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Report on
Geotechnical Investigation

Grammar Edgecliff Sports Area
11 Alma St, Paddington

Prepared for
Sydney Grammar School

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Integrated Practical Solutions

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

	Signature	Date
Author	for	9 March 2020
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Report on Geotechnical Investigation
Grammar Edgecliff Sports Area
Alma Street, Paddington

1. Introduction

This report presents the results of a geotechnical investigation for a proposed sports facility at Edgecliff Preparatory School (also known as The Sydney Grammar School – Edgecliff). The investigation was commissioned by Ms. Tina Tang of Jattca Property Solutions Pty Ltd acting on behalf of The Sydney Grammar School and was undertaken in accordance with Douglas Partners Pty Ltd's (DP) Conditions of Engagement.

It is understood that the proposed development includes the demolition of the existing three tennis courts and associated buildings and on-grade carpark, followed by the construction of a new sports facility containing a multipurpose function hall, fencing hall, rifle range, swimming pool and service areas such as the lobby, and change rooms. It is understood that a below ground basement comprising the swimming pool and car parking is proposed. Excavation for the single level basement and pool deck will be about 2 m to 3.5 m below existing surface level with the pool requiring excavation to about 4 m to 5.5 m below current surface levels. The investigation was carried out to provide information on the subsurface conditions for design and planning purposes.

The investigation included the drilling of seven boreholes, four of which were rock cored boreholes and eight cone penetration tests (CPT). Samples were taken from the boreholes for subsequent laboratory testing. One groundwater monitoring well was installed during the field work, and subsequent groundwater level measurements were undertaken. Details of the field and laboratory testing are provided within this report together with comments on design and construction issues.

2. Site Description

The area for development is approximately 500 m south west of Keltie Bay (Sydney Harbour) and approximately 250 m from Rushcutters Creek, which leads to Keltie bay. The site is a roughly rectangular shaped area of approximately 5000 m^2 with surface levels gently dipping to the north from about RL6.5 m Australian Height Datum (AHD) to RL 4.3 m AHD along the northern side, where a batter then falls down to the sports field.

At the time of DP's investigation the site was occupied by three concrete surfaced tennis courts, a single level brick toilet block building and an on-grade asphaltic concrete carpark. Based on a casual observation during the investigation, the external brickwork of the existing building, the carpark pavement and tennis court surface appeared to be in relatively good condition.

The site is situated on the boundary between areas of medium rise residential buildings and medium rise mixed use buildings. A summary of current land uses immediately adjacent to the proposed development area at the time of DP's presence on site are provided in Table 1.

Table 1: Summary of Adjacent Land Uses.

General Direction Relative to Development	Land Use Description
North	Turf covered sports field which is part of the Sydney Grammar School campus
East and South	Two to three storey residential brick buildings with on grade parking
West	One to three storey mixed use buildings with some observed to have basement car parking.

3. Regional Geology

Reference to the Sydney 1:100 000 Series Soil Landscape Sheet indicates that the site is within the boundary of an area of disturbed terrain however is also close to the erosional Gymea landscape and residual Hawkesbury soil landscape. Figure 1 shows the mapping of soils landscapes relative to the development area.

Figure 1: Soil Landscape Mapping of the Development Area

The disturbed soil landscape (shaded grey) is described as an area of level plain to hummocky terrain, extensively disturbed by human activity, including complete disturbance, removal or burial of soil. The Gymea landscape group (shaded light orange) is described as an erosional profile of shallow to moderately deep sandy loams and clayey sands or sandy clays. The Hawkesbury group (shaded pink) is a colluvial landscape derived from Hawkesbury Sandstone and generally consisting of earthy sands, clayey sands and sandy clays.

Reference to the Sydney 1:100 00 Series Geology Sheet indicates that the site, within the area of disturbed terrain, is likely underlain by Hawkesbury Sandstone at depth. Hawkesbury sandstone typically comprises medium to coarse grained, quartz sandstone with some shale bands or lenses.

The results of the investigation on site confirmed the regional mapping, with a sandy soil profile underlain by Hawkesbury Sandstone encountered within the boreholes and inferred from cone penetration test (CPT) refusal.

4. Field Work Methods

The field work for the investigation was undertaken on 19 to 20 December 2019, 15 to 16 January 2020 and 25 January 2020 and included:

- On-site electronic detection of buried services at proposed borehole and test locations;
- Drilling of seven boreholes (BH1 to BH7) using a tight access tracked drilling rig and a bobcat mounted drilling rig. Three of the boreholes were drilled to a depth of 12 m using solid flight augers or rotary mud drilling with no rock encountered. The remaining four boreholes were similarly drilled to the top of rock at depths of between 3.5 m and 8.5 m, before being continued to depths of between 10.3 m and 14.5 m using NMLC diamond core drilling techniques to obtain continuous 50 mm diameter core samples of the bedrock;
- Installation of a groundwater monitoring well at BH1, to 11.7 m depth, followed by purging of coring introduced water. Subsequent groundwater level measurement and sampling was undertaken on 20 December 2019 as well as an additional water level measurement on 25 January 2020;
- CPT testing at eight locations (CPT1 to CPT8) to refusal on inferred bedrock at 4.3 m to 20.5 m depth, using ballasted truck and track mounted test rigs to push a 35 mm diameter cone tipped probe into the soil with a hydraulic ram system. Continuous measurements are made of the end-bearing pressure on the cone tip and the friction readings are displayed during the test and are stored on a computer for subsequent plotting of results and interpretation.

All field work was carried out under the direction of a geotechnical engineer. All test locations were backfilled with drilling / excavated soil upon completion. The test locations are shown on Drawing 1 in Appendix B. The borehole and test locations were measured using a high precision differential GPS system accurate to 0.1 m in plan and elevation. Eastings and northings and RL have been provided on the borehole and test logs.

5. Field Work Results

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

5.1 Subsurface Profile

The general subsurface profile at the bore and CPT locations is summarised as follows:

Unit 1	**FILL**	Generally sandy fill to a depth of between 2.0 m and 3.5 m, with inclusions of brick and sandstone gravel; and minor charcoal, ash and organic matter.
Unit 2	**SAND / CLAYEY SAND**	Generally very loose to loose, pale grey to grey, medium grained sand with dark grey organic clay to a depth of 3.5 m and 8.0 m.
Unit 3	**SAND**	Typically medium dense to dense, fine to medium grained grey to pale grey sand to a depth of between 6.3 m and 11.7 m.
Unit 4	**INTERBEDDED SANDS AND CLAYS**	Typically medium dense to dense sand with stiff clay lenses to borehole termination and CPT refusal depths of between 12.0 m and 20.5 m. The clay lenses were typically 0.3 m thick.
Unit 5	**SANDSTONE**	Medium to high strength sandstone encountered at depths of between 3.5 m to 8.5 m within BH3 and BH5-7.

5.2 Groundwater

Groundwater seepage was observed during auger drilling of some boreholes as well as within the hole created after withdrawal of the CPT test rods. A groundwater monitoring well was installed at BH1; details of the well can be found in the groundwater well log in Appendix C. A summary of the measured groundwater levels are provided in Table 2.

Table 2: Summary of Groundwater Measurements

Test Location	Surface RL (m AHD)	Groundwater Depth (m)	Groundwater RL (m AHD)	Date	Comments
BH1	5.9	3.0	2.9	19 Dec 2019	Seepage observed whilst augering
		4.0	1.9	15 Jan 2020	Groundwater Well measurement
		4.2	1.7	24 Jan 2020	
BH2	4.1	2.4	1.7	19 Dec 2019	Seepage observed whilst augering
BH3	4.1	2.5	1.6	20 Dec 2019	Seepage observed whilst augering
BH4	6.2	3.5	2.7	18 Dec 2019	Seepage observed whilst augering
BH5	7.0	3.1	3.9	18 Dec 2019	Seepage observed whilst augering
BH6	6.3	4.0	2.3	15 Jan 2020	Seepage observed whilst augering
BH7	6.3	3.9	2.4	15 Jan 2020	Seepage observed whilst augering
CPT1	4.1	2.0	2.1	15 Jan 2020	Seepage observed after withdrawal of CPT rods
CPT2	4.1	2.0	2.1	15 Jan 2020	Seepage observed after withdrawal of CPT rods
CPT3	4.1	2.3	1.8	15 Jan 2020	Seepage observed after withdrawal of CPT rods
CPT4	4.2	2.3	1.9	15 Jan 2020	Seepage observed after withdrawal of CPT rods
CPT5	6.2	3.7	2.5	15 Jan 2020	Seepage observed after withdrawal of CPT rods
CPT6	5.9	4.2	1.7	24 Jan 2020	Seepage observed after withdrawal of CPT rods
CPT7	4.1	2.6	1.5	24 Jan 2020	Seepage observed after withdrawal of CPT rods
CPT8	4.1	-	-	24 Jan 2020	Hole collapse after withdrawal of rods

It should be noted that groundwater levels are transient and that fluctuations may occur in response to climatic, seasonal and tidal changes.

6. Laboratory Testing

Laboratory testing was carried out on five samples (four soil and one groundwater) to determine:

- Soil and groundwater aggressiveness for exposure classification of buried concrete and steel elements; and
- California bearing ratio (CBR).

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

Table 3: Summary of Chemical laboratory Test Results

Borehole	Material	Depth (m)	Conductivity (μS/cm)	pH	Cl (PPM)	SO_4 (PPM)
BH1	Water	-	1100	6.0	260	38
BH4	Soil	7.0 – 7.45	21	8.2	10	<10
BH5	Soil	0.9 – 1.0	62	9.3	<10	10
BH6	Soil	7.0 – 7.45	15	7.7	<10	<10

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

Table 4: Summary of Physical Laboratory Test Results

Borehole	Depth (m)	Material	CBR (%)	MDD (t/m^3)	OMC (%)	FMC (%)
BH6	0.4 – 0.8	Sand Fill	14	1.61	15.0	6.9

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

The point load test results on the rock cores were tested in-house, with results presented on the borehole logs in Appendix C.

7. Geotechnical Model

For design purposes, the observed subsurface profile during the investigation has been grouped into five geotechnical units. Three geotechnical cross sections (Section A-A', B-B' and C-C') showing the interpreted subsurface profile between the test locations are presented in Appendix B.

The interpreted depth and RL's at the top of various units and the layer thicknesses at each test location are shown in Tables 5A to 5D. Reference should be made to the borehole and CPT logs for more detailed information and descriptions of the soil and rock profile.

There is a significant fill depth underlying the site, which is assumed to have been used to raise grounds levels to form the playing field and to provide a level platform for the existing tennis courts.

The groundwater wells installed during the field work indicate groundwater levels at RL 1.7 m to RL1.9 m during the period of 15 January 2020 and 25 January 2020. These levels are considered to be indicative of the regional groundwater table at this site due to the site being in close proximity to Keltie Bay.

Table 5A: Summary of Geotechnical Model (Boreholes)

Unit	Material	Depth m and Reduced Level (m AHD)To Top of Each Unit						
		BH1	BH2	BH3	BH4	BH5	BH6	BH7
1	Fill	0.0 (5.9)	0.0 (4.1)	0.0 (4.1)	0.0 (6.2)	0.0 (7.0)	0.0 (6.3)	0.0 (6.3)
2	Sand / Clayey Sand: vl-l	2.8 (3.1)	2.5 (1.6)	2.1 (2.0)	3.5 (2.7)	2.7 (4.3)	N/E	2.7 (3.6)
3	Sand: md-d	6.0 (-0.1)	7.0 (-2.9)	N/E	6.3 (-0.1)	N/E	3.5 (2.8)	N/E
4	Interbedded Sands and Clay: md-d and f-st	11.1 (-5.2)	11.7 (-7.6)	N/E	N/E	N/E	N/E	N/E
5	Sandstone: M-H	N/E	N/E	3.6 (0.5)	N/E	3.5 (3.5)	8.5 (-2.2)	6.6 (-0.3)

Notes: vl = very loose, l = loose, md = medium dense, d = dense, f = firm, st = stiff, M = medium strength, H = high strength, N/E = not encountered

Table 5B: Summary of Geotechnical Model (CPTs)

Unit	Material	Depth m and Reduced Level (m AHD) To Top of Each Unit							
		CPT1	CPT2	CPT3	CPT4	CPT5	CPT6	CPT7	CPT8
1	Fill	0.0 (4.1)	0.0 (4.1)	0.0 (4.1)	0.0 (4.2)	0.0 (6.2)	0.0 (5.9)	0.0 (4.1)	0.0 (4.1)
2	Sand / Clayey Sand: vl-l	2.0 (2.1)	2.7 (1.4)	2.8 (1.3)	2.3 (1.9)	2.6 (3.6)	3.4 (2.5)	2.5 (1.6)	2.4 (1.7)
3	Sand: md-d	N/E	N/E	6.7 (-2.6)	6.5 (-2.3)	5.4 (0.8)	6 (-0.1)	6.4 (-2.3)	8.0 (-3.9)
4	Interbedded Sands and Clay: md-d and f-st	N/E	N/E	11.5 (-7.4)	9.4 (-5.2)	9.8 (-3.6)	10.5 (-4.6)	9.4 (-5.3)	10.3 (-6.2)
5	Sandstone: M-H	4.3 (-0.2)	5.9 (-1.8)	12.5 (-8.4)	19.0 (-14.0)	18.8 (-12.6)	20.5 (-14.6)	18.0 (-13.9)	11.0 (-6.9)

