Douglas Partners
Geotechnics / Environment / Groundwater

Report on
Geotechnical Investigation

Site 2 - Proposed Open Play Space
4 Vernon Street, Strathfield

Prepared for
Meriden School

Project 86568.02
May 2019

Integrated Practical Solutions

Document History

Document details

Project No.	86568.02	Document No.	R.003.Rev1
Document title	Report on Geotechnical Investigation Site 2 - Proposed Open Play Space		
Site address	4 Vernon Street, Strathfield		
Report prepared for	Meriden School		
File name	86568.02.R.003.Rev1.docx		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Shahin Falahati	Michael Thom	20 February 2019
Revision 1	Shahin Falahati	Scott Easton	29 May 2019

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Richard Arkell, Meriden School
Revision 1	1	0	Richard Arkell, Meriden School

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		29 May 2019
Reviewer		29 May 2019

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Report on Geotechnical Investigation
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1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed open play space area at 'Site 2', 4 Vernon Street, Strathfield (the site). The investigation was commissioned in an email dated 7 January 2019 by Mr Richard Arkell on behalf of Meriden School and was undertaken in accordance with Douglas Partners' proposal SYD181254.P.001.Rev0 dated 12 December 2018.

It is understood that the proposed development will include the demolition of existing structures and construction of an on-ground open space play area with a shade structure, seating stands and a new car port.

The investigation was carried out to provide information on the subsurface conditions for design and planning purposes.

The investigation included the drilling of four hand augered boreholes and dynamic cone penetration testing. Details of the field and laboratory testing are given in the report, together with comments on design and construction issues.

DP has also prepared a Preliminary Site Investigation for Contamination (PSI) report for the site. This geotechnical investigation report should be read in conjunction with the DP PSI report.

2. Site Description

The site is a rectangular-shaped area of about 470 m^2 with surface levels observed to be gradually dipping gently downwards to the west from Reduced Level (RL) 16.9 m Australian Height Datum (AHD) at the eastern site boundary to RL 16.0 m AHD at the western site boundary. At the time of DP's presence on site a single story brick building surrounded by grass covered areas, trees and pavements occupied the site. This building is understood to form part of the Meriden Junior School.

Based on a preliminary inspection:

- The external brickwork of the brick building appeared to be in a relatively good condition; and
- The pavements within the site appeared to be in a poor condition with sign of cracking / movement evident.

It was observed that the driveway between 2 and 4 Vernon Street is shared between the two properties.

The site is situated within an area developed for a variety of uses. A summary of the land uses adjacent to the location of the proposed building at the time of DP's presence on site is provided in Table 1.

Table 1: Summary of Adjacent Land use

Direction Relative to the Site	Land Use description
North	One-storey residential building at 2 Vernon St with on ground parking
East	Two-storey building which forms part of the Meriden Junior School
South	Two-storey building known as the “Blackman Auditorium” with on ground parking
West	Vernon Street followed by a one-storey residential buildings with on ground parking

3. Regional Geology

The Geological Survey of NSW 1:100,000 Series Sheet 9130 for Sydney indicates that the site is underlain by Ashfield Shale which typically comprises black to dark grey shale and laminite (interlaminated siltstones and sandstones).

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

4. Field Work Methods

The field work was carried out on the 17 January 2019 and comprised:

- On-site electronic scanning for buried services at proposed borehole locations;
- Drilling of four boreholes using a hand auger in grassed areas of the site around the existing structure. The boreholes were drilled to a refusal depth of about 1.0 m to 1.4 m on hard clay / ironstone bands;
- Dynamic cone penetrometer (DCP) test adjacent to each borehole location to depths of about 1.5 m or prior refusal to give an indication of the engineering properties of the soil and to infer the depth to top of rock;
- Collection of soil samples from the hand auger at regular depth intervals for identification, classification and laboratory purposes; and
- Observation for any signs of groundwater ingress within the boreholes during and shortly after drilling.

All boreholes were backfilled with drilling spoil, upon completion. The locations of the boreholes are shown in Drawing 1 in Appendix B. The test locations were measured from existing site features and levels were estimated using the supplied survey plan. East and northings provided on the borehole logs have been obtained from NSW government online mapping.

5. Field Work Results

The detailed borehole logs are included in Appendix C, together with notes defining classification methods and terms used to describe the soils and rocks.

5.1 Boreholes

Based on the results of the site investigation, the sequence of subsurface materials encountered at the site, in increasing depth order, is summarised in Table 2. Discussion on selection of 'Units' is provided in Section 7.

Table 2: Summary of the Subsurface Ground Profile

Unit	Material	Depth Range to Top of Unit (m)	RL Range to Top of Unit (m AHD)	Thickness (m)	General Description
1	Filling	0	16.8 to 15.8	0.2	Typically sandy silt filling with inclusion of rootlets and gravels.
2	Residual Soil	0.2	16.6 to 15.7	1.0 to 1.3	High plasticity, firm to stiff residual clays becoming very stiff and hard with depth.
3	EL-VL Shale	1.2 to 1.5	15.6 to 14.4	Not observed	Inferred to be extremely low to very low strength shale. The depth / RL to the top of this unit has been inferred from depth which DCP refusal occurred. It should be noted that refusal can also occur on ironstone bands which can be present in the Ashfield shale formation.

