Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Roseville College SWELL Centre
29 & 37 Bancroft Avenue, Roseville

Prepared for
Anglican Schools Corporation

Project 85310.01
October 2019

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	85310.01	Document No.	R.001.Rev1
Document title	Report on Geotechnical Investigation Proposed Roseville College SWELL Centre		
Site address	29 & 37 Bancroft Avenue, Roseville		
Report prepared for	Anglican Schools Corporation		
File name	85310.01.R.001.Rev1		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Peter Valenti	Michael J Thom	31 July 2019
Revision 1	Peter Valenti	Geoff Young	11 October 2019

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Ms Maddy Ryan - EPM Projects Pty Ltd
Revision 1	1	0	Mr Jordan Graham - EPM Projects Pty Ltd

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

	Signature		Date
Author	Peter Valenti		11.10.19
Reviewer	Peter Valenti	for Geoff Young	11.10.19

bsi. ISO 9001 Quality Management
FS 604853

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Table of Contents

Page

Douglas Partners
Geotechnics / Environment / Groundwater

Report on Geotechnical Investigation
Proposed Roseville College SWELL Centre
29 & 37 Bancroft Avenue, Roseville

1. Introduction

This report presents the results of a geotechnical investigation undertaken for the proposed SWELL Centre at 29 & 37 Bancroft Avenue, Roseville (Roseville College). The work was commissioned by Anglican Schools Corporation, and was undertaken in consultation with the project managers EPM Projects Pty Ltd.

It is understood the SWELL development includes the construction of a two-storey car park with rooftop hardcourts, a multi-purpose three-storey building with swimming pool and the widening of Recreational Avenue. Excavation of between 6 m and 8 m deep is anticipated for the car park, building basement levels, and swimming pool.

This investigation included the drilling of boreholes, installation of groundwater wells and laboratory testing. The results of the field work and laboratory testing are provided in this report together with comments relating to design and construction.

Reference should also be made to a contamination assessment (ref: Report 85310.02.R.001.Rev0, dated August 2019) undertaken concurrently with this investigation by DP.

2. Site Description

The site of the proposed development is located in the north-eastern corner of the Roseville College school grounds, on the southern side of Bancroft Avenue, Roseville. A residential property at 37 Bancroft Avenue also forms part of the eastern side of the site. The Joy Yeo Performing Arts Complex with basement car park at RL 81.4 m, Roseville Lawn Tennis Club and Recreation Avenue are located to the south, a residential one to two-storey building to the east, and Rose Cottage to the west.

At the time of the investigation, the site was occupied by tennis courts, pavements and landscaped garden areas within Roseville College, with a residential building, swimming pool and tennis court present within 37 Bancroft Avenue. Mature trees are located mostly within the northern and eastern areas of the site.

The ground surface slopes down at about 5° towards the east from about RL 86 m to RL 82 m.

The northern end of Recreation Avenue includes an asphaltic concrete pavement underlain by numerous utilities. Aerial photographs pre-dating October 2018 show that a concrete pavement used to occupy most of the pavement area. A grassed batter about 1 m high extends along the eastern side of the road and slopes down towards the Tennis Club. A similar height, timber sleeper retaining

wall is located at the southern and northern ends of the eastern boundary, with backfilled ground behind the wall.

3. Regional Geology

Reference to the Sydney 1:100 000 Series Geological Sheet indicates that the site is underlain by Ashfield Shale, with Hawkesbury Sandstone located within lower-lying areas about 200 m north of the site. Ashfield Shale, which typically comprises black to dark grey shale and laminite, is often underlain by a transitional unit, the Mittagong Formation, which typically includes interbedded fine grained sandstones and siltstones. Hawkesbury Sandstone typically comprises medium to coarse grained quartz sandstone with some shale bands or lenses. The Mittagong Formation was confirmed by the previous investigation and the Hawkesbury Sandstone by the current investigation.

Reference to the Prospect/Parramatta River Acid Sulfate Soils Risk Map Edition 2 (DLWC, 1997) indicates that the site is located in an area with no known acid sulfate soil occurrence.

4. Previous Investigations

DP previously completed a geotechnical investigation for the Joy Yeo Performing Arts Centre in 2005, which included two rock-cored boreholes (BH302 and BH303) to depths of about 7.6 m and 10.3 m. The boreholes were located at the southern end of the proposed SWELL Centre. The locations of the previous boreholes are shown on Drawing 1 in Appendix B, with borehole logs provided in Appendix C.

The subsurface profile encountered in the previous boreholes (BH302 and BH303) is summarised as:

- Filling – silty or sandy clay filling to depths of 0.5 m;
- Natural Soil – stiff and very stiff silty clay and clay to depths of 2.5 m;
- Bedrock – initially extremely low strength sandstone, generally increasing to medium and high strength sandstone/siltstone, with many extremely or very low strength rock bands. Below about 7 m depth, the lower strength bands are generally absent leaving medium and high strength sandstone to the bottom of the boreholes.

No free groundwater was observed in the boreholes during augering and the use of water as a flushing medium during rock coring precluded any further observations of groundwater.

5. Field Work Methods

The current field work for this investigation included:

- Inspection of the site by an experienced geotechnical engineer;
- Drilling of six boreholes (BH401 to BH406) within the area of the proposed SWELL Centre. Boreholes BH401, BH405 and BH406 were rock-cored boreholes, with groundwater monitoring

wells installed within BH401 and BH406. Boreholes BH402 and BH404 were drilled to confirm the depth to rock. These boreholes were drilled using a small drilling rig with push-tubes within the soil and then NMLC-sized (50 mm diameter) diamond core drilling techniques to obtain rock core samples.

One hand augered borehole (BH403) was undertaken at the rear of the residence at 37 Bancroft Avenue due to restricted access to a drill rig and for contamination testing purposes;

- Drilling of two hand-augered boreholes (BH407 and BH408) along the eastern side of Recreational Avenue. Note BH407 was located directly adjacent to the existing pavement/kerb and BH408 was located within the backfilled area between the road and the timber-sleeper retaining wall;
- Standard penetrometer tests (SPTs) and dynamic cone penetrometer (DCP) tests were undertaken within the boreholes and at location 409 to assess the soil strength;
- Co-ordination of field work, logging of the soil/rock profile, and photographing and Point Load Strength Index (Is_{50}) testing on selected samples of the rock core by a geotechnical engineer.

The locations of the current boreholes are shown on Drawing 1 in Appendix B.

The ground surface level and position at the borehole locations were measured using a high-precision global positioning system. Surface levels were measured relative to Australian height datum (AHD) and coordinates measured relative to MGA94 Zone 56.

6. Field Work Results

Details of the subsurface conditions encountered in the current boreholes are provided in the detailed borehole logs in Appendix C, together with colour photographs of the rock core samples and notes defining classification methods and descriptive terms.

The subsurface conditions encountered in current boreholes (BH401 to BH406) within the area of the proposed SWELL Centre can be summarised as:

- Pavement – 50 mm thick asphaltic concrete over a 150 mm thick concrete slab at BH406;
- Filling – clayey silt and silty sand (topsoil) filling in the upper 0.1 m to 0.25 m depths and/or clayey filling to depths of between 0.8 m and 1.2 m in BH402 to BH406;
- Natural Soil – firm/stiff to very stiff clay and sandy clay to depths of between 1.6 m and 2.5 m. Borehole BH403 was discontinued in stiff clay at 1.1 m depth due to hand-auger refusal occurring on an ironstone band;
- Bedrock – extremely low strength sandstone below depths of between 1.6 m and 2.5 m.

  In rock-cored boreholes BH401, BH405 and BH406, medium strength sandstone was intersected below depths of 2.0 (RL 80.1 m), 3.7 m (RL 81.9 m) and 4.7 m (RL 81.7 m), respectively. Extremely low strength rock or clay seams were present within the medium strength sandstone within BH405 and BH406.

High strength sandstone was encountered in BH401 and BH405 below about RL 75 m and RL 79 m.

The rock discontinuities were typically along bedding planes dipping up to 10° below horizontal.

No free groundwater was observed in the boreholes during push-tubing and the use of water as a flushing medium during rock coring precluded any further observations of groundwater.

Following purging of drilling fluid, groundwater was measured on 16 July 2019 within groundwater monitoring wells in BH401 and BH406 at approximate depths of 3.8 m (RL 78.3 m) and 3.3 m (RL 83.1 m), respectively.

The subsurface conditions encountered in current boreholes (BH407 and BH408) within the area of the proposed Recreation Avenue widening can be summarised as:

- Pavement – A concrete kerb to 0.15 m underlain by roadbase gravel to 0.3 m depth in BH407;
- Filling – sandy silt (topsoil) filling then clayey filling to 0.6 m in BH408, located behind the existing retaining wall;
- Natural Soil – firm/stiff to very stiff clay to depths of 1.4 m and 1.6 m, at which depth the boreholes were discontinued due to hand-auger refusal on ironstone bands.

No free groundwater was observed within the borehole depths whilst drilling.

The results of DCP409 indicated moderately to well compacted filling and/or very stiff and hard clay to 1.2 m depth, with the DCP test discontinued at 1.2 m depth.

7. Laboratory Testing

7.1 Physical Properties

Selected soil samples were tested for Atterberg Limits and linear shrinkage to assess the soil plasticity, and California bearing ratio (CBR) for pavement design purposes by others. The detailed laboratory test results for physical properties are included in Appendix D and are summarised in Table 1.

Table 1: Laboratory Test Results of Physical Properties

Bore	Depth (m)	Material	W_F (%)	W_P (%)	W_L (%)	PI (%)	LS (%)	CBR (%)	MDD (t/m^3)	OMC (%)	Swell (%)
BH405	0.5-1.0	Clay	20.0	-	-	-	-	6	1.8	17.0	2.0
BH407	0.3-0.8	Clay	20.1	-	-	-	-	4	1.75	17.0	2.0
BH405	1.9-2.0	Clay	-	22	53	31	12.0	-	-	-	-
BH406	0.9-1.0	Clay	-	28	68	40	13.0	-	-	-	-
BH407	0.4-0.5	Clay	-	16	37	21	10.5	-	-	-	-

Notes: W_F = Field Moisture Content; W_P = Plastic Limit; W_L = Liquid Limit; PI = Plasticity Index; CBR = California Bearing Ratio; MDD = Maximum Dry Density; OMC = Optimum Moisture Content; LS = Linear Shrinkage

Selected samples of the rock core were tested in the laboratory to determine the Point Load Strength Index (Is_{50}) values to assist with the rock strength classification. The results of the testing are shown on the borehole logs at the appropriate depth. The Is_{50} values for the rock ranged from approximately 0.3 MPa to 2.2 MPa, indicating that the rock samples tested were medium to high strength. Assuming a multiplication factor of 20 x $Is_{(50)}$ for sandstone bedrock gives an estimated uniaxial compressive strength (UCS) ranging from approximately 6 MPa to 44 MPa for the samples tested.

