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Investigation Summary Report

Client	Billard Leece Partnership Pty Ltd	**Project No.**	83313.00
Project	Central Coast Schools - Warnervale	**Date**	18 Jul 2018
Address	75 Warnervale Road, Warnervale	**Doc No.**	R.001.Rev0

Introduction: This factual report presents the results of field work and laboratory testing undertaken by Douglas Partners Pty Ltd (DP) in connection with a proposed new primary school at 75 Warnervale Road, Warnervale. The work was carried out for Billard Leece Partnership Pty Ltd, architects, and was undertaken in accordance with DP's proposal CCT170012.P.001.Rev2 dated 14 December 2017.

Details regarding the proposed development are limited at this stage of the project, although it is anticipated that existing buildings associated with a former primary school at the site are to be demolished or removed to make way for new single storey school buildings including a hall, administration block, and classrooms.

This project forms part of the 'Central Coast Package' issued by the Department of Education (DoE).

Investigation is proposed to be carried out in two stages, with Stage 1 works being associated with a preliminary assessment to provide factual information on site conditions. This information is intended to be used to assist with undertaking a targeted, Stage 2 assessment once an indicative layout of the proposed school has been determined.

Description of Site: The site is located on the southern side of Warnervale Road and comprises the site of the former Warnervale School. It is a rectangular shaped area measuring about 320 m long by 140 m wide and has the following main features:

- Several single storey fixed and demountable buildings associated with the former school located in a fenced-off area in the north-western corner of the site;
- A concrete playing court and grass covered areas in the north-eastern portion of the site;
- Predominantly bush covered area occupying approximately two-thirds of the overall site;
- An 20 m to 30 m wide strip of land along the western boundary that appeared to have been recently cleared of vegetation and was covered with mulch;
- Ground surface levels fall from the north-western corner down to the south-eastern corner, with a difference in level estimated to be about 5 m.

Reference to the interim 1:25,000 scale Geological Series Sheet for Wyong indicates that the site is within an area mapped as being underlain by the Tuggerah Formation. It is also located in an area mapped as having no known occurrence of acid sulfate soils.

Field Work Methods: The field work was undertaken on 21 December 2017 and comprised the drilling of nine boreholes (Bores 1 – 9) to depths ranging from 0.7 m to 2.5 m using a push tube rig fitted with 60 mm diameter sampling tubes. Dynamic cone penetrometer tests (DCPs) were carried out adjacent to the boreholes to provide information on the relative strengths or densities of the soils at the test locations.

The test locations were set out by a senior geotechnical engineer from DP, whereas the field work was carried out by an engineering geologist who operated the rig and prepared engineering logs detailing the subsoil profile encountered in the bores. Prior to drilling, the test locations were scanned for the presence of buried services by a professional service locator.

Access was not able to be obtained within the fenced portion in the north-western corner of the site. All boreholes were, therefore, positioned outside of that area. Access into the bush covered portion of the site was also limited, with several boreholes then positioned within the cleared strip along the western side and along an access track on the eastern side of the bush. Drawing 1, attached, shows the locations of the boreholes at the site.

Regular samples of the soils encountered in the boreholes were collected for identification purposes and selected samples were later submitted for subsequent laboratory testing.

Field Work Results: Details of the subsurface conditions encountered in the boreholes are presented in the attached borehole logs. These should be read in conjunction with the accompanying explanatory notes, which define the descriptive terms and classification methods.

Laboratory Testing: Bulk samples of the subgrade soils were collected using a hand shovel from Bores 1 and 5. These samples were submitted to the laboratory for measurements of compaction properties and California bearing ratio (CBR).

The samples were compacted to approximately 100% Standard dry density ratio at close to the estimated optimum moisture content and then soaked for four days under a surcharge loading of 4.5 kg prior to testing. Detailed results of the laboratory tests are attached and are summarised in Table 1.