EL = Extremely Low Strength, VL = Very Low Strength

5.2 Groundwater

Groundwater ingress was not observed in the boreholes or prior to backfilling within three hour of completion of drilling. It should be noted that groundwater levels are transient and that fluctuations may occur in response to climatic and seasonal conditions.

6. Laboratory Testing

Laboratory testing was carried out on four soil samples to determine:

- Soil aggressivity for exposure classification of buried concrete and steel elements; and
- Atterberg Limits and Linear Shrinkage

The results of the geotechnical and chemical laboratory testing are presented in Table 3 and 4 respectively. The detailed laboratory test reports are given in Appendix D.

Table 3: Summary of Geotechnical Laboratory Test Results

BH ID	Depth	Material	Atterberg Limits (%)				Moisture Content (%)
			LL	PL	PI	LS	
BH3	0.4-0.5	Clay	73	28	45	16.5	34.5

Note: MC = Moisture Content, LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index, LS = Linear Shrinkage

The above results indicate that the residual clay is typically of highly plasticity and are likely to exhibit a high propensity for shrink-swell movements with change in moisture content (i.e. reactive).

Table 4: Summary of Chemical Laboratory Test Results

Borehole ID	Depth (m)	Conductivity (µS/cm)	pH	Cl (PPM)	SO_4 (PPM)
BH1	0.5	70	5.3	<10	57
BH3	0.2	51	6.2	<10	10
BH4	0.5	110	5.2	<10	170

Notes: Cl = Chloride ion concentration, SO_4 = Sulphate ion concentration, PPM = Parts Per Million

7. Geotechnical Model

For design purposes, the observed subsurface profile during the investigation has been grouped into three geotechnical units.

The interpreted depth and RLs at the top of the various units at each test location is shown in Table 5. Reference should be made to the borehole logs for more detailed information and descriptions of the soil profile.

It is expected that the regional groundwater table in the area would be relatively deep and within the underlying rock. Perched seepage flows will, however, occur along the soil and rock interface and may also occur within fractured zones and joints in the rock. Seepage flows are likely to increase following periods of extended wet weather.

Table 5: Summary of Geotechnical Model

Unit	Material	Depth [m] Reduced Level (m AHD) to Top of Each Unit			
		BH1	BH2	BH3	BH4
1	Filling	[0.0] (16.8)	[0.0] (15.9)	[0.0] (16.7)	[0.0] (16.8)
2	Residual Soil	[0.2] (16.6)	[0.2] (15.7)	[0.2] (16.5)	[0.2] (16.6)
3	EL-VL Shale	[1.5] (15.3)	[1.5] (14.4)	[1.2] (15.5)	[1.2] (15.6)

Notes: EL = Extremely Low Strength, VL = Very Low Strength
Depth / RL to top of Unit inferred from depth which DCP refusal occurred

8. Proposed Development

It is understood that the proposed development will include the demolition of existing structures and construction of an on-ground open space play area with a shade structure, seating stands and a new car port. Excavations are anticipated to extend to depths of no more than about 1 m below existing surface levels to allow for levelling works and construction of new footings, service trenches, etc.

9. Comments

9.1 Dilapidation Surveys

Dilapidation surveys should be carried out on adjacent / existing buildings, pavements and infrastructure that may be affected by the excavation works. The dilapidation surveys should be undertaken before the commencement of any excavation work in order to document any existing defects so that claims for damage due to construction related activities can be accurately assessed.

9.2 Excavations

9.2.1 Excavatability

It is understood that bulk excavations on the site will probably be less than 1 m deep so excavations will typically extend through filling and firm to very stiff residual clays. Extremely low to very low strength shale may be encountered in some parts of the site where excavations extend deeper than 1 m below existing surface levels

Excavation in filling, residual clays and extremely low to very low strength shale should be readily achievable using conventional earthmoving equipment such as excavators with bucket attachments. Some ripping may be required within iron indurated / ironstone bands.

9.2.2 Disposal of Excavated Material

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the Waste Classification Guidelines (EPA, 2014). This includes filling and natural materials that may be removed from the site. Reference should be made to the preliminary in-situ waste classification provided in the DP PSI report.

9.2.3 Groundwater

Groundwater was not observed in the boreholes during and shortly after drilling. Assuming excavations do not extend any deeper than about 1 m below existing surface levels, groundwater seepage is not expected to be encountered in the proposed excavations.

Should proposed excavations intersect the soil and rock interface, some seepage should be expected along the soil / rock interface, particularly following a period of heavy rainfall. This seepage is not expected to be associated with a regional groundwater table and will fluctuate with rainfall and climatic conditions. During construction, it is anticipated that any seepage into the excavations could be controlled by conventional 'sump-and-pump' methods.