7.2 Chemical Properties

Two soil samples were analysed to assess the aggressivity of the soil to buried steel and concrete structures. A summary of the results is provided in Table 2. The detailed laboratory test report is included in Appendix D.

Table 2: Summary of Soil Aggressivity Test Results

Borehole	Soil Type	Depth (m)	pH (pH units)	EC (µS/cm)	Chloride (mg/kg)	Sulfate (mg/kg)
BH401	Sandy Clay	1.5 – 1.6	5.1	78	44	71
BH408	Clay	0.9 – 1.0	4.7	71	<10	100

Notes: EC = electrical conductivity; All samples mixed at a ratio of 1(soil):5(water) prior to testing

8. Proposed Development

It is understood the development will consists of three parts. Part 1 will involve the demolition of two existing sports courts and construction of a two-storey car park consisting of a one to two level basement with two hardcourts on the rooftop. A floor level at RL 80.2 m is proposed for car park Level 1.

Part 2 involves the demolition of a residential building at 37 Bancroft Avenue and construction of a three-storey building including a swimming pool, gym, general learning areas and other student/staff facilities with basement car park (extending from Part 1). A floor level at RL 78.9 m is proposed for basement Level 1 and the pool deck. The bottom of the pool is proposed to be RL 77.1 m, with the proposed water balance tank and air supply tunnel having a base level up to 1 m deeper than the bottom of the pool.

Excavation of between 6 m and 8 m deep is anticipated for the car park, building basement levels, and swimming pool.

Part 3 involves the widening and reconstruction of Recreation Avenue with a retaining wall along the eastern common boundary with Roseville Lawn Tennis Club and a driveway at the northern end of the Recreation Avenue to the new basement car park.

9. Comments

9.1 Geological Model

A summary of the subsurface conditions encountered across the proposed SWELL Centre site are shown in four interpreted geotechnical cross-sections A - A' to D - D' in Drawings 2 to 5 in Appendix B, with the proposed basement floor levels and bottom of pool shown indicatively. It should be noted that the interpreted geotechnical boundaries are shown for illustration purposes only and that the soil/rock profiles should be expected to vary in between and away from the borehole locations.

The proposed SWELL Centre is likely to be underlain by filling less than about 1.5 m deep, overlying stiff to very stiff residual clay extending to the top of extremely low strength Hawkesbury Sandstone bedrock ranging between about RL 80 m and RL 86 m.

The bedrock surface is expected to dip down towards the north and east. The rock is initially extremely low to very low strength and generally becomes more consistent medium and high strength sandstone with depth.

Based on measurements of groundwater within monitoring wells, groundwater seepage is expected at the soil and rock interface and within bedrock along rock joints and extremely/highly weathered bedrock bands, generally above the proposed basement levels. The groundwater seepage levels should be expected to fluctuate with variations in climate.

Along Recreation Avenue, the subsurface conditions beneath the existing pavement materials are likely to include residual clay, with filling expected within service trenches beneath the pavement and

behind retaining walls on the eastern side of the pavement. Groundwater seepage should be expected at the soil and rock interface.

9.2 Earthworks

9.2.1 Excavation Conditions

For the proposed basement levels (i.e. between RL 80.2 m and RL 77.1 m), mostly medium with some high strength sandstone is expected to be exposed at bulk excavation levels.

Excavations for the SWELL Centre will initially intersect filling, natural clays and extremely low and very low strength rock which should be readily removed using conventional earthmoving equipment such as excavators. Excavation of low strength (or stronger) rock would generally require ripping by a bulldozer, with excavation of medium and high strength rock requiring ripping by a heavy bulldozer. Alternatively, rock hammers could be used to break up the rock. Productivity within medium and high strength rock may be low (even with large dozers) and therefore some pre-splitting or rock hammering may be necessary to improve efficiency.

Detailed excavations for service trenches, footings and lift pits within medium strength (or stronger) rock could be carried out using a rotary rock saw with diamond teeth, rock hammers or rotary milling heads.

9.2.2 Groundwater

Groundwater was encountered within monitoring wells in BH401 and BH406 at approximate depths of 3.8 m (RL 78.3 m) and 3.3 m (RL 83.1 m), respectively. The water measured is above the proposed basement levels, and is expected to be groundwater seepage within the bedrock rather than a transient water table. Groundwater seepage is expected to enter the excavation at the soil/rock interface and through rock joints and defects in the basement floor and walls, particularly after periods of rainfall.

During construction and in the long term, it is anticipated that seepage into the excavation could be controlled by perimeter and subfloor drainage connected to a sump-and-pump system. On this basis, a drained basement may be considered for this site. Generally, water collected from dewatering operations should be suitable for disposal by pumping to stormwater drains subject to confirmation testing of groundwater quality and approval from regulatory authorities. Similarly, consideration may also be given to recycling the water for irrigation of school gardens.

Previous experience indicates that the water within Hawkesbury Sandstone and Ashfield Shale can also have moderate concentrations of dissolved solids including iron. Once groundwater comes into contact with the atmosphere, precipitation of iron oxides is likely to occur and provision should be made for the periodic filtering and/or cleaning of this precipitate from subsoil drains, sumps, pumps and other fittings.

Reference should be made to DP's preliminary contamination investigation (Ref: Report 85310.01.R.001.Rev0) for preliminary advice on groundwater.

9.2.3 Disposal of Excavated Material

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the Waste Classification Guidelines (EPA, 2014). Reference should be made to DP's contamination report (Ref: Report 85310.01.R.001.Rev0) for details on the preliminary contamination status of the soils.

9.2.4 Acid Sulfate Soils

Acid sulfate soils are typically encountered in low-lying (generally below RL 5 m AHD), water-logged, estuarine or marine soil deposits of recent Holocene Age, and can include organic deposits.

Given the site topography (i.e. above RL 82 m), residual soils encountered within boreholes, and DP's experience in the site area, ASS are not expected at the site.

9.2.5 Dilapidation Surveys

Dilapidation (building condition) reports should be undertaken on surrounding properties that may be affected by the excavations prior to commencing work on the site to document any existing defects so that any claims for damage due to construction related activities can be accurately assessed.

9.2.6 Vibrations

During excavation, it will be necessary to use appropriate methods and equipment to keep ground vibrations at adjacent buildings and structures within acceptable limits. The level of acceptable vibration is dependent on various factors including the type of building structure (e.g. reinforced concrete, brick, etc.), its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the building and the vibration transmitting medium.
A ground vibration limit of 8 mm/sec vector sum peak particle velocity (VSPPV) is commonly adopted at the foundation level of existing buildings/structures for both architectural and human comfort considerations, although this vibration limit may need to be reduced if there are sensitive buildings, structures or equipment in the area. It is noted that vibration levels above 2 - 3 mm/sec may be strongly perceptible to occupants of adjacent buildings.

As the magnitude of vibration transmission is site specific, it is recommended that a vibration trial be undertaken at the commencement of rock excavation. The trial may indicate that smaller or different types of excavation equipment should be used for bulk (or detailed) excavation purposes.

9.3 Excavation Support

9.3.1 Batter Slopes

Recommended temporary and permanent batter slopes for unsupported excavations up to a maximum height of 3 m are shown in Table 3. Such batters may be more appropriate for use in the road widening. Deeper excavations and/or steeper batters will require further geotechnical review and input. The batters recommended below are also subject to assessment of jointing in the rock by a geotechnical engineer. If adverse jointing is present in the rock then flatter batters or stabilisation may

be required. If surcharge loads are applied near the crest of the slope then further geotechnical review and probably flatter batters or stabilisation using rock bolts or soil nails may be required.

Table 3: Recommended Safe Batter Slopes for Exposed Material

Exposed Material	Maximum Temporary Batter Slope (H : V)	Maximum Permanent Batter Slope (H : V)
Filling and Natural Clay	1 : 1	2 : 1
Variable Extremely Low to Very Low Strength Bedrock	0.75 : 1	1 : 1
Consistent Medium Strength (or Stronger) Sandstone	Vertical*	Vertical*

Note: * Subject to jointing assessment by experienced Geotechnical Engineer/Engineering Geologist

Unlike medium strength (or stronger) sandstone, weaker rock is expected to deteriorate and break down in the long-term if left exposed to the weather. It is therefore recommended that excavations exposing soil and/or extremely low to low strength rock should be covered with mesh reinforced shotcrete pinned to the face with dowels for long term protection to erosion.

9.3.2 Retaining Walls

The proposed basement excavation and Recreation Avenue road widening are likely to extend up to or close to the site boundaries. Vertical excavations on the site will require retaining structures both during construction and as part of the final structure.

Shoring support methods generally require tie-back anchors for stability, particularly where limiting ground movements behind the wall is essential. The use of rock anchors extending onto neighbouring properties and public land will require permission from the property owners.

A soldier pile/infill panel wall system consisting of bored, rock socketed piles, at typical intervals of 2 – 3 m centres is considered to be a suitable shoring system for this site. As excavation proceeds, structurally reinforced, shotcrete infill panels, or similar, are constructed in between the piles. A row of ground anchors may be required to provide additional lateral support. Excavation drops of 1.5 m depth should be inspected by a geotechnical engineer to confirm subsurface conditions and to check whether any additional stabilisation or support is required.

A more rigid contiguous pile wall consisting of closely spaced, or almost touching, rock-socketed piles may be required where movement sensitive structures are to be supported or where surcharge loads from buildings or similar are present. The wall may form part of the final structure, sealed by a shotcrete panel facing that is constructed as the bulk excavation progresses.

Both of the pile wall systems above can often be designed to also provide foundation support for the perimeter of the structure. The piles are normally drilled with a minimum “toe in” design to provide lateral restraint at the base of the excavation based on the passive resistance of the rock in which the pile is socketed.

The drilling of the shoring piles may require the use of a high-powered piling rig capable of drilling into medium and high strength rock. Prospective piling contractors should be asked to make their own assessment on the type of equipment required to achieve the design requirements and pile depths.
For the road widening, it is anticipated that a retaining wall less than 2 m high is required. In this case, gravity or cantilevered retaining walls are considered to be a suitable retention system.

9.3.3 Design

Excavations braced, anchored or propped, either temporarily or permanently, will be subject to earth pressures above the top of medium strength rock.

The preliminary design of cantilevered or single propped/anchored walls may be based on the parameters provided in Table 4, with a triangular earth pressure distribution (i.e. with zero pressure at the ground surface) calculated using an active earth pressure coefficient (k_a) where some wall movement is acceptable, or an "at-rest" earth pressure coefficient (k_o) where wall movement is to be reduced. The pressure coefficients in Table 4 assume a level ground surface behind the top of the wall.

