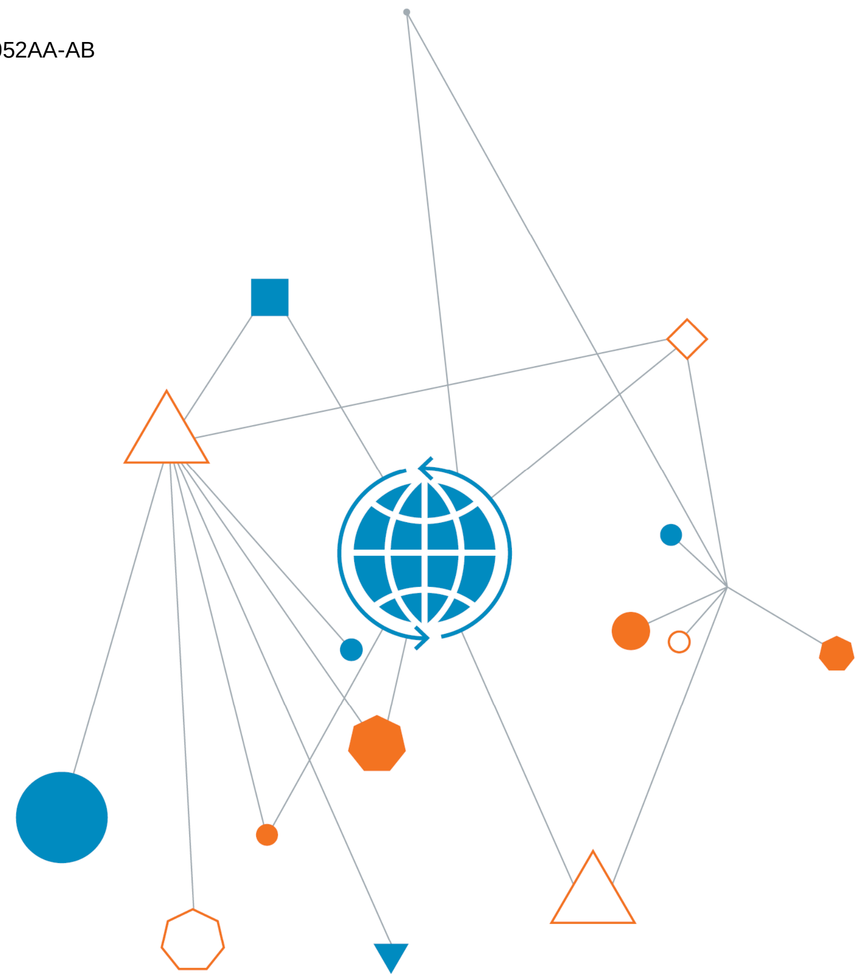
coffey

MLC School Burwood

Geotechnical Investigation - Proposed MLC School Redevelopment, Burwood, NSW 2134

GEOTLCOV25052AA-AB
26 June 2014



When you
think with a
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problems
get smaller

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MLC School Burwood
Rowley Street, Burwood
NSW 2134

GEOTLCOV25052AA-AB

25 June 2014

Attention: Greg McGirr

Dear Greg,

Geotechnical Investigation – Proposed MLC School Redevelopment, Burwood, NSW 2134

Coffey Geotechnics Pty Ltd (Coffey) is pleased to present the results of a geotechnical investigation carried out for the proposed MLC School Redevelopment in Burwood, NSW.

Please contact the undersigned should you have any questions regarding this report.

For and on behalf of Coffey

Delfa Sarabia

Senior Geotechnical Engineer

Distribution: Original held by Coffey Geotechnics Pty Ltd

1 electronic copy to MLC School Burwood

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1. Introduction

This report presents the results of a geotechnical investigation carried out by Coffey Geotechnics Pty Ltd (Coffey) for the proposed MLC School Redevelopment at Rowley Street in Burwood, NSW. The investigation was commissioned by Greg McGirr of MLC School Burwood and was carried out in general accordance with our proposal GEOTLCOV25052AA-AA, dated 7 February 2014.

The objective of the geotechnical investigation was to provide geotechnical information on ground conditions for the design of the building foundations, pavements and other associated structures.

1.1. Proposed Development

Based on architectural drawings provided to Coffey by Taylor Thomson Whitting, the proposed development will comprise the construction of a new three storey building with a one level basement in the north east part of the development footprint with excavations of up to 3m depth required for the basement. There is also a proposed addition of a second storey to the single level building in the north west part of the site including the construction of new pavements.

2. Method of Investigation

2.1. Fieldwork

Fieldwork for the geotechnical investigation was carried out on 7 and 8 June 2014 and comprised the drilling of six boreholes (BH1 to BH6). BH1, BH2 and BH5 were drilled to top of rock about 1.3m to 1.5m below the ground surface, and then extended until tungsten carbide (TC–bit) refusal to depths ranging between 4.0m to 4.3m below the ground surface. BH3 and BH4 were cored into rock and terminated at depths of 8.0m and 8.1m respectively. BH6 was a hand augered borehole and terminated at refusal at a depth of 1.7m below ground surface. The borehole locations were recorded using tape measurements from existing site features. Figure 1 shows the borehole locations.

The boreholes were drilled using a track mounted drilling rig and were advanced in soils using solid flight augers with a Tungsten Carbide (TC) drill bit and HQ drilling in rock. Standard Penetration Test was carried out during auger drilling at selected intervals to assess soil strength and obtain soil samples. Disturbed samples were collected from BH1 BH4, BH5 and BH6.

On completion, all boreholes were backfilled with cuttings. Fieldwork was supervised by a Coffey Geotechnical Engineer who was present throughout the drilling operations to undertake sampling and testing, record test results, and log materials encountered.

2.2. Laboratory Testing

The following laboratory tests were carried out on selected soil and rock samples:

- Four Moisture Content tests;
- One Atterberg Limits and Linear Shrinkage test; and
- One 4 day soaked CBR and one Standard Compaction Test.

3. Results of the Investigation

3.1. Site Description

The school is located at 45 Park Road in Burwood, NSW. It is bounded by Grantham Street to the west, Rowlet Street to the south and Park Road to the east. The proposed development is limited to the northern part of the site as shown in Figure 1.

There are currently two residential buildings and three school buildings of one to three levels within the development footprint.

3.2. Regional Geology

The Sydney 1:100,000 Geological Sheet indicates that the site is underlain by Ashfield Shale of the Wainamatta Group. Ashfield Shale is described as dark grey to black shale and laminite.

3.3. Subsurface Conditions

The engineering borehole logs and photos of the material encountered are presented in Appendix A, together with Coffey soil and rock explanation sheets which describe the terms and symbols used in log preparation. The engineering borehole logs which were extracted from a geotechnical report prepared by Jeffrey & Katauskas provided to Coffey by TTW are presented as Appendix C. The subsurface conditions have been inferred from the latest geotechnical investigation carried out by Coffey and the previous investigation by Jeffrey and Katauskas.

The subsurface conditions encountered at the site were relatively consistent, and typically comprised gravelly sand to silty sand or gravelly clay to silty clay till overlying residual silty clay which is underlain by extremely weathered, very low strength shale. At depths of approximately 1.1m to 1.5m across the site, low strength shale is typically encountered. The thickest fill layer was encountered in BH2 comprising 1.2m of gravelly clay underlain by 0.2m of gravelly sand.

No information is available on the existing fill and therefore is considered to be uncontrolled fill unless information on fill history and certificates can be provided by the Client.

Table 1 presents a summary of the inferred geotechnical model of the encountered ground conditions.

Table 1: Inferred Geotechnical Model

Unit	Material/Origin	Description	Range of Approximate Unit Thickness[b] (m)	Approximate Depth to Top of Unit[b] (m)
1	Fill	Gravelly sand to silty sand / gravelly clay to silty clay	0.1-1.4	0
2	Residual Soil	Silty Clay: high plasticity, orange to yellow brown, very stiff to hard	0.8–1.7	0.1-1.4
3a	Bedrock	Class V Shale[a] – Extremely weathered, very low strength	1.0-3.0	1.1-2.2
3b	Bedrock	Class IV or better Shale[a] [c] – Extremely weathered to highly weathered, estimated low to medium strength	Not Encountered	>2.6

Notes: (a) Rock classified as shale in accordance with Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl, Dec 1998.

(b) The depth/RL and layer thicknesses provided above are based on conditions observed at the borehole locations and may not be representative of all areas of the site.

(c) Class III shale was encountered in BH4 at 6.5m.

3.4. Groundwater

Groundwater was not encountered during augering in soil and weathered rock to a maximum depth of 4.3m. In deeper boreholes (BH3 and BH4), water was used as drilling fluid while coring the rock which precluded observation of the water table.

3.5. Laboratory Testing Results

3.5.1. Geotechnical Testing

Appendix B contains laboratory soil test certificates.

The laboratory results indicate that the Unit 2 Residual Soil has Moisture Contents ranging from 18.3% to 32.8% (averaging 26.2%).A sample from Unit 2 Residual Soil comprising Silty Clay has a Liquid Limit of 79%, a Plasticity Index of 52%, and a Linear Shrinkage of 18% (BH4, 0.3m-0.5m).

The result of one soaked CBR test on Unit 2 Residual Soil comprising Silty Clay indicates a value of 2% (BH4, 0.3–0.5m).

3.5.2. Soil Aggressivity Tests

Soil samples obtained from BH1 and BH4 were subjected to soil aggressivity tests comprising chloride, pH and sulphate. The soil aggressivity test results were assessed in accordance with Australian Standard AS2159-2009 Piling – "Design and Installation". Chemical test results indicate non-aggressive conditions to concrete and steel elements.

The Prospect/Parramatta River Acid Sulfate Soil Risk Map indicates that the site is within the area of no known occurrence of acid sulfate soils.

4. Discussion and Recommendations

4.1. Excavation Conditions

Based on proposed localised excavations for the facility of no greater than 3 m below the ground surface at the north-east part of the development, excavations will penetrate through Unit 1 Fill, Unit 2 Residual Soil and Unit 3a Bedrock. It is expected that the upper soils and very low strength bedrock could be readily excavated using conventional earthmoving plant such as a large excavator with a tooth bucket.

Groundwater was not observed above the proposed excavation depth of 3m. Groundwater levels may change over time and also occur as perched water within the soil profiles following rainfall events. However, based on our experience in similar projects, it is expected that seepage into excavation should be controllable by pumping from sumps.

4.2. Earthworks

Where filling is required to raise site levels and support floor slabs for building loading or pavements we recommend that engineered fill be used. The subgrade for engineered fill should be prepared by stripping topsoil, existing fill and unsuitable materials, and benching the ground surface so that fill can be placed in near horizontal layers.

Each bench should be proof rolled with 4 passes of smooth single-drum, non-vibratory roller of minimum weight 12 tonnes. An experienced earthworks practitioner should observe the proof rolling to detect soft, wet or heaving zones. Where such zones are encountered the affected area should be improved by appropriate methods. These methods may include:

- Excavation of the affected soil and replacement with non-reactive Engineered Fill;
- Tyning and moisture conditioning of the in-situ material and compaction to achieve the criteria below for Engineered Fill.

Engineered fill required to support structures or pavements should be compacted to at least 98% Standard Maximum Dry Density (SMDD). Engineered Fill should be spread in layers not exceeding 300mm loose thickness and moisture conditioned to Standard Optimum Moisture Content (SOMC) ±2% then compacted without delay with appropriate compaction plant.