9.3 Excavation Support

9.3.1 Batter Slopes

Temporary batters in the sandy silt filling should be cut at slopes of 1.5 Horizontal (H) to 1 Vertical (V) or flatter. Temporary batters in the residual soils and weathered rock should be cut at slopes of 1H to 1V or flatter. If steeper cuts are required in soil or weathered rock, then they must be supported by shoring at all times.

For permanent batters (if required) slopes of 2H to 1V or flatter are recommended, however such slopes need to be protected from erosion. If grassed slopes are proposed, slopes of 3H to 1V or flatter are recommended for ease of maintenance.

9.3.2 Retaining Walls

If any retaining walls are required for the development, then they may be designed based on the parameters provided in Table 6 and using a triangular earth pressure distribution.

Table 6: Retaining Wall Design Parameters

Unit	Material	Unit Weight (kN/m^3)	Active Earth Pressure Coefficient K_a	Passive Earth Pressure Coefficient K_p
1	Filling	20	0.4	-
2	Residual Soil	20	0.3	2.5
3	EL-VL Shale	24	0.3	400 kPa Ultimate Stress Block; or 200 kPa Allowable Stress Block

The values of Ka should generally be increased by 50% to reduce lateral (inward) wall deflections near sensitive, existing structures. Lateral pressures due to surcharge loads from sloping ground surfaces or nearby structures 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 wall.

Passive resistance provided by the upper 0.5 m of the material exposed at base of any excavation should be ignored in the wall design to allow for possible disturbances that may occur during construction and over-excavation. It is noted that significant wall movement is needed to mobilise full passive pressure in the residual soil and hence this should be allowed for in the design where relevant.

Where soil is backfilled immediately behind retaining walls, free-draining, granular material should be used and suitable drainage provided. Compaction of the soils should be undertaken using hand-operated or light weight equipment.

9.4 Site Classification

The laboratory tests on the residual soils indicate that they are of high plasticity and have a high potential for shrink / swell movements with changes in moisture content.

If the proposed buildings were to be constructed over filling thicker than 0.4 m, then the site would be classified as Class P when assessed in accordance with AS 2870 – 2011 Residential slabs and footings. However, where the filling is stripped during the bulk excavation then the site is classified as Class H1.

It is noted that abnormal moisture conditions could also exist after removal of trees, resulting in a more severe Class H2 or P site classification. Reference should be also be made to AS2870 for design, construction, performance criteria and maintenance precautions.

If existing trees are to be removed or if the site is to be filled with reactive clays (e.g. excavated from elsewhere on-site), the effect of the readjustment in soil moisture in the underlying clays should be carefully assessed. Should any large trees require removal, we recommend they be removed well in advance of construction to allow for readjustment of the moisture content of the highly reactive clay subsoil. Removal of any large trees should also include the removal of the tree stump and roots.

9.5 Subgrade Preparation and Engineered Filling

Site preparation will be required prior to construction of ground slabs and proposed pavements/ driveways. Earthworks recommendations provided in this report should be complemented by reference to AS 3798 – 2007 Guidelines on earthworks for commercial and residential developments.

The following methodology is suggested for subgrade preparation of pavements and on-grade slabs and for raising of site levels using engineered filling:

- Strip the filling down to the surface of the residual soils. This material can either be removed from site or retained for landscaping purposes as it is not suitable for engineered filling, due to the high silt and organic content.
- Proof rolling of the exposed (clay) subgrade should be carried out prior to placement of any filling or the construction of slabs. Proof rolling should comprise six passes of a smooth drum roller (say at least 10 tonne). The final pass should be carried out under the observation of a geotechnical engineer to identify any soft or saturated zones. Any such zones should be over-excavated to a maximum depth of 600 mm and replaced with compacted durable granular material.
- As the site is underlain by highly reactive clay, it is important to ensure that the clay soils do not become desiccated during earthworks. If this occurs, the clay subgrade must be watered gradually and rolled until the cracks disappear. If desiccation were to occur the soils may up after being covered by buildings and/ or floor slabs with consequent swelling and possible damage.
- If any filling is required to raise surface levels, it should be placed in layers not greater than 200 mm loose thickness and compacted to between 98% to 100% of Standard dry density, with moisture content within ±2% of the optimum moisture content.
- The natural residual soil and rock on the site is suitable for reuse as engineered filling provided it has a maximum particle size of 100 mm. Reuse should also consider the contamination status and is subject to approval by an environmental consultant.

9.6 Foundations

The design of foundations and slabs for structures on the site may be carried out in accordance with the recommendations given in AS 2870 – 2011 Residential slabs and footings.

It is recommended that all footings for the various structures be founded on material with similar strength (at each structure location) in order to provide uniform support and reduce the likelihood of differential settlements occurring. For design of shallow footings the allowable end bearing pressures provided in Table 7 may be used.

The designer should bear in mind that the rock was inferred to be present at relatively shallow depths in some parts of the site. Therefore, in order to achieve the minimum embedment depth for Class H1 site, the excavation for some of these footings may encounter bedrock.
As an alternative, proposed structures could be founded on bored piles taken down to rock. The parameters in Table 7 may be used for design of bored piles.