Table 4: Recommended Earth Pressure Coefficients and Bulk Unit Weights

Material	Earth Pressure Coefficient		Bulk Unit Weight (kN/m^3)
	Active (K_a)	At Rest (K_o)	
Filling or Natural Soil	0.3	0.5	20
Extremely Low to Very Low Strength Bedrock	0.1	0.15	22
Medium Strength (or Stronger) Bedrock	0	0	24

All surcharge loads should be allowed for in the retaining wall design including building footings, inclined slopes behind the wall, traffic and construction related activities.

Retaining/shoring walls should be designed for full hydrostatic pressures unless appropriate drainage systems are implemented in the design.

The final or detailed design of retaining walls should be undertaken using a computer program such as WALLAP, which can take due regard of soil-structure interaction during the progressive stages of wall construction, anchoring and bulk excavation.

9.3.4 Passive Resistance

Passive resistance for piles founded in rock below the base of the bulk excavation (including allowance for services and/or footings) may be based on the ultimate passive restraint value provided in Table 5. This ultimate value represents the pressure mobilised at high displacements and therefore it will be necessary to incorporate a factor of safety of at least 2 to limit wall movement. The top 0.5 m

of the pile socket should be ignored due to possible disturbance from the excavation process and over-excavation.

Table 5: Recommended Passive Resistance Values

Foundation Stratum	Ultimate Passive Pressure (kPa)
Medium Strength (or Stronger) Sandstone	4,000

9.3.5 Ground Anchors

The preliminary design of temporary ground anchors for the support of shoring/retaining systems may be carried out on the basis of the parameters and maximum bond stresses given in Table 6.

Table 6: Bond Stresses for Anchor Design

Material Description	Maximum Allowable Bond Stress (kPa)	Maximum Ultimate Bond Stress (kPa)
Extremely Low to Very Low Strength Bedrock	75	150
Medium Strength (or Stronger) Bedrock	500	1000

The parameters given in Table 6 assume that the drilled holes are clean and adequately flushed. The anchors should be bonded behind a line drawn up at 45 degrees from the base of the shoring or the top of medium (or stronger) strength sandstone, whichever is shallower. 'Lift-off' tests should be carried out to confirm the anchor capacities. It is suggested that ground anchors should be proof loaded to 125% of the design working load and locked-off at no higher than 80% of the working load.

It is anticipated that the building will support the shoring walls over the long term and therefore the ground anchors are expected to be temporary only. The use of permanent anchors would require careful attention to corrosion protection including full column grouting and the use of an internal corrugated sheathing over the full length of the anchor. A detailed specification would need to be prepared for the installation and stressing of permanent anchors.

9.4 Foundations

It is expected that mostly medium with some high strength sandstone will be exposed at the bulk excavation levels for the SWELL Centre. Therefore, shallow pad footings are likely to be appropriate to support the proposed building column loads.

Preliminary design of footings may be based on the parameters provided in Table 7, but will need to be confirmed with detailed investigations including additional rock-cored boreholes at the south-eastern and central areas of the site once the site is readily accessible to a drilling rig.

For footings located beyond the basement perimeter and for the retaining wall along the eastern side of the road widening, shallow footings may be founded on at least stiff clay and designed for an allowable bearing pressure of 100 kPa.

Table 7: Preliminary Design Parameters for Foundation Design

Foundation Material	Maximum Allowable Bearing Pressure		Maximum Ultimate Pressure		Elastic Modulus (MPa)
	End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	
Medium Strength Bedrock	3,500	350	15,000	600	500

Footings should be founded below a 45 degree line drawn up from the toe of any adjacent excavations or retaining walls.

Foundations proportioned on the basis of the allowable bearing pressure in Table 7 would be expected to experience total settlements of less than 1% of the footing width under the applied working load, with differential settlements between adjacent columns expected to be less than half of this value.

The results of the laboratory tests indicate that the natural clay is highly reactive and therefore highly susceptible to shrink-swell movements with variations in moisture conditions. Although the proposed development is not a residential development, the characteristic surface movement (y_s) is likely to be similar to a Class M Site Classification as defined in AS 2870 Residential slabs and footings. Assuming a single 10 m high tree is located 5 m away from the structure, additional movement due to trees (y_t) of 20 mm should be expected.

All footings should be inspected by a geotechnical engineer to confirm that foundation conditions are suitable for the design parameters.

9.5 Soil Aggressivity

The laboratory test results for soil aggressivity were compared with the exposure classifications outlined in Australian Standard AS 2159 – 2009 Piling – Design and installation. The results indicate that the soils tested are ‘mild’ to buried concrete elements and ‘non-aggressive’ to buried steel elements.

9.6 Seismic Design

In accordance with Australian Standard AS 1170 - 2007 Structural Design Actions, Part 4 Earthquake Actions in Australia, based on the current borehole information, a site subsoil Class C_e (Shallow Soil Site) is considered to be appropriate given the depth to very low strength or stronger rock is greater than 3 m. AS 1170 nominates a hazard factor (Z) of 0.08 for Sydney.

9.7 Subgrade Preparation

From a geotechnical perspective, the existing filling is considered to be suitable for re-use as engineered filling provided any deleterious materials (e.g. particles greater than 80 mm, topsoil or organic material, vegetation etc.) are removed prior to placement.

From an environmental/contamination perspective, however, the suitability of the existing soils for re-use as engineered filling (or in landscaped areas) on site and for off-site waste disposal should be confirmed with reference also made to DP's contamination advice report (Ref: 85310.01.R.001.Rev0).

For the Recreational Avenue road widening and the on-grade car park pavement, the following subgrade preparation measures are recommended up to design subgrade level:

- Remove any filling within the proposed pavement footprint to a depth of at least 0.5 m below design subgrade level, or to the top of natural soil, whichever is shallower;
- Proof roll the exposed subgrade surface using a minimum 10-tonne roller (or smaller if inaccessible) in non-vibration mode. The proof roll should be witnessed by an experienced geotechnical engineer to detect any 'soft' spots;
- Any loose/soft areas identified during proof rolling should be removed/rectified as directed by the geotechnical engineer;
- Replacement filling should then be placed in loose layer thicknesses not greater than 200 mm (dependent upon the size of compaction machinery) and compacted to a minimum dry density ratio of 100% relative to Standard compaction with moisture contents maintained within 2% of Standard optimum moisture content. Replacement and new filling should be free of oversize particles (>80mm) and deleterious material;
- Some moisture conditioning (i.e. drying or wetting) may be required for compaction of filling; and
- Density testing in accordance with AS 3798 - 2007 Guidelines on earthworks for commercial and residential developments should be undertaken to at least a Level 2 standard to verify the required compaction criteria is achieved.

9.8 Pavements

Based on the laboratory test results, CBR values of 4% and 6% were indicated for the natural clay. Based on DP's experience and given the potential for variable subgrade conditions, a design CBR value of 3% is suggested for the Recreational Avenue pavement thickness design.

For the basement car park, a design CBR of 20% could be adopted for the medium strength sandstone, which is expected to be exposed at bulk level.

9.9 Drainage

Surface and subsurface drainage for the proposed basement car park and Recreational Avenue road widening should be installed to direct water run-off away from the pavements. All collected stormwater and groundwater seepage should be designed to discharge into a suitable disposal system.

9.10 Further Investigation

It is recommended that further investigation including rock-cored boreholes be undertaken within the central and south-eastern corner of the SWELL Centre, where the present site was inaccessible to a drilling rig. This will provide geotechnical information for detailed design of the shoring and footings.

10. Limitations

Douglas Partners (DP) has prepared this report for this project at 29 & 37 Bancroft Avenue, Roseville in accordance with DP's proposal SYD190049.P.001.Rev1 dated 22 February 2019 and acceptance received from EPM Projects Pty Ltd, dated 6 March 2019, on behalf of the client, Anglican Schools Corporation. The work was carried out under a contract provided by Anglican Schools Corporation. This report is provided for the exclusive use of Anglican Schools Corporation for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

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

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

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the

hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

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

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

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

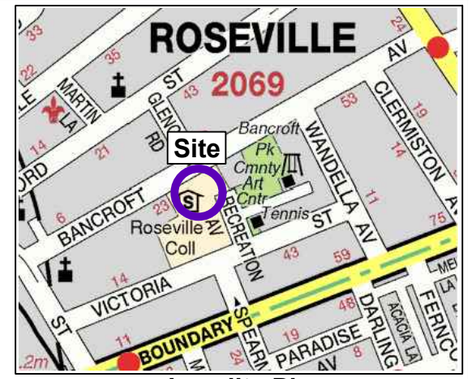
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawings

0 5 10 15 20 30 40 50m

1:500 @ A3



Locality Plan

NOTE:
2: Base image from Nearmap.com (Date 1.7.2019)
2: Test locations are approximate only and are shown with reference to existing features.

LEGEND

- Borehole location
- DCP test location
- Previous borehole location
- W Groundwater monitoring well
- A A' Geotechnical Cross Section A-A'

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Anglican Schools Corporation		TITLE: **Locations of Tests** **Proposed Roseville College SWELL Centre** **29 & 37 Bancroft Avenue, ROSEVILLE**
OFFICE: Sydney	DRAWN BY: PSCH	
SCALE: 1:1000 @ A3	DATE: 19.7.2019	

N

PROJECT No:	85310.01
DRAWING No:	1
REVISION:	0

A

A'

BH405
Offset 1.3m

BH404
Offset 0.6m

BH401
Offset 5.7m

FILLING

CLAY: st-vst

SANDSTONE: EL

SANDSTONE: M

SANDSTONE: H

st-vst
vst
vst
EL
M
M
H

N = 19
N = 20

Bottom Depth
10 m

st-vst
EL
EL

N = 13
refusal

Bottom Depth
2.35 m

N = 5
f-st
EL
refusal
M
M
H

Bottom Depth
10 m

Car Park Level 1
RL 80.2m

Bottom of Pool
RL 77.1m

90
88
86
84
82
80
78
76
74
72
70

0
10
20
30
40
50
60
70

DISTANCE ALONG PROFILE (m)

LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Concrete
- Filling
- Sandstone
- Sandstone coarse grained
- Sandstone fine grained
- Siltstone
- Silty Clay

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only. Should be read in conjunction with detailed logs.