Fill within 0.3 m depth of floor slab/pavement subgrade level should be compacted to at least 100% SMDD.

Preparation for, and construction of Engineered Fill should be carried out under Level 1 Geotechnical Inspection and Testing as defined in Section 8.2 of *AS 3798 – 2007 Guidelines on earthworks for commercial and residential developments.*

From a geotechnical viewpoint, the Unit 1, Unit2 and Unit 3 materials are expected to be suitable for re-use as Engineered Fill, provided unsuitable materials such as organics, waste or oversized particles are removed and strict moisture control is adopted.

4.3. Excavation Support

4.3.1. Unsupported Cut and Fill Batters

Table 2 below presents our recommended temporary and permanent batters for cuts up to 4m in height and above the groundwater table. Temporary batter recommendations are those for construction purposes, which are expected to be in place for up to three months.

Table 2 – Recommended Unsupported Maximum Batters

Material	Temporary Batter	Permanent Batter
Uncontrolled Fill / Topsoil (Unit 1) [1]	1.5(H):1(V)	3(H):1(V)
Engineered Fill [1]	1(H):1(V)	2(H):1(V)
Cut in Residual Soil (Unit 2) and Class V Shale (Unit 3a) [1] (very low strength rock)	1(H):1(V)	2(H):1(V)
Cut in Class IV Shale (Unit 3b) [1] (low strength or better rock)	1(H):1(V)	1.5(H):1(V)

Notes: 1. Protection against erosion may be required.

The recommended maximum batters given above are based on there being no structures or surcharge located at or near the crest of the cuts. Should steeper slopes be required in the fill, soil and weathered rock materials, these materials would need to be retained by engineer designed retaining structures.

Surface drainage is also to be diverted away from the excavation. It is recommended that all batter slopes be inspected by a Geotechnical Engineer. Heavy machinery is also to be kept at least 3m away from the top of the batters.

4.3.2. Excavation Retaining Wall

Where there is insufficient room to form temporary batters, then a retention system will be required which could be incorporated into the permanent structure.

Common support systems used for soil and shale bedrock profiles in Sydney include:

- Soldier pile walls with infill panels (usually shotcrete or precast concrete panels)
- Contiguous piled walls.

Retaining walls/pile elements will have to be specifically sized and designed to support any adjacent structures or surcharge loads that lie within the excavation zone of influence. For preliminary design, the zone of influence can be estimated by drawing a line at approximately 2H:1V from the base of the excavation to the ground surface behind the excavated face.

Depending on the stiffness requirements of the shoring and need to limit ground deformations behind the shoring wall, shoring systems could be cantilevered, internally braced or anchored.

The proposed excavation will induce ground movements due to removal of lateral support. Within the retained profile, the magnitude of adjacent ground movements will depend on the ground conditions, design lateral pressure, shoring system adopted, construction sequence and workmanship. Documented data has shown that for well-constructed shoring, vertical and lateral movements may be in the order of 0.1% to 0.3% of the retained height. If this aspect is critical, further geotechnical analysis should be carried out to assess likely ground movements when designing the shoring system.

Table 3 provides parameters for retaining wall design.

Table 3: Earth Pressure Coefficients for Retaining Wall Design

Geotechnical Unit	Bulk Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle	Active Earth Pressure Coefficient (K_a)	At Rest Earth Pressure Coefficient (K_0)	Passive Earth Pressure Coefficient (K_p)
Unit 1 Fill	20	0	25	0.4	0.5	2.5
Unit 2 Residual Soil	20	5	25	0.4	0.5	2.5
Unit 3a Class V Shale	23	10	25	0.4	0.5	2.5
Unit 3b Class IV Shale	23	20	30	0.4	0.5	2.5

Note: K and K_p values apply for a horizontal ground surface behind the retaining structure.

Retaining structures should also be designed to support full hydrostatic water pressures unless effective drainage is provided behind the retaining structures.

If temporary rock anchors are required they should be designed for an allowable (working) bond stress of 150 kPa into the Unit 3b Shale provided that bond lengths are between 3 m and 7 m and anchors are to be proof loaded to at least 1.4 times their design working load. Anchor designs should be based on allowing effective bonding to be developed behind the ‘active zone’ which is determined by drawing a line at 45^o from the base of the retaining wall intersecting the ground surface behind the excavated face.

4.4. Potential Impacts on Adjacent Structures and Existing Services

If excavations are to be located within 12m of existing structures, and assuming excavation depths of between 3m to 4m, then the location, footing type, layout and founding depth of house and nature and depth of any sensitive buried services within the potential zone of influence of the excavation should be determined before excavation commences. Where adjacent structures and services are located within the zone of influence, the ground may experience horizontal and vertical movements from excavation induced ground movements. The resulting potential impacts on such structures and services should be assessed as part of excavation retention design.

4.5. Foundations

It is expected that bulk excavations, will expose mostly Unit 3b Shale across the site.

We recommend that the new building be supported uniformly on pad, strip footings or short pile footings founded on Unit 3a Class V Shale (at depths typically 1.5 m below present ground surface levels). Where bulk excavation is not envisaged, footings will need to be extended to either the underlying Unit 3a Class V Shale or Unit 3b Class IV Shale using piles or be structurally separate from those parts of the building that are founded on rock to accommodate the potential for differential settlements between differing foundation stratum. Allowable geotechnical design parameters for shallow footings (strip or pad footings) and Limit State geotechnical design parameters for piles are provided in Table 4 below.

Table 4: Recommended Pad/Strip Footing Design Parameters

Geotechnical Unit	Allowable End Bearing Pressure [(a)] (kPa)	Ultimate End Bearing Pressure [(a)] (kPa)	Ultimate shaft Adhesion [(b,c)] (kPa)	Modulus (MPa)
Unit 3a – Class V Shale (extremely low strength shale)	700	2,000	50	50
Unit 3b – Class IV Shale (low strength shale)	1,000	3,000	150	250

Notes:

a) Assumes a minimum embedment of at least 0.3m into the relevant bearing stratum. Where allowable end bearing is used for the design, settlement of the footing is expected to be less that 1% of footing width.

b) Assumes a minimum embedment of at least 2 pile diameters into the relevant bearing stratum.

c) Shaft adhesion should be ignored for strip or pad footings.

For Limit State pile design the geotechnical strength reduction factor, ϕ_g, should be calculated in accordance with AS2159-2011. The ϕ_g value will depend on risk factors as defined in AS2159 that Coffey is not presently able to anticipate and this would normally be chosen by the pile designer. The lowest value of ϕ_g provided by AS2159 is 0.4 and this could be adopted for preliminary design. Coffey would be pleased to assist the designer with the necessary risk assessment that may provide a higher ϕ_g and more economical design.

For uplift loads a further reduction factor of 0.7 should be applied to the shaft adhesion in addition to the geotechnical strength reduction factor.

Serviceability should be assessed using the modulus values in Table 4 to check that settlements are within tolerable limits.

For construction we recommend that footing excavations should be inspected by a geotechnical engineer to verify that rock quality is consistent with design assumptions.

4.6. Seismic Design Parameters

Based on AS 1170.4 – 2007, the Earthquake Hazard Factor, Z, for the Sydney region is 0.08. The site is generally classified as Sub-Soil Class B_e – Rock (based on the proposed excavation extending into or near to the rock surface).

The Earthquake Design Category could then be assessed based on a Probability Factor, k_p, (which is related to an Annual Probability of being Exceeded) as defined in Table 3.1 of AS 1170.4 – 2007.

4.7. Pavement Design Parameters

CBR testing of soil sample collected from Unit 2 Residual Soil in BH4 (0.3 – 0.5 m) indicated soaked CBR value of 2% indicating poor pavement subgrade conditions. Where a CBR value of less than 3% is determined for a pavement subgrade, we recommend improvement by subgrade modification or replacement. Modification of the upper 300mm of the pavement subgrade by the addition of 2% modifying agent such as cement or lime would allow an overall subgrade design CBR of 3% to be adopted. If insitu treatment by ripping and mixing is adopted, it will be necessary to apply more than 2% of the modifying agent (say 4% to 6%) to achieve an average of 2% within the modified material. Trials may be necessary to assess the efficacy of the treatment process.

Satisfactory performance of pavements will require careful attention to surface and subsurface drainage to prevent the subgrade soil from wetting up. Site landscaping should be designed to prevent the ponding of water adjacent to pavements and also structures. Sub-surface drainage should be provided.

5. Limitations

Subsurface conditions can be complex, vary over relatively short distances and over time. The inferred geotechnical model and recommendations in this report are based on limited subsurface investigations at discrete locations. The engineering logs describe subsurface conditions only at the investigation locations.

Additional investigations may be required to support detailed design due to factors such as scope limitations and changes to the nature of the project. Coffey should be engaged to assist with detailed design and/or to review designs. During construction Coffey should verify that conditions exposed are consistent with design assumptions.

Site contamination has not been assessed as part of the geotechnical investigation. Coffey would be pleased to assist with contamination assessment, if required.

The attached document entitled “Important Information about Your Coffey Report” forms an integral part of this report and presents additional information about the uses and limitations of the report.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures

LEGEND

- COFFEY BOREHOLE LOCATION
- EXISTING BOREHOLE LOCATION (J & K)
- APPROXIMATE SCHOOL BOUNDARY
- PROPOSED DEVELOPMENT FOOTPRINT

N

10 0 10 30 50

Scale (metres) 1:1000

AERIAL IMAGE SOURCE: GOOGLE EARTH PRO 6.0.2

AERIAL IMAGE ©: SINCLAIR KNIGHT MERZ 2014

drawn	CL / LH
approved	SP
date	25 / 06 / 14
scale	AS SHOWN
original size	A4

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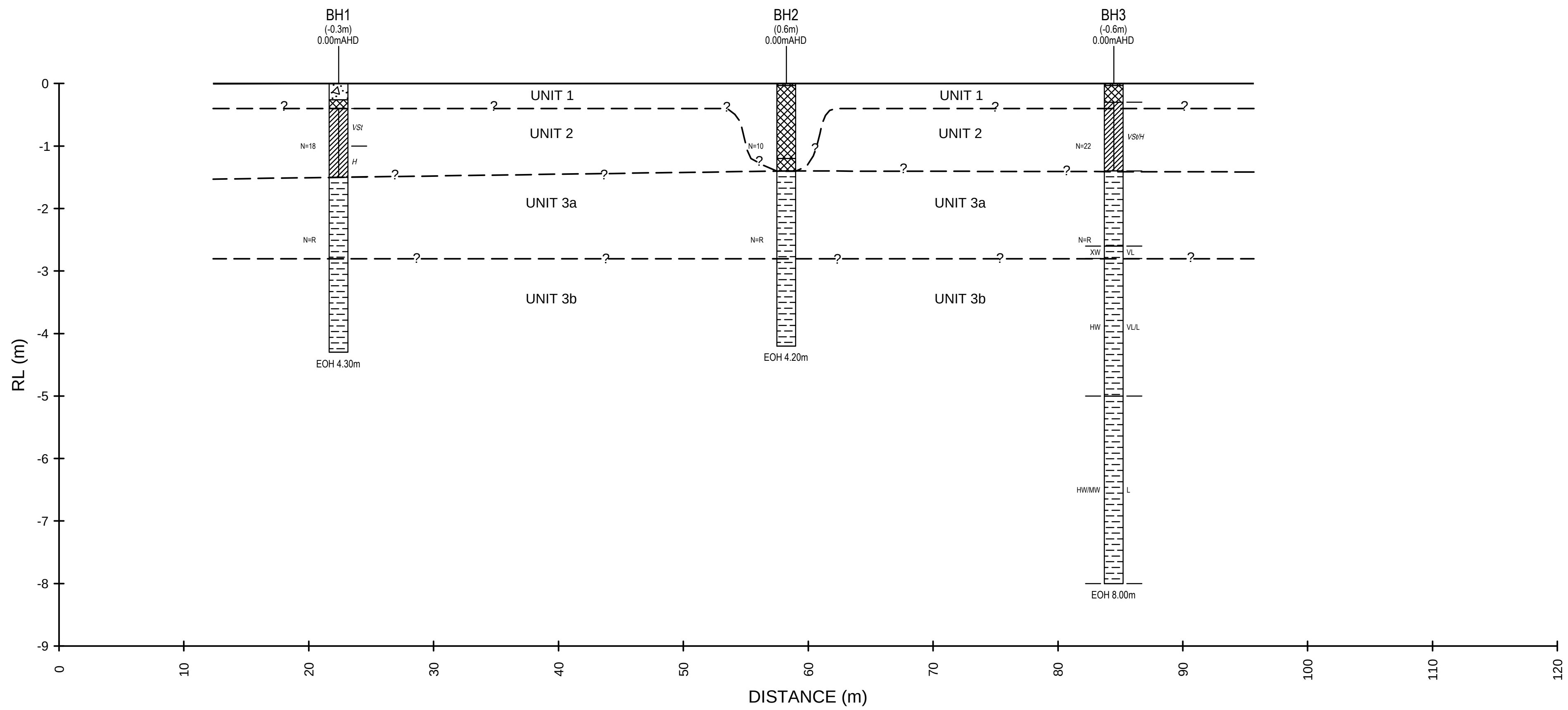
client: MLC SCHOOL C/- TAYLOR THOMSON WHITTING (NSW) PTY LTD