Table 7: Foundation Design Parameters for Footings

Unit	Foundation Stratum	Maximum Allowable Pressure (Serviceability)		Maximum Ultimate Pressure (Ultimate Limit State)		Young's Modulus, E (MPa)
		End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	
1	Filling	150	-	450	-	25
2	Residual Soil Firm to Stiff Clay	75	-	225	-	10
2	Residual Soil Very Stiff Clay or Stronger	150	-	450	-	30
3	EL-VL Shale	700	70	3,000	100	70

Piles proportioned on the basis of the above allowable shaft adhesion and end bearing pressures would be expected to experience total settlements of less than 1% of the minimum footing dimension under the applied working (i.e. serviceability) load, with differential settlements between adjacent columns expected to be less than half this value.

Footings designed using ultimate values and Limit State Design will need to consider serviceability which usually governs the design in this case. For pile design, a basic geotechnical strength reduction factor, Φ_{gb}, of about 0.48 (or possibly higher) calculated from Table 4.3.2 (A, B, and C) of AS2159-2009: Piling Design and Installation, is considered feasible. However, the structural engineer will need to make their own assessment with the final (Φ_{gb}) number being dependent on the design and installation method (and associated risk rating) adopted by the structural engineer. A Φ_{gb} of 0.4 is required if pile load testing is not carried out.

All footings should be inspected by a geotechnical engineer or engineering geologist prior to the placement of steel reinforcement and concrete.

9.7 Seismic Design

Based on the sub-surface conditions encountered at the boreholes, the site has been assessed in accordance with Section 4 of AS 1170.4 – 2007 (Structural Design Actions: Part 4 - Earthquake Actions in Australia) and has been assigned to the site sub-soil Class Ce (shallow soil).

9.8 Soil Aggressivity

In accordance with AS2159-2009, the results of the chemical laboratory testing indicate that the soils are mildly aggressive to buried concrete and non-aggressive to buried steel.

10. Further Geotechnical Input

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

- Dilapidation surveys.

During Construction

- Waste Classification of all material to be excavated and transported off site;
- Footing and pile inspections during construction; and
- Geotechnical engineer to observe proof rolling of the prepared sub-grade.

11. Conclusion

This report has discussed various geotechnical aspects of the proposed development and has outlined appropriate construction methods, monitoring requirements, and design parameters. Similar structures have been constructed in Sydney without significant impacts to surrounding properties. It is considered that the proposed structures could be designed and constructed without significant adverse impacts to surrounding properties.

12. Limitations

Douglas Partners (DP) has prepared this report for this project at ‘Site 2’, 4 Vernon Street, Strathfield in accordance with DP’s proposal SYD181254.P.001.Rev0 dated 12 December 2018 and acceptance received from Mr Richard Arkell on behalf of Meriden School dated 7 January 2019. The work was carried out under DP’s Conditions of Engagement. This report is provided for the exclusive use of Meriden School 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.
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 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. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

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.

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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

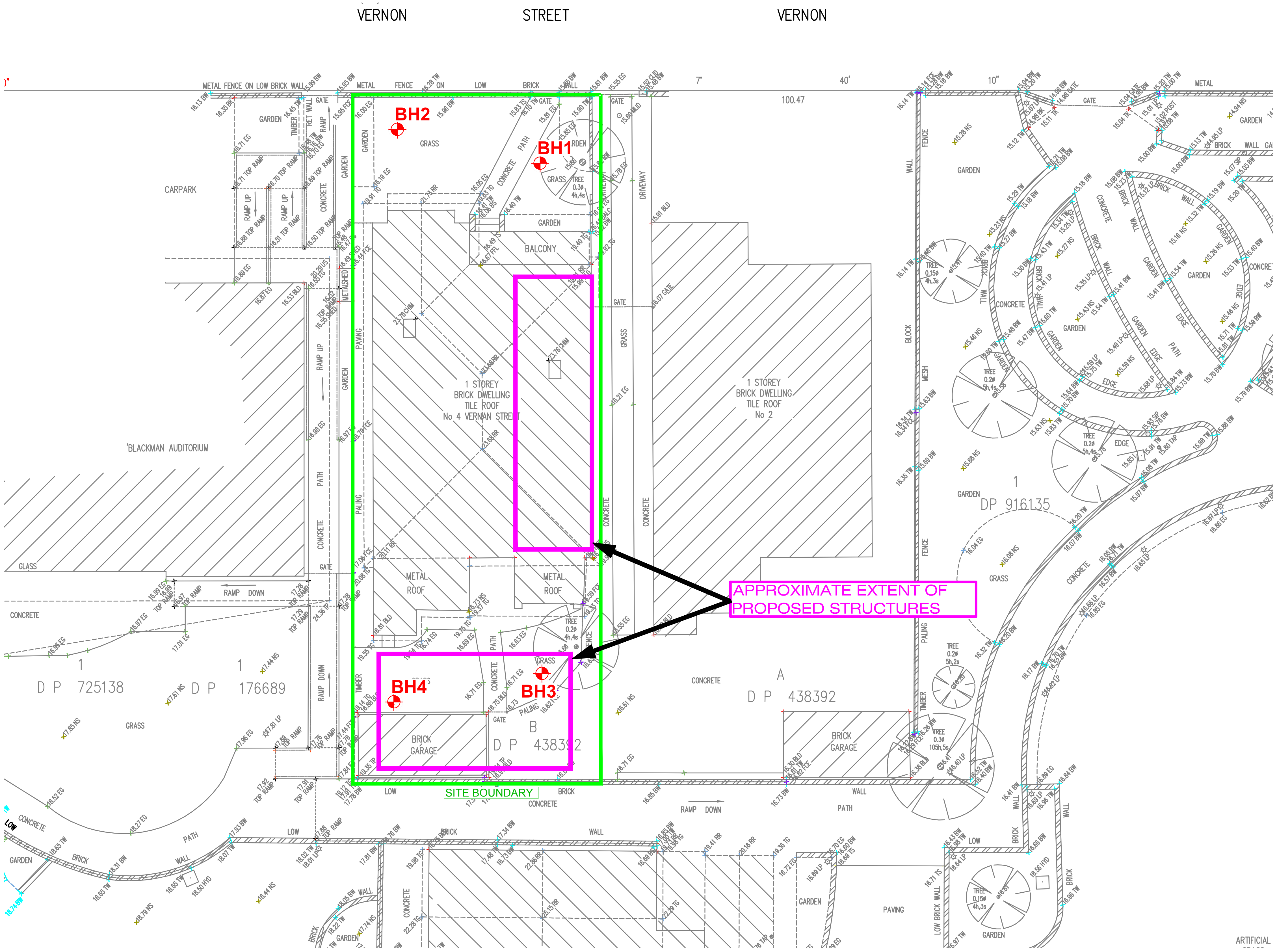
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