Table 1: Summary of California Bearing Ratio Testing

Sample Location	Depth (m)	Description	FMC (%)	OMC (%)	MDD (t/m^3)	CBR (%)	Swell (%)
Bore 1	0.7 - 0.9	Orange brown mottled grey SANDY CLAY	10.8	12.5	1.89	12	0.5
Bore 5	0.2 - 0.5	Yellow brown SANDY CLAY	20.3	18.0	1.71	2.5	3.0

Notes: FMC = Field moisture content OMC = Optimum moisture content MDD = Maximum dry density
CBR = California bearing ratio

Shrink-swell index (or instability index) testing was carried out on two undisturbed samples of natural clay soils taken from within the site. The results of these tests are summarised in Table 2.

Table 2: Summary of Instability Index Testing

Test Location	Depth (m)	Description	I_{ss} (per ΔpF)	Initial Pocket Penetrometer Reading (kPa)	Final Pocket Penetrometer Reading (kPa)
Bore 3	0.7 – 1.0	Orange brown CLAY	5.0	225	100
Bore 4	0.4 – 0.55	Orange brown and red brown CLAY	3.4	600	200

Note: I_{ss} = Shrink-swell index

Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Warnervale in accordance with DP's proposal dated 14 December 2017 and acceptance received from Billard Leece Partnership Pty Ltd dated 18 December 2017. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Billard Leece Partnership Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or subsurface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition

materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Reviewed by

Darryl Carson
Senior Associate

Brent Kerry
Senior Associate

Attachments:

About this Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Borehole Logs
Laboratory Test Results
Drawing 1 – Locations of Tests

About this Report

Douglas Partners

Introduction

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

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling

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

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

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

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

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

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

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

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

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

Symbols & Abbreviations

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

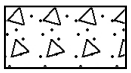
Symbols & Abbreviations

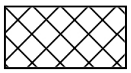
Graphic Symbols for Soil and Rock

General

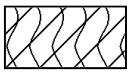

Asphalt

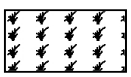

Road base

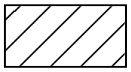

Concrete

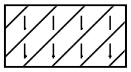

Filling

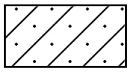
Soils


Topsoil

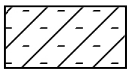

Peat

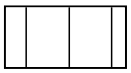

Clay

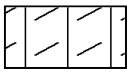

Silty clay

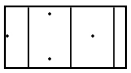

Sandy clay

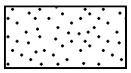

Gravelly clay

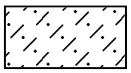

Shaly clay

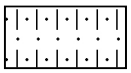

Silt


Clayey silt


Sandy silt

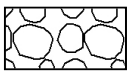

Sand

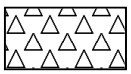

Clayey sand


Silty sand


Gravel

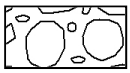

Sandy gravel


Cobbles, boulders

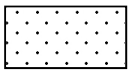

Talus

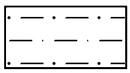
Sedimentary Rocks

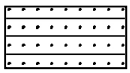

Boulder conglomerate

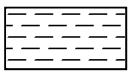

Conglomerate


Conglomeratic sandstone

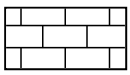

Sandstone


Siltstone

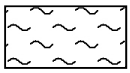

Laminite

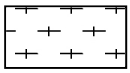

Mudstone, claystone, shale

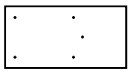

Coal


Limestone

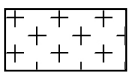
Metamorphic Rocks

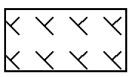

Slate, phyllite, schist

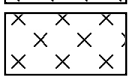

Gneiss

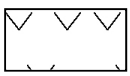

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Billard Leece Partnership Pty Ltd
PROJECT: Central Coast Schools - Warnervale
LOCATION: 75 Warnervale Road, Warnervale