project: GEOTECHNICAL INVESTIGATION
PARK ROAD, BURWOOD, NSW

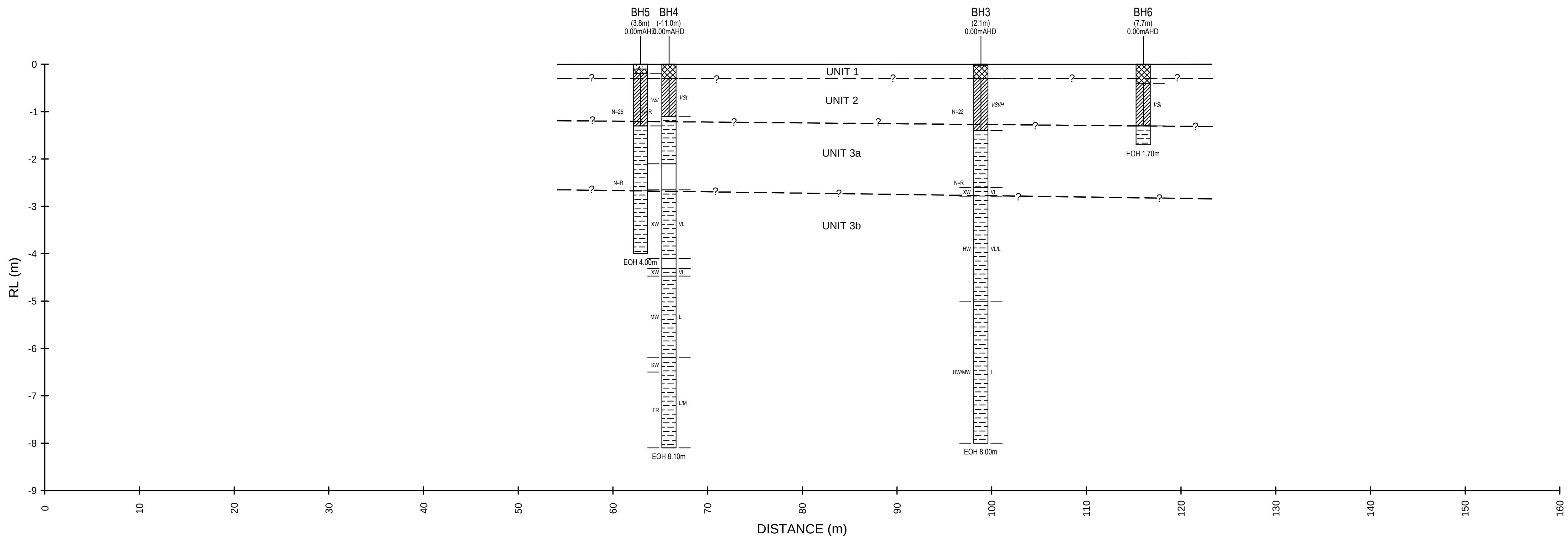
title: BOREHOLE LOCATION PLAN

project no: GEOTLCOV25052AA-AB | figure no: FIGURE 1 | rev: A

PLOT DATE: 25/06/2014 3:32:18 PM DWG FILE: F:\GEOTECHNICS\1.PROJECTS\GEOTLCOV\250\GEOTLCOV25052AA MLC SCHOOL DEVELOPMENT\12. CAD\GEOTLCOV25052AA-AB.DWG



SECTION A-A'



SECTION B-B'

LEGEND

- CONCRETE
- FILL
- SILTY CLAY
- SHALE
- NO CORE
- IV ROCK CLASSIFICATION (PELLS ET AL, 1998)
- DX WEATHERING (SEE EXPLANATION SHEETS)
- N*=17 STANDARD PENETRATION TEST RESULT

UNIT 1 - FILL

UNIT 2 - RESIDUAL SOIL

UNIT 3a - CLASS V SHALE

UNIT 3b - CLASS IV SHALE OR BETTER

revision no.	description	drawn	approved	date

Horizontal Scale (metres) 1:500 (5 0 5 15 25)

Vertical Scale (metres) 1:100 (1 0 1 3 5)

drawn	CL / LH
approved	SP
date	25 / 06 / 14
scale	AS SHOWN
original size	A3

coffey

client: MLC SCHOOL C/- TAYLOR THOMSON WHITTING (NSW) PTY LTD

project: GEOTECHNICAL INVESTIGATION
PARK ROAD, BURWOOD, NSW

title: SECTION A-A' AND B-B'

project no: GEOTLCOV25052AA-AB | figure no: FIGURE 2 | rev: A

Appendix A

Engineering Borehole Logs and Explanation Sheets

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Soil Description Explanation Sheet (1 of 2)

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 µm to 2.36 mm
	medium	200 µm to 600 µm
	fine	75 µm to 200 µm

MOISTURE CONDITION

Dry Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material	Structure and fabric of parent rock visible.
Residual soil	Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil	Deposited by wind.
Alluvial soil	Deposited by streams and rivers.
Colluvial soil	Deposited on slopes (transported downslope by gravity).
Fill	Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.
Lacustrine soil	Deposited by lakes.
Marine soil	Deposited in ocean basins, bays, beaches and estuaries.

coffey

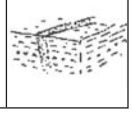
Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

<table>
<tr><th colspan="7">FIELD IDENTIFICATION PROCEDURES
(Excluding particles larger than 60 mm and basing fractions on estimated mass)</th><th>USC</th><th>PRIMARY NAME</th></tr>
<tr><td rowspan="8">COARSE GRAINED SOILS
More than 50% of materials less than 63 mm is larger than 0.075 mm</td><td rowspan="16">(A 0.075 mm particle is about the smallest particle visible to the naked eye)</td><td rowspan="4">GRAVELS
More than half of coarse fraction is larger than 2.36 mm</td><td rowspan="2">CLEAN GRAVELS (Little or no fines)</td><td colspan="3">Wide range in grain size and substantial amounts of all intermediate particle sizes.</td><td>GW</td><td>GRAVEL</td></tr>
<tr><td colspan="3">Predominantly one size or a range of sizes with more intermediate sizes missing.</td><td>GP</td><td>GRAVEL</td></tr>
<tr><td rowspan="2">GRAVELS WITH FINES (Appreciable amount of fines)</td><td colspan="3">Non-plastic fines (for identification procedures see ML below)</td><td>GM</td><td>SILTY GRAVEL</td></tr>
<tr><td colspan="3">Plastic fines (for identification procedures see CL below)</td><td>GC</td><td>CLAYEY GRAVEL</td></tr>
<tr><td rowspan="4">SANDS
More than half of coarse fraction is smaller than 2.36 mm</td><td rowspan="2">CLEAN SANDS (Little or no fines)</td><td colspan="3">Wide range in grain sizes and substantial amounts of all intermediate sizes</td><td>SW</td><td>SAND</td></tr>
<tr><td colspan="3">Predominantly one size or a range of sizes with some intermediate sizes missing.</td><td>SP</td><td>SAND</td></tr>
<tr><td rowspan="2">SANDS WITH FINES (Appreciable amount of fines)</td><td colspan="3">Non-plastic fines (for identification procedures see ML below).</td><td>SM</td><td>SILTY SAND</td></tr>
<tr><td colspan="3">Plastic fines (for identification procedures see CL below).</td><td>SC</td><td>CLAYEY SAND</td></tr>
<tr><td rowspan="8">FINE GRAINED SOILS
More than 50% of material less than 63 mm is smaller than 0.075 mm</td><td></td><td colspan="4">IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.</td><td></td><td></td></tr>
<tr><td rowspan="4">SILTS & CLAYS
Liquid limit less than 50</td><td colspan="2">DRY STRENGTH</td><td>DILATANCY</td><td>TOUGHNESS</td><td></td><td></td></tr>
<tr><td colspan="2">None to Low</td><td>Quick to slow</td><td>None</td><td>ML</td><td>SILT</td></tr>
<tr><td colspan="2">Medium to High</td><td>None</td><td>Medium</td><td>CL</td><td>CLAY</td></tr>
<tr><td colspan="2">Low to medium</td><td>Slow to very slow</td><td>Low</td><td>OL</td><td>ORGANIC SILT</td></tr>
<tr><td rowspan="3">SILTS & CLAYS
Liquid limit greater than 50</td><td colspan="2">Low to medium</td><td>Slow to very slow</td><td>Low to medium</td><td>MH</td><td>SILT</td></tr>
<tr><td colspan="2">High</td><td>None</td><td>High</td><td>CH</td><td>CLAY</td></tr>
<tr><td colspan="2">Medium to High</td><td>None</td><td>Low to medium</td><td>OH</td><td>ORGANIC CLAY</td></tr>
<tr><td colspan="3">HIGHLY ORGANIC SOILS</td><td colspan="4">Readily identified by colour, odour, spongy feel and frequently by fibrous texture.</td><td>Pt</td><td>PEAT</td></tr>
<tr><td colspan="9">• Low plasticity – Liquid Limit w_L less than 35%. • Medium plasticity – w_L between 35% and 50%. • High plasticity – w_L greater than 50%.</td></tr>
</table>