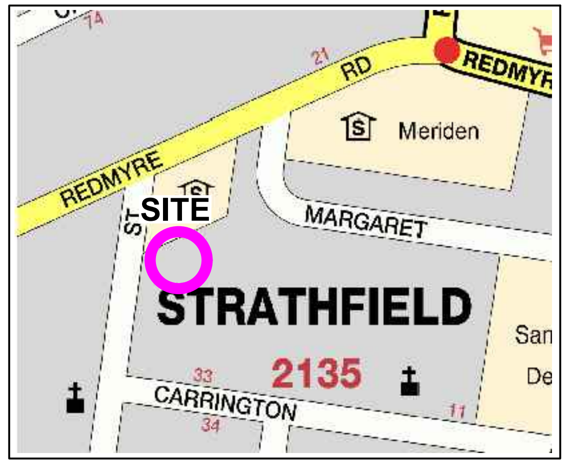
Site Inspection

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

Drawings





Locality Plan

0 1 2 3 4 6 8 10 15 20m

1:200 @ A3

NOTE:

1: Base drawing from Linker Surveying (Ref 161014, dated 1.11.2016)

2: Test locations are approximate only and are shown with reference to existing features.

LEGEND

Borehole location

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Meriden School		TITLE: **Site Plan**	PROJECT No: 86568.02
OFFICE: Sydney	DRAWN BY: PSCH	**Site 2 - Proposed Open Play Space**	DRAWING No: 1
SCALE: 1:200 @ A3	DATE: 17.1.2019	**4 Vernon Street, STRATHFIELD**	REVISION: 0

Appendix C

Field Work Results

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.

Symbols & Abbreviations

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Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
$\underline{\triangledown}$	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

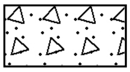
Symbols & Abbreviations

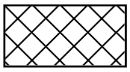
Graphic Symbols for Soil and Rock

General

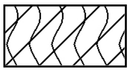
 Asphalt

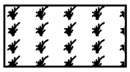
 Road base

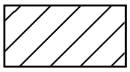
 Concrete

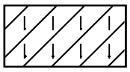
 Filling

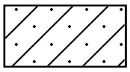
Soils

 Topsoil

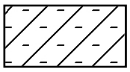
 Peat

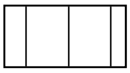
 Clay

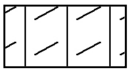
 Silty clay

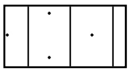
 Sandy clay

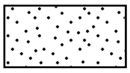
 Gravelly clay

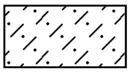
 Shaly clay

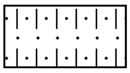
 Silt

 Clayey silt

 Sandy silt

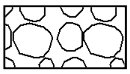
 Sand

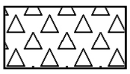
 Clayey sand

 Silty sand

 Gravel

 Sandy gravel

 Cobbles, boulders

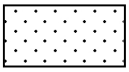
 Talus

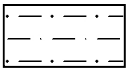
Sedimentary Rocks

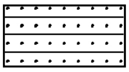
 Boulder conglomerate

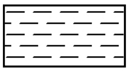
 Conglomerate

 Conglomeratic sandstone

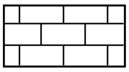
 Sandstone

 Siltstone

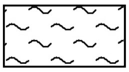
 Laminite

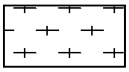
 Mudstone, claystone, shale

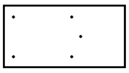
 Coal

 Limestone

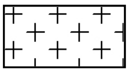
Metamorphic Rocks

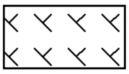
 Slate, phyllite, schist

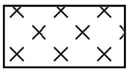
 Gneiss

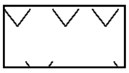
 Quartzite

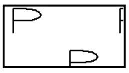
Igneous Rocks

 Granite

 Dolerite, basalt, andesite

 Dacite, epidote

 Tuff, breccia

 Porphyry

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.