Notes: vl = very loose, l = loose, md = medium dense, d = dense, f = firm, st = stiff, M = medium strength, H = high strength, N/E = not encountered

Table 5C: Summary of Geotechnical Model (Layer Thickness – Boreholes)

Unit	Material	Thickness of Each Unit						
		BH1	BH2	BH3	BH4	BH5	BH6	BH7
1	Fill	2.8	2.5	2.1	3.5	2.7	3.5	2.7
2	Sand / Clayey Sand: vl-l	3.2	4.5	1.5	2.8	0.8	NE	3.9
3	Sand: md-d	5.1	4.7	NE	Not confirmed	NE	NE	NE
4	Interbedded Sands and Clay: md-d and f-st	Not confirmed	Not confirmed	NE	NE	NE	NE	NE

Notes: vl = very loose, l = loose, md = medium dense, d = dense, f = firm, st = stiff, M = medium strength, H = high strength, N/E = not encountered

Table 5D: Summary of Geotechnical Model (Layer Thickness – CPTs)

Unit	Material	Thickness of Each Unit							
		CPT1	CPT2	CPT3	CPT4	CPT5	CPT6	CPT7	CPT8
1	Fill	2.0	2.7	2.8	2.3	2.6	3.4	2.5	2.4
2	Sand / Clayey Sand: vl-l	2.3	3.2	3.9	4.2	2.8	2.6	3.9	5.6
3	Sand: md-d	NE	NE	4.8	2.9	4.4	4.5	3	2.3
4	Interbedded Sands and Clay: md-d and f-st	NE	NE	1.0	9.6	9.0	9.96	8.6	0.7

Notes: vl = very loose, l = loose, md = medium dense, d = dense, f = firm, st = stiff, M = medium strength, H = high strength

8. Proposed Development

Based on the supplied architectural drawings prepared by Allen Jack + Cottier (AJ+C), it is understood that the development of the site will involve demolition of the existing facilities and construction of a new sports complex including a multipurpose hall, fencing / taekwondo hall, rifle range, swimming pools, car parking and minor service areas such as a lobby, change rooms and toilets.

It is understood that a below ground basement comprising the swimming pools and car parking is proposed. It is assumed that the single level basement and pool deck (RL2.65) will require bulk excavation to about RL2.2 which is about 2 m to 3.5 m below existing surface level. The swimming pools are set back about 4-5 m from the boundaries and may require bulk excavation to about RL0.5 which is about 4 m to 5.5 m below current surface levels.

It is also understood a new proposed road is to provide access from the south west corner of the site, at the intersection of Neild Avenue and Boundary Street, to the sport facility car park.

9. Comments

9.1 Hydrology

Based on the two discrete groundwater measurements from the groundwater monitoring well at BH1, and seepage observed during the drilling of the boreholes and CPT tests, DP currently has limited information on the groundwater depth and fluctuations. The measurement in the groundwater monitoring well (BH1) indicates groundwater at RL1.7 m to RL1.9 m. It must be recognised, however, that groundwater levels fluctuate with prevailing weather/climate conditions and possibly tidal variation in the nearby Sydney Harbour. Seepage depth measurements from other tests suggest that groundwater varies from RL1.5 m to RL 2.5 m, however ‘smearing’ and densification effect on the sidewall of boreholes and CPT test form a temporary ‘seal’ to prevent groundwater recharge in the borehole in the short term. Generally a temporary rise in groundwater of at least 1-2 m may be expected within sandy soils. Further groundwater monitoring within wells across the site, preferably using data-loggers, is required to assess groundwater levels and fluctuations for detailed design.

The permeability or hydraulic conductivity of the sand will change according to variation in the silt and clay content, and grain size of the sand.

9.2 Dewatering and Tanking

Based on the information provided it is expected that excavation to RL2.2 m for the pool deck and basement will be close to, and possibly slightly above the groundwater level in some areas during normal/dry weather. Following heavy rainfall and prolonged wet weather it is likely that the groundwater level may rise and be temporarily above the bulk excavation. Bulk excavation for the swimming pools to RL0.5 m may be about 1.5 m to 2 m below the groundwater.

Excavation for the pools, and possibly the pool deck and basement, will require excavation below the groundwater and will require dewatering to enable excavation and construction to be completed. It is recommended that the basement structure and pools are tanked and designed to resist uplift forces associated with groundwater levels.

Generally the groundwater level should be lowered to at least 1 m below the bulk excavation to allow machinery to operate and traverse the site. On this basis, the groundwater level (measured at the time of the investigation) may need to be temporarily lowered by approximately 1 m for the pool deck and basement and 2.5 m to 3 m for the pools.

In the absence of detailed monitoring, it is suggested that typical hydrostatic loads due to a groundwater table rising to 2 m above the measured groundwater level should be considered in the design of the permanent basement structure. This is essentially assuming a rise to the ground surface is some areas.

In the long term, the downward force to resist uplift is typically provided by the weight of the building itself, and the detailing of the slab and foundations should be designed accordingly.

Numerical modelling should be carried out to assess the effectiveness of the proposed dewatering system and predict drawdown levels and associated settlements on adjacent properties. Groundwater modelling is generally carried out once details of the proposed shoring and dewatering system are available. Design proponents should bear in mind the integral nature of the depth of the shoring walls and the dewatering/pumping system design such that if one of these elements is modified it will likely impact on the other.

The dewatering of the site should be carried out by a contractor with demonstrated experience in similar conditions.

9.2.1 Hydrogeological Impact

Woollahra Municipal Council’s Guidelines for Geotechnical and Hydrogeological Reports indicates that temporary changes in the water level during construction should not exceed 0.3 m, unless calculations based on site specific results can support a greater change, and that the development will not change the water table by more than 0.2 m.

The deepest excavation is expected to about 1.5 m below the measured groundwater level and therefore a maximum drawdown of less than 1.5 m would be expected. This drawdown can be reduced further by installing impermeable shoring walls to depth. If shoring walls are installed to rock then it is expected that minimal drawdown would occur outside the excavation, however the depth to rock increases to about 20 m at the western end of the site. A drawdown of 1.5 m is expected be within the range of historic low groundwater levels in the Paddington area and therefore settlements due to drawdown of 1.5 m within the loose to medium dense sands should be relatively minor (less than 5 mm). In order to further reduce the risk of adverse impacts to surrounding properties it is suggested that the proposed shoring and dewatering scheme should be designed to target a drawdown of no more than 1.0 m at the surrounding properties. It is considered that a target temporary drawdown limit of 1 m is more reasonable and can be justified, given the known historic natural variations in water levels in this area.

A tanked (i.e. fully water-tight) basement is recommended for the site so that there is no long term pumping requirements or drawdown surrounding the site.

9.2.2 Piping Failure

Erosion of the sandy soils may occur in the form of piping failures of the material at the base of the excavation if the basement excavation is not adequately dewatered. This can lead to the sudden collapse of shoring walls. Piping failure occurs when excess hydrostatic pressure acting on the soils within the excavation becomes equal to the effective weight of the overlying soil. The risk of piping failure will generally be greatest in the event that the dewatering pumps fail when bulk excavation is below the water level. It is recommended that the shoring wall should have a minimum embedment of 5 m below the deepest bulk excavation level to reduce the risk of piping failure. Where rock is encountered at shallower depths the shoring may terminate in rock above the suggested 5 m embedment. As outlined in the following sections a deeper wall embedment may be required to reduce groundwater inflows and to limit drawdown (and consequent settlement) on adjacent properties.

9.2.3 Method of Dewatering

Dewatering on sites underlain by sandy soils is usually undertaken with spears installed at regular intervals within the confines of the excavation. Spears (slotted PVC pipes) are installed below the groundwater table and generally spaced at about 1 m to 2 m centres around the perimeter of the excavation. Alternatively larger diameter spears can be used and positioned close to the centre of the site. The spears are connected by a series of pumps and hoses which collect groundwater, usually in a sedimentation tank, prior to discharge off-site.

Based on previous experience in the area, the relatively clean sands underlying the site are likely to have a bulk permeability (k) of between $2.5x10^{-4}$ m/sec to $5x10^{-4}$ m/sec. This value is typical for clean sands and may be used as a basis for preliminary design of the temporary spear-point dewatering system for this site. ‘Sump-and-pump’ dewatering methods will not be practical or effective for the high permeability sandy soils at this site.

DP recommends that detailed seepage modelling be completed to assess pumping volumes and external groundwater levels during construction.

If dewatering is proposed, both Woollahra Council and WaterNSW may impose a number of conditions on the dewatering works, including groundwater level monitoring within and outside the basement excavation and that the groundwater be tested for quality and contamination both during and prior to dewatering. Typically three groundwater monitoring wells, outside the basement excavation are required.

9.2.4 Drawdown and Settlement

It is suggested that the shoring and dewatering scheme should target a drawdown of 1 m outside the site. Inflow and drawdown can be reduced by installing the impermeable shoring wall to rock or greater depths. During construction, it is recommended that drawdown outside the excavation in the vicinity of the adjacent properties should be monitored in general accordance with the following:

- install standpipes in accessible areas on adjacent properties (or footpaths/roads) to monitor groundwater drawdown levels during dewatering;
- measure groundwater levels on a weekly basis for three weeks prior to operation of the dewatering system to establish pre-developed (i.e. ‘baseline’) levels;
- measure groundwater levels twice per day during the first two days of dewatering, and then daily during the first week of dewatering and then weekly until decommissioning of the dewatering pumps, or until a lesser frequency is advised by the geotechnical engineer;
- the measured values are to be provided to the geotechnical engineer and hydrogeologist on the day of measurement for review;

- Where drawdown levels exceed a ‘trigger level’ (to be set) below pre-developed groundwater levels, the reason for the change in groundwater level should be investigated. Measures to correct the exceedance if required could include reduction of pumping rates or suspension of dewatering;

9.2.5 Groundwater Disposal

Groundwater that is removed from the site will require disposal. Generally, water resulting from dewatering operations should be suitable for disposal by pumping to stormwater drains, subject to confirmation testing and approval from Council and Water NSW, as necessary. Investigation of groundwater quality should be carried out prior to inform the shoring and dewatering design in case it is beneficial or necessary to further reduce inflow rates. Further testing and reporting may be required to determine appropriate disposal options, together with approval from relevant authorities (i.e. Woollahra Council and/or Water NSW).

9.3 Dilapidation Surveys

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

9.4 Excavation Conditions and Batter Slopes

Excavations are expected to be carried out through fill, natural sands and possibly sandstone in some areas. Fill and sands should be readily removed using conventional earthmoving equipment such as tracked excavators. Generally rock hammers, rotary rock saws or grinders will be required to excavate medium to high strength bedrock if encountered. The excavation rate that can be achieved varies considerably and is dependent upon the degree of jointing in the rock, rock strength, type of machinery and skill of the operator. It is suggested that bulk excavation tenderers be required to make their own assessment of the equipment required to carry out the work.

Trafficability on the sandy soils during bulk earthworks will generally require the use of tracked plant and machinery. Trafficability after bulk excavation could be improved by placement of a layer of compacted crushed concrete or similar hard and durable rockfill, which may subsequently be used as sub-base.

During the bulk excavation phase, it is recommended that temporary batter slopes within the perimeter shoring walls that are above the groundwater table, do not exceed 1.5H:1V (Horizontal : Vertical) in both fill and sandy soils.
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 2012). Reference should be made to the contamination assessment report prepared by DP (Ref: 99538.01.R.001).

9.5 Excavation Support & Shoring

Vertical excavations within the sandy soils will require retaining/shoring structures both during construction and as part of the final structure. Temporary anchors or bracing may be used to provide lateral restraint and limit wall movements.

9.5.1 Shoring/Retaining Wall Design

Preliminary design of shoring with multiple rows of anchors/bracing may be based on a trapezoidal earth pressure of 6H kPa (6 x excavation height in m), or 8H for walls adjacent to sensitive structures (e.g. buildings on high-level footings).

The pressure distributions given above do not include hydrostatic pressure due to groundwater behind shoring/retaining walls. It is suggested that a potential groundwater level to 2 m above the measured groundwater level should be adopted in the design of retaining walls, in which case the buoyant unit weight of the soil may be adopted to estimate the earth pressures acting on the wall.

The minimum embedment depth for the shoring will need to consider the wall stability and also the need to reduce inflow rates and drawdown of the water table on surrounding areas. This embedment depth will also be determined by the target (groundwater table) drawdown limit. It is recommended that the shoring wall should have a minimum embedment of 5 m (or to rock) below the deepest bulk excavation level to reduce the risk of piping failure, however this will need to be assessed in conjunction with inflow and drawdown assessment.