ROCK STRENGTH
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High

SOIL STRENGTH/CONSISTENCY
f - Firm
st - Stiff
vst - Very stiff
h - Hard
l - Loose
md - Medium dense
d - Dense
vd - Very dense

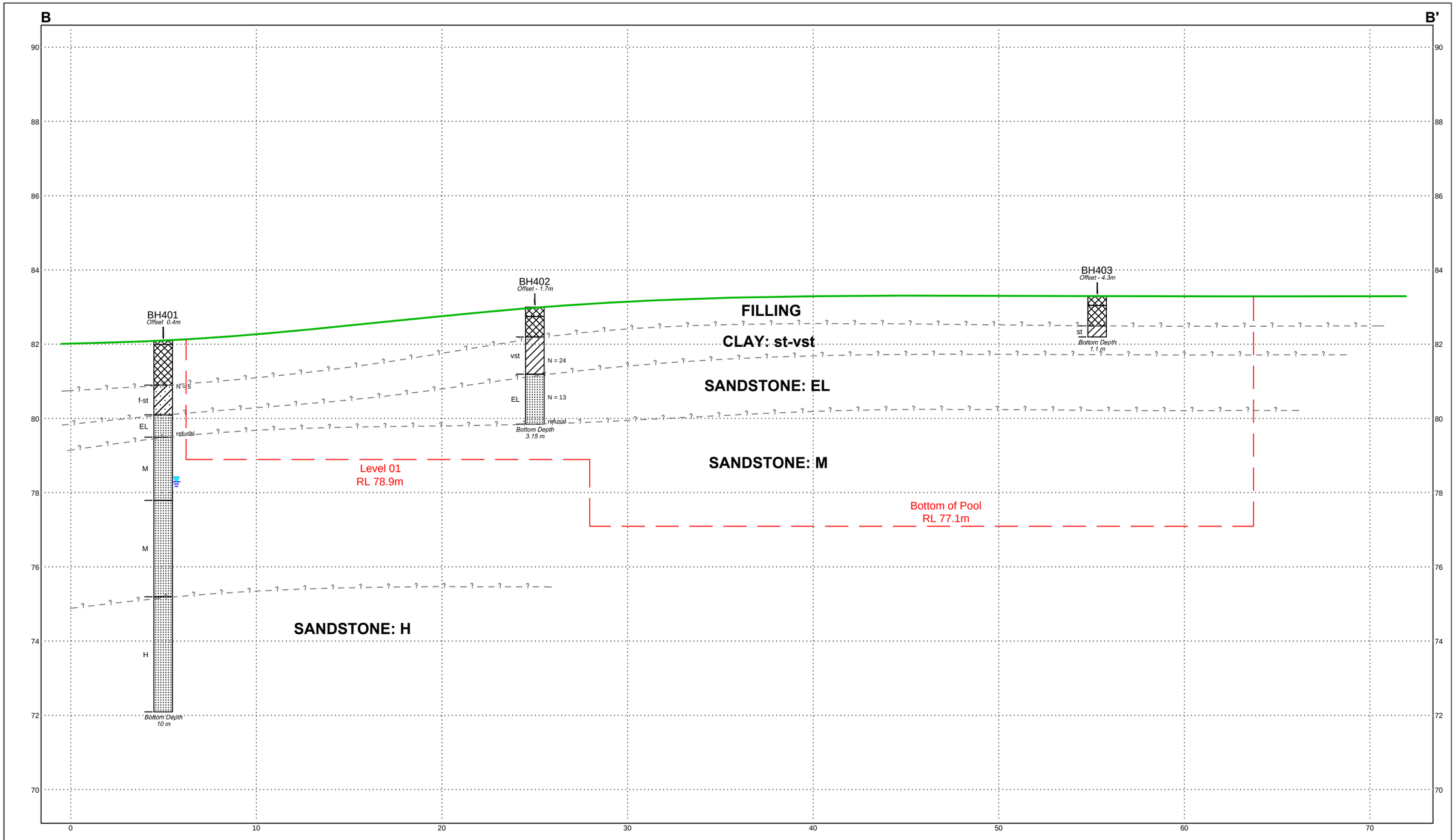
TESTS / OTHER
N - Standard penetration test value
- Water level
- Inferred Geological boundary

0 4
Horizontal Scale (metres)

Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Anglican Schools Corporation		TITLE: **Interpreted Geotechnical Cross Section A-A'**	PROJECT No: 85310.01
OFFICE: Sydney	DRAWN BY: LJH	**Proposed Roseville College SWELL Centre**	DRAWING No: 2
SCALE: 1:200 (H) 1:100 (V) @ A3	DATE: 09.10.2019	**29 & 37 Bancroft Avenue, ROSEVILLE**	REVISION: 1



LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Concrete
- Filling
- Sandstone
- Sandstone coarse grained
- Sandstone fine grained
- Siltstone
- Silty Clay

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only. Should be read in conjunction with detailed logs.

ROCK STRENGTH
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High

SOIL STRENGTH/CONSISTENCY
f - Firm
st - Stiff
vst - Very stiff
h - Hard
l - Loose
md - Medium dense
d - Dense
vd - Very dense

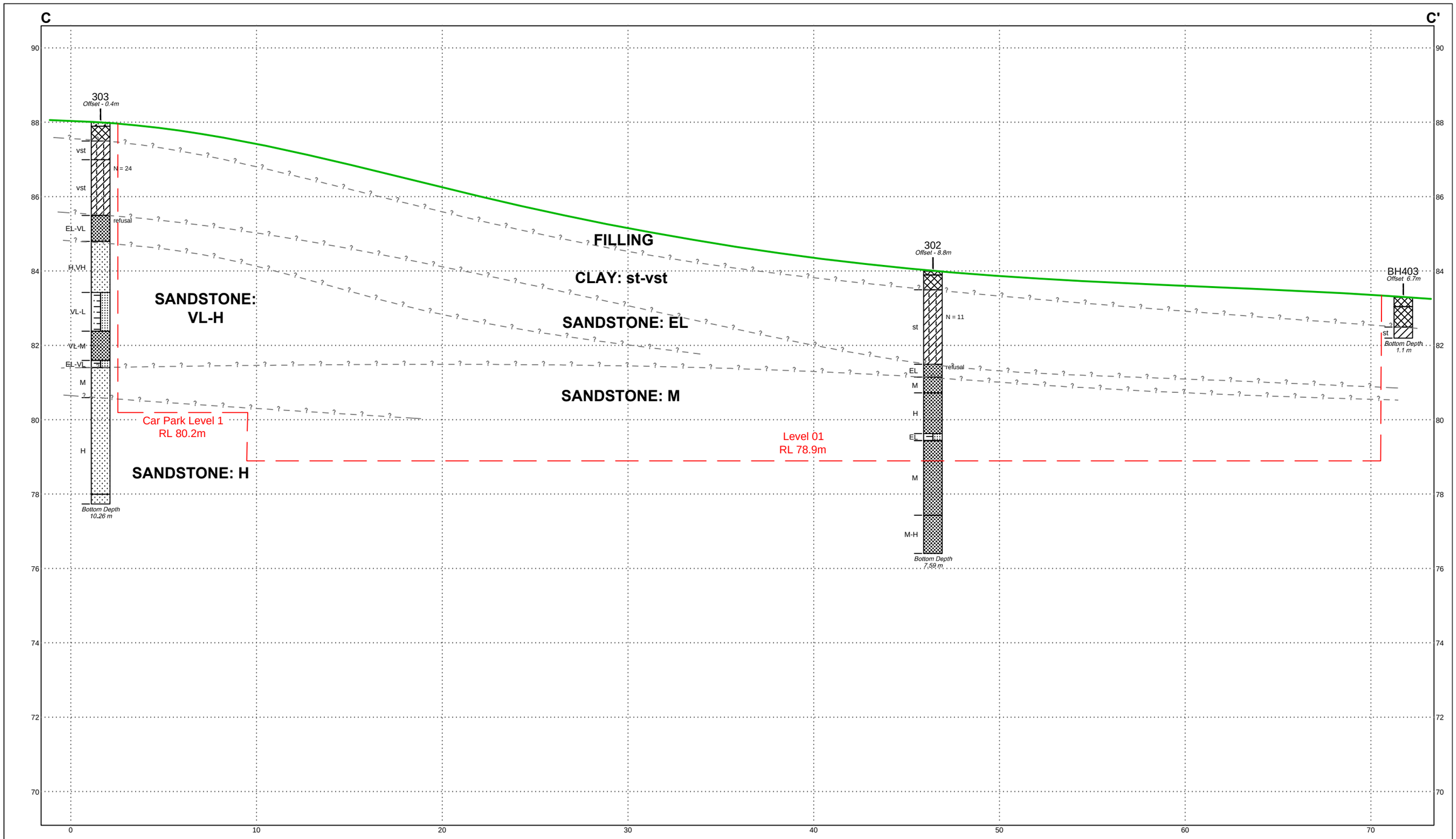
TESTS / OTHER
N - Standard penetration test value
Water level
Inferred Geological boundary

0 4
Horizontal Scale (metres)

Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Anglican Schools Corporation		TITLE: **Interpreted Geotechnical Cross Section B-B'**	PROJECT No: 85310.01
OFFICE: Sydney	DRAWN BY: LJH	**Proposed Roseville College SWELL Centre**	DRAWING No: 3
SCALE: 1:200 (H) 1:100 (V) @ A3	DATE: 09.10.2019	**29 & 37 Bancroft Avenue, ROSEVILLE**	REVISION: 1



LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Concrete
- Filling
- Sandstone
- Sandstone coarse grained
- Sandstone fine grained
- Siltstone
- Silty Clay

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only. Should be read in conjunction with detailed logs.