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

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coffey

Engineering Log - Borehole

Borehole ID.	**BH1**
sheet:	1 of 1
project no.	**GEOTLCOV25052AA**
date started:	**08 Jun 2014**
date completed:	**08 Jun 2014**
logged by:	**CL**
checked by:	**PLV**

client: ***MLC School c/- Taylor Thomson Whitting Pty Ltd***

principal:

project: ***MLC School Redevelopment***

location: ***MLC School, Burwood, NSW 2134***

position: E: 324346; N: 6250573 (Datum Not Specified) surface elevation: 0.00 m (AHD) angle from horizontal: 90°

drill model: Commacchio 305, Track mounted hole diameter : 100 mm

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T		Not Encountered		0				**CONCRETE**: 0.26m.				**PAVEMENT**
								FILL: Gravelly CLAY: low plasticity, brown, with fine to medium grained gravel and some sand.	<Wp			**FILL**
			DS				CH	**Silty CLAY**: high plasticity, mottled orange brown, yellow brown, pale grey and red brown, with a trace of fine grained ironstone gravel.		VSt		**RESIDUAL SOIL**
			SPT 3, 9, 9 N*=18	-1	1.0			0.8 m: becoming grey mottled yellow brown and red brown		H		
				-2	2.0			**SHALE**: extremely weathered, pale grey and red brown, with some ironstaining, estimated very low strength.				**EXTREMELY WEATHERED BEDROCK**
			SPT 10 N*=R	-3	3.0							
				-4	4.0							
								Borehole BH1 terminated at 4.3 m Refusal				
				-5	5.0							
				-6	6.0							
				-7	7.0							

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25052AA.GPJ <<DrawingFile>> 25/06/2014 15:28

coffey

Engineering Log - Borehole

Borehole ID.	**BH2**
sheet:	1 of 1
project no.	**GEOTLCOV25052AA**
date started:	**08 Jun 2014**
date completed:	**08 Jun 2014**
logged by:	**CL**
checked by:	**PLV**

client: ***MLC School c/- Taylor Thomson Whitting Pty Ltd***

principal:

project: ***MLC School Redevelopment***

location: ***MLC School, Burwood, NSW 2134***

position: E: 324382; N: 6250567 (Datum Not Specified) surface elevation: 0.00 m (AHD) angle from horizontal: 90°

drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T		Not Encountered		0				**FILL: BRICK PAVERS**: 0.03m.	<Wp			**PAVEMENT**
			E					**FILL: Gravelly CLAY**: low plasticity, brown, fine to medium grained gravel and brick fragments, with a trace of sand.				**FILL**
			E									
			E	-1	1.0							
			SPT 3, 3, 7 N*=10					**FILL: Gravelly SAND**: fine to coarse grained, grey and brown, fine to medium grained gravel.	D			
								SHALE: extremely weathered, pale grey, estimated very low strength.				**EXTREMELY WEATHERED BEDROCK**
				-2	2.0							
			SPT 10/50mm N*=R									
				-3	3.0							
				-4	4.0							
								Borehole BH2 terminated at 4.2 m Refusal				
				-5	5.0							
				-6	6.0							
				-7	7.0							

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3
no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey

Engineering Log - Borehole

Borehole ID.	**BH3**
sheet:	1 of 2
project no.	**GEOTLCOV25052AA**
date started:	**07 Jun 2014**
date completed:	**07 Jun 2014**
logged by:	**CL**
checked by:	**PLV**

client: ***MLC School c/- Taylor Thomson Whitting Pty Ltd***

principal:

project: ***MLC School Redevelopment***

location: ***MLC School, Burwood, NSW 2134***

position: Not Specified | surface elevation: Not Specified | angle from horizontal: 90°

drill model: Commacchio 305, Track mounted | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T CASING		Not Encountered						**FILL: BRICK PAVERS**: 0.03m.	D			**PAVEMENT**
								Gravelly SAND: medium to coarse grained, brown and dark brown, fine gravel.				**FILL**
			SPT 5, 9, 13 N*=22		1.0		CH	**Silty CLAY**: high plasticity, mottled orange brown, red brown and pale grey, with a trace of fine grained ironstone gravel.	<Wp	VSt / H		**RESIDUAL SOIL**
			SPT 10/100mm N*=R		2.0			**SHALE**: extremely weathered, pale grey, estimated very low strength.				**EXTREMELY WEATHERED BEDROCK**
					3.0			Borehole BH3 continued as cored hole				
					4.0							
					5.0							
					6.0							
					7.0							

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3
no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests

B	bulk disturbed sample
D	disturbed sample
E	environmental sample
SS	split spoon sample
U##	undisturbed sample ##mm diameter
HP	hand penetrometer (kPa)
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
VS	vane shear; peak/remouded (kPa)
R	refusal
HB	hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Cored Borehole

Borehole ID.	**BH3**
sheet:	2 of 2
project no.	**GEOTLCOV25052AA**
date started:	**07 Jun 2014**
date completed:	**07 Jun 2014**
logged by:	**CL**
checked by:	**PLV**

client: ***MLC School c/- Taylor Thomson Whitting Pty Ltd***

principal:

project: ***MLC School Redevelopment***

location: ***MLC School, Burwood, NSW 2134***

position: Not Specified | surface elevation: Not Specified | angle from horizontal: 90°

drill model: Commacchio 305, Track mounted | drilling fluid: | hole diameter : 100 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description (ROCK TYPE: grain characterisics, colour, structure, minor components)	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral)	samples, field tests & Is(50) (MPa) (a = axial; d = diametral)	core run & RQD	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other)
			1.0							
			2.0		start coring at 2.60m					
HQ	Not Encountered		3.0		**SHALE**: pale grey, red brown and yellow brown, indistinctly laminated at 0°, with some iron staining.	XW / HW		a=0.05 d=0.02	61%	SM, 200 mm, extremely weathered; SM, 50 mm, extremely weathered; SM, 30 mm, extremely weathered; SM, 30 mm, extremely weathered
			4.0					a=0.24 d=0.28		SM, 20 mm, extremely weathered; SM, 30 mm, extremely weathered; SM, 60 mm, extremely weathered; multiple partings of 50mm - PT, 0, PL, RO, FeSN; SM, 110 mm, extremely weathered
			5.0		**SHALE**: dark grey, with yellow brown iron staining, distinctly laminated at 0°.	HW / MW		a=0.50 d=0.20; a=0.28 d=0.07	69%	SM, 20 mm, extremely weathered; SM, 20 mm, extremely weathered; SM, 30 mm, extremely weathered; SM, 40 mm, extremely weathered
			6.0					a=0.03 d=0.07		SM, 20 mm, extremely weathered; SM, 80 mm, extremely weathered; SM, 20 mm, extremely weathered; PT, 0°, PL, RO, CN
			7.0						58%	PT, 0°, PL, RO, CN; JT, 80°, PL, RO, Fe SN; PT, 0°, PL, RO, CN; PT, 0°, PL, RO, CN; PT, 0°, PL, RO, CN; JT, 15°, PL, RO, CN; JT, 65°, PL, RO, Fe SN; Highly fractured zone, 200mm

general: Defects are:PT, 0°, PL, RO, Fe SN, unless otherwise described

Borehole BH3 terminated at 8.00 m
Target depth

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
HA hand auger

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
DW distinctly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SZ shear zone
SS shear surface
CS crushed seam
SM seam
DB drilling break

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
SL slickensided
POL polished
SO smooth
RO rough
VR very rough

coating
CN clean
SN stain
VN veneer
CO coating

PointID : BH3 Depth Range: 2.60 - 6.00 m

drawn	CL	coffey	client:	MLC School c/- Taylor Thomson Whitting Pty Ltd
approved	PLV		project:	MLC School Redevelopment MLC School, Burwood, NSW 2134
date	11/06/2014		title:	**CORE PHOTOGRAPH** **BH3**
scale	N.T.S.			
original size	A4		project no: GEOTLCOV25052AA	fig no: **FIGURE 1** rev:

CDF_0_9_04BB.GLB GrfcTbl COF PHOTO CORE PHOTO 1 PER PAGE GEOTLCOV25052AA.GPJ <<DrawingFile>> 11/06/2014 11:34

PointID : BH3 Depth Range: 6.00 - 8.00 m

drawn	CL	coffey	client:	MLC School c/- Taylor Thomson Whitting Pty Ltd
approved	PLV		project:	MLC School Redevelopment MLC School, Burwood, NSW 2134
date	11/06/2014		title:	**CORE PHOTOGRAPH** **BH3**
scale	N.T.S.		project no: GEOTLCOV25052AA	fig no: **FIGURE 2** rev:
original size	A4			

coffey

Engineering Log - Borehole

Borehole ID. **BH4**
sheet: 1 of 3
project no. **GEOTLCOV25052AA**

client: **MLC School c/- Taylor Thomson Whitting Pty Ltd**
principal:
project: **MLC School Redevelopment**
location: **MLC School, Burwood, NSW 2134**

date started: **07 Jun 2014**
date completed: **07 Jun 2014**
logged by: **CL**
checked by: **PLV**

position: Not Specified
surface elevation: Not Specified
angle from horizontal: 90°
drill model: Commacchio 305, Track mounted
hole diameter : 100 mm

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T, CASING		Not Encountered						**FILL: Silty SAND**: fine to medium grained, dark brown, with some fine to medium grained igneous gravel and a trace of rootlets.	M			**FILL**
			B + D				CH	**Silty CLAY**: high plasticity, mottled red brown, orange brown, yellow brown and pale grey, with a trace of fine to medium grained ironstone gravel.	<Wp	VSt		**RESIDUAL SOIL**
			DS									
			SPT 8, 10/50mm N*=R		1.0			**SHALE**: extremely weathered, pale grey, with some iron staining, estimated very low strength.				**EXTREMELY WEATHERED BEDROCK**
					2.0			Borehole BH4 continued as cored hole				
					3.0							
					4.0							
					5.0							
					6.0							
					7.0							

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25052AA.GPJ <<DrawingFile>> 13/06/2014 10:10

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
N nil
C casing

penetration
1 2 3
no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Engineering Log - Cored Borehole

Borehole ID.	**BH4**
sheet:	2 of 3
project no.	**GEOTLCOV25052AA**
date started:	**07 Jun 2014**
date completed:	**07 Jun 2014**
logged by:	**CL**
checked by:	**PLV**

client: ***MLC School c/- Taylor Thomson Whitting Pty Ltd***

principal:

project: ***MLC School Redevelopment***

location: ***MLC School, Burwood, NSW 2134***

position: Not Specified | surface elevation: Not Specified | angle from horizontal: 90°

drill model: Commacchio 305, Track mounted | drilling fluid: | hole diameter : 100 mm

method & support	water	depth (m)	material description	weathering & alteration	samples, field tests & Is(50) (MPa)	core run & RQD	defect descriptions (particular)
		1.0					
		2.0	start coring at 2.10m				
HQ	Not Encountered		**NO CORE:** 0.55 m				
		3.0	**SHALE**: grey and brown, with red brown and orange brown iron staining.	XW		0%	
		4.0	**NO CORE:** 0.21 m				
			SHALE: grey and brown, with red brown and orange brown iron staining.	XW			JT, 25°, PL, RO, Fe SN
			SHALE: dark grey, with some iron staining, distinctly laminated at 0°.	MW	a=0.31 d=0.04		JT, 50°, PL, RO, Fe SN
		5.0					PT, 0°, PL, RO, CN
							JT, 55°, ST, RO, Fe SN
						65%	
					a=0.02		SM, 110 mm, extremely weathered/highly weathered
							PT, 0°, PL, RO, CN
		6.0					JT, 50°, PL, RO, Fe SN
							JT, 15°, PL, RO, Fe SN
							JT, 50°, PL, RO, Fe SN
			SHALE: dark grey, distintly laminated at 0°.	SW			JT, 35°, PL, RO, CN
							SM, 180 mm, extremely weathered
				FR	a=0.40 d=0.25		
		7.0			a=0.79 d=0.45		PT, 0°, PL, RO, CN
						83%	SM, 10 mm, extremely weathered
					a=0.68 d=0.54		JT, 15°, PL, RO, CN
							SM, 60 mm, extremely weathered