In the design of the shoring/retaining walls due allowance should be made for surcharge loads including adjacent structures, site sheds, stored materials, road traffic and plant operating above the excavation during construction.

Detailed design of shoring should preferably be carried out using WALLAP, FLAC or other accepted computer analysis programs capable of modelling progressive excavation and anchoring and predicting potential lateral movements, stresses and bending moments induced within the walls.

9.5.2 Shoring/Retaining Wall Systems

A secant pile wall would generally be suitable for the site, comprising interlocking Continuous Flight Auger (CFA) piles or alternatively CFA piles with jet-grouted ‘columns’ between the piles after the installation of the ‘hard’ reinforced (CFA) piles. This shoring system can generally provide an effective seal to minimise sand loss and water inflow from behind the wall, and if adequately supported, can minimise lateral deflections. The ‘hard’ (reinforced) piles can be incorporated into the vertical load carrying footing system and can generally form part of the basement structure.

Soil mixed wall systems (e.g. CSM) could also provide a suitable alternative to the more conventional secant pile wall. These walls are constructed using specialised equipment to either blend cement with the in-situ soils to create a soil-cement mix. There are several different systems available and further advice should be obtained from the specialist piling contractor regarding the suitability of the wall system to this site. In particular, confirmation should be sought in relation to the consistency/strength of the soil mixed wall, the long term durability, and permeability.

A diaphragm wall system could also be used on the site, however, the large equipment and plant required may not be suitable for the relatively small site.

Sheet piles are generally only suitable for shallower excavations above the water table and where there are no movement sensitive structures adjacent to the excavation. The shallow depth to rock in some areas may also cause issues for driving and damaging sheets. If vibrations, shallow rock issues, and inflow rates can be controlled then sheet piles may be considered.

A contiguous pile wall comprising closely spaced/touching CFA piles is not recommended for this site due to risks associated with seepage and sand loss or erosion in between the piles, particularly below the groundwater table.

For CFA piles, care will be required to avoid ‘decompression’ of the sandy soils during augering, which can lead to loosening of the founding stratum beneath existing footings and damage to adjacent structures. It may be necessary to adopt temporary segmental casing system (i.e. CSP) to reduce the risk of decompression in critical areas.

As a guide, well designed (and constructed) shoring walls in sand supported by ‘tieback’ ground anchors may experience lateral wall movements due to earth pressure in the order of 1 mm to 2 mm for each metre of excavation depth. The extent of movement will depend on the final design and construction methods used. A programme of precise survey monitoring should be adopted to assess shoring wall and adjacent building movement progressively during the excavation to ensure that tolerable limits are not exceeded and to provide an early indication of whether additional support is required.

9.5.3 Adjacent Foundations

Consideration may be given to stabilising or underpinning the foundations beneath the neighbouring properties in close proximity to the excavation, which are expected to comprise shallow strip footings or pad footings (this may change with time due to future development). This would improve the strength of the sands and also help to reduce differential movements. This may be achieved through grout injection or chemical stabilisation. The permission of the subject (adjacent) property owner(s) would be necessary to obtain. Further advice should be obtained from specialist contractors regarding the suitability of stabilisation and/or underpinning options at this site.

9.5.4 Ground Anchors

It is presumed that temporary tieback ground anchors or a stiff propping system (e.g. hydraulic struts) will be used to restrict wall movements during the construction phase, with permanent support of walls provided by the final basement structure (i.e. floor slabs).

Design of temporary anchors may be based on a friction angle (ϕ) of 28 degrees within loose sand and 33 degrees within medium dense sands. A maximum allowable bond stress of 500 kPa and ultimate bond stress of 1000 kPa may be adopted within medium strength or stronger sandstone. Trial anchors may be used to determine if higher friction angles/shaft adhesion values are achievable. The anchors should be bonded behind a line drawn up at 45 degrees from the base of the excavation, and lift-off tests should be carried out to confirm the anchor capacities. Post-grouting techniques may be used to achieve higher capacities.

The anchors will need to be carefully positioned and possibly inclined at steeper angles to avoid adjacent services and footings for adjacent buildings. It is noted that permission from adjacent property owners will be required prior to installing soil anchors beneath their land.

It is recommended that only reputable, specialist anchor contractors be engaged to design and/or install temporary anchors on this site.

9.6 Subgrade Preparation

It is expected that the subgrade for the new pavements will generally comprise of sandy fill and at bulk excavation level the subgrade will comprise lose to medium dense sand and possibly rock.

The bulk soil sample (fill) that was tested returned a CBR value of 14%, however given the typical variability of the fill it is recommended that a preliminary CBR value of 7% be adopted for pavement design purposes. It is recommended that once the existing surface levels at the location of the proposed driveway have been stripped an inspection be carried out by an experienced geotechnical engineer to confirm the appropriate CBR value to use for design.

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

The following methodology is suggested for subgrade preparation for pavements, raising of site levels and at bulk excavation level, following excavation and dewatering:

- Strip the fill to remove any organic and root affected material;
- Where soil / fill is exposed, proof rolling of the subgrade should be carried out prior to placement of any fill or the construction of slabs. Proof rolling should comprise six passes of a smooth drum roller (say at least 10 tonne). The final pass should be carried out under the observation of a geotechnical engineer to identify any soft or saturated zones. Any such zones should be over-excavated to a maximum depth of 600 mm and replaced with compacted durable granular material, subject to geotechnical inspection and advise at the time;
- If any fill is required to raise surface levels, it should be placed in layers not greater than 200 mm loose thickness and compacted to between 98% to 100% of Standard dry density, with moisture content within ±2% of the optimum moisture content.

The filling and rock on the site is suitable for reuse as engineered filling provided it has a maximum particle size of 100 mm and free of organic material. Reuse should also consider the contamination status and is subject to approval by an environmental consultant.

As heavy plant may be required to operate on the site, it is recommended that a working platform be constructed on the prepared subgrade. The platform should be constructed from good quality granular material with low fines, such as recycled concrete or high strength ripped sandstone. The thickness of the platform should be assessed once specific details of the heavy plant that will operate within the basement are known. It is expected that the rockfill layer will be necessary to achieve compaction of the subgrade material at the bulk excavation level. This layer should provide the necessary ‘confinement’ of the sands expected at subgrade level, to achieve a reasonable level of compaction.

9.7 Foundations

9.7.1 Shallow Foundations

Based on the results of the investigation, the foundation materials below the proposed basement level will generally comprise loose to medium dense sand. Rock may be relatively shallow below the basement in some areas and very loose to loose sand may be encountered in some areas (i.e. CPT5; see Drawing 4). Therefore, it is expected that shallow or high-level (e.g. pad or strip) footings could be founded on sand although footings may be relatively large and settlements would need to be considered.

The allowable end bearing pressure in sands will depend on the density/strength of the foundations, depth of embedment and size of the footing and depth to groundwater. As a guide, allowable end bearing pressures and elastic modulus values for the typical soil strata are provided in Table 6. The ultimate and allowable end bearing pressures shown in Table 6 are based on a pad footing with a plan area of 2 m by 2 m, embedment of 0.5 m and a factor of safety equal to 2.5.

Table 6: Summary of Typical Design Parameters for Shallow Foundations

Foundation Material	Ultimate Bearing Capacity (kPa)	Allowable Bearing Capacity (kPa)	Elastic Modulus (MPa)
Sand / Clayey Sand: very loose to loose	180-200	80-100	10
Sand: medium dense	400 - 450	160 – 180	35

The settlement of shallow footings founded on sand may be estimated on the basis of the Young’s Modulus values given in Table 6.

9.7.2 Raft Slabs

Consideration may be given to the use of a raft slab foundation. However, this will be subject to detailed review and analysis of bearing pressures and settlements once more specific details of the founding level, column layout and slab loadings have been confirmed. The possible presence of varying founding materials (i.e. loose sand and sandstone) below the raft slab should be considered in the design particularly for concentrated column and shear core loadings and differential settlement between raft slabs.

Details of structural loads were not available at the time of preparing this report. Based on similar sized projects it is anticipated that a distributed slab load in the order of 50 kPa may be applicable for the four storey building. As a guide, for raft slab foundations, preliminary settlement analyses has been carried out assuming a distributed slab load of 50 kPa, with a loaded area of 20 m by 20 m. Based on the results of the analyses, preliminary design of raft slabs to support column and floor loadings may be based on a modulus of subgrade reaction (k) value of the order of 3.5 kPa/mm to

4.5 kPa/mm for the broadly loaded area. Settlements of between 20 mm to 25 mm could be expected under the assumed loads. It is noted that the 'k' value (which is not strictly a soil parameter) is very dependent on the size of the loaded area and the rigidity of the raft system and therefore these values may not be applicable to other raft slab arrangements.

Construction of the raft slabs should incorporate subgrade preparation as outlined in Section 9.6. It is also suggested that a minimum 150 mm thick layer of good quality, durable rockfill such as recycled concrete or fine crushed rock should be placed and compacted over the prepared surface, particularly at the more heavily loaded areas. The granular layer will help to confine the sandy soils and improve the compaction and density of the surface soils.

A piled raft foundation may also be considered to reduce differential settlements, if required.

Further geotechnical analysis and advice and possibly investigation (CPTs) will be required in relation to the design and construction of both raft slabs and piled raft slabs, if these are to be considered.

9.7.3 Pile Foundations

The alternative to shallow foundations is to support the structural loads on piles founded within the medium dense to dense sand which is expected at depths of between approximately 3.5 m and 8 m below the existing surface level. The presence of the more variable interbedded sand and clay profile below this sand layer, and associated reduction in geotechnical capacity, must also be considered in the pile design. Piles to rock could also be considered but rock is relatively deep on the western part of the site.

Continuous Flight Auger (CFA), concrete injected piles could be considered for this site, as could cast-in-situ screwed concrete pile types such as Atlas or Omega piles. These types of piles are all associated with relatively low levels of noise and vibration. Screwed cast in-situ concrete piles generally leave a reinforced concrete screw shaped pile and involve lateral displacement of the soil during installation, more efficiently using the in-situ capacity of the soil.

It is expected that noise and vibration constraints at this site will preclude the use of driven pile types. Open bored piles will not be appropriate due to the potential for soil collapse and groundwater inflow and the relatively small site will preclude the use of bored piles being drilled under bentonite due to the size of the equipment required.

As a guide for design of piles in soil, a preliminary estimate of the geotechnical capacity of CFA (concrete or grout-injected) piles (0.6 m diameter) is provided in Appendix E. This estimate is based on the result of CPT5 and for piles founded below 7 m depth (from 2 m below the approximate basement pool level). The pile capacity estimate is calculated using ConePile ® which is an in-house DP pile analysis and design program. The pile capacity estimate indicates the assessed ultimate end bearing and shaft friction values with depth together with an ultimate geotechnical ($R_{d,ug}$) and design strength ($R_{d,g}$) for the piles at varying depths.
As a guide, and as shown in Appendix E, a $R_{d,g}$ of 750 kN should be available at 13 m depth (below existing surface levels) for a 600 mm diameter CFA pile based on an assumed geotechnical strength reduction factor ($Ø_g$) of 0.4.

Piles founded within rock may be designed using the values in Table 7. Shaft adhesion values for uplift (tension) may be taken as being equal to 70% of the shaft adhesion values for compression in Table 7.

Table 7: Recommended Design Parameters for Axial Loading

Unit	Foundation Stratum	Maximum Allowable Pressure (Serviceability)		Maximum Ultimate Pressure (Ultimate Limit State)		Vertical Elastic Modulus E (MPa)
		Allowable End Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)	Ultimate End Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa)	
5	Sandstone: medium to high strength	3500	350	40,000	700	1000

Piles in rock designed using the allowable parameters provided in Table 7 would be expected to experience settlements less than 1% of the pile diameter.

For pile design, a basic geotechnical strength reduction factor, Φ_{gb}, of about 0.52 (or possibly higher) calculated from Table 4.3.2 (A, B, and C) of AS2159-2009: Piling Design and Installation, is considered feasible. However, the structural engineer will need to make their own assessment with the final (Φ_{gb}) number being dependent on the design and installation method (and associated risk rating) adopted by the structural engineer. A Φ_{gb} of 0.4 is required if pile load testing is not carried out and the ARR is 2.5 or greater

9.8 Soil and Groundwater Aggressivity

In accordance with AS2159-2009, the results of the chemical laboratory testing indicate that the:

- Soils are non-aggressive to buried steel and mildly aggressive to buried concrete;
- Groundwater is severely aggressive to buried steel and mildly aggressive to buried concrete.

The possible presence of acid sulphate soils in the area should also be considered and may warrant a more prudent approach to durability design (e.g. ‘moderate’ classification). Reference should be made to the contamination assessment report prepared by DP (Ref: 99538.01.R.001).

9.9 Seismic Loading

In accordance with AS1170-2007 “Structural Design Actions, Part 4: Earthquake Actions in Australia” a site subsoil Class D_e (deep or soft soil site) is considered to be appropriate for the site, with the soil profile generally medium dense / firm or better with some very loose sand layers and an inferred rock depth of about 20 m from CPT testing.