ROCK STRENGTH
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High

SOIL STRENGTH/CONSISTENCY
f - Firm
st - Stiff
vst - Very stiff
h - Hard
l - Loose
md - Medium dense
d - Dense
vd - Very dense

TESTS / OTHER
N - Standard penetration test value
- Water level
- ? – – - Inferred Geological boundary

0 4
Horizontal Scale (metres)

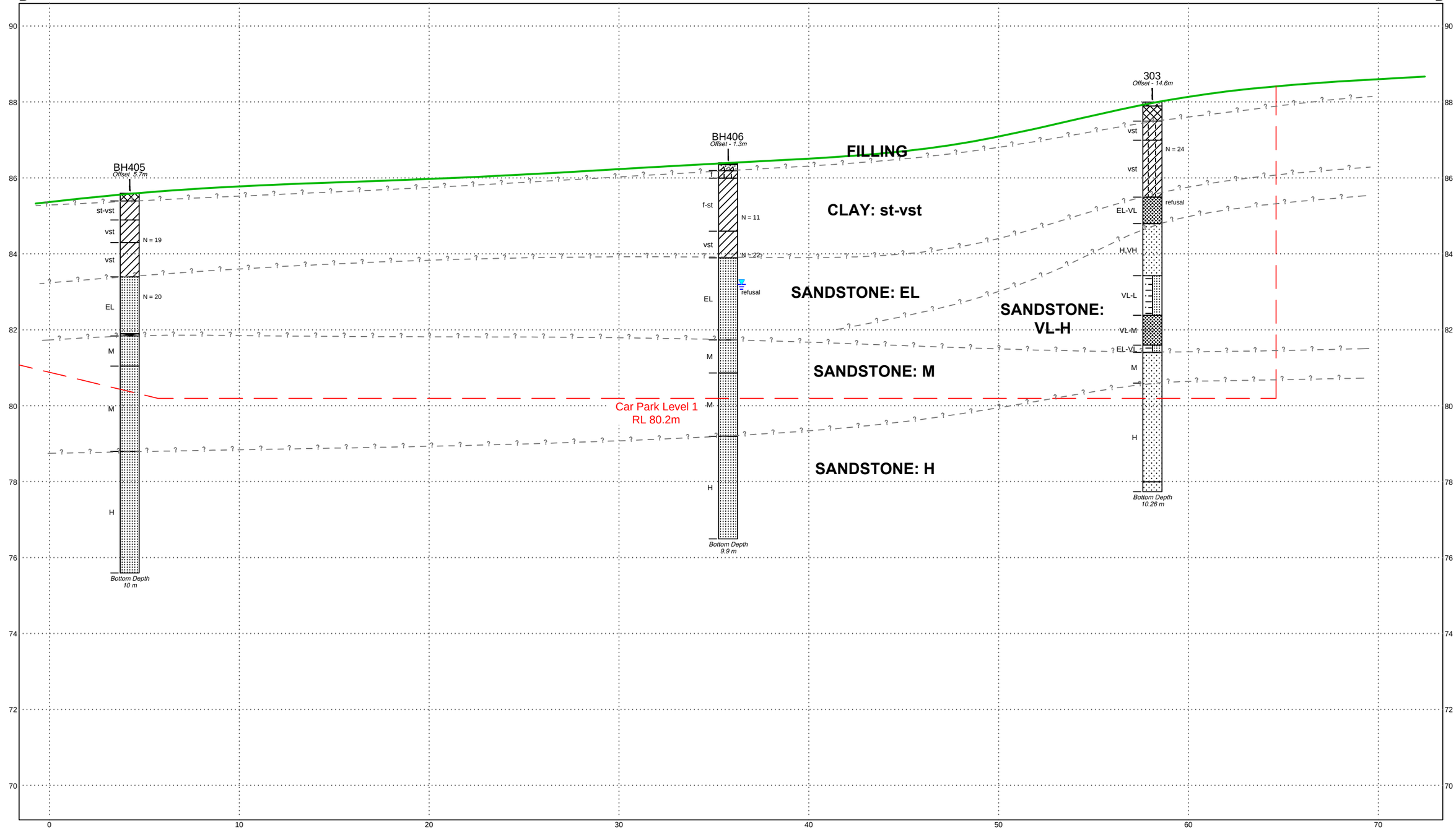
Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Anglican Schools Corporation		TITLE: **Interpreted Geotechnical Cross Section C-C'**	PROJECT No: 85310.01
OFFICE: Sydney	DRAWN BY: LJH	**Proposed Roseville College SWELL Centre**	DRAWING No: 4
SCALE: 1:200 (H) 1:100 (V) @ A3	DATE: 09.10.2019	**29 & 37 Bancroft Avenue, ROSEVILLE**	REVISION: 1

D

D'



LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Concrete
- Filling
- Sandstone
- Sandstone coarse grained
- Sandstone fine grained
- Siltstone
- Silty Clay

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only. Should be read in conjunction with detailed logs.

ROCK STRENGTH
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High

SOIL STRENGTH/CONSISTENCY
f - Firm
st - Stiff
vst - Very stiff
h - Hard
l - Loose
md - Medium dense
d - Dense
vd - Very dense

TESTS / OTHER
N - Standard penetration test value
- Water level
- Inferred Geological boundary

0 4
Horizontal Scale (metres)

Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Anglican Schools Corporation		TITLE: **Interpreted Geotechnical Cross Section D-D'**	PROJECT No: 85310.01
OFFICE: Sydney	DRAWN BY: LJH	**Proposed Roseville College SWELL Centre**	DRAWING No: 5
SCALE: 1:200 (H) 1:100 (V) @ A3	DATE: 09.10.2019	**29 & 37 Bancroft Avenue, ROSEVILLE**	REVISION: 1

Appendix C

Results of Previous and Current Field Work

Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

Soil Descriptions

Douglas Partners

Description and Classification Methods

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

Soil Types

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

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

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

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

The proportions of secondary constituents of soils are described as:

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

Definitions of grading terms used are:

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

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Descriptions

Soil Origin

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

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

Transported soils may be further subdivided into:

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

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

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

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

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

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

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

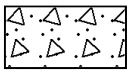
Symbols & Abbreviations

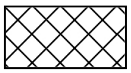
Graphic Symbols for Soil and Rock

General

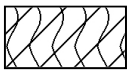

Asphalt

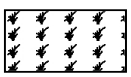

Road base

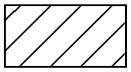

Concrete

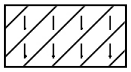

Filling

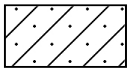
Soils


Topsoil

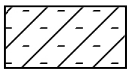

Peat

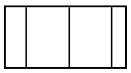

Clay

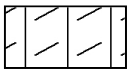

Silty clay

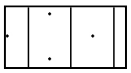

Sandy clay

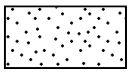

Gravelly clay

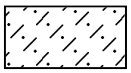

Shaly clay

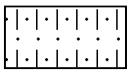

Silt


Clayey silt


Sandy silt

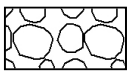

Sand

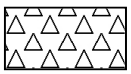

Clayey sand


Silty sand


Gravel

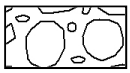

Sandy gravel


Cobbles, boulders

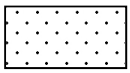

Talus

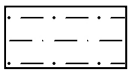
Sedimentary Rocks

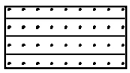

Boulder conglomerate

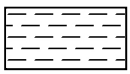

Conglomerate


Conglomeratic sandstone

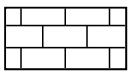

Sandstone


Siltstone

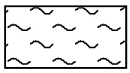

Laminite

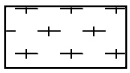

Mudstone, claystone, shale

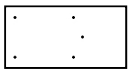

Coal


Limestone

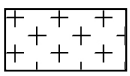
Metamorphic Rocks

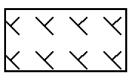

Slate, phyllite, schist

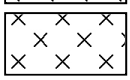

Gneiss

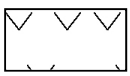

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 82.1 m AHD
EASTING: 331778
NORTHING: 6260361
DIP/AZIMUTH: 90°/--

BORE No: BH401
PROJECT No: 85310.01
DATE: 27-6-2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
82	0.1	FILLING: red-brown sandy gravel filling, humid							D/E			
		FILLING: brown and grey silty clay filling trace ironstone gravels, rootlets, sand and ceramic fragments, moist							D/E			BD4270619(x2)
81	1								D/E			
	1.2	SANDY CLAY: firm to stiff, pale grey fine sandy clay, moist							S			6,2,3 N = 5
									D/E			
80	2											
	2.0	SANDSTONE: extremely low strength, pale grey, fine to medium grained sandstone							S			4,25/50 refusal
	2.6	SANDSTONE: medium strength, highly to moderately weathered, slightly fractured to unbroken, red-brown, medium grained sandstone										PL(A) = 0.33
79	3								C	100	100	
						16-07-19		3.72m: B, 0-10°, pl, ro, fe co				PL(A) = 0.85
78	4											
	4.3	SANDSTONE: medium strength, fresh, slightly fractured to unbroken, pale grey and pale brown medium grained sandstone						4.77m: B, 0-10°, pl, ro, cly 10mm				PL(A) = 0.92
77	5							5.21m: B, 0-10°, pl, ro, cly vn				
									C	100	100	PL(A) = 0.64
76	6							5.96m: B, 0-10°, pl, ro, cly vn				
								6.22m: B, 0-10°, pl, ro, cly co				
	6.9	SANDSTONE: high strength, fresh, unbroken, pale grey, medium grained sandstone										PL(A) = 1.3
75	7											
								7.68m: B, 0-10°, pl, ro, cly vn				PL(A) = 1
74	8								C	100	100	
								8.67m: B, 0-10°, pl, ro, cly vn				PL(A) = 1.4
73	9											
	10.0							9.8m: B, 0-10°,pl, ro,cly				PL(A) = 1.2

Bore discontinued at 10.0m

RIG: Geoprobe 4x4 **DRILLER:** Terratest **LOGGED:** AT **CASING:** HW to 2.7m

TYPE OF BORING: Hand auger to 1.5m, Pushtube to 2.7m, NMLC to 10.00m

WATER OBSERVATIONS: No free groundwater observed whilst pushtubing

REMARKS: Location coordinates are in MGA94 Zone 56. Groundwater well installed, refer to well construction diagram for well construction details.

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: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 82.1 m AHD
EASTING: 331778
NORTHING: 6260361
DIP/AZIMUTH: 90°/--

BORE No: BH401
PROJECT No: 85310.01
DATE: 27-6-2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW, HW, MW, SW, FS, FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
72								vn				
71	11											
70	12											
69	13											
68	14											
67	15											
66	16											
65	17											
64	18											
63	19											

RIG: Geoprobe 4x4 **DRILLER:** Terratest **LOGGED:** AT **CASING:** HW to 2.7m

TYPE OF BORING: Hand auger to 1.5m, Pushtube to 2.7m, NMLC to 10.00m

WATER OBSERVATIONS: No free groundwater observed whilst pushtubing

REMARKS: Location coordinates are in MGA94 Zone 56. Groundwater well installed, refer to well construction diagram for well construction details.

