 N = 12	Blank PVC; Bentonite
	2.0m: w<PL, very stiff to hard.	S	2.5–2.79	5,30/140 refusal bouncing	
2.75	SILTSTONE: brown and grey with fine grained sandstone laminations, low to medium strength, highly weathered, highly fractured, Ashfield Shale.	C	2.85–3.48 (3.2)	PL(A) = 0.33	
3.36	SILTSTONE: grey-dark grey with fine grained sandstone laminations and beds, medium to high strength, slightly to moderately weathered, fractured to highly fractured, Ashfield Shale.	C	3.48–5.17 (4.3)	PL(A) = 1.2	Gravel; Machine slotted PVC screen
		C	5.17–5.89 (5.75)	PL(A) = 0.64	
5.89	Bore discontinued at 5.89m				End cap

RIG: Bobcat **DRILLER:** JE **LOGGED:** RMM **CASING:** HW to 2.5m HQ to 2.9m

TYPE OF BORING: Diatube to 0.12m, Solid Flight Auger (TC-bit) to 2.5m, rotary (water) to 2.85m, NMLC to 5.89m

WATER OBSERVATIONS: No free groundwater observed while augering

REMARKS:

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: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 26.2 AHD
EASTING: 321903
NORTHING: 6250103.2
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 86967.00
DATE: 24/10/2019
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water	Well Construction Details
0.12	CONCRETE: 120mm thick.	A	0.2				
0.17	FILL/Sandy GRAVEL: fine to medium, igneous, sand is fine to medium, moist.	A	0.5				
0.5	FILL/SAND: fine to medium, yellow-brown, trace clay, moist.	A	1.0				
	Sandy CLAY SC: low to medium plasticity, sand is fine to medium, yellow-brown to brown, w<PL, very stiff to hard, residual, grading into weathered siltstone.	S	1.0–1.29		20,25/140 refusal bouncing		
		S	1.5–1.95		25,18,25 N = 43		
2.1	SILTSTONE: red-brown and grey, very low strength with fine to medium grained sandstone bands, Ashfield Shale.	S	2.5–2.79		18,25/140 refusal bouncing		
	3.0m: grey-dark grey, with low strength bands.						
4.14		S	4.0–4.14		25/140 refusal bouncing		
	Bore discontinued at 4.14m TC bit refusal						

RIG: Bobcat **DRILLER:** JE **LOGGED:** RMM **CASING:** Uncased

TYPE OF BORING: Diatube to 0.12m, Solid Flight Auger (TC-bit) to 4.00m, SPT to 4.14m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 22.8 AHD
EASTING: 321922.5
NORTHING: 6250151.7
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 86967.00
DATE: 29/10/2019
SHEET 1 OF 1

Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
0.4	FILL/Silty SAND: fine to medium, dark brown, trace rootlets, moist.		A	0.1				
0.7	FILL/SAND: medium to coarse, dark brown-dark grey with fine to coarse igneous gravel, trace clay, moist.		A A	0.5 0.7				
1.0	CLAY CI: medium plasticity, pale grey, w<PL, very stiff to hard, residual, grading into weathered siltstone.							
1.4	SILTSTONE: dark grey-dark brown, very low to low strength, Ashfield Shale.		S	1.0 1.11		25/110 refusal bouncing		
	Bore discontinued at 1.4m TC bit refusal							

RIG: Bobcat **DRILLER:** JE **LOGGED:** RK **CASING:** Uncased
TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.40m
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Lawn covered at surface

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

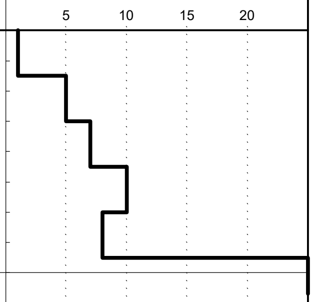
CLIENT: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 28.4 AHD
EASTING: 321907.4
NORTHING: 6250092.4
DIP/AZIMUTH: 90°/--

BORE No: BH8
PROJECT No: 86967.00
DATE: 25/10/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILL/Silty SAND: fine, brown, trace fine subangular igneous gravel and rootlets, dry to moist, apparently in a loose condition.		A	0.1			
28	0.15	FILL/Gravelly SAND: fine to medium, grey-brown, gravel is fine to medium, subangular, igneous, moist, apparently in a medium dense condition.		A	0.5			
	0.6	CLAY CI: medium plasticity, pale grey mottled orange-brown, with fine grained sand, w<PL, very stiff to hard, residual.		A	0.65			
	0.8	Bore discontinued at 0.8m Auger refusal						

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand Equipment **DRILLER:** RMM **LOGGED:** RMM **CASING:** Uncased
TYPE OF BORING: Hand auger to 0.8m
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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: St Patrick's College
PROJECT: Proposed Science & Learning Centre
LOCATION: Francis St, Strathfield

SURFACE LEVEL: 27.2 AHD
EASTING: 321954.7
NORTHING: 6250119.3
DIP/AZIMUTH: 90°/--

BORE No: BH9
PROJECT No: 86967.00
DATE: 25/10/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
27		FILL/Silty SAND: fine grained, dark brown-brown with rootlets, trace fine subangular igneous gravel and clay, dry to moist, apparently in a loose condition.		A	0.1				
	0.4	0.4m: fabric (possible geotextile)							
		FILL/CLAY: medium plasticity, brown, orange-brown, grey and red, trace fine to coarse sand, w~PL		A	0.6				
	0.8	CLAY CI-CH: medium to high plasticity, red and grey, w~PL, stiff, residual		A	1.0				
26	1.2	Bore discontinued at 1.2m Auger refusal							