10. Further Investigation

After development approval (DA) is obtained and before detailed structural design commences, it will be necessary to carry out a geotechnical investigation on the site comprising a minimum of:

- piezometers to measure groundwater fluctuations and to perform in-situ drawdown tests to estimate permeability of the soils/rock;
- sampling and analysis of groundwater quality; and
- Installation of data loggers to obtain continuous measurement of groundwater levels and fluctuations.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at Sydney Grammar School - Edgecliff in accordance with DP's proposal SYD191243.P.001.Rev1 dated 25 November 2019 and acceptance received by Sydney Grammar School dated 5 December 2019. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Sydney Grammar School for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and 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 testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

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

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

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

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Introduction

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

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

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

Site Anomalies

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

Information for Contractual Purposes

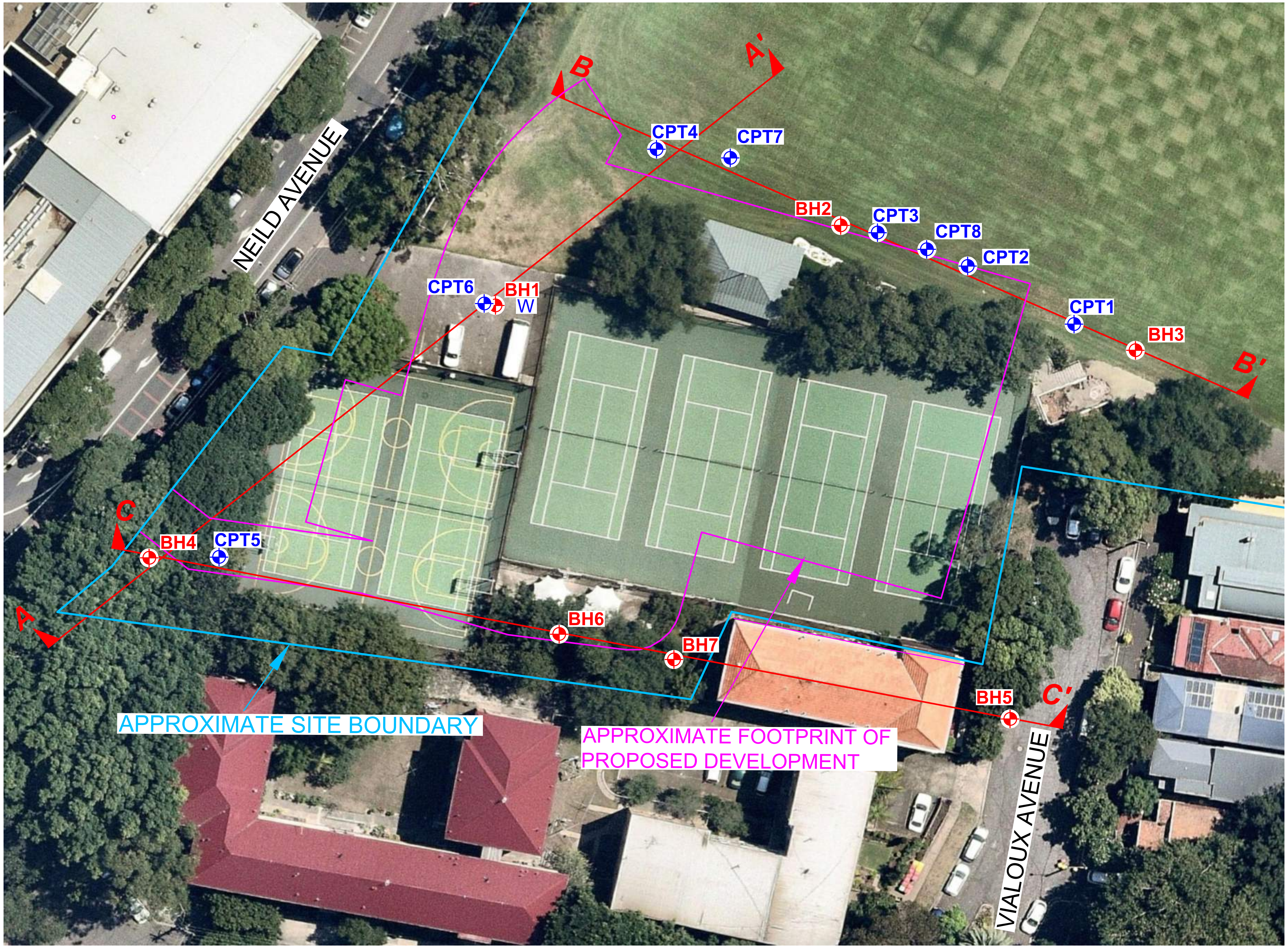
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

Site Inspection

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

Appendix B

Drawings



Locality Plan

LEGEND

- Borehole Location
- W Groundwater well
- Cone Penetration Test Location
- A A' Interpreted Cross-Section (Refer to Drawings 2, 3 and 4)

NOTE:

1: Base image from Nearmap.com (Dated 21.1.2020)

2: Test locations surveyed using differential GPS

3: Proposed building footprint taken from AJ+C Drawing 191101 (Dated 1.11.2019)

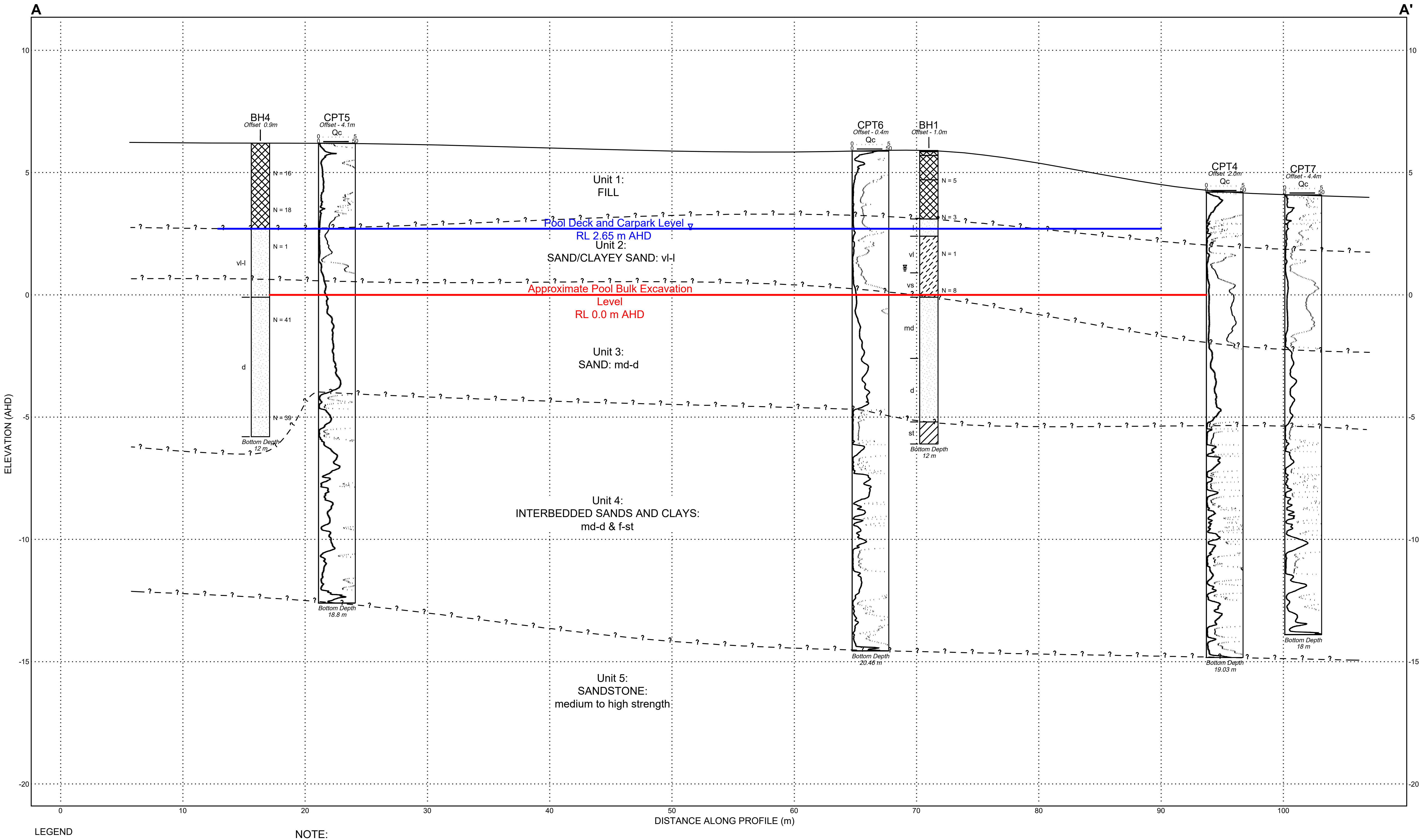
0 5 10 15 20 30 40

1:500 @ A3

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Sydney Grammar School		TITLE: **Test Location Plan**	PROJECT No: 99538.00
OFFICE: Sydney	DRAWN BY: JDB	**Grammar Edgecliff Sports Area**	DRAWING No: 1
SCALE: 1:500 @ A3	DATE: 11.02.2020	**11 Alma Street, Paddington**	REVISION: 0

N



LEGEND

■ Asphaltic Concrete

▨ Clay

▦ Filling

☐ Sand

▨ Clayey Sand

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. See report for more detailed strata unit descriptions.
3. 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
▽ - Observed Water level
– ? – – - Inferred Geology

0 6
Horizontal Scale (metres)

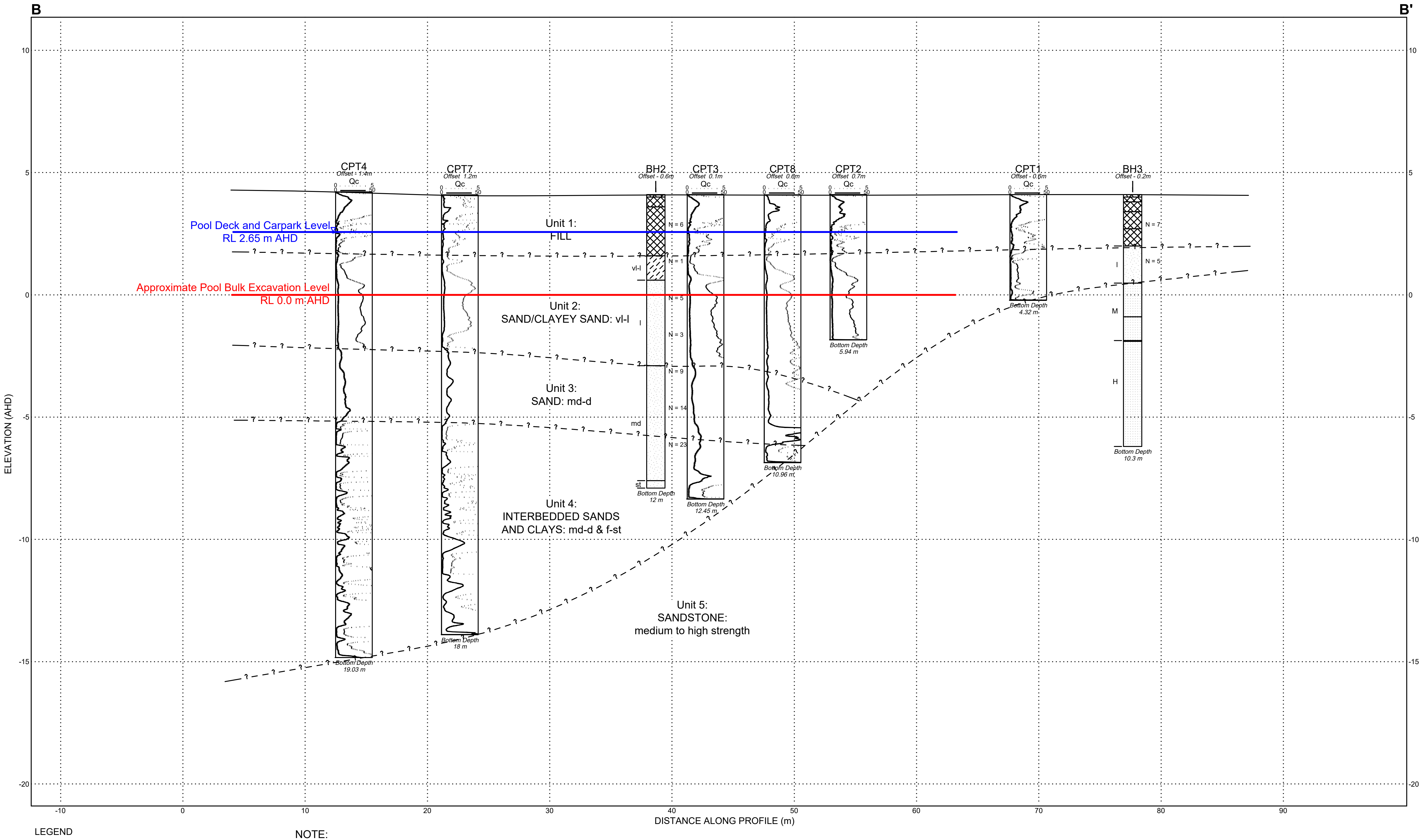
Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Sydney Grammar School
OFFICE: Sydney
DRAWN BY: JDB / IT
SCALE: 1:300 (H) 1:150 (V) @ A3
DATE: 11.02.2020