BOREHOLE LOG

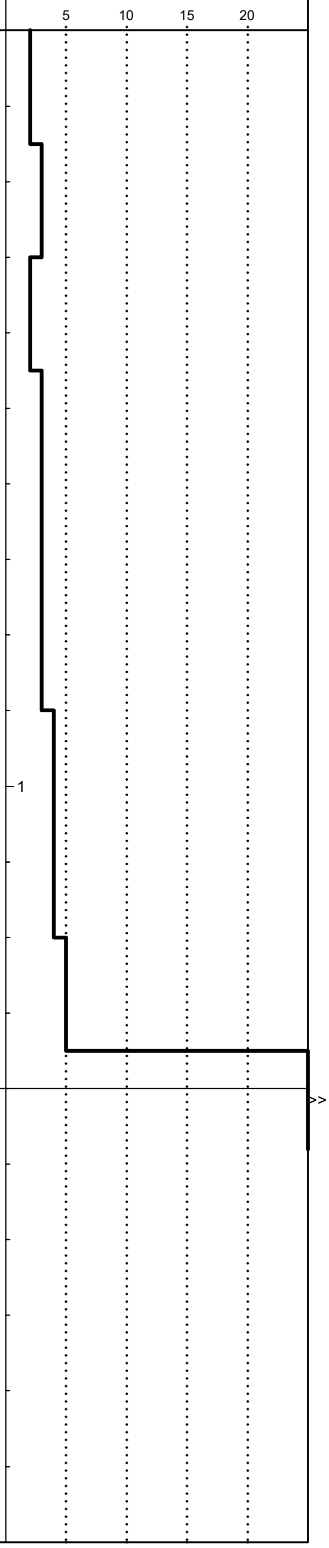
CLIENT: Meriden School
PROJECT: Site 2 - Proposed Open Play Space
LOCATION: 4 Vernon Street, Strathfield

SURFACE LEVEL: 15.8 AHD
EASTING: 323302
NORTHING: 6250096
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 86568.02
DATE: 17-1-2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING (Topsoil): dark grey, sandy silt topsoil with trace of rootlets and gravels	A/E	0.1–0.2			
	0.2	CLAY: firm, red brown to brown clay with trace of silt, damp	A/E	0.4–0.5			
15	0.8	CLAY: stiff, pale grey and pale brown clay with trace of ironstone bands, moist below 1.35 m: becoming hard	A/E	0.9–1.0			
	1.4	Bore discontinued at 1.4m Hand auger refusal on ironstone bands					
14							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand Tools **DRILLER:** AT **LOGGED:** AT **CASING:** Uncased
TYPE OF BORING: Hand auger to 1.5m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Borehole backfilled with drilling spoil

☐ 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

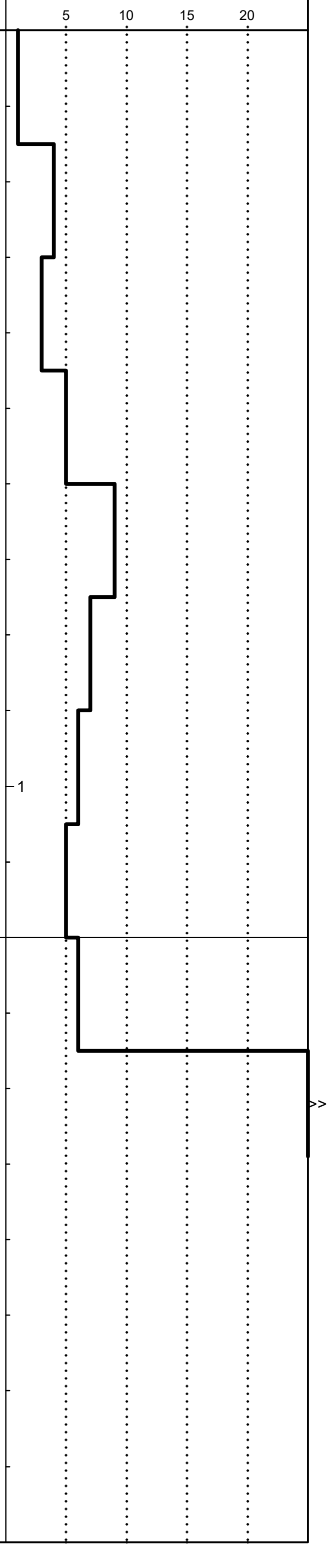
CLIENT: Meriden School
PROJECT: Site 2 - Proposed Open Play Space
LOCATION: 4 Vernon Street, Strathfield