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

BORE No: 1
PROJECT No: 83313.00
DATE: 21/12/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		SAND: Dense to very dense, grey brown and yellow brown sand with trace clay and rootlets		D	0.2				
					0.4				
				B D	0.5				
					0.6				
	0.7	SANDY CLAY: Very stiff to hard, orange bown mottled grey brown sandy clay, M<Wp			0.7				
				B	0.8		pp >400		
					0.9				
	1			D	1.0				1
					1.3		pp = 350-380		
		- clayey sand/sandy clay band from 1.4m - 1.5m							
		- becoming red brown and grey at 1.55m							
					1.7		pp = 350-380		
	2			D	2.0				2
					2.2		pp = 320-370		
	2.5	Bore discontinued at 2.5m. Limit of investigation							
	3								3

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:**
TYPE OF BORING: 60mmϕ Dynamic Push Tube (continuous sample)
WATER OBSERVATIONS: No Free Groundwater Observed
REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Billard Leece Partnership Pty Ltd
PROJECT: Central Coast Schools - Warnervale
LOCATION: 75 Warnervale Road, Warnervale

SURFACE LEVEL: --
EASTING: 356180
NORTHING: 6319998
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 83313.00
DATE: 21/12/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.2	SAND: Medium dense, grey brown sand with some rootlets, humid		D	0.1			
		CLAY: Hard, yellow brown clay with trace sand and organics, M<Wp		B	0.2			
				D	0.5		pp >400	
	0.6	SANDY CLAY: Very stiff to hard, orange brown sandy clay, M<Wp		D	0.7		pp >400	
	0.75	Bore discontinued at 0.75m. Refusal on sandstone						

Dynamic Penetrometer Test (blows per 150mm)
5 10 15 20
1 2 3

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:**
TYPE OF BORING: 60mm ϕ Dynamic Push Tube (continuous sample)
WATER OBSERVATIONS: No Free Groundwater Observed
REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Billard Leece Partnership Pty Ltd
PROJECT: Central Coast Schools - Warnervale
LOCATION: 75 Warnervale Road, Warnervale

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

BORE No: 3
PROJECT No: 83313.00
DATE: 21/12/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILLING: Generally comprising, brown clayey sand with some rootlets, humid		D	0.1				
				D	0.3				
	0.35	SAND: Dense, grey brown and yellow brown sand with trace clay and organics							
	0.5	SANDY CLAY: Hard, orange brown sandy clay with trace organics			0.5		pp >400		
				D	0.6				
	0.7	CLAY: Stiff, orange brown clay, M<Wp			0.7				
				U_{50}					
	1				1.0		pp = 150-160		
	1.15	SANDY CLAY: Very stiff, grey brown sandy clay							
	1.25				1.2		pp = 350-400		
	1.3	SANDSTONE: Extremely low strength, extremely weathered, orange brown sandstone with soil like properties		D	1.3				
		Bore discontinued at 1.3m. Refusal on sandstone							
	2								
	3								

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:**

TYPE OF BORING: 60mmϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Billard Leece Partnership Pty Ltd
PROJECT: Central Coast Schools - Warnervale
LOCATION: 75 Warnervale Road, Warnervale

SURFACE LEVEL: --
EASTING: 356180
NORTHING: 6319943
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 83313.00
DATE: 21/12/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.15	FILLING: Green grey and brown gravelly sand roadbase filling, humid		D	0.1				
		SAND: Very dense, grey brown sand with trace rootlets, humid		D	0.2				
	0.35	CLAY: Hard, orange brown and red brown clay with trace organics and some sand			0.4				
				U_{50}	0.55				
	1			D	1.0				1
	1.05	SANDSTONE: Extremely low strength, extremely weathered, grey sandstone with soil like properties		D	1.1				
	1.1	Bore discontinued at 1.1m. Refusal on sandstone							
	2								2
	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:**

TYPE OF BORING: 60mmϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Billard Leece Partnership Pty Ltd
PROJECT: Central Coast Schools - Warnervale
LOCATION: 75 Warnervale Road, Warnervale