RIG: Hand Equipment **DRILLER:** RMM **LOGGED:** RMM **CASING:** Uncased
TYPE OF BORING: Hand auger to 1.2m
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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
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Appendix D

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: lujia.wu@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Lujia Wu
soil technician
NATA Accredited Laboratory Number: 828

Report Number:	**86967.00-1**
Issue Number:	1
Date Issued:	12/11/2019
Client:	SDA Structures Pty Ltd
	Studio 2, 61 Victoria Road, Rozelle NSW 2039
Contact:	Andrew Simpson
Project Number:	86967.00
Project Name:	Proposed Science and Learing Centre
Project Location:	Francis Street, STRATHFIELD
Work Request:	5153
Sample Number:	SY-5153A
Date Sampled:	04/11/2019
Dates Tested:	04/11/2019 - 07/11/2019
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**BH1 (2.5-2.95m)**
Material:	CLAY: pale grey, with iron indurated bands

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	43		
Plastic Limit (%)	22		
Plasticity Index (%)	**21**		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
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Fax: (02) 9809 0666
Email: lujia.wu@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Lujia Wu
soil technician

NATA Accredited Laboratory Number: 828

Report Number: **86967.00-1**
Issue Number: 1
Date Issued: 12/11/2019
Client: SDA Structures Pty Ltd
Studio 2, 61 Victoria Road, Rozelle NSW 2039
Contact: Andrew Simpson
Project Number: 86967.00
Project Name: Proposed Science and Learing Centre
Project Location: Francis Street, STRATHFIELD
Work Request: 5153
Sample Number: SY-5153B
Date Sampled: 04/11/2019
Dates Tested: 04/11/2019 - 07/11/2019
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH4 (2.5-2.95m)**
Material: CLAY: pale grey mottled yellow-brown, with subangular ironstone gravel

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	42		
Plastic Limit (%)	21		
Plasticity Index (%)	**21**		

Material Test Report

Report Number: **86967.00-1**
Issue Number: 1
Date Issued: 12/11/2019
Client: SDA Structures Pty Ltd
Studio 2, 61 Victoria Road, Rozelle NSW 2039
Contact: Andrew Simpson
Project Number: 86967.00
Project Name: Proposed Science and Learing Centre
Project Location: Francis Street, STRATHFIELD
Work Request: 5153
Dates Tested: 04/11/2019 - 06/11/2019

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
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NATA
WORLD RECOGNISED ACCREDITATION

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Approved Signatory: Lujia Wu
soil technician
NATA Accredited Laboratory Number: 828

Moisture Content AS 1289 2.1.1

Sample Number	Sample Location	Moisture Content (%)	Material
SY-5153A	BH1 (2.5-2.95m)	20.8 %	CLAY: pale grey, with iron indurated bands
SY-5153B	BH4 (2.5-2.95m)	20.3 %	CLAY: pale grey mottled yellow-brown, with subangular ironstone gravel

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customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 230027

Client Details

Client	Douglas Partners Pty Ltd
Attention	Alexander Hanna
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86967.00, Strathfield**
Number of Samples	2 Soil
Date samples received	04/11/2019
Date completed instructions received	04/11/2019

Analysis Details

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

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

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

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

Report Details

Date results requested by	11/11/2019
Date of Issue	07/11/2019

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Results Approved By
Nick Sarlamis, Inorganics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

Soil Aggressivity			
Our Reference		230027-1	230027-2
Your Reference	UNITS	BH1	BH6
Depth		2.0	1.5-1.95
Date Sampled		24/10/2019	24/10/2019
Type of sample		Soil	Soil
pH 1:5 soil:water	pH Units	8.4	9.0
Electrical Conductivity 1:5 soil:water	µS/cm	230	79
Chloride, Cl 1:5 soil:water	mg/kg	<10	26
Sulphate, SO4 1:5 soil:water	mg/kg	150	<10

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Soil Aggressivity					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	99	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	120	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sam

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

Report Comments

pH has exceeded the recommended technical holding times, Envirolab Group form 347 "Recommended Preservation and Holding Times" can be provided on request (available on the Envirolab website)

Envirolab Services Pty Ltd
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customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 230434

Client Details

Client	Douglas Partners Pty Ltd
Attention	Alexander Hanna
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86967.00, Strathfield**
Number of Samples	1 Water
Date samples received	08/11/2019
Date completed instructions received	08/11/2019

Analysis Details

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

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

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

Report Details

Date results requested by	15/11/2019
Date of Issue	15/11/2019

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Results Approved By
Nick Sarlamis, Inorganics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

Miscellaneous Inorganics		
Our Reference		230434-1
Your Reference	UNITS	BH5
Date Sampled		07/11/2019
Type of sample		Water
Date prepared	-	08/11/2019
Date analysed	-	08/11/2019
pH	pH Units	7.6
Electrical Conductivity	µS/cm	2,700
Chloride, Cl	mg/L	380
Sulphate, SO4	mg/L	140
Resistivity in water	ohm m	3.8

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Miscellaneous Inorganics					Duplicate					Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			08/11/2019	[NT]	[NT]	[NT]	[NT]	08/11/2019	[NT]
Date analysed	-			08/11/2019	[NT]	[NT]	[NT]	[NT]	08/11/2019	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	102	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	82	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	81	[NT]
Resistivity in water	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sam

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

Samples received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.