SURFACE LEVEL: 15.9 AHD
EASTING: 323300
NORTHING: 6250089
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 86568.02
DATE: 17-1-2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING (Topsoil): dark grey, sandy silt topsoil with trace of rootlets and gravels		A/E	0.1–0.2			
	0.2	CLAY: stiff, red brown to brown clay with trace of silt, damp		A/E*	0.4–0.5			
		below 0.6 m: becoming very stiff						
15	0.7	CLAY: stiff to very stiff, pale grey and pale brown clay with trace of ironstone bands, moist		A/E	0.9–1.0			
	1.2	Bore discontinued at 1.2m Hand auger refusal on ironstone bands						
14								

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand Tools **DRILLER:** AT **LOGGED:** AT **CASING:** Uncased
TYPE OF BORING: Hand auger to 1.2m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: *BD1/170119, Borehole backfilled with drilling spoil

☐ 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

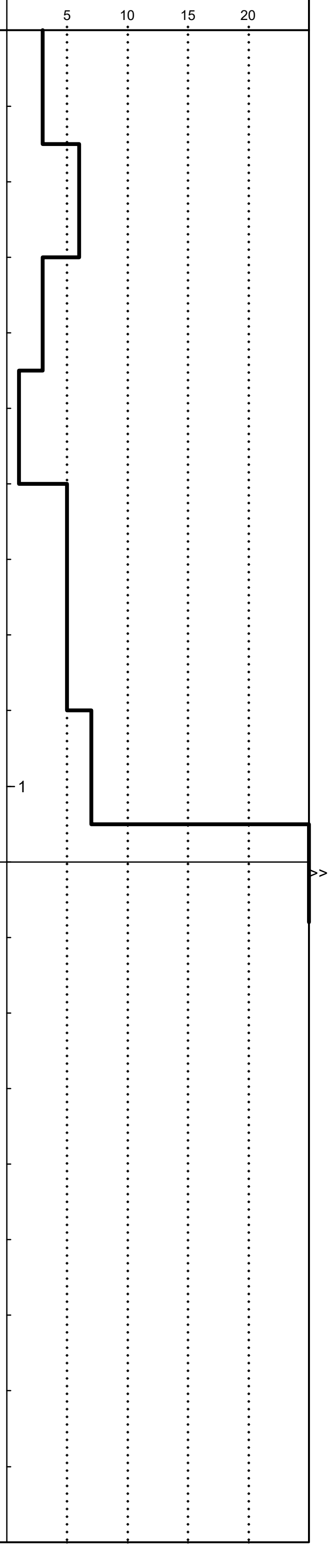
CLIENT: Meriden School
PROJECT: Site 2 - Proposed Open Play Space
LOCATION: 4 Vernon Street, Strathfield

SURFACE LEVEL: 16.7 AHD
EASTING: 323326
NORTHING: 6250091
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 86568.02
DATE: 17-1-2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING (Topsoil): dark grey, sandy silt topsoil with trace of rootlets and gravels		A/E	0.1 – 0.2			
	0.2	CLAY: firm, red brown to brown clay with trace of silt, damp below 0.45 m: becoming soft		A/E*	0.4 – 0.5			
16	0.6	CLAY: stiff, pale grey and pale brown clay with trace of ironstone bands, moist below: 1.05 m: becoming hard		A/E	0.9 – 1.0			
	1.1	Bore discontinued at 1.1m Hand auger refusal on ironstone bands						
15								

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand Tools **DRILLER:** AT **LOGGED:** AT **CASING:** Uncased

TYPE OF BORING: Hand auger to 1.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *BD2/170119, Borehole backfilled with drilling spoil

☐ 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)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

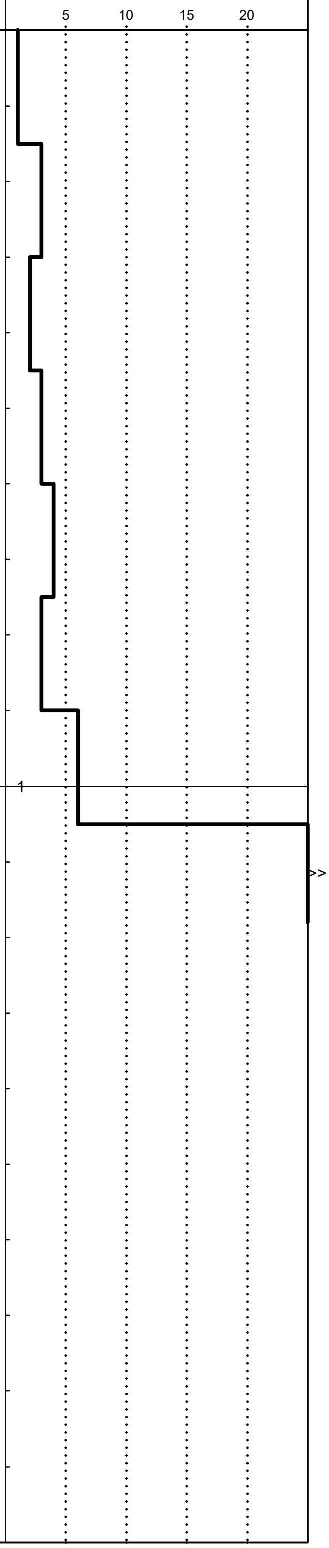
CLIENT: Meriden School
PROJECT: Site 2 - Proposed Open Play Space
LOCATION: 4 Vernon Street, Strathfield