TITLE: Interpreted Geotechnical Cross-section A-A'
Grammar Edgecliff Sports Area
11 Alma Street, Paddington

PROJECT No: 99538.00
DRAWING No: 2
REVISION: 0



LEGEND

☒	Core Loss	☐	Sandstone
▨	Clayey Sand	▨	Topsoil
▦	Filling		
☐	Sand		

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TESTS / OTHER
N - Standard penetration test value
⊽ - Observed Water level
– ? – – - Inferred Geology

0 6
Horizontal Scale (metres)

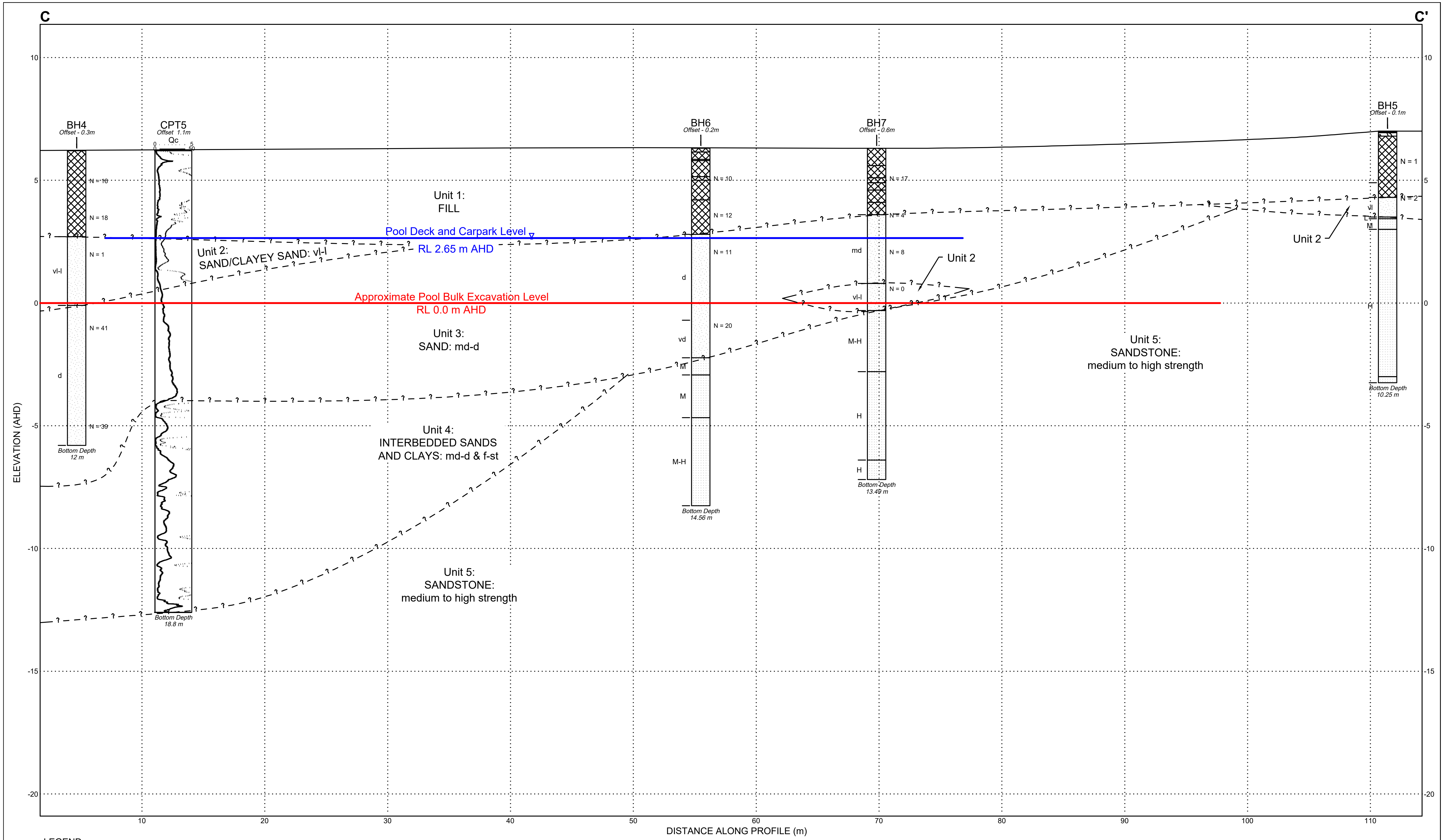
Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Sydney Grammar School
OFFICE: Sydney
DRAWN BY: JDB / IT
SCALE: 1:300 (H) 1:150 (V) @ A3
DATE: 11.02.2020

TITLE: Interpreted Geotechnical Cross-section B-B'
Grammar Edgecliff Sports Area
11 Alma Street, Paddington

PROJECT No: 99538.00
DRAWING No: 3
REVISION: 0



LEGEND

▨ Filling

☐ Sand

░ Sandstone

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. See report for more detailed strata unit descriptions.
3. Summary logs only. Should be read in conjunction with detailed logs.

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st - Stiff
vst - Very stiff
h - Hard
l - Loose
md - Medium dense
d - Dense
vd - Very dense

TESTS / OTHER
N - Standard penetration test value
▽ - Observed Water level
– ? – – - Inferred Geology

0 6
Horizontal Scale (metres)

Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Sydney Grammar School
OFFICE: Sydney
DRAWN BY: JDB / IT
SCALE: 1:300 (H) 1:150 (V) @ A3
DATE: 11.02.2020

TITLE: Interpreted Geotechnical Cross-section C-C'
Grammar Edgecliff Sports Area
11 Alma Street, Paddington

PROJECT No: 99538.00
DRAWING No: 4
REVISION: 0

Appendix C

Field Work Results

Sampling Methods

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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.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. 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	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

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
Friable	Fr	-

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	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

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;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

Dry (D)	Non-cohesive and free-running.
Moist (M)	Soil feels cool, darkened in colour. Soil tends to stick together. Sand forms weak ball but breaks easily.
Wet (W)	Soil feels cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Rock Descriptions

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it 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 Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

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

* 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
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured , usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

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 occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

Douglas Partners

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

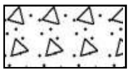
Other

fg	fragmented
bnd	band
qtz	quartz

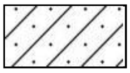
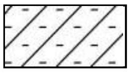
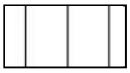
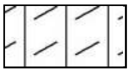
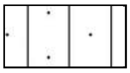
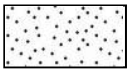
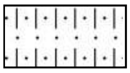
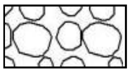
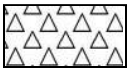
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

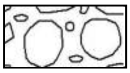
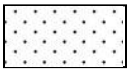
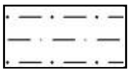
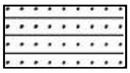
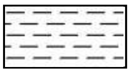
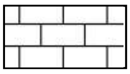
General

■	Asphalt
	Road base
	Concrete
	Filling

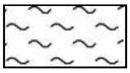
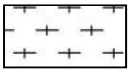
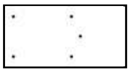
Soils

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

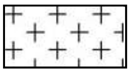
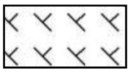
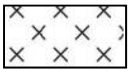
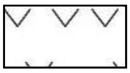
Sedimentary Rocks

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

Metamorphic Rocks

	Slate, phyllite, schist
	Gneiss
	Quartzite

Igneous Rocks

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

Cone Penetration Tests

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

• Cone tip resistance	q_c
• Sleeve friction	f_s
• Inclination (from vertical)	i
• Depth below ground	z

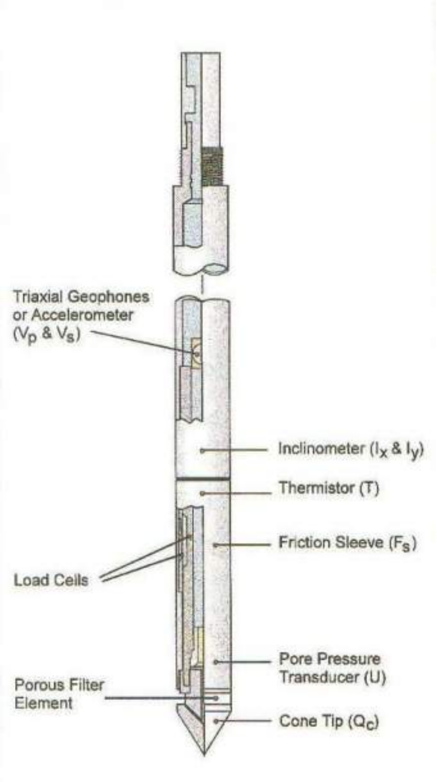


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

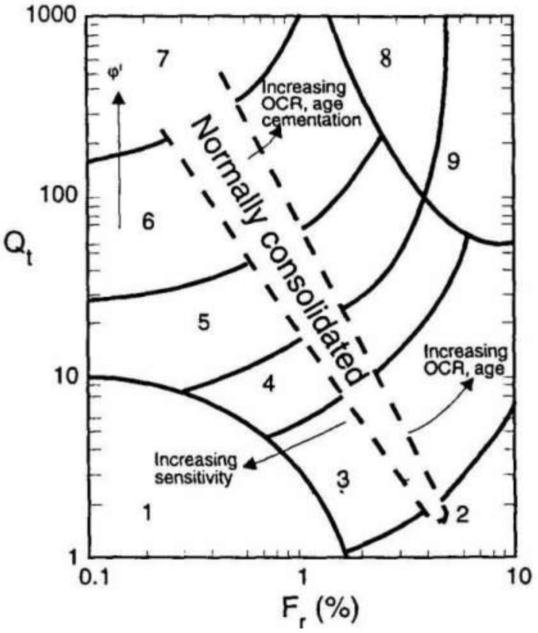


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

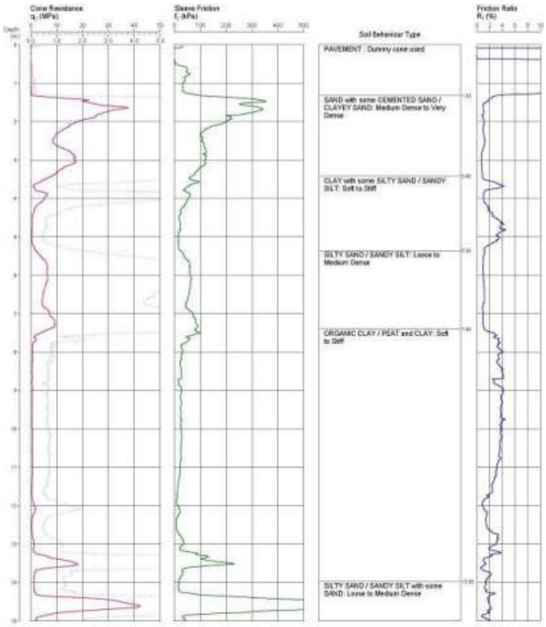


Figure 4: Sample Cone Plot

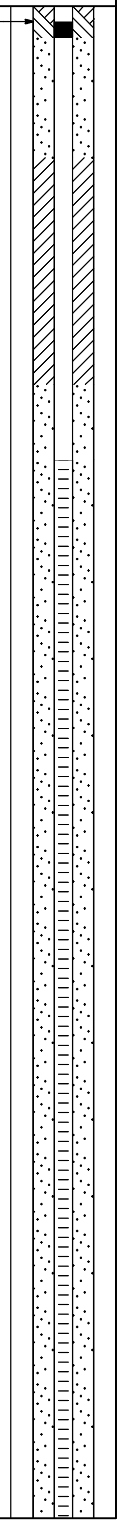
BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 5.9 AHD
EASTING: 336157
NORTHING: 6249865
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 99538.00
DATE: 19/12/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.05	ASPHALTIC CONCRETE		A/E	0.0				Gatic flush with ground level Top Cap
	0.2	FILL/ROADBASE: grey, medium to coarse sand, angular to subangular igneous gravels, apparently well compacted, moist		A/E	0.2 0.5				Backfill Material (0.2-1.0m)
		FILL/SAND and GRAVEL: fine to medium, pale grey-brown, trace of brick fragments, charcoal, ash, clinker and organic matter, apparently poorly compacted, moist		A/E					
5	1			S	1.0 1.45		6,3,2 N = 5		1
	1.2	FILL/SAND : fine to medium grained, light brown, trace of concrete, ripped sandstone gravel, ash and charcoal, apparently poorly compacted, moist							Blank PVC Casing (0.2-3.0m) Bentonite Plug (1.0-2.5m)
4	2			A/E	1.9 2.0				2
				S	2.5 2.95		1,2,1 N = 3		
	2.8	FILL/SAND: fine to medium, brown, trace of indurated coffee sand, sandstone gravel, clinker and charcoal, loose, moist							
3	3			A/E	3.0 3.1				3
2	4			A/E	3.9 4.0				4
				S	4.0 4.45		1,0,1 N = 1		
	4.5	FILL/Clayey SAND: fine grained, low plasticity, grey, dark grey organic clay, trace sandstone gravel, clinker and charcoal, very loose to loose, wet							
1	5								5
0	6								6
	6.0	SAND SP: fine grained, grey, medium dense, alluvial, wet							
-1	7								7 Gravel (2.5-11.7m) Slotted PVC Casing (3.0-11.7m)
				S	7.5 7.95		2,3,5 N = 8		
-2	8								8
		8.5m: becoming pale grey and dense, possibly aeolian							
-3	9								9
-4	10.0								