SURFACE LEVEL: --
EASTING: 356080
NORTHING: 6320017
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 83313.00
DATE: 21/12/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		SAND: Medium dense, grey brown sand with trace clay, humid		D	0.1				
	0.18	SANDY CLAY: Stiff, yellow brown sandy clay with trace organics, M<Wp			0.25				
				B	0.3		pp = 220-280		
		- grading to red brown at 0.5m		D	0.5		pp = 120-150		
					0.6		pp = 280-320		
	0.65								
	0.7	SANDSTONE: Extremely low strength, extremely weathered, grey sandstone with soil like properties		D	0.7				
		Bore discontinued at 0.7m. Refusal on sandstone							
	1								1
	2								2
	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:**

TYPE OF BORING: 60mmϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Billard Leece Partnership Pty Ltd
PROJECT: Central Coast Schools - Warnervale
LOCATION: 75 Warnervale Road, Warnervale

SURFACE LEVEL: --
EASTING: 356180
NORTHING: 6319902
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 83313.00
DATE: 21/12/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		SAND: Dense, grey brown sand with trace rootlets, humid		D	0.1				
	0.35	CLAY: Very stiff, orange brown and red brown clay with trace organics and some sand, M<Wp			0.4		pp >400		
				D	0.5				
					0.8		pp >400		
	1.0	SANDSTONE: Extremely low strength, extremely weathered, grey and yellow brown sandstone with soil like properties							
				D	1.5		pp >500		
	1.7	Bore discontinued at 1.7m. Refusal on sandstone							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:**
TYPE OF BORING: 60mmϕ Dynamic Push Tube (continuous sample)
WATER OBSERVATIONS: No Free Groundwater Observed
REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Billard Leece Partnership Pty Ltd
PROJECT: Central Coast Schools - Warnervale
LOCATION: 75 Warnervale Road, Warnervale

SURFACE LEVEL: --
EASTING: 356060
NORTHING: 6319943
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 83313.00
DATE: 21/12/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		SANDY CLAY: Stiff, yellow brown sandy clay with some organics		D	0.1				
					0.2		pp = 90-150		
	0.25	SAND: Medium dense, grey brown sand with trace rootlets, humid		D	0.3				
	0.35	CLAYEY SAND: Very dense, orange brown clayey sand with decomposed organics and blue grey staining, humid		D/E	0.5				
				D/E	0.65				
	0.7								
	0.75	SANDSTONE: Extremely low strength, extremely weathered, grey sandstone with soil like properties							
		Bore discontinued at 0.75m. Refusal on sandstone							
	1								
	2								
	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:**

TYPE OF BORING: 60mmϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Billard Leece Partnership Pty Ltd
PROJECT: Central Coast Schools - Warnervale
LOCATION: 75 Warnervale Road, Warnervale

SURFACE LEVEL: --
EASTING: 356060
NORTHING: 6319878
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 83313.00
DATE: 21/12/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.05	SAND: Loose, grey brown sand with trace clay, humid							
		CLAY: Firm to stiff, orange brown clay with trace organics, M~Wp			0.2				
				U_{50}	0.3		pp = 130-160		
					0.5		pp = 140-180		
	0.8	CLAYEY SAND: Very dense, orange brown mottled grey clayey sand, humid							
	1			D	1.0				
	1.4	CLAY: Very stiff, grey clay, M<Wp							
					1.5		pp = 280-350		
				D	1.6				
	1.7								
	1.75	SANDSTONE: Extremely low strength, extremely weathered, grey sandstone with soil like properties							
		Bore discontinued at 1.75m. Refusal on sandstone							
	2								
	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:**

TYPE OF BORING: 60mmϕ Dynamic Push Tube (continuous sample)

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Billard Leece Partnership Pty Ltd
PROJECT: Central Coast Schools - Warnervale
LOCATION: 75 Warnervale Road, Warnervale