SURFACE LEVEL: 16.8 AHD
EASTING: 323326
NORTHING: 6250085
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 86568.02
DATE: 17-1-2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING (Topsoil): dark grey, sandy silt topsoil with trace of rootlets, gravels and possible ash	A/E	0.1–0.2			
	0.2	CLAY: firm to stiff, red brown to brown clay with trace of silt, damp	A/E	0.4–0.5			
16	0.7	CLAY: stiff to very stiff, pale grey and pale brown clay with trace of ironstone bands, moist	A/E	0.9–1.0			
15	1 1.0	Bore discontinued at 1.0m Hand auger refusal on ironstone bands					

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand Tools **DRILLER:** AT **LOGGED:** AT **CASING:** Uncased
TYPE OF BORING: Hand auger to 1.0m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Borehole backfilled with drilling spoil

☐ 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

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West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Results of Dynamic Penetrometer Tests

Client	Meriden School	**Project No.**	86568.02
Project	Site 2 – Meriden Junior School, 4 Vernon Street	**Date**	17/01/19
Location	4 Vernon St, Strathfield	**Page No.**	1 of 1

Test Locations	BH1	BH2	BH3	BH4						
RL of Test (AHD)	15.8	15.9	16.7	16.8						
Depth (m)	**Penetration Resistance** Blows/150 mm									
0.00 – 0.15	2	1	3	1						
0.15 – 0.30	3	4	6	3						
0.30 – 0.45	2	3	3	2						
0.45 – 0.60	3	5	1	3						
0.60 – 0.75	3	9	5	4						
0.75 – 0.90	3	7	5	3						
0.90 – 1.05	4	6	7	6						
1.05 – 1.20	4	5	30/130	30/150						
1.20 – 1.35	5	6	Ref	Ref						
1.35 – 1.50	30/130	30/140								
1.50 – 1.65	Ref	Ref								
1.65 – 1.80										
1.80 – 1.95										
1.95 – 2.10										
2.10 – 2.25										
2.25 – 2.40										
2.40 – 2.55										
2.55 – 2.70										
2.70 – 2.85										
2.85 – 3.00										
3.00 – 3.15										
3.15 – 3.30										
3.30 – 3.45										
3.45 – 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑
AS 1289.6.3.3, Sand Penetrometer ☐

Tested By AT
Checked By SF

Remarks Ref = Refusal, 30/130 indicates 30 blows for 130 mm penetration

Appendix D

Laboratory Test Results

Material Test Report

Report Number:	**86568.02-1**
Issue Number:	1
Date Issued:	25/01/2019
Client:	Meriden School
	10-12 Redmyre Rd, Strathfield NSW 2135
Contact:	Richard Arkell
Project Number:	86568.02
Project Name:	Meriden School
Project Location:	Margaret Street, Strathfield
Work Request:	4006
Sample Number:	19-4006A
Date Sampled:	17/01/2019
Sampling Method:	Sampled by Engineering Department
Sample Location:	**BH3 (0.4 - 0.5m)**
Material:	CLAY: red-brown to brown clay with traces of silt

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: mick.gref@douglaspartners.com.au

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NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Mick Gref
Senior Technician
NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	73		
Plastic Limit (%)	28		
Plasticity Index (%)	**45**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	16.5		
Cracking Crumbling Curling	Curling		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	34.5

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CERTIFICATE OF ANALYSIS 209793

Client Details

Client	Douglas Partners Pty Ltd
Attention	Shahin Falahati
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86568.02, Site 2-Meriden Junior School**
Number of Samples	3 Soil
Date samples received	18/01/2019
Date completed instructions received	18/01/2019

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	25/01/2019
Date of Issue	24/01/2019

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Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

Misc Inorg - Soil				
Our Reference		209793-1	209793-2	209793-3
Your Reference	UNITS	BH1	BH3	BH4
Depth		0.5m	0.2m	0.5m
Date Sampled		17/01/2019	17/01/2019	17/01/2019
Type of sample		Soil	Soil	Soil
Date prepared	-	21/01/2019	21/01/2019	21/01/2019
Date analysed	-	21/01/2019	21/01/2019	21/01/2019
pH 1:5 soil:water	pH Units	5.3	6.2	5.2
Electrical Conductivity 1:5 soil:water	µS/cm	70	51	110
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	57	10	170

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. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			21/01/2019	[NT]	[NT]	[NT]	[NT]	21/01/2019	[NT]
Date analysed	-			21/01/2019	[NT]	[NT]	[NT]	[NT]	21/01/2019	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	103	[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]	89	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	89	[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; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.