RIG: Bobcat **DRILLER:** JE **LOGGED:** SI **CASING:** HQ to 8.0m

TYPE OF BORING: Solid flight auger (TC-bit) to 3.5m; Rotary (mud) to 12.0m

WATER OBSERVATIONS: Free groundwater observed at 3.0m whilst augering

REMARKS: Stand pipe installed to 11.7m (screen 11.7 to 3.0m, solid PVC 3.0 to 1.0m, gravel 11.7 to 2.5m, bentonite 1.0 to 2.5m, backfill to surface)

SAMPLING & IN SITU TESTING LEGEND

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

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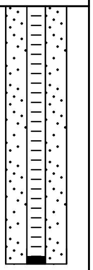
BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 5.9 AHD
EASTING: 336157
NORTHING: 6249865
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 99538.00
DATE: 19/12/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SAND SP; fine grained pale grey, medium dense, possibly aeolian, wet	⁙						
-5	11 11.1	CLAY CI: medium plasticity, brown, with fine sand, w~PL, stiff, residual	▨	S	11.0 11.45		2,4,6 N = 10		11 End Cap
-6	12 12.0	Bore discontinued at 12.0m							12
-7	13								13
-8	14								14
-9	15								15
-10	16								16
-11	17								17
-12	18								18
-13	19								19
-14									



RIG: Bobcat **DRILLER:** JE **LOGGED:** SI **CASING:** HQ to 8.0m
TYPE OF BORING: Solid flight auger (TC-bit) to 3.5m; Rotary (mud) to 12.0m
WATER OBSERVATIONS: Free groundwater observed at 3.0m whilst augering
REMARKS: Stand pipe installed to 11.7m (screen 11.7 to 3.0m, solid PVC 3.0 to 1.0m, gravel 11.7 to 2.5m, bentonite 1.0 to 2.5m, backfill to surface)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
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BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 4.1 AHD
EASTING: 336199
NORTHING: 6249875
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 99538.00
DATE: 19/12/2019
SHEET 1 OF 2

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
0.1	FIILL/TOPSOIL: grey-brown, silty sand, with rootlets	A/E	0.1 0.2				
0.5	FILL/SAND: fine to medium, pale brown to brown, trace brick and concrete fragments, ash, slag and rootlets, apparently loose, dry	A/E	0.4 0.5				
	FILL/Sandy GRAVEL: fine grained, with clay, crushed sandstone gravel and cobbles, trace shale gravel, slag and rootlets, apparently poorly to moderately compacted, moist	A/E	0.9 1.0				
		S	1.0 1.45		5,2,4 N = 6		
		*A/E	1.9 2.0				
	2.4m: becoming wet						
2.5	FIll/Clayey SAND: fine to medium grained, dark grey, with organic matter, trace ash, wet, very loose to loose, alluvial	S	2.5 2.95		0,0,1 N = 1		
3.5	SAND: fine to medium, pale grey to grey, trace organic matter, loose, wet, alluvial	S	4.0 4.45		3,2,3 N = 5		
		S	5.5 5.95		1,2,1 N = 3		
7.0	SAND: fine, pale grey brown, medium dense, wet , alluvial (possibly aeolian)	S	7.0 7.45		5,4,5 N = 9		
		S	8.5 8.95		6,7,7 N = 14		

RIG: Bobcat **DRILLER:** JE **LOGGED:** SI **CASING:** HQ to 8.0m

TYPE OF BORING: Solid flight auger to 3.5m; Rotary (mud) to 12.0m

WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering

REMARKS: *BD219122019

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 4.1 AHD
EASTING: 336199
NORTHING: 6249875
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 99538.00
DATE: 19/12/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water	Well Construction Details
-6		SAND: fine, pale grey brown, medium dense, wet , alluvial (possibly aeolian) *(continued)*		S	10.0 10.45		8,12,11 N = 23		
-7	11								11
	11.7	Clay CI: medium plasticity, pale brown to brown, trace silt and fine sand, apparently stiff to very stiff, residual							
-8	12 12.0	Bore discontinued at 12.0m							12
-9	13								13
-10	14								14
-11	15								15
-12	16								16
-13	17								17
-14	18								18
-15	19								19

RIG: Bobcat **DRILLER:** JE **LOGGED:** SI **CASING:** HQ to 8.0m
TYPE OF BORING: Solid flight auger to 3.5m; Rotary (mud) to 12.0m
WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering
REMARKS: *BD219122019

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 4.1 AHD
EASTING: 336235
NORTHING: 6249860
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 99538.00
DATE: 20/12/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
4	0.1	FiLL/TOPSOIL : grey, silty sand, with rootlets		A/E	0.1 0.2				
		FILL/SAND: fine to medium grained, pale grey, with ripped sandstone gravel, dry, trace ash, apparently poorly compacted		*A/E	0.4 0.5				
3	0.7	FILL/Silty CLAY: low plasticity, grey, with ripped shale gravel, w<PL, moderately compacted		A/E	0.9 1.0				
	1			S	1.45		4,5,2 N = 7		1
2	1.4	FILL/Clayey SAND: low plasticity, dark grey, with sandstone gravels and cobbles, apparently well compacted, w<PL, dry		A/E	1.5 1.6				
	2			A/E	1.9 2.0				2
1	2.1	Clayey SAND SC: fine to medium grained, dark grey, with oraganic matter, trace sandstone gravel, wet, loose, alluvial (possibly fill)		S	2.5 2.95		3,2,3 N = 5		
	3								3
0	3.62	SANDSTONE: medium grained, brown to dark brown, medium strength to high strength, moderately weathered, slightly fractured and unbroken, Hawkesbury Sandstone		C	3.62 3.75		PL(A) = 0.9		
	4								4
-1					4.6		PL(A) = 0.8		
	5				5.4		PL(A) = 1.3		5
-2					5.8				
	6			C					6
	6.1	SANDSTONE: medium to coarse grained, pale grey, high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone			6.1		PL(A) = 1.5		
-3	7				7.2		PL(A) = 1.8		7
-4	8				8.3		PL(A) = 1.7		8
					8.75				
-5	9			C	9.2		PL(A) = 2.1		9
	10.0								

RIG: Bobcat **DRILLER:** JE **LOGGED:** SI **CASING:** HQ to 3.8m
TYPE OF BORING: Solid flight auger (TC-bit) to 3.62m; NMLC Coring to 10.3m
WATER OBSERVATIONS: Free groundwater observed at 2.5m whilst augering
REMARKS: *BD320122019

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 4.1 AHD
EASTING: 336235
NORTHING: 6249860
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 99538.00
DATE: 20/12/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
-6		SANDSTONE: as above	⁙	C	10.1		PL(A) = 1.5		
	10.3	Bore discontinued at 10.3m			10.3				
-7	11								11
-8	12								12
-9	13								13
-10	14								14
-11	15								15
-12	16								16
-13	17								17
-14	18								18
-15	19								19

RIG: Bobcat **DRILLER:** JE **LOGGED:** SI **CASING:** HQ to 3.8m
TYPE OF BORING: Solid flight auger (TC-bit) to 3.62m; NMLC Coring to 10.3m
WATER OBSERVATIONS: Free groundwater observed at 2.5m whilst augering
REMARKS: *BD320122019

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 6.2 AHD
EASTING: 336115
NORTHING: 6249834
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 99538.00
DATE: 18/12/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILL/SAND: fine to medium, pale grey to grey-brown, with ripped sandstone and brick gravel and cobbles, trace of decomposed organic matter and ash, dry, apparently moderately compacted to well compacted		A/E	0.1 0.2				
				A/E	0.4 0.5				
				A/E	0.9 1.0				
				S	1.0 1.45		6,6,10 N = 16		
				A/E	1.9 2.0				
		2.5m: becoming wet		S	2.5 2.95		5,5,13 N = 18		
				A/E	3.0 3.1				
	3.5	FILL/SAND: fine to medium, grey, trace of clay, sandstone gravel, clinker and organic matter, wet, very loose to loose, alluvial		A/E	3.9 4.0				
				S	4.0 4.45		0,0,1 N = 1		
	5.0	SAND: fine to medium, grey, trace of clay, wet, very loose to loose, alluvial		A/E	5.5 5.6				
		SAND: fine to medium, pale brown to pale grey, wet, dense, alluvial		S	7.0 7.45		12,16,25 N = 41		

RIG: Rig 16 **DRILLER:** BG **LOGGED:** SI **CASING:** HQ to 5.0m
TYPE OF BORING: Solid flight auger to 3.0m, Rotary to 12.0m
WATER OBSERVATIONS: Free groundwater observed at 3.5m
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 6.2 AHD
EASTING: 336115
NORTHING: 6249834
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 99538.00
DATE: 18/12/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
		SAND: fine to medium, pale brown to pale grey, wet, dense, alluvial *(continued)*	⁘	S	11.0 11.45		14,16,23 N = 39		
	12.0	Bore discontinued at 12.0m							

RIG: Rig 16 **DRILLER:** BG **LOGGED:** SI **CASING:** HQ to 5.0m
TYPE OF BORING: Solid flight auger to 3.0m, Rotary to 12.0m
WATER OBSERVATIONS: Free groundwater observed at 3.5m
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 7.0 AHD
EASTING: 336220
NORTHING: 6249815
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 99538.00
DATE: 18/12/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
7	0.06	ASPHALTIC CONCRETE							
	0.2	ROADBASE GRAVEL: medium to coarse, angular to subangular gravel, apparently well compacted, dry		A/E	0.2 0.3				
				A/E	0.4 0.5				
		FILL/SAND: fine to medium, grey-brown to pale grey, with ripped sandstone gravel and cobbles, brick and aspahltic fagments, trace of ash, dry to moist, variably compacted 0.6m: hydrocarbon odour							
				A/E	0.9 1.0				
6	1			S	1.45		0,0,1 N = 1		1
				A/E	1.5 1.6				
				A/E	1.9 2.0				
5	2								2
				A/E	2.4 2.5				
	2.7	SAND: fine grained, pale grey brown, moist, very loose to loose, alluvial (possibly colluvial)		S	2.95		1,1,1 N = 2		
4	3								3
	3.5								
	3.57	SANDSTONE: medium grained, pale grey brown, low to medium strength, Hawkesbury Sandstone			3.57				
					3.7		PL(A) = 0.7		
3	4 4.0	SANDSTONE: medium grained, brown, medium strength, moderately weathered, slightly fractured, Hawkesbury Sandstone							4
		SANDSTONE: medium grained, pale grey, brown then pale grey, high strength, moderately weathered then fresh, slightly fractured and unbroken Hawkesbury Sandstone							
					4.65		PL(A) = 1.7		
2	5			C					5
					5.5		PL(A) = 1.1		
1	6								6
					6.3		PL(A) = 2		
					6.52				
0	7								7
					7.25		PL(A) = 2.1		
-1	8			C					8
					8.3		PL(A) = 2.1		
-2	9								9
					9.3		PL(A) = 2.2		
					9.58				
				C					
	10.0								

RIG: Bobcat **DRILLER:** JE **LOGGED:** SI **CASING:** HQ to 3.57m
TYPE OF BORING: Solid flight auger to 0.4m, diacore to 0.6m; NMLC Coring to 10.25m
WATER OBSERVATIONS: Free groundwater observed at 3.1m whilst augering
REMARKS: HC odour at 0.8m to 1.0m

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 7.0 AHD
EASTING: 336220
NORTHING: 6249815
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 99538.00
DATE: 18/12/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
-3		SANDSTONE: as above Bore discontinued at 10.25m		C	10.15 10.25		PL(A) = 2.3		
-4	11								11
-5	12								12
-6	13								13
-7	14								14
-8	15								15
-9	16								16
-10	17								17
-11	18								18
-12	19								19

RIG: Bobcat **DRILLER:** JE **LOGGED:** SI **CASING:** HQ to 3.57m
TYPE OF BORING: Solid flight auger to 0.4m, diacore to 0.6m; NMLC Coring to 10.25m
WATER OBSERVATIONS: Free groundwater observed at 3.1m whilst augering
REMARKS: HC odour at 0.8m to 1.0m