Defects are:PT, 0°, PL, RO, Fe SN, unless otherwise described

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
HA hand auger

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
DW distinctly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SZ shear zone
SS shear surface
CS crushed seam
SM seam
DB drilling break

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
SL slickensided
POL polished
SO smooth
RO rough
VR very rough

coating
CN clean
SN stain
VN veneer
CO coating

Engineering Log - Cored Borehole

coffey

Borehole ID.	**BH4**
sheet:	3 of 3
project no.	**GEOTLCOV25052AA**
date started:	**07 Jun 2014**
date completed:	**07 Jun 2014**
logged by:	**CL**
checked by:	**PLV**

client: ***MLC School c/- Taylor Thomson Whitting Pty Ltd***

principal:

project: ***MLC School Redevelopment***

location: ***MLC School, Burwood, NSW 2134***

position: Not Specified | surface elevation: Not Specified | angle from horizontal: 90°

drill model: Commacchio 305, Track mounted | drilling fluid: | hole diameter : 100 mm

method & support	water	RL (m)	depth (m)	graphic log	material description (ROCK TYPE: grain characterisics, colour, structure, minor components)	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) (a = axial; d = diametral)	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
								a=0.60 d=0.58 a=0.93 d=0.71			JT, 35°, PL, RO, CN
					Borehole BH4 terminated at 8.10 m Target depth						
			9.0								
			10.0								
			11.0								
			12.0								
			13.0								
			14.0								
			15.0								

CDF_0_9_04BB.GLB Log COF BOREHOLE: CORED GEOTLCOV25052AA.GPJ <<DrawingFile>> 13/06/2014 10:15

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
HA hand auger

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
DW distinctly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

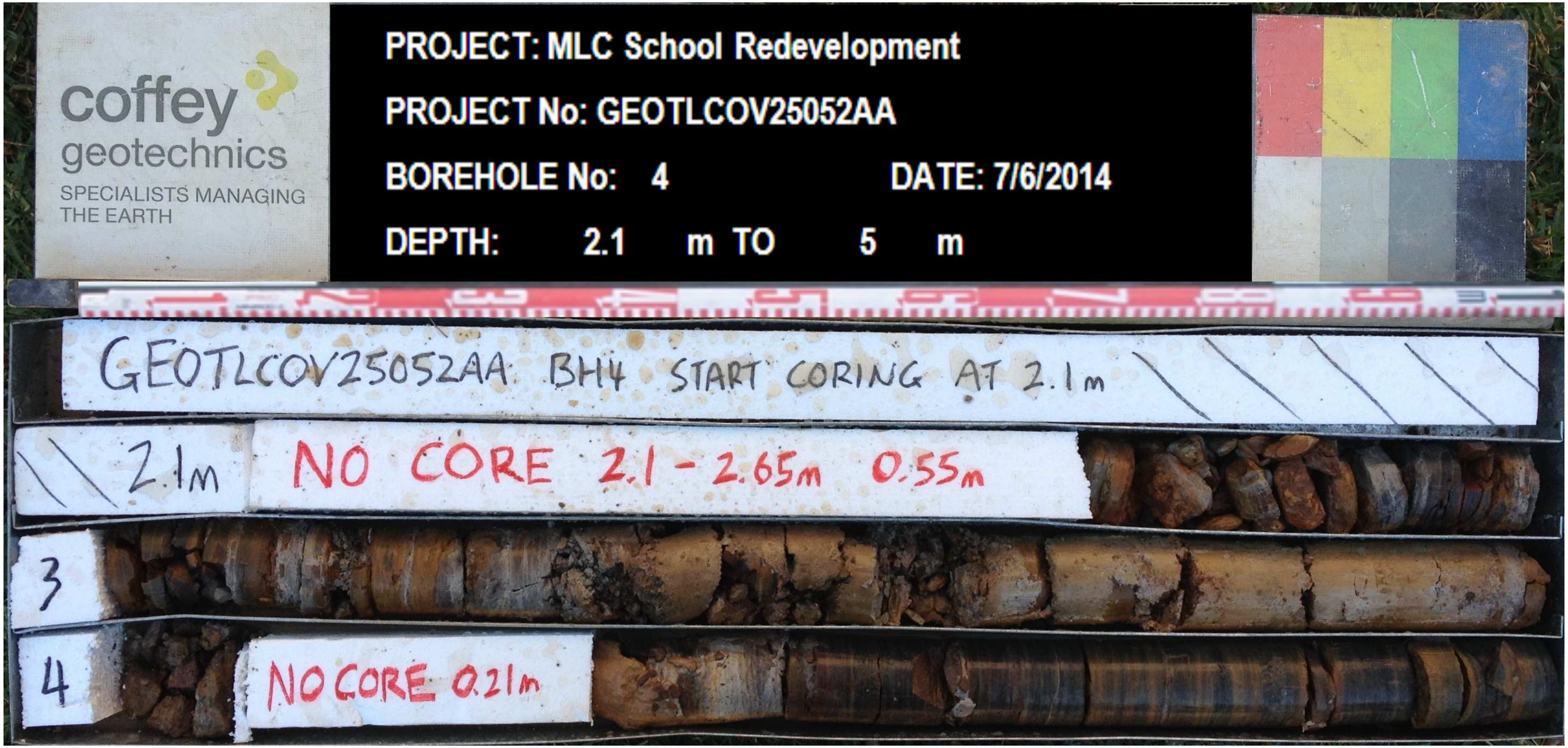
strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SZ shear zone
SS shear surface
CS crushed seam
SM seam
DB drilling break

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
SL slickensided
POL polished
SO smooth
RO rough
VR very rough

coating
CN clean
SN stain
VN veneer
CO coating



PointID : BH4 Depth Range: 2.10 - 5.00 m

drawn	CL	coffey	client:	MLC School c/- Taylor Thomson Whitting Pty Ltd
approved	PLV		project:	MLC School Redevelopment MLC School, Burwood, NSW 2134
date	11/06/2014		title:	**CORE PHOTOGRAPH** **BH4**
scale	N.T.S.		project no: GEOTLCOV25052AA	fig no: **FIGURE 3** rev:
original size	A4			

CDF_0_9_04BB.GLB GrfcTbl COF PHOTO CORE PHOTO 1 PER PAGE GEOTLCOV25052AA.GPJ <<DrawingFile>> 11/06/2014 11:34

PointID : BH4 Depth Range: 5.00 - 8.10 m

drawn	CL	coffey	client:	MLC School c/- Taylor Thomson Whitting Pty Ltd
approved	PLV		project:	MLC School Redevelopment MLC School, Burwood, NSW 2134
date	11/06/2014		title:	**CORE PHOTOGRAPH** **BH4**
scale	N.T.S.		project no:	GEOTLCOV25052AA
original size	A4		fig no:	**FIGURE 4** — rev:

coffey

Engineering Log - Borehole

Borehole ID.	**BH5**
sheet:	1 of 1
project no.	**GEOTLCOV25052AA**
date started:	**07 Jun 2014**
date completed:	**07 Jun 2014**
logged by:	**CL**
checked by:	**PLV**

client: ***MLC School c/- Taylor Thomson Whitting Pty Ltd***

principal:

project: ***MLC School Redevelopment***

location: ***MLC School, Burwood, NSW 2134***

position: Not Specified | surface elevation: Not Specified | angle from horizontal: 90°

drill model: Commacchio 305, Track mounted | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T (0.0–4.0 m)		Not Encountered						**CONCRETE**: 0.1m.				**PAVEMENT**
							CH	**FILL: Gravelly SAND**: fine to coarse grained, brown, fine to medium grained gravel.	D			**FILL**
								Silty CLAY: high plasticity, mottled yellow brown, orange brown, red brown and grey, with a trace of ironstone gravel.	<Wp	VSt		**RESIDUAL SOIL**
			SPT 5, 9, 16 N*=25		1.0							
								SHALE: extremely weathered, pale grey, estimated very low strength.				**EXTREMELY WEATHERED BEDROCK**
					2.0							
			SPT 10/70mm N*=R									
					3.0							
			DS									
					4.0			Borehole BH5 terminated at 4.0 m Near refusal				
					5.0							
					6.0							
					7.0							

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger
- * bit shown by suffix
- e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- N nil
- C casing

penetration
1 2 3
no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Engineering Log - Hand Auger

Borehole ID.	***BH6***
sheet:	1 of 1
project no.	***GEOTLCOV25052AA***
date started:	***07 Jun 2014***
date completed:	***07 Jun 2014***
logged by:	***CL***
checked by:	***PLV***

client: ***MLC School c/- Taylor Thomson Whitting Pty Ltd***

principal:

project: ***MLC School Redevelopment***

location: ***MLC School, Burwood, NSW 2134***

position: Not Specified | surface elevation: Not Specified | angle from horizontal: 90°

drill model: | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA		Not Encountered	E, E, DS					**FILL: Silty CLAY**: medium plasticity, dark brown, with some fine to medium grained gravel.	<Wp			**FILL**
					1.0		CH	**Silty CLAY**: high plasticity, mottled red brown, orange brown, yellow brown and pale grey, with a trace of ironstone gravel.		VSt		**RESIDUAL SOIL**
								SHALE: extremely weathered, pale grey, very low strength.				**EXTREMELY WEATHERED BEDROCK**
					2.0			Hand Auger BH6 terminated at 1.7 m Near refusal				
					3.0							
					4.0							
					5.0							
					6.0							
					7.0							

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3
no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Appendix B

Laboratory Testing Results

Melbourne
3-5 Kingston Town Close
Oakleigh VIC 3166
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

web : www.eurofins.com.au
e.mail : EnviroSales@eurofins.com.au
ABN – 50 005 085 521

eurofins | mgt

Company Name:	Coffey Geotechnics Pty Ltd Chatswood	**Order No.:**		**Received:**	Jun 11, 2014 2:45 PM
Address:	Level 18, Tower B, Citadel Tower 799 Pacific Highway Chatswood NSW 2067	**Report #:**	421360	**Due:**	Jun 18, 2014
		Phone:	+61 2 9406 1000	**Priority:**	5 Day
		Fax:	+61 2 9406 1002	**Contact Name:**	Gurpreet Singh
Client Job No.:	GEOTLCOV25052AA				

Eurofins | mgt Client Manager: Jean Heng

Sample Detail					% Moisture	Chloride	pH (1:5 Aqueous extract)	Sulphate (as S)
Laboratory where analysis is conducted								
Melbourne Laboratory - NATA Site # 1254 & 14271								
Sydney Laboratory - NATA Site # 18217					X	X	X	X
Brisbane Laboratory - NATA Site # 20794								
External Laboratory								
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**				
H1 0.5-0.6	Jun 08, 2014		Soil	S14-Jn07832	X	X	X	X
H4 0.3-0.5	Jun 07, 2014		Soil	S14-Jn07833	X	X	X	X

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Material Test Report

Report No: ARTA14S-00465-1
Issue No: 1

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	Taylor Thomson Whitting (NSW) Pty Ltd
Project No.:	INFOARTA01223AA
Project Name:	GEOTLCOV25052AA - MLC SCHOOL DEVELOPMENT
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/06/2014

Sample Details

Sample ID:	ARTA14S-00465
Client Sample:	BH1
Date Sampled:	08/06/2014
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	MLC School, Burwood, NSW 2134
Sample Location:	BH1 (1.00 to 1.45 m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	18.3	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: ARTA14S-00463-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	Taylor Thomson Whitting (NSW) Pty Ltd
Project No.:	INFOARTA01223AA
Project Name:	GEOTLCOV25052AA - MLC SCHOOL DEVELOPMENT
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/06/2014