SURFACE LEVEL: --
EASTING: 356066
NORTHING: 6319799
DIP/AZIMUTH: 90°/--

BORE No: 9
PROJECT No: 83313.00
DATE: 21/12/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		SAND: Loose, grey brown sand with trace rootlets, humid		D	0.4				
	0.5	CLAYEY SAND: Medium dense, orange brown clayey sand with some organics, moist		D	0.7				
	1.0	SANDY CLAY: Stiff to very stiff, yellow brown mottled grey sandy clay, M<Wp			1.2		pp = 190-240		
				D	1.5				
					1.7		pp = 350-380		
					2.3		pp = 380-400		
	2.5	Bore discontinued at 2.5m. Limit of investigation		D	2.5				

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3

RIG: Toyota 4WD **DRILLER:** M Harrison **LOGGED:** M Harrison **CASING:**
TYPE OF BORING: 60mmϕ Dynamic Push Tube (continuous sample)
WATER OBSERVATIONS: No Free Groundwater Observed
REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Material Test Report

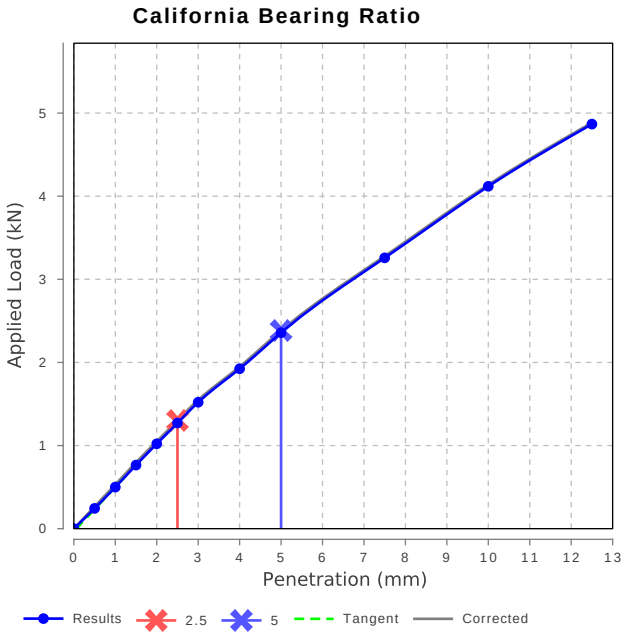
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Central Coast Laboratory
Unit 5/3 Teamster Close Tuggerah NSW 2259
Phone: (02) 4351 1422
Fax: (02) 4351 1422
Email: dan.byrnes@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Dan Byrnes
Laboratory Manager
NATA Accredited Laboratory Number: 828

Report Number: **83313.00-1**
Issue Number: 1
Date Issued: 22/01/2018
Client: Billard Leece Partnership Pty Ltd
Level 7/180 Flinders Street, Melbourne VIC 3000
Contact: Michael Cashell
Project Number: 83313.00
Project Name: Central Coast Schools - Warnervale
Project Location: 75 Warnervale Road, Warnervale
Work Request: 656
Sample Number: 18-656C
Date Sampled: 10/01/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **1 (0.7-0.9m)**
Material: Orange brown mottled grey SANDY CLAY

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**12**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.89		
Optimum Moisture Content (%)	12.5		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	98.5		
Dry Density after Soaking (t/m^3)	1.89		
Field Moisture Content (%)	10.8		
Moisture Content at Placement (%)	12.5		
Moisture Content Top 30mm (%)	13.3		
Moisture Content Rest of Sample (%)	13.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