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

BORE: BH401 PROJECT: ROSEVILLE JUNE 2019

2.6 – 7.0m

BORE: BH401 PROJECT: ROSEVILLE June 2019

7.0 – 10.0 m

WELL LOG

CLIENT: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 82.1 m AHD
EASTING: 331778
NORTHING: 6260361
DIP/AZIMUTH: 90°/--

BORE No: BH401
PROJECT No: 85310.01
DATE: 27/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
82	0.1	FILLING: red-brown sandy gravel filling, humid		D/E	0.1–0.2				Backfill
		FILLING: brown and grey silty clay filling trace ironstone gravels, rootlets, sand and ceramic fragments, moist		D/E	0.4–0.5		BD4270619(x2)		
81	1			D/E	0.9–1.0				
	1.2	SANDY CLAY: firm to stiff, pale grey fine sandy clay, moist		S			6,2,3 N = 5		
				D/E	1.45–1.6				
80	2								Bentonite
	2.0	SANDSTONE: extremely low strength, pale grey, fine to medium grained sandstone							Blank PVC
				S	2.4–2.6		4,25/50 refusal		
	2.6	SANDSTONE: medium strength, highly to moderately weathered, slightly fractured to unbroken, red-brown, medium grained sandstone							
79	3				2.95		PL(A) = 0.33		
				C					
78	4				3.95		PL(A) = 0.85	16-07-19	
	4.3	SANDSTONE: medium strength, fresh, slightly fractured to unbroken, pale grey and pale brown medium grained sandstone			4.5				
77	5				4.95		PL(A) = 0.92		
				C	5.9		PL(A) = 0.64		
76	6								
	6.9	SANDSTONE: high strength, fresh, unbroken, pale grey, medium grained sandstone			6.9		PL(A) = 1.3		Gravel
75	7				7.3				Machine slotted PVC screen
					7.9		PL(A) = 1		
74	8			C					
73	9				8.95		PL(A) = 1.4		
	10				9.95		PL(A) = 1.2		End cap
72	10.0	Bore discontinued at 10.0m			10.0				

RIG: Geoprobe 4x4 **DRILLER:** Terratest **LOGGED:** AT **CASING:** HW to 2.7m

TYPE OF BORING: Hand auger to 1.5m, Pushtube to 2.7m, NMLC to 10.00m

WATER OBSERVATIONS: No free groundwater observed whilst pushtubing

REMARKS: Location coordinates are in MGA94 Zone 56. Groundwater well installed, refer to well construction diagram for well construction details.

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: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 83.0 m AHD
EASTING: 331787
NORTHING: 6260343
DIP/AZIMUTH: 90°/--

BORE No: BH402
PROJECT No: 85310.01
DATE: 27/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
83	0	FILLING: dark grey clayey silt filling (topsoil), trace rootlets		D/E	0.1		PID<1		
	0.25	FILLING: brown silty clay filling, with fine gravel trace sand, damp		D/E	0.2 0.4 0.5				
	0.8	CLAY: very stiff, red-brown and pale grey-brown clay, with some ironstone bands, moist		D/E	0.9 1.0				
82	1			S	1.2 1.65		25,18,6 N = 24		1
	1.8	SANDSTONE: extremely low strength, pale grey and red-brown fine grained sandstone		D/E	1.9 2.0				
81	2	Below 2.5m: grading to pale grey		S	2.2 2.65		4,4,9 N = 13		2
				D/E	2.9 3.0				
80	3			S	3.15		30,B refusal		3
	3.15	Bore discontinued at 3.15m Refusal of pushtube/SPT within extremely low strength sandstone							
79	4								4

RIG: Geoprobe 4x4 **DRILLER:** Terratest **LOGGED:** AT **CASING:** uncased
TYPE OF BORING: Pushtube to 3.15m
WATER OBSERVATIONS: No free groundwater observed whilst pushtubing
REMARKS: Location coordinates are in MGA94 Zone 56.

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: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 83.3 m AHD
EASTING: 331801
NORTHING: 6260316
DIP/AZIMUTH: 90°/--

BORE No: BH403
PROJECT No: 85310.01
DATE: 28/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
83	0.25	FILLING: dark grey, silty sand filling (topsoil) trace of rootlets		D/E	0.1–0.2				
	0.8	FILLING: dark brown to dark grey silty clay filling with some medium sand, trace ironstone gravel, ceramics and plastic, moist to damp		D/E	0.4–0.5				
82	1.1	CLAY: stiff, brown to dark brown clay, trace silt and ironstone gravel, moist to damp		D/E	0.9–1.0				
		Bore discontinued at 1.1m Refusal on ironstone band							

RIG: Hand tools **DRILLER:** AT **LOGGED:** AT **CASING:** uncased

TYPE OF BORING: Hand Auger to 1.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

☐ 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: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 84.7 m AHD
EASTING: 331757
NORTHING: 6260346
DIP/AZIMUTH: 90°/--

BORE No: BH404
PROJECT No: 85310.01
DATE: 26/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
84	0.4	FILLING: dark grey silty clay filling (topsoil), with some fine sand and rootlets, humid		D/E	0.1 0.2		PID<1 BD2260619		
		FILLING: brown to orange-brown, clay filling, with some concrete gravel, moist to damp		D/E	0.4 0.5				
	1			D/E	0.9 1.0				1
	1.1	CLAY: stiff to very stiff, orange-brown, clay, trace silt, moist		S D/E	1.2 1.4 1.5		2,7,6 N = 13		
83	1.6	SANDSTONE: extremely low strength, red-brown and pale grey, fine grained sandstone		D/E	1.65 1.9 2.0				2
	2.2	SANDSTONE: extremely low strength, pale grey, fine grained sandstone with some red-brown ironstone bands		S	2.2		25,B refusal		
82	2.35	Bore discontinued at 2.35m Refusal of pushtube/SPT within extremely low strength sandstone			2.35				3
81	4								4
80									

RIG: Geoprobe 4x4 **DRILLER:** Terratest **LOGGED:** AT **CASING:** uncased
TYPE OF BORING: Pushtube to 2.35m
WATER OBSERVATIONS: No free groundwater observed whilst pushtubing
REMARKS: Location coordinates are in MGA94 Zone 56.

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: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 85.6 m AHD
EASTING: 331733
NORTHING: 6260336
DIP/AZIMUTH: 90°/--

BORE No: BH405
PROJECT No: 85310.01
DATE: 26/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
85	0.2	FILLING: dark grey-brown silty sand filling (topsoil), trace rootlets, damp							D/E			
		CLAY: stiff to very stiff, grey-brown clay, trace silt and sand, damp (possibly fill)							D/E			
	0.7	CLAY: very stiff, orange-brown mottled pale grey clay, trace ironstone gravel, moist							B			
	1								D/E			
	1.3	CLAY: very stiff, red-brown clay, with ironstone gravel and trace silt, humid to moist							S			4,8,11 N = 19
84	2								D/E			BD1260619
	2.2	SANDSTONE: extremely low strength, pale grey, fine to medium grained sandstone, with some ironstone bands										
83	3								S			5,10,10 N = 20
									D/E			
82	3.7											
	3.76	SANDSTONE: medium strength, highly weathered, fractured to slightly fractured, brown to red-brown, medium grained sandstone						3.7m: CORE LOSS: 60mm	C	100	100	PL(A) = 0.84
	4											
	4.55	SANDSTONE: medium strength, slightly weathered, slightly fractured to unbroken, pale grey to pale brown, medium grained sandstone with some extremely low strength clay seams										PL(A) = 1.1
81	5							5.14m: partial void 10mm 5.2m: Cs, 200mm 5.53m: B, 0-10°, pl, ro, cly co 5.75m: B, 80-90°, un, ro, cln	C	100	100	PL(A) = 0.89
80	6											
	6.8	SANDSTONE: high strength, fresh, slightly fractured to unbroken, pale grey to pale brown medium grained sandstone						6.79m: B, 0-10°, pl, ro, cbs co 7.04m: B, 0-10°, pl, ro, cbs co				PL(A) = 0.86
79	7											
78								7.62m: B, 0-10°, pl, ro, cbs co				PL(A) = 2.2
	8								C	100	100	
77												
	9							8.9m: B, 0-10°, pl, ro, cly co				PL(A) = 1.6
76												
	10.0	Bore discontinued at 10.0m										PL(A) = 1.1

RIG: Geoprobe 4x4 **DRILLER:** Terratest **LOGGED:** AT **CASING:** HW to 3.7m

TYPE OF BORING: Pushtube to 3.7m, NMLC to 10.00m

WATER OBSERVATIONS: No free groundwater observed whilst pushtubing

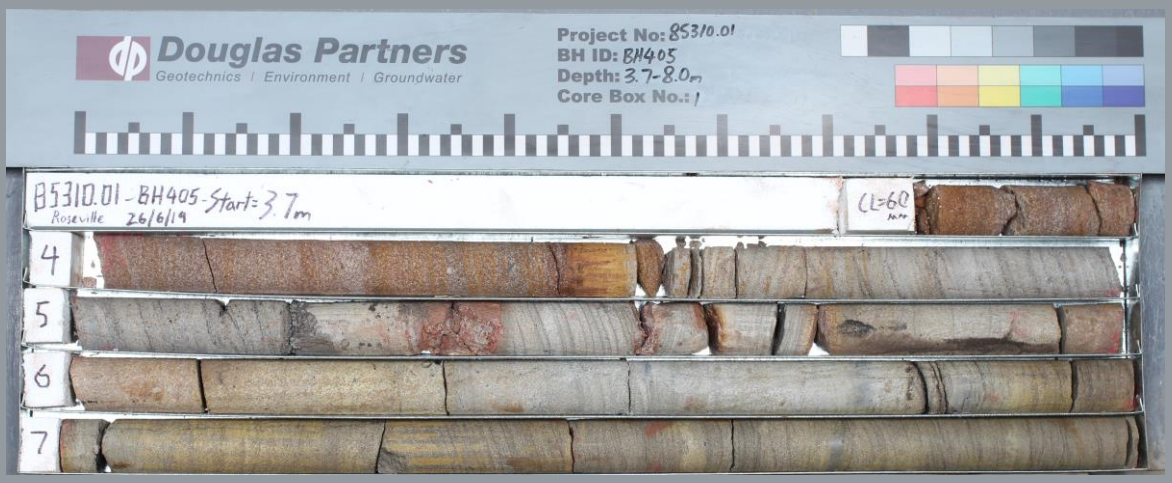
REMARKS: Location coordinates are in MGA94 Zone 56.