Sample Details

Sample ID:	ARTA14S-00463
Client Sample:	BH3
Date Sampled:	08/06/2014
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	MLC School, Burwood, NSW 2134
Sample Location:	BH3 (0.7 to 0.8 m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	21.8	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

coffey

Report No: ARTA14S-00464-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	Taylor Thomson Whitting (NSW) Pty Ltd
Project No.:	INFOARTA01223AA
Project Name:	GEOTLCOV25052AA - MLC SCHOOL DEVELOPMENT
Lot No.:	TRN:

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/06/2014

Sample Details

Sample ID:	ARTA14S-00464
Client Sample:	BH4
Date Sampled:	08/06/2014
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	MLC School, Burwood, NSW 2134
Sample Location:	BH4 (0.3 to 0.5 m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	32.8	
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	18.0	
Mould Length (mm)		249.9	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	79	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	27	
Plasticity Index (%)	AS 1289.3.3.1	52	
Date Tested		13/06/2014	
Standard Maximum Dry Density (t/m³)	AS 1289.5.1.1	1.48	
Standard Optimum Moisture Content (%)		27.0	
Retained Sieve 19mm (%)		2	
Compactive Effort		Standard	
Date Tested		11/06/2014	
CBR At 5.0mm (%)	AS 1289.6.1.1	2.0	
Maximum Dry Density (t/m³)		1.48	
Optimum Moisture Content (%)		27.0	
Dry Density before Soaking (t/m³)		1.48	
Density Ratio before Soaking (%)		100	
Moisture Content before Soaking (%)		27.0	
Moisture Ratio before Soaking (%)		100	
Dry Density after Soaking (t/m³)		1.44	
Density Ratio after Soaking (%)		98	
Swell (%)		2.5	
Moisture Content of Top 30mm (%)		32.8	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Material Test Report

Report No: ARTA14S-00464-1
Issue No: 1

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	Taylor Thomson Whitting (NSW) Pty Ltd
Project No.:	INFOARTA01223AA
Project Name:	GEOTLCOV25052AA - MLC SCHOOL DEVELOPMENT
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

WORLD RECOGNISED ACCREDITATION

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/06/2014

Sample Details

Sample ID:	ARTA14S-00464
Client Sample:	BH4
Date Sampled:	08/06/2014
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	MLC School, Burwood, NSW 2134
Sample Location:	BH4 (0.3 to 0.5 m)

Test Results

Description	Method	Result	Limits
Moisture Content of Remaining Depth (%)		28.4	
Compactive Effort		Standard	
Surcharge Mass (kg)		4.50	
Period of Soaking (Days)		4	
Oversize Material		Excluded	
Oversize Material (%)		1.8	
Date Tested		17/06/2014	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: CBR:ARTA14S-00464
Issue No: 1

California Bearing Ratio Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	Taylor Thomson Whitting (NSW) Pty Ltd
Project No.:	INFOARTA01223AA
Project Name:	GEOTLCOV25052AA - MLC SCHOOL DEVELOPMENT
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

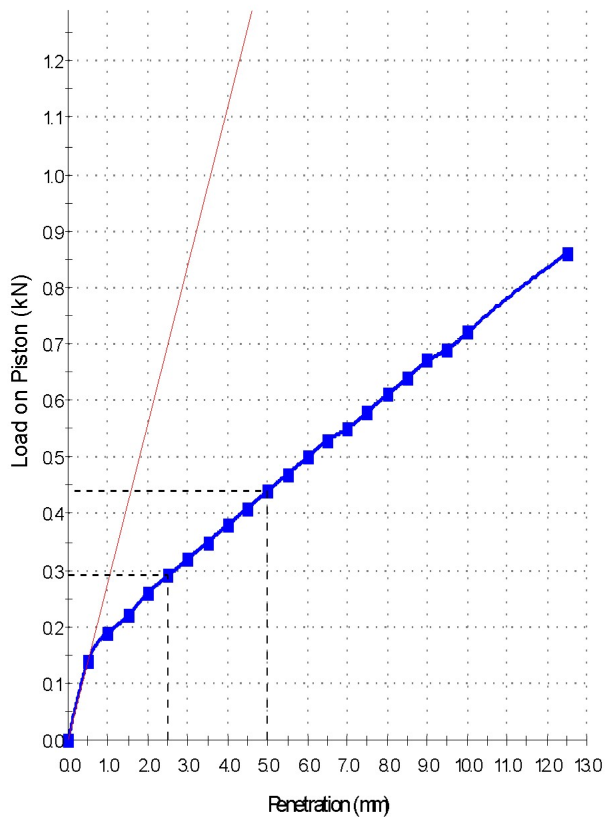
NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/06/2014

Sample Details

Sample ID:	ARTA14S-00464	Sampling Method:	Submitted by client
Date Sampled:	8/06/2014	Material:	Subgrade
Date Submitted:	10/06/2014	Source:	Ex Job Site
Date Tested:	17/06/2014	Specification:	No Specification
Project Location:	MLC School, Burwood, NSW 2134		
Sample Location:	BH4 (0.3 to 0.5 m)		

Load vs Penetration



Test Results

AS 1289.6.1.1

CBR At 5.0mm (%):	2.0
Maximum Dry Density (t/m³):	1.48
Optimum Moisture Content (%):	27.0
Dry Density before Soaking (t/m³):	1.48
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	27.0
Moisture Ratio before Soaking (%):	100
Dry Density after Soaking (t/m³):	1.44
Density Ratio after Soaking (%):	98
Swell (%):	2.5
Moisture Content of Top 30mm (%):	32.8
Moisture Content of Remaining Depth (%):	28.4
Compactive Effort:	Standard
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Oversize Material:	Excluded
Oversize Material (%):	1.8

AS 1289.2.1.1

Field Moisture Content (%):	32.8

Comments

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: MDD:ARTA14S-00464
Issue No: 1

Maximum Dry Density Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	Taylor Thomson Whitting (NSW) Pty Ltd
Project No.:	INFOARTA01223AA
Project Name:	GEOTLCOV25052AA - MLC SCHOOL DEVELOPMENT
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

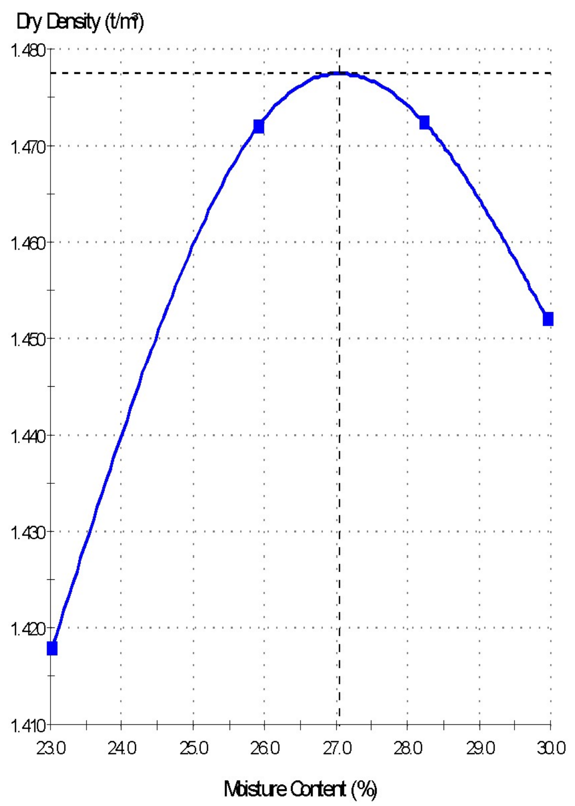
NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/06/2014

Sample Details

Sample ID:	ARTA14S-00464	Sampling Method:	Submitted by client
Date Sampled:	8/06/2014	Material:	Subgrade
Date Submitted:	10/06/2014	Source:	Ex Job Site
Date Tested:	11/06/2014	Specification:	No Specification
Project Location:	MLC School, Burwood, NSW 2134		
Sample Location:	BH4 (0.3 to 0.5 m)		

Dry Density - Moisture Content Relationship



Test Results

AS 1289.5.1.1

Standard MDD (t/m³):	1.48
Standard OMC (%):	27.0
Retained Sieve 19mm (%):	2

Comments

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: ARTA14S-00466-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	Taylor Thomson Whitting (NSW) Pty Ltd
Project No.:	INFOARTA01223AA
Project Name:	GEOTLCOV25052AA - MLC SCHOOL DEVELOPMENT
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

WORLD RECOGNISED ACCREDITATION

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/06/2014

Sample Details

Sample ID:	ARTA14S-00466
Client Sample:	BH6
Date Sampled:	08/06/2014
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	MLC School, Burwood, NSW 2134
Sample Location:	BH6 (0.7 to 0.8 m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	31.9	

Comments

N/A

Appendix C

Previous Engineering Borehole Logs (Jeffery & Katauskas)

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **1**
1/2

Client: MLC SCHOOL
Project: PROPOSED YEAR 6 COHORT BUILDING
Location: MLC MIDDLE SCHOOL, GRANTHAM STREET, BURWOOD, NSW

Job No. 23490VT **Method:** JK 250 **R.L. Surface:** ≈ 26.2m
Date: 22-10-09 **Datum:** AHD
Logged/Checked by: L.Y./

Groundwater Record	Samples (ES / U50 / DB / DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
ON COMPLE-TION OF CORING			0			FILL: Sandy silt, low plasticity, brown and light grey, with a trace of fine to medium grained sandstone gravel and igneous gravel.	MC<PL			GRASS COVER APPEARS POORLY COMPACTED
	DS	N = 10 3,4,6			CH	SILTY CLAY: high plasticity, red brown, with a trace of fine to medium grained ironstone gravel.	MC>PL	H	>600 >600 >600	
			1			as above, but light grey and mottled orange brown, with fine to medium grained ironstone gravel.				
DRY ON COMPLE-TION OF AUGER-ING	DS	N = 23 9,10,13							>600 >600 >600	
			2		-	SHALE: light grey with clay bands and occasional L-M strength iron indurated bands.	XW	EL -VL	-	VERY LOW 'TC' BIT RESISTANCE
	DS	N > 21 24, 21/150mm REFUSAL	3						>600 >600 >600	
										LOW RESISTANCE WITH MODERATE BANDS
	DS		4			as above, but dark grey with ironstone bands.	DW	L-M		
						REFER TO CORED BOREHOLE LOG				END OF AUGERING AT 4.35m
			5							
			6							
			7							


JEFFERY & KATAUSKAS PTY LTD
JOB NO: 23490VT
BH1
Start Coring at: 4.35m
4
CORE LOSS 0.60 m
5
6
7
8
EOBH @ 8.67m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No. 1

Client: MLC SCHOOL
Project: PROPOSED YEAR 6 COHORT BUILDING
Location: MLC MIDDLE SCHOOL, GRANTHAM STREET, BURWOOD, NSW

Job No. 23490VT **Core Size:** NMLC **R.L. Surface:** ≈ 26.2m
Date: 22-10-09 **Inclination:** VERTICAL **Datum:** AHD
Drill Type: JK250 **Bearing:** **Logged/Checked by:** L.Y./