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 6.3 AHD
EASTING: 336165
NORTHING: 6249825
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 99538.00
DATE: 15/1/2020
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.15	FILL/Silty SAND: fine to medium, dark brown with fine sandstone gravel, brick fragments, moist		*A/E	0.0 0.01				
	0.5	FILL/Clayey SAND: fine to medium, yellow-brown, with clay, moist, variably compacted		A/E	0.3 0.4				
		FILL/Silty SAND: fine to medium, brown, with fine sandstone gravel and cobble, moderately to well compacted, moist		A/E	0.9 1.0				
				S			6,5,5 N = 10		
	1.3	FILL/Silty SAND: fine to medium, grey to brown, with clay, fine sandstone gravel, trace brick fragments, ash, clinker and decomposing organic matter, moist, apparently moderately to well compacted, burnt odour		A/E	1.4 1.45 1.5				
				A/E	1.9 2.0				
				A/E	2.4 2.5				
				S	2.95		3,3,9 N = 12		
	3.5	SAND: fine to medium, dark grey and pale grey, trace silt, medium dense, moist, alluvial							
		4.0 m: becoming wet		A/E	3.9 4.0				
				S	4.45		4,5,6 N = 11		
				S	7.0 7.45		5,8,12 N = 20		
	8.53	SANDSTONE: orange-brown, medium to coarse grained, moderately weathered, slightly fractured, medium strength with very to low strength bands, Hawkesbury Sandstone		C	8.53				

RIG: BG 17 **DRILLER:** BG **LOGGED:** KR **CASING:** HQ to 8.53 m
TYPE OF BORING: Solid flight auger to 4.0m, Rotary to 8.53 m; NMLC to 14.56 m
WATER OBSERVATIONS: Free groundwater observed at 4.0m whilst augering
REMARKS: *BD220200116

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 6.3 AHD
EASTING: 336165
NORTHING: 6249825
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 99538.00
DATE: 15/1/2020
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
		SANDSTONE: orange-brown, medium to coarse grained, moderately weathered, slightly fractured, medium strength with very to low strength bands, Hawkesbury Sandstone *(continued)*	⁙	C					
	10.97	SANDSTONE: medium to coarse grained, pale grey, fresh, unbroken, medium to high strength, Hawkesbury Sandstone	⁙		11.58				
			⁙	C					
	14.56	Bore discontinued at 14.56m			14.56				

RIG: BG 17 **DRILLER:** BG **LOGGED:** KR **CASING:** HQ to 8.53 m
TYPE OF BORING: Solid flight auger to 4.0m, Rotary to 8.53 m; NMLC to 14.56 m
WATER OBSERVATIONS: Free groundwater observed at 4.0m whilst augering
REMARKS: *BD220200116

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 6.3 AHD
EASTING: 336179
NORTHING: 6249822
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 99538.00
DATE: 15/1/2020
SHEET 1 OF 2

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	FILL/Silty SAND: fine to medium, brown, trace clay, fine sandstone gravel and brick fragments, moist, variably compacted	B	0.0				
		A/E	0.04 0.1				
		A/E	0.4 0.5				
0.7	FILL/SAND: fine to medium, pale grey, with sandstone gravel and cobbles, trace silt and clay, moist, apparently moderately to well compacted	A/E	0.9 1.0				
		S			8,10,7 N = 17		
		A/E	1.4 1.45 1.5				
1.7	FILL/SAND: fine to mediumm, brown, fine sandstone gravel, with, sandstone gravels and clay, trace glass fragment, ash and clinker, moist, apparently poorly to moderately compacted	A/E	1.9 2.0				
			2.5				
		S			2,2,2 N = 4		
2.7	SAND SW: fine to medium, brown to pale grey, trace silt, clay and decomposing organic matter, moist, medium dense, alluvial (possibly fill)	A/E	2.9 2.95 3.0				
		A/E	3.9 4.0				
		S			3,5,5 N = 10		
			4.45				
4.5	Silty SAND SM: fine to medium , dark brown to brown, wet, medium dense, alluvial	A	5.0 5.1				
		A	5.4 5.5				
5.5	SAND SW: fine to medium, grey and brown, trace silt, wet, very loose to loose, alluvial	S			1,0,0 N = 0		
			5.95				
6.61	SANDSTONE: medium to coarse grained, orange and brown, , medium to high strength, moderately weathered, slightly fractured, Hawkesbury Sandstone		6.61				
		C					
			7.9				
		C					
9.1	SANDSTONE: medium to coarse grained, pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone						

RIG: BG 17 **DRILLER:** BG **LOGGED:** KR **CASING:** HQ to 6.61 m

TYPE OF BORING: Solid flight auger to 6.61 m; NMLC to 13.49 m

WATER OBSERVATIONS: Free groundwater observed at 3.9m whilst augering

REMARKS: *BD120200115

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: Sydney Grammar School
PROJECT: Grammar Edgecliff Sports Area
LOCATION: 11 Alma Street, Paddington

SURFACE LEVEL: 6.3 AHD
EASTING: 336179
NORTHING: 6249822
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 99538.00
DATE: 15/1/2020
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SANDSTONE: medium to coarse grained, pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone *(continued)*		C					
					10.51				
				C					
	13.49	Bore discontinued at 13.49m			13.49				

RIG: BG 17
DRILLER: BG
LOGGED: KR
CASING: HQ to 6.61 m

TYPE OF BORING: Solid flight auger to 6.61 m; NMLC to 13.49 m

WATER OBSERVATIONS: Free groundwater observed at 3.9m whilst augering

REMARKS: *BD120200115

SAMPLING & IN SITU TESTING LEGEND

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

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 4.1

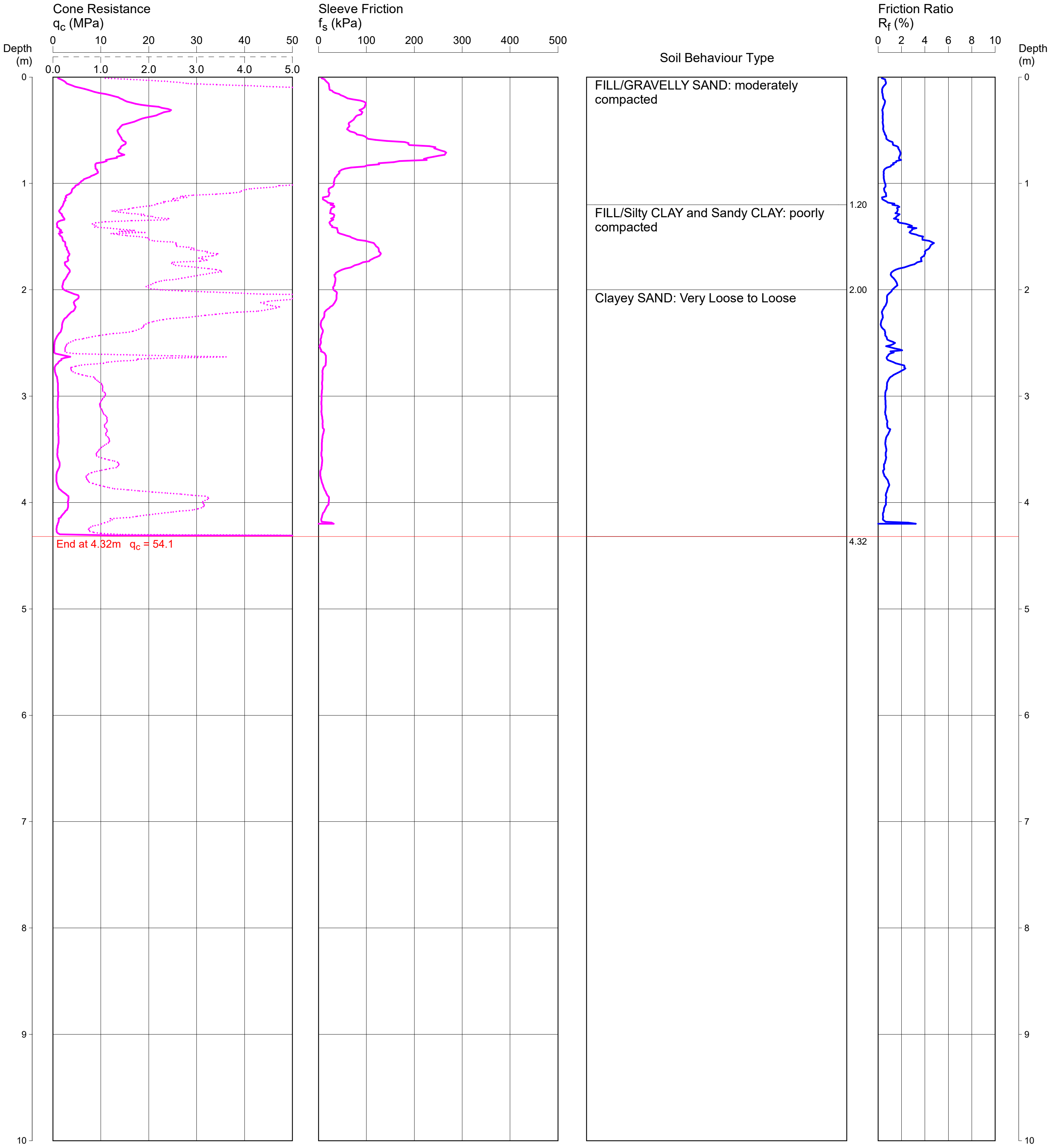
COORDINATES: 336227E 6249863N GDA94

CPT1

Page 1 of 1

DATE 15/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL;
GROUNDWATER MEASURED AT 2.0m AFTER REMOVAL OF RODS

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT1.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 4.1

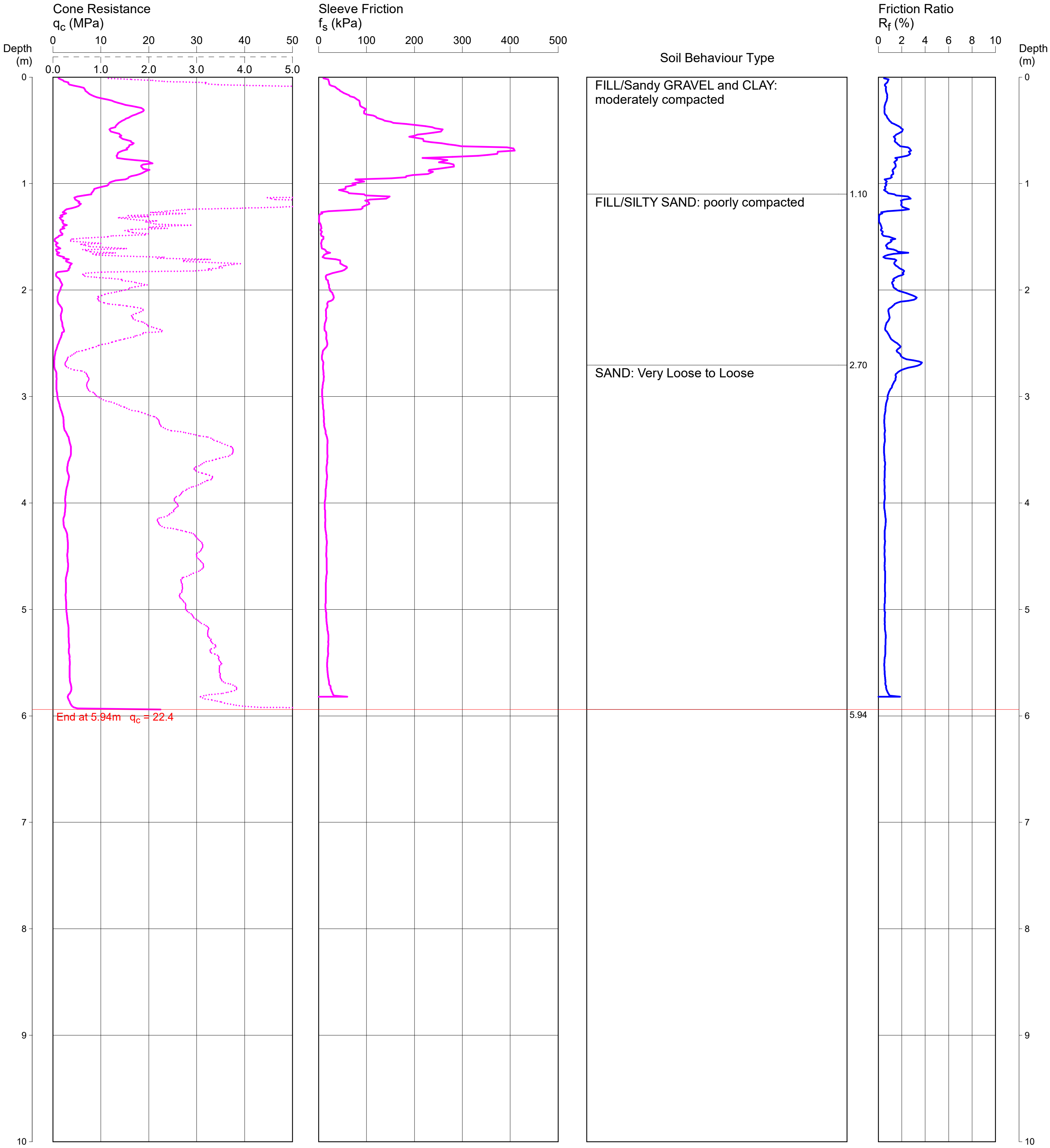
COORDINATES: 336214E 6249870N MGA94

CPT2

Page 1 of 1

DATE 15/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL;
GROUNDWATER MEASURED AT 2.0m AFTER REMOVAL OF RODS

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Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 4.1