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

BORE: BH405 PROJECT: ROSEVILLE JUNE 2019



3.7 – 8.0m

BORE: BH405 PROJECT: ROSEVILLE JUNE 2019

8.0 – 10.0 m

BOREHOLE LOG

CLIENT: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 86.4 m AHD
EASTING: 331742
NORTHING: 6260305
DIP/AZIMUTH: 90°/--

BORE No: BH406
PROJECT No: 85310.01
DATE: 27/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
86	0.05	ASPHALTIC CONCRETE										
	0.2	CONCRETE SLAB: 150mm thick										
	0.4	SILTY CLAY: firm, grey to pale brown clay, moist to damp (possibly filling)							D/E			PID<1
									D/E			
85	1	CLAY: firm to stiff, pale grey mottled orange brown clay, with trace silt, moist										
		from 1.5m: grading to pale grey							S			3,4,7 N = 11
	1.8	CLAY: very stiff, pale grey clay, trace of ironstone gravel, humid to moist							D/E			BD3270619
84	2								S			9,9,13 N = 22
	2.5	SANDSTONE: extremely low strength, pale grey, fine grained sandstone with some ironstone bands							D/E			
83	3					16-07-19			S			14,18,25/100 refusal
82	4											
	4.66	SANDSTONE: medium strength, highly to moderately weathered, fractured, red-brown and brown, medium grained sandstone with some extremely low strength clay seams						4.74m: B, 0-10°, pl, ro, cly co				PL(A) = 0.32
81	5											
	5.53	SANDSTONE: medium strength, moderately weathered to fresh stained, fractured, pale grey and pale brown, medium grained sandstone with some extremely low strength clay seams						5.43m: B, 0-10°, pl, ro, fe, stn 5.48m: Cs, 50mm 5.74m: B, 0-10°, pl, ro cly, co 5.91m: Cs, 50mm 6.3m: Cs, 60mm 6.45m: Cs, 100mm	C	100	79	PL(A) = 0.35
80	6											
								6.78m: B, 0-10°, pl, ro, fe vn				PL(A) = 0.43
	7											
	7.2	SANDSTONE: medium strength, fresh, slightly fractured to unbroken, pale grey medium grained sandstone						7.35m: B, 0-10°, pl, ro, cly vn 7.54m: B, 0-10°, pl, ro, cly co	C	100	97	PL(A) = 0.71
79	8											
								8.27m: B, 0-10°, pl, ro, cly co				PL(A) = 0.9
78	9											
									C	100	100	
77	9.9	Bore discontinued at 9.9m										PL(A) = 1

RIG: Geoprobe 4x4 **DRILLER:** Terratest **LOGGED:** AT **CASING:** HW to 4.5m

TYPE OF BORING: Pushtube to 4.5m, NMLC to 9.9m

WATER OBSERVATIONS: No free groundwater observed whilst pushtubing

REMARKS: Location coordinates are in MGA94 Zone 56. Groundwater well installed, refer to well construction diagram for well construction details.

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

BORE: BH406 PROJECT: ROSEVILLE June 2019

4.5 – 9.0m

BORE: BH406 PROJECT: ROSEVILLE June 2019

9.0 – 9.9m

WELL LOG

CLIENT: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 86.4 m AHD
EASTING: 331742
NORTHING: 6260305
DIP/AZIMUTH: 90°/--

BORE No: BH406
PROJECT No: 85310.01
DATE: 27/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
86	0.05	ASPHALTIC CONCRETE							Backfill
	0.2	CONCRETE SLAB: 150mm thick		D/E	0.2		PID<1		
	0.4	SILTY CLAY: firm, grey to pale brown clay, moist to damp (possibly filling)		D/E	0.3 0.4 0.5				
	1	CLAY: firm to stiff, pale grey mottled orange brown clay, with trace silt, moist							1
85				S	1.2		3,4,7 N = 11		
		from 1.5m: grading to pale grey			1.65				
	1.8	CLAY: very stiff, pale grey clay, trace of ironstone gravel, humid to moist		D/E	1.9 2.0		BD3270619		Bentonite Blank PVC
84	2				2.2				2
				S			9,9,13 N = 22		
	2.5	SANDSTONE: extremely low strength, pale grey, fine grained sandstone with some ironstone bands			2.65				
	3			D/E	2.9 3.0				3
83				S	3.2		14,18,25/100 refusal	▼ 16-07-19	
	4				3.6				4
82					4.5				
	4.66	SANDSTONE: medium strength, highly to moderately weathered, fractured, red-brown and brown, medium grained sandstone with some extremely low strength clay seams							
	5				4.9		PL(A) = 0.32		5
81	5.53	SANDSTONE: medium strength, moderately weathered to fresh stained, fractured, pale grey and pale brown, medium grained sandstone with some extremely low strength clay seams		C	5.8		PL(A) = 0.35		
	6								6
80					6.6				Gravel
					6.85		PL(A) = 0.43		
	7								7 Machine slotted PVC screen
	7.2	SANDSTONE: medium strength, fresh, slightly fractured to unbroken, pale grey medium grained sandstone							
79				C	7.9		PL(A) = 0.71		
	8								8
78									
	9				8.94		PL(A) = 0.9		9
					9.1				
77				C					
	9.9	Bore discontinued at 9.9m			9.85		PL(A) = 1		End cap

RIG: Geoprobe 4x4 **DRILLER:** Terratest **LOGGED:** AT **CASING:** HW to 4.5m

TYPE OF BORING: Pushtube to 4.5m, NMLC to 9.9m

WATER OBSERVATIONS: No free groundwater observed whilst pushtubing

REMARKS: Location coordinates are in MGA94 Zone 56. Groundwater well installed, refer to well construction diagram for well construction details.

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: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 82.2 m AHD
EASTING: 331794
NORTHING: 6260283
DIP/AZIMUTH: 90°/--

BORE No: BH407
PROJECT No: 85310.01
DATE: 28/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
82	0.15	CONCRETE KERB							
	0.3	ROADBASE GRAVEL: 15-20mm aggregates in a medium sand matrix		D/E	0.2		Bulk sample: 0.3-0.8m		
				B	0.3				
				D/E	0.4				
	0.8	CLAY: firm to stiff, brown mottled red-brown clay, trace silt, moist			0.5				
81	1	CLAY: very stiff to hard, red-brown clay trace of ironstone gravel, moist		D/E	0.9 1.0				
	1.4	Bore discontinued at 1.4m Refusal on ironstone band							
80	2								
79	3								
78	4								
77	5								
76	6								
75	7								
74	8								
73	9								

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

RIG: Hand tools **DRILLER:** AT **LOGGED:** AT **CASING:** uncased

TYPE OF BORING: Hand auger to 1.4m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Augered adjacent to road's concrete kerb

☐ 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: Anglican Schools Corporation
PROJECT: Proposed Roseville College SWELL Centre
LOCATION: 29 & 37 Bancroft Avenue, Roseville

SURFACE LEVEL: 82.0 m AHD
EASTING: 331803
NORTHING: 6260263
DIP/AZIMUTH: 90°/--

BORE No: BH408
PROJECT No: 85310.01
DATE: 28/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
82	0.25	FILLING: dark grey, sandy silt fill (topsoil) trace of rootlets		D/E	0.1 0.2				
	0.6	FILLING: red-brown to dark brown clay, with silt and ironstone gravels, damp		D/E	0.4 0.5				
81	1	CLAY: stiff to very stiff, red-brown mottled pale grey clay, trace silt and ironstone gravels, moist		D/E	0.9 1.0				
	1.6	Bore discontinued at 1.6m Refusal on ironstone band							
80	2								
79	3								
78	4								
77	5								
76	6								
75	7								
74	8								
73	9								

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

RIG: Hand tools **DRILLER:** AT **LOGGED:** AT **CASING:** uncased

TYPE OF BORING: Hand auger to 1.6m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

☐ 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

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Results of Dynamic Penetrometer Tests

Client Anglican Schools Corporation
Project Proposed Roseville College SWELL Centre
Location 29 & 37 Bancroft Avenue, Roseville

Project No. 85310.01
Date 28/6/19
Page No. 1 of 1

Test Locations	BH403	BH407	BH408	DCP409						
RL of Test (AHD)	83.3	82.2	82.0	81.3						
Depth (m)	**Penetration Resistance** Blows/150 mm									
0.00 – 0.15	2	1	2	3						
0.15 – 0.30	3	5	3	6						
0.30 – 0.45	6	3	3	8						
0.45 – 0.60	8	2	6	7						
0.60 – 0.75	6	3	6	8						
0.75 – 0.90	3	5	8	9						
0.90 – 1.05	25	25	12	13						
1.05 – 1.20	R	R	16	15						
1.20 – 1.35			D	D						
1.35 – 1.50										
1.50 – 1.65										
1.65 – 1.80										
1.80 – 1.95										
1.95 – 2.10										
2.10 – 2.25										
2.25 – 2.40										
2.40 – 2.55										
2.55 – 2.70										
2.70 – 2.85										
2.85 – 3.00										
3.00 – 3.15										
3.15 – 3.30										
3.30 – 3.45										
3.45 – 3.60										

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

Tested By AT
Checked By PAV

Remarks R = Refusal, D = Discontinued


DOUGLAS PARTNERS PTY LTD
PROPOSED JOY YEO PERFORMING ARTS CENTRE - ROSEVILLE
BORE 302 PROJECT 43334 AUGUST 2005
ROSEVILLE 43334 BH-2 START-2.85M
3
4
5
6
2.85m – 7.0m


DOUGLAS PARTNERS PTY LTD
PROPOSED JOY YEO PERFORMING ARTS CENTRE - ROSEVILLE
BORE 302 PROJECT 43334 AUGUST 2005
7
END BH- 7.59M
7.0m – 7.59m

BOREHOLE LOG

CLIENT: Roseville College
PROJECT: Proposed Joy Yeo Performing Arts Complex
LOCATION: Recreation Ave, Roseville

SURFACE LEVEL: 84.0
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 302
PROJECT No: 43334
DATE: 19 Aug 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break)	Type	Core Rec. %	RQD %	Test Results & Comments
84	0.1	GRASS							A			
		FILLING - grey silty clay and brown silty clay, with some ironstone gravel and a trace of sand							A			
	0.5	SILTY CLAY - stiff, orange brown and light grey silty clay							A			
83	1								S			4,5,6 N = 11
82	2							Note: Unless otherwise stated, rock is farctured along rough planar joints & bedding planes (dipping 0°- 10°)				
	2.5	SANDSTONE - extremely low strength, extremely weathered, off white and yellow brown medium grained sandstone. Friable							S			30/150mm refusal
81	2.85	SANDSTONE - medium and extremely low strength, highly weathered, fractured, light grey brown medium grained sandstone						2.85m: J75° healed				
	3							2.96m: B				
	3.27	SANDSTONE - high strength, moderately to slightly weathered, fractured to slightly fractured, light grey, red and orange brown medium grained sandstone						2.98m: B, 30mm sandy clay				PL(A) = 2.1MPa
								3.11m: B, 5mm sandy clay				
80	4							3.56m: B, 1mm sandy clay				
								3.68m: B, 1mm sandy clay				PL(A) = 1.5MPa
	4.37							3.74m: B				
	4.55	SILTSTONE & SANDSTONE - extremely low strength, extremely weathered, grey and light grey siltstone and sandstone						3.9m: B	C	100	72	
	4.56							4.6m: B, 6mm clay				PL(A) = 0.8MPa
79	5	SANDSTONE - medium then low to medium strength, fresh stained, fractured and slightly fractured, light grey and orange brown fine grained sandstone with 5-10% siltstone laminae						4.83m: B, ironstained				
								4.9m: B, 5mm sandy clay & incipient 90° J				
								4.92m: B				
								4.96m: B				
								5.04m: B, 7mm sandy clay				PL(A) = 0.3MPa
								5.15m: B, ironstained				
78	6	Below 5.93m: fresh						5.47m: B				
								5.87m: B				
		6.47-6.56m: extremely low strength band						5.93m: B, 2mm sandy clay				
	6.56							6.15m: B, 3mm sandy clay				
		SANDSTONE - medium then medium to high strength, fresh, slightly fractured, light grey medium grained sandstone							C	100	95	PL(A) = 0.6MPa
77	7											PL(A) = 1MPa
								7.47m: B				
	7.59	Bore discontinued at 7.59m										
76	8											
75	9											