Water Loss/Level	Barrel Lift	Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		4	START CORING AT 4.35m						
FULL RET-URN			CORE LOSS: 0.6m						
		5	CLAY SEAM: 0.21m						
			SHALE: light grey, with iron indurated bands.	DW	VL-L			CRUSHED SHALE WITH CLAY 100 mm.t - CS,70 mm.t - CS,60 mm.t	
			as above, but dark grey with occassional iron indurated bands.			×		- CS,35 mm.t	
		6			EL			CRUSHED SHALE, 90 mm.t - J,90°,P,S	
					L-M	×		- J,60°,P,S CRUSHED SHALE, 60 mm.t - J,90°,P,S - CS,100 mm.t	
		7			M	×			
		8				× ×			
		9	END OF BOREHOLE AT 8.67m						
		10							

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Borehole No.
2

BOREHOLE LOG

Client: MLC SCHOOL
Project: PROPOSED YEAR 6 COHORT BUILDING
Location: MLC MIDDLE SCHOOL, GRANTHAM STREET, BURWOOD, NSW

Job No. 23490VT **Method:** JK 250 **R.L. Surface:** ≈ 25.6m
Date: 22-10-09 **Datum:** AHD
Logged/Checked by: L.Y./

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE -TION OF AUGER - ING			0			FILL: Silty clay, medium plasticity, dark brown mottled orange brown, with traces of fine to medium grained igneous gravel, slag and roots.	MC>PL			GRASS COVER APPEARS POORLY COMPACTED
		N = 4 1,2,2			CL-CH	SILTY CLAY: medium to high plasticity, red brown.	MC>PL	St	210 220 225	
			1							
ON COMPLE -TION OF CORING		N = 14 2,6,8					MC≈PL	H	560 >600 >600	
			2		-	SHALE: light grey, with L-M strength iron indurated bands and clay bands.	XW-DW	EL-VL	-	
			3							
			4			as above, but with ironstone bands.				LOW RESISTANCE WITH MODERATE BANDS
			5			as above, but dark grey.				
			6							
			7				DW	M		

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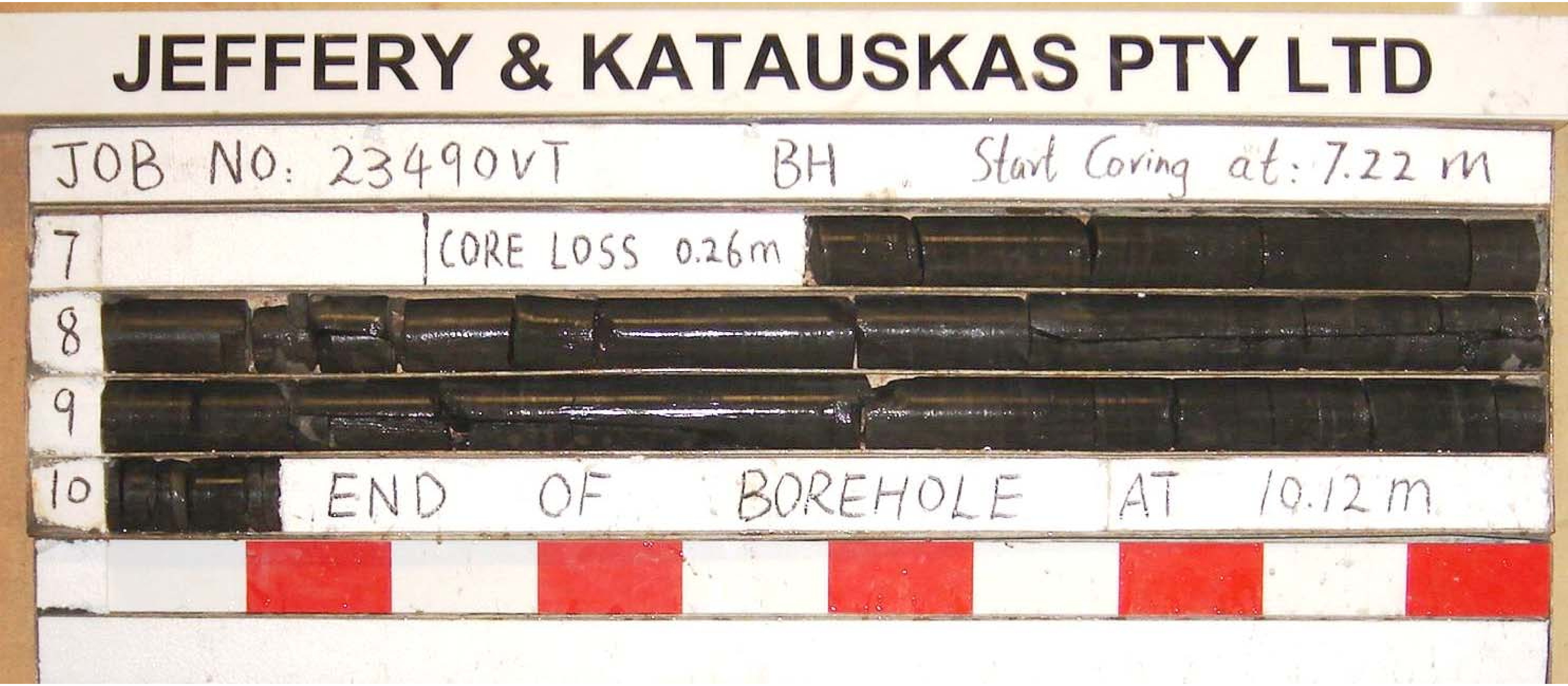
Borehole No.
2

BOREHOLE LOG

Client: MLC SCHOOL
Project: PROPOSED YEAR 6 COHORT BUILDING
Location: MLC MIDDLE SCHOOL, GRANTHAM STREET, BURWOOD, NSW

Job No. 23490VT **Method:** JK 250 **R.L. Surface:** ≈ 25.6m
Date: 22-10-09 **Datum:** AHD
Logged/Checked by: L.Y./

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■				-	SHALE: dark grey.	DW	M		
									REFER TO CORED BOREHOLE LOG				END OF AUGERING AT 7.22m
						8							
						9							
						10							
						11							
						12							
						13							
						14							


JEFFERY & KATAUSKAS PTY LTD
JOB NO: 23490VT
BH
Start Coring at: 7.22 m
7
CORE LOSS 0.26m
8
9
10
END OF BOREHOLE AT 10.12 m

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Borehole No. 2
3/3

CORED BOREHOLE LOG

Client: MLC SCHOOL
Project: PROPOSED YEAR 6 COHORT BUILDING
Location: MLC MIDDLE SCHOOL, GRANTHAM STREET, BURWOOD, NSW

Job No. 23490VT | **Core Size:** NMLC | **R.L. Surface:** ≈ 25.6m
Date: 22-10-09 | **Inclination:** VERTICAL | **Datum:** AHD
Drill Type: JK250 | **Bearing:** | **Logged/Checked by:** L.Y./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (EL VL L M H VH EH)	DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS – DESCRIPTION: Type, inclination, thickness, planarity, roughness, coating. Specific	General
		7		START CORING AT 7.22m						
				CORE LOSS: 260 mm.t.						
		8		SHALE: dark grey.	DW	M-H			- J,90°,P,S - J,90°,P,S	
		9								
		10								
				END OF BOREHOLE AT 10.12m						
		11								
		12								
		13								

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BOREHOLE LOG

Borehole No. **3**
1/2

Client: MLC SCHOOL
Project: PROPOSED YEAR 6 COHORT BUILDING
Location: MLC MIDDLE SCHOOL, GRANTHAM STREET, BURWOOD, NSW

Job No. 23490VT **Method:** JK 250 **R.L. Surface:** ≈ 25.9m
Date: 22-10-09 **Datum:** AHD
Logged/Checked by: L.Y./

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE -TION			0		BRICK PAVERS: 50 mm.t.				
				SP	GRAVELLY SAND: fine to medium grained, yellow brown.	D	-	-	
				-	FILL: Sandy silt, low plasticity, brown and light grey, with a trace of fine to coarse grained sandstone gravel.	MC<PL	-	-	
	DS	N = 14 5,5,9	1	CL-CH	SILTY CLAY: medium to high plasticity, light grey, mottled red brown.	MC>PL	H	- >600 >600 >600	
	DS	N >19 12,19/ 120mm REFUSAL	2	-	SHALE: light grey with L-M strength iron indurated bands and clay bands.	XW	EL	-	VERY LOW RESISTANCE WITH MODERATE BANDS
			3			DW	VL-L		
AFTER 40 MINS OF DRILL -ING			4 5 6						
			7		SHALE: dark grey, with iron indurated bands.		M		

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BOREHOLE LOG

Borehole No. 3

Client: MLC SCHOOL
Project: PROPOSED YEAR 6 COHORT BUILDING
Location: MLC MIDDLE SCHOOL, GRANTHAM STREET, BURWOOD, NSW

Job No. 23490VT **Method:** JK 250 **R.L. Surface:** ≈ 25.9m
Date: 22-10-09 **Datum:** AHD
Logged/Checked by: L.Y./

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
								-	SHALE: dark grey.	DW	M		
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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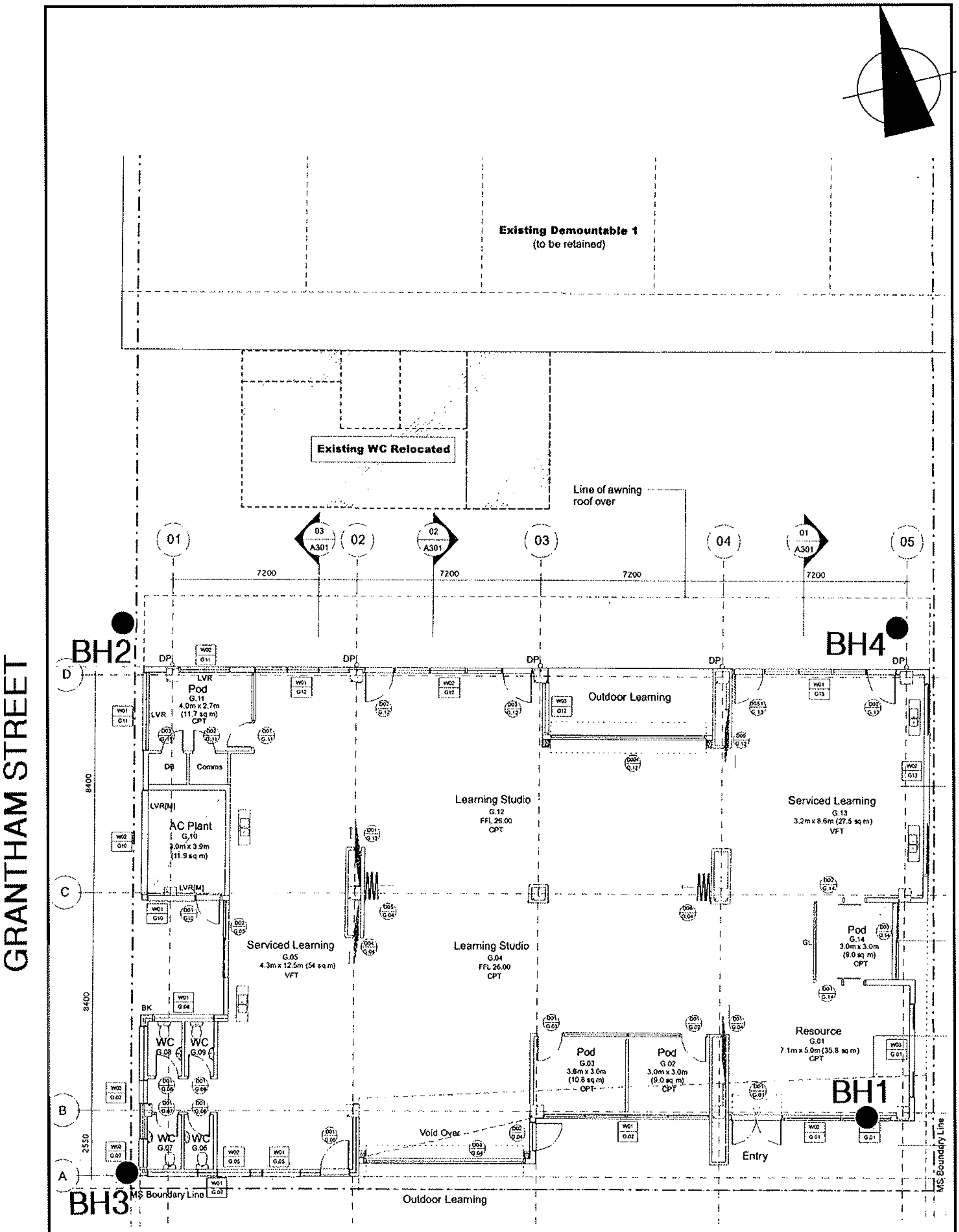
Borehole No.
4
1/1