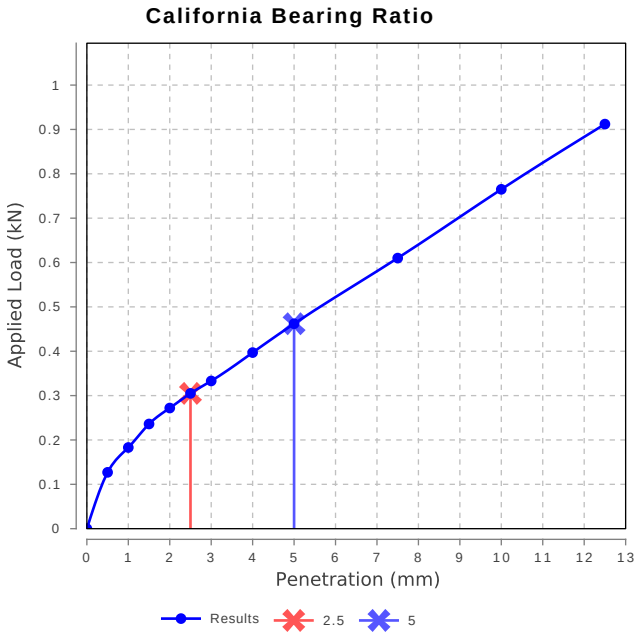
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Central Coast Laboratory
Unit 5/3 Teamster Close Tuggerah NSW 2259
Phone: (02) 4351 1422
Fax: (02) 4351 1422
Email: dan.byrnes@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Dan Byrnes
Laboratory Manager
NATA Accredited Laboratory Number: 828

Report Number: **83313.00-1**
Issue Number: 1
Date Issued: 22/01/2018
Client: Billard Leece Partnership Pty Ltd
Level 7/180 Flinders Street, Melbourne VIC 3000
Contact: Michael Cashell
Project Number: 83313.00
Project Name: Central Coast Schools - Warnervale
Project Location: 75 Warnervale Road, Warnervale
Work Request: 656
Sample Number: 18-656D
Date Sampled: 10/01/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **5 (0.25-0.5m)**
Material: Yellow brown SANDY CLAY

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**2.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.71		
Optimum Moisture Content (%)	18.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.66		
Field Moisture Content (%)	20.3		
Moisture Content at Placement (%)	18.1		
Moisture Content Top 30mm (%)	23.0		
Moisture Content Rest of Sample (%)	19.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	3.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number: **83313.00-1**
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Level 7/180 Flinders Street, Melbourne VIC 3000
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NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Dan Byrnes
Laboratory Manager
NATA Accredited Laboratory Number: 828

Shrink Swell Index AS 1289 7.1.1 & 2.1.1		
Sample Number	18-656A	18-656B
Sampling Method	Sampled by Engineering Department	Sampled by Engineering Department
Date Sampled	09/01/2018	09/01/2018
Date Tested	10/01/2018	10/01/2018
Material Source	In-situ	In-situ
Sample Location	3 (0.7-1.0m)	4 (0.4-0.55m)
Inert Material Estimate (%)	0	0
Pocket Penetrometer before (kPa)	225	600
Pocket Penetrometer after (kPa)	100	200
Shrinkage Moisture Content (%)	18.7	21.3
Shrinkage (%)	**5.3**	**3.4**
Swell Moisture Content Before (%)	18.9	21.0
Swell Moisture Content After (%)	27.1	24.0
Swell (%)	**7.6**	**5.6**
Shrink Swell Index Iss (%)	**5.0**	**3.4**
Visual Description	Orange brown SANDY CLAY	Orange brown and red brown SANDY CLAY
Cracking	Uncracked	Slightly Cracked
Crumbling	No	Yes
Remarks	**	**

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.
NATA Accreditation does not cover the performance of pocket penetrometer readings.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Billard Leece Partnership Pty Ltd			TITLE:	**Locations of Tests**
OFFICE:	Central Coast	DRAWN BY:	DRC		**Central Coast Schools – School No. 01 - Warnervale**
SCALE:	As Shown	DATE:	31.1.2018		**75 Warnervale Road, Warnervale**

PROJECT No:	83313.00
DRAWING No:	1
REVISION:	0