RIG: Bobcat **DRILLER:** E Grimmer **LOGGED:** Jardine **CASING:** HW to 2.50m

TYPE OF BORING: Solid flight auger (TC bit) to 2.50m; Rotary to 2.85m; NMLC-Coring to 7.59m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

CHECKED
Initials: RLF
Date: 9/05

Douglas Partners
Geotechnics · Environment · Groundwater


DOUGLAS PARTNERS PTY LTD
PROPOSED JOY YEO PERFORMING ARTS CENTRE - ROSEVILLE
BORE 303 PROJECT 43334 AUGUST 2005
ROSEVILLE
43334 Bh 3 START 3.2M
4
5
6
7
3.2m – 8.0m


DOUGLAS PARTNERS PTY LTD
PROPOSED JOY YEO PERFORMING ARTS CENTRE - ROSEVILLE
BORE 303 PROJECT 43334 AUGUST 2005
8
9
10
END BORE HOLE 10.26M
8.0m – 10.26m

BOREHOLE LOG

CLIENT: Roseville College
PROJECT: Proposed Joy Yeo Performing Arts Complex
LOCATION: Recreation Ave, Roseville

SURFACE LEVEL: 88.0
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 303
PROJECT No: 43334
DATE: 18-19 August 05
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
88	0.1	PAVEMENT										
		FILLING - brown sandy clay filling, with some ironstone gravel							A			
	0.5	SILTY CLAY - very stiff, orange brown and off white silty clay, with ironstone gravel							A			
87	1 1.0	SILTY CLAY - very stiff, red brown and yellow grey silty clay, with ironstone bands							A			
									S			6,10,14 N = 24
86	2							Note: Unless otherwise stated, rock is fractured along rough planar joints & bedding planes (dipping 0°- 20°), some ironstained				
	2.5	SANDSTONE - extremely low to very low strength, extremely to highly weathered, light grey and red brown sandstone, with medium strength iron cemented bands							S			12,26/100mm refusal
85	3 3.2	IRON CEMENTED SANDSTONE - high and very high strength, extremely and highly weathered, fractured, red brown fine grained sandstone, with extremely low strength bands							C	100	0	PL(A) = 3.5MPa
84	4							3.93m: J65° 4.07m: J35°				
	4.57	SILTSTONE AND SANDSTONE - very low and very low to low strength, highly and slightly weathered, slightly fractured, dark grey siltstone and light grey fine grained sandstone, interlaminated										PL(A) = 0.1MPa
83	5											
	5.61	SANDSTONE - very low and medium strength, moderately and slightly weathered, slightly fractured to fractured, red brown and grey fine to medium grained sandstone						5.69m: J30°	C	100	21	PL(A) = 0.5MPa PL(A) = 0.2MPa
82	6											
	6.4											
	6.59	SILTSTONE AND SANDSTONE - extremely low and very low strength, extremely and highly weathered, dark grey siltstone and light grey fine grained sandstone interlaminated						6.75m: J30°				PL(A) = 0.6MPa
81	7											
		SANDSTONE - medium then high strength, moderately then slightly weathered, slightly fractured, red brown and grey fine to medium grained sandstone						7.55m: B				PL(A) = 2MPa
80	8	8.18m: 60mm low strength siltstone band						8.4m: B	C	100	94	PL(A) = 1.9MPa
								8.8m: B				
79	9											
		- 40mm extremely low strength siltstone band						9.7m: B				PL(A) = 1.5MPa

RIG: Bobcat **DRILLER:** E Grimmer **LOGGED:** Jardine/Parmar **CASING:** HW to 2.50m

TYPE OF BORING: Solid flight auger (TC bit) to 2.50m; Rotary to 3.20m; NMLC-Coring to 10.26m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

CHECKED
Initials: PLE
Date: 9/05

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Roseville College
PROJECT: Proposed Joy Yeo Performing Arts Complex
LOCATION: Recreation Ave, Roseville

SURFACE LEVEL: 88.0
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 303
PROJECT No: 43334
DATE: 18-19 August 05
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
78	10.0	SANDSTONE - as before							C	100	94	
	10.26	Bore discontinued at 10.26m										
77	11											
76	12											
75	13											
74	14											
73	15											
72	16											
71	17											
70	18											
69	19											

RIG: Bobcat **DRILLER:** E Grimmer **LOGGED:** Jardine/Parmar **CASING:** HW to 2.50m

TYPE OF BORING: Solid flight auger (TC bit) to 2.50m; Rotary to 3.20m; NMLC-Coring to 10.26m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

CHECKED
Initials: RCF
Date: 9/05

Douglas Partners
Geotechnics · Environment · Groundwater

Appendix D

Results of Laboratory Testing

Material Test Report

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

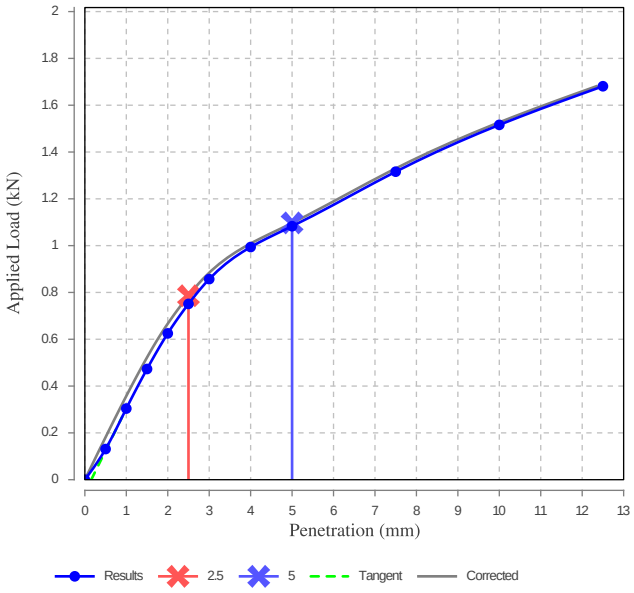
Accredited for compliance with ISO/IEC 17025 - Testing

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

Report Number: **85310.01-1**
Issue Number: 1
Date Issued: 24/07/2019
Client: Anglican Schools Corporation
Suite 102/9 Gloucester Road, Hurstville NSW 2220
Contact: Adam Forbes
Project Number: 85310.01
Project Name: Proposed Roseville College SWELL Centre
Project Location: 29 & 37 Bancroft Avenue, Roseville
Work Request: 4567
Sample Number: 19-4567A
Date Sampled: 28/06/2019
Dates Tested: 01/07/2019 - 22/07/2019
Sampling Method: Sampled by Engineering Department
Sample Location: **BH405 (0.5-1.0m)**
Material: CLAY - Orange-brown and pale grey mottled clay with trace ironstone gravel

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**6**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.80		
Optimum Moisture Content (%)	17.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.77		
Field Moisture Content (%)	20.0		
Moisture Content at Placement (%)	17.4		
Moisture Content Top 30mm (%)	21.8		
Moisture Content Rest of Sample (%)	18.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	216		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

California Bearing Ratio



Material Test Report

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

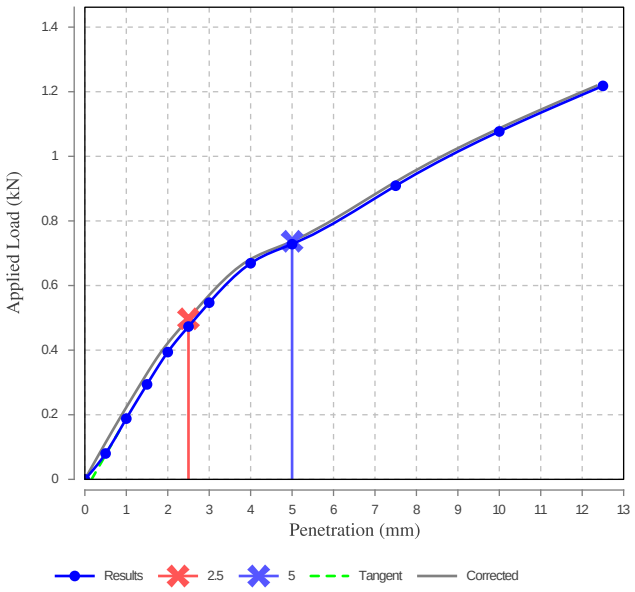
Accredited for compliance with ISO/IEC 17025 - Testing

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

Report Number: **85310.01-1**
Issue Number: 1
Date Issued: 24/07/2019
Client: Anglican Schools Corporation
Suite 102/9 Gloucester Road, Hurstville NSW 2220
Contact: Adam Forbes
Project Number: 85310.01
Project Name: Proposed Roseville College SWELL Centre
Project Location: 29 & 37 Bancroft Avenue, Roseville
Work Request: 4567
Sample Number: 19-4567B
Date Sampled: 28/06/2019
Dates Tested: 01/07/2019 - 22/07/2019
Sampling Method: Sampled by Engineering Department
Sample Location: **BH407 (0.3-0.8m)**
Material: CLAY - Brown and red-brown mottled clay trace silt

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**4.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.75		
Optimum Moisture Content (%)	17.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	99.0		
Dry Density after Soaking (t/m^3)	1.72		
Field Moisture Content (%)	20.1		
Moisture Content at Placement (%)	17.0		
Moisture Content Top 30mm (%)	22.9		
Moisture Content Rest of Sample (%)	19.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	217		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

California Bearing Ratio



Material Test Report

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

Accredited for compliance with ISO/IEC 17025 - Testing

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

Report Number: **85310.01-1**
Issue Number: 1
Date Issued: 24/07/2019
Client: Anglican Schools Corporation
Suite 102/9 Gloucester Road, Hurstville NSW 2220
Contact: Adam Forbes
Project Number: 85310.01
Project Name: Proposed Roseville College SWELL Centre
Project Location: 29 & 37 Bancroft Avenue, Roseville
Work Request: 4567
Sample Number: 19-4567C
Date Sampled: 28/06/2019
Dates Tested: 01/07/2019 - 08/07/2019
Sampling Method: Sampled by Engineering Department
Sample Location: **BH405 (1.9-2.0m)**
Material: CLAY - Red-brown clay with ironstone gravel and trace silt

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	53		
Plastic Limit (%)	22		
Plasticity Index (%)	**31**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	12.0		
Cracking Crumbling Curling	None		