BOREHOLE LOG

Client: MLC SCHOOL
Project: PROPOSED YEAR 6 COHORT BUILDING
Location: MLC MIDDLE SCHOOL, GRANTHAM STREET, BURWOOD, NSW

Job No. 23490VT **Method:** JK 250 **R.L. Surface:** ≈ 25.9m
Date: 22-10-09 **Datum:** AHD
Logged/Checked by: L.Y./

Groundwater Record	Samples (ES / U50 / DB / DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLE -TION			0			BRICK PAVERS: 50mm.t.				
					SP	GRAVELLY SAND: fine to medium grained, yellow brown.	-	-	-	APPEARS POORLY COMPACTED
	DS	N = 6 1,2,4			-	FILL: Silty clay, low to medium plasticity, dark brown and grey with a trace of slag.	MC>PL	-	-	
			1		CL-CH	SILTY CLAY: medium to high plasticity, orange brown mottled yellow brown.	MC>PL	VSt- H	320 320 400	
	DS	N = 18 7,7,11				as above, but light grey mottled brown with ironstone gravel.		H	>600 >600 >600	
	DS		2		-	SHALE: light grey with L strength iron indurated bands and clay bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE WITH MODERATE BANDS
			3							
	DS		4			as above, but dark grey and brown.	DW	L		LOW TO MODERATE RESISTANCE
▼ AFTER 0.25 HRS OF DRILL -ING	DS		5			as above, but dark grey.		M		MODERATE RESISTANCE
			6			END OF BOREHOLE AT 6.0m				
			7							



BOREHOLE LOCATION PLAN

SCALE (m)

0 10

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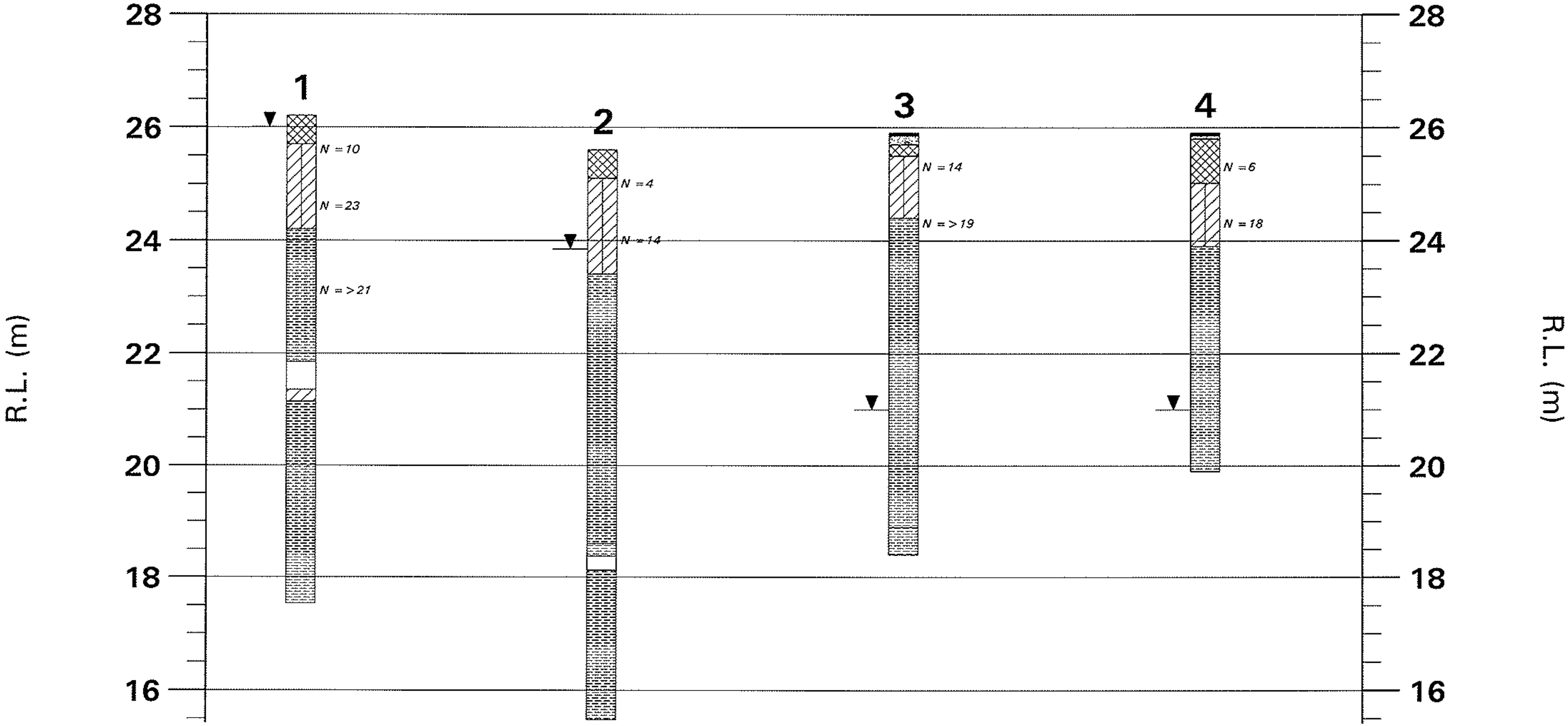
Report No. 23490VT **Figure No. 1**

GRAPHICAL BOREHOLE SUMMARY



	Fill		Core Loss/ Empty		Asphaltic/ Bituminous Paving or Coal	▼	Observed water level	Nc	SOLID CONE BLOW COUNTS PER 150mm
	Silty Clay		Clay		Gravelly Sand	N	SPT "N" VALUE		
	Shale								

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 100 (vert) ; NTS (horiz)

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Job No.: 23490VT

Figure No.: 2

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REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained 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.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water 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 "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength 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 F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm 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 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N>30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "N_c" on the borehole logs, together with the number of blows per 150mm penetration.

Static Cone Penetrometer Testing and Interpretation: Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The 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.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- 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 be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to 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 perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg bricks, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soil for Engineering Purposes'*. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg to a twenty storey building). If this happens, the company 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 aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

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, the company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed that at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document *'Guidelines for the Provision of Geotechnical Information in Tender Documents'*, published by the Institution of Engineers, Australia. Where information obtained from this investigation 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. The company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

REVIEW OF DESIGN

Where major civil or structural developments are proposed <u>or</u> where only a limited investigation has been completed <u>or</u> where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

SITE INSPECTION

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to
ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or
iii) full time engineering presence on site.

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GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

SOIL

- FILL
- TOPSOIL
- CLAY (CL, CH)
- SILT (ML, MH)
- SAND (SP, SW)
- GRAVEL (GP, GW)
- SANDY CLAY (CL, CH)
- SILTY CLAY (CL, CH)
- CLAYEY SAND (SC)
- SILTY SAND (SM)
- GRAVELLY CLAY (CL, CH)
- CLAYEY GRAVEL (GC)
- SANDY SILT (ML)
- PEAT AND ORGANIC SOILS

ROCK

- CONGLOMERATE
- SANDSTONE
- SHALE
- SILTSTONE, MUDSTONE, CLAYSTONE
- LIMESTONE
- PHYLLITE, SCHIST
- TUFF
- GRANITE, GABBRO
- DOLERITE, DIORITE
- BASALT, ANDESITE
- QUARTZITE

DEFECTS AND INCLUSIONS

- CLAY SEAM
- SHEARED OR CRUSHED SEAM
- BRECCIATED OR SHATTERED SEAM/ZONE
- IRONSTONE GRAVEL
- ORGANIC MATERIAL

OTHER MATERIALS

- CONCRETE
- BITUMINOUS CONCRETE, COAL
- COLLUVIUM

UNIFIED SOIL CLASSIFICATION TABLE

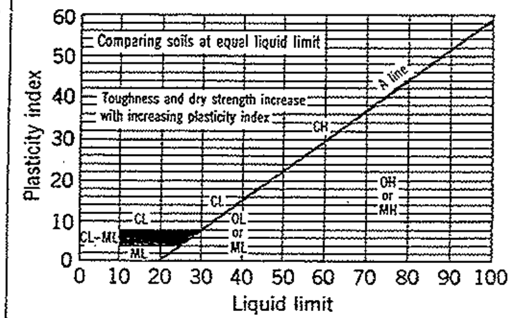
(The 75 μm sieve size is about the smallest particle visible to naked eye)

Major division	Subdivision		Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)	Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils. More than half of material is *larger* than 75 μm sieve size[b]	Gravels. More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or *PI* less than 4. Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics	Atterberg limits above "A" line, with *PI* greater than 7
	Sands. More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines	Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5. Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7

Laboratory classification (coarse-grained): Use grain size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols

Identification Procedures on Fraction Smaller than 380 μm Sieve Size

Major division	Subdivision	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols	Typical Names	Information Required for Describing Soils
Fine-grained soils. More than half of material is *smaller* than 75 μm sieve size	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity chart
for laboratory classification of fine grained soils

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).

2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

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LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.
	C	Extent of borehole collapse shortly after drilling.
		Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos screening.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	MC>PL	Moisture content estimated to be greater than plastic limit.
	MC≈PL	Moisture content estimated to be approximately equal to plastic limit.
	MC<PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY - runs freely through fingers.
	M	MOIST - does not run freely but no free water visible on soil surface.
	W	WET - free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25kPa
	S	SOFT - Unconfined compressive strength 25-50kPa
	F	FIRM - Unconfined compressive strength 50-100kPa
	St	STIFF - Unconfined compressive strength 100-200kPa
	VSt	VERY STIFF - Unconfined compressive strength 200-400kPa
	H	HARD - Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** — **SPT 'N' Value Range (Blows/300mm)**
	VL	Very Loose — <15 — 0-4
	L	Loose — 15-35 — 4-10
	MD	Medium Dense — 35-65 — 10-30
	D	Dense — 65-85 — 30-50
	VD	Very Dense — >85 — >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

Ref: Standard Sheets/Log Symbols
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LOG SYMBOLS

ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL		Easily remoulded by hand to a material with soil properties.
		0.03	
Very Low:	VL		May be crumbled in the hand. Sandstone is "sugary" and friable.
		0.1	
Low:	L		A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
		0.3	
Medium Strength:	M		A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
		1	
High:	H		A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
		3	
Very High:	VH		A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
		10	
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	