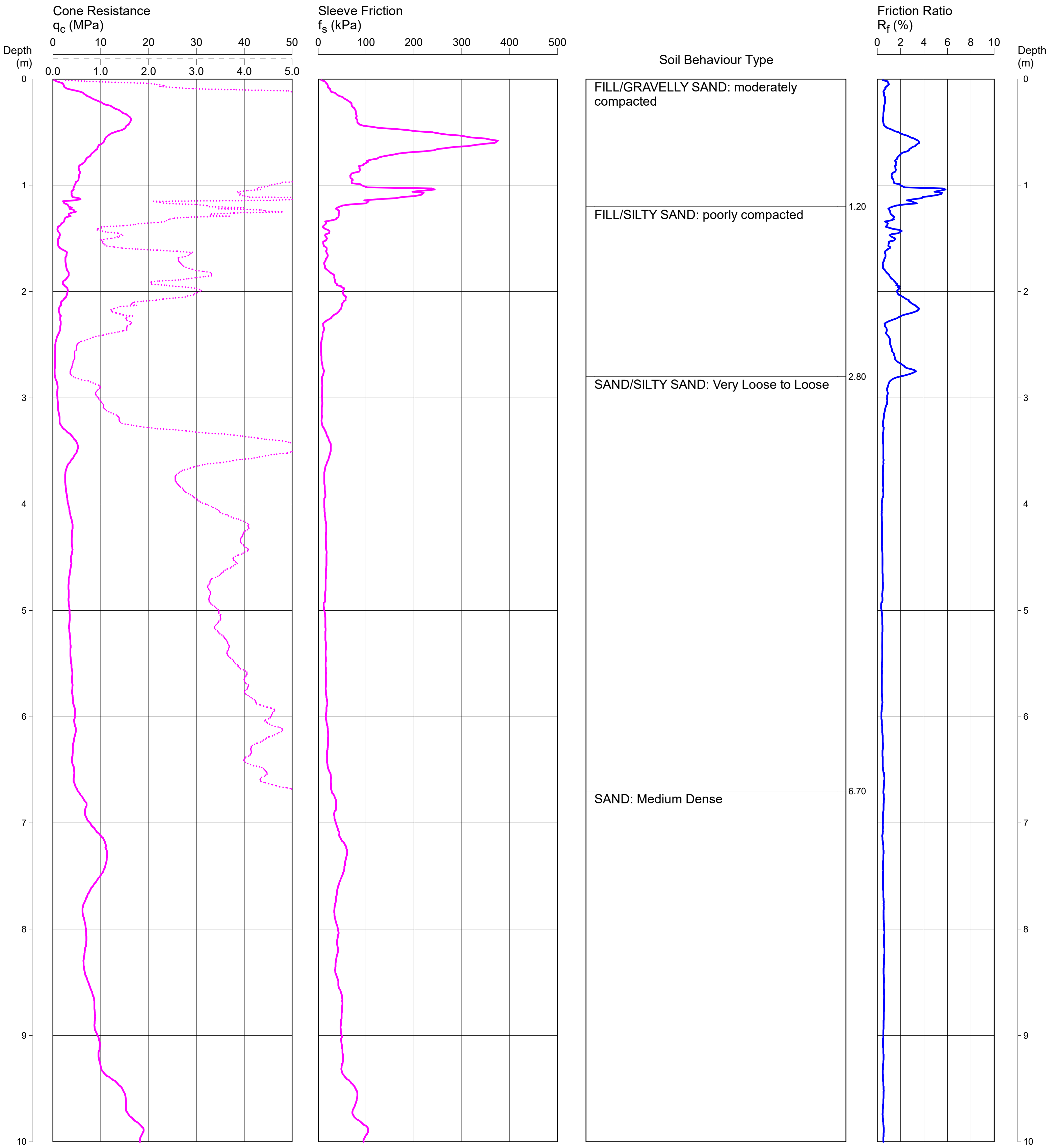
COORDINATES: 336203E 6249874N GDA94

CPT3

Page 1 of 2

DATE 15/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL;
GROUNDWATER MEASURED AT 2.3m AFTER REMOVAL OF RODS

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT3.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 4.1

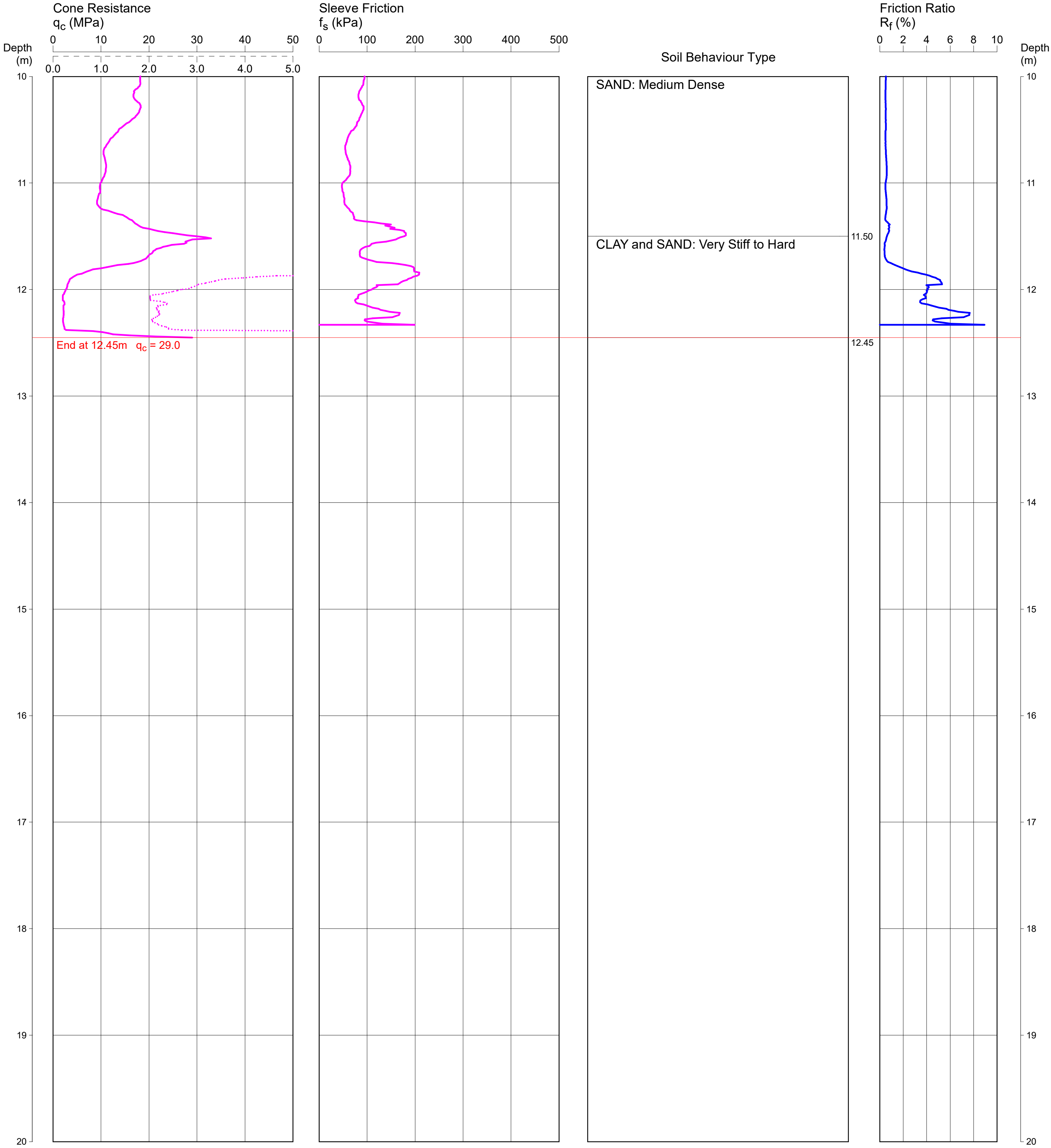
COORDINATES: 336203E 6249874N GDA94

CPT3

Page 2 of 2

DATE 15/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL;
GROUNDWATER MEASURED AT 2.3m AFTER REMOVAL OF RODS

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT3.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 4.2

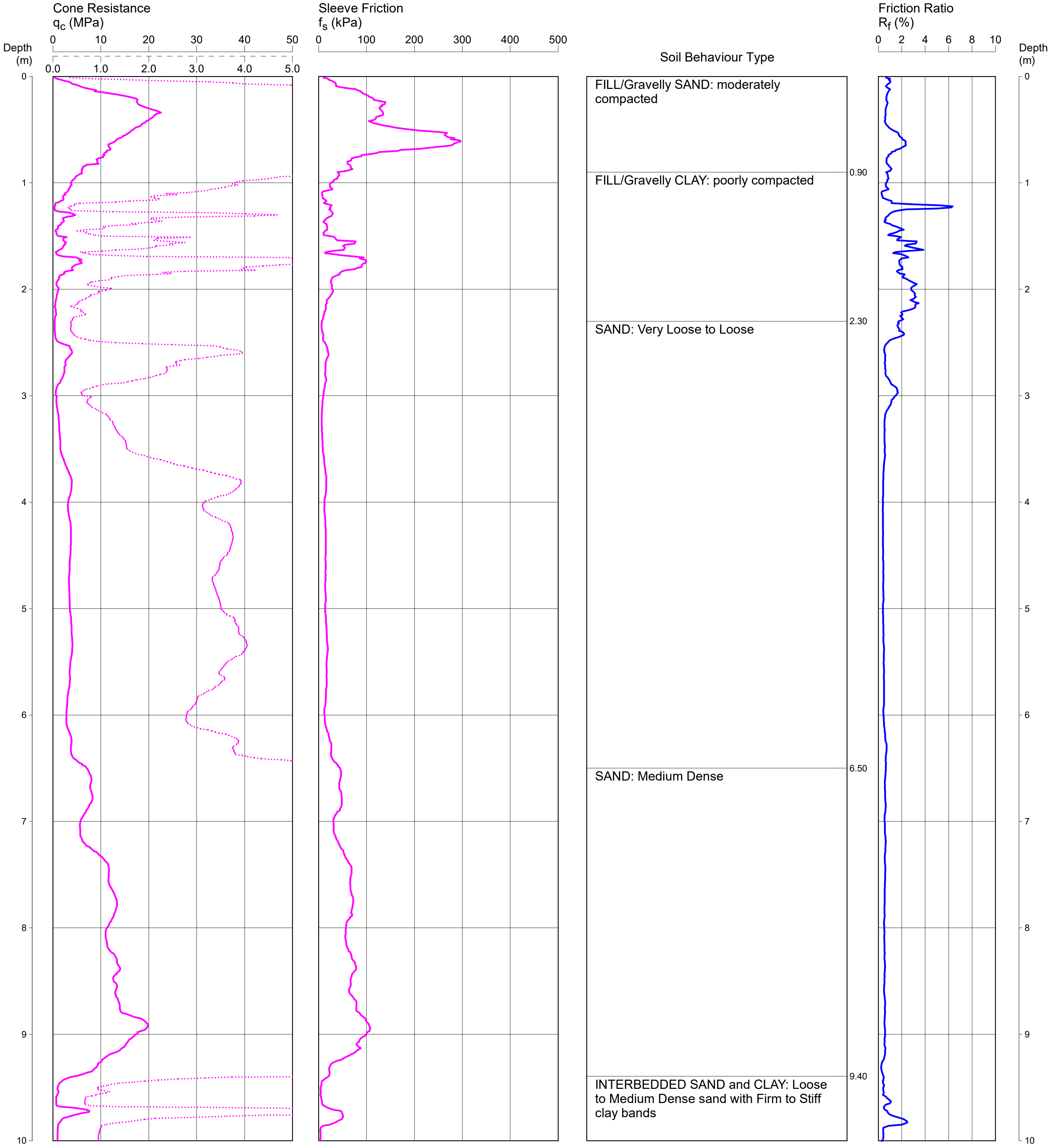
COORDINATES: 336176E 6249884N GDA94

CPT4

Page 1 of 2

DATE 15/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL;
GROUNDWATER MEASURED AT 2.3m AFTER REMOVAL OF RODS

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Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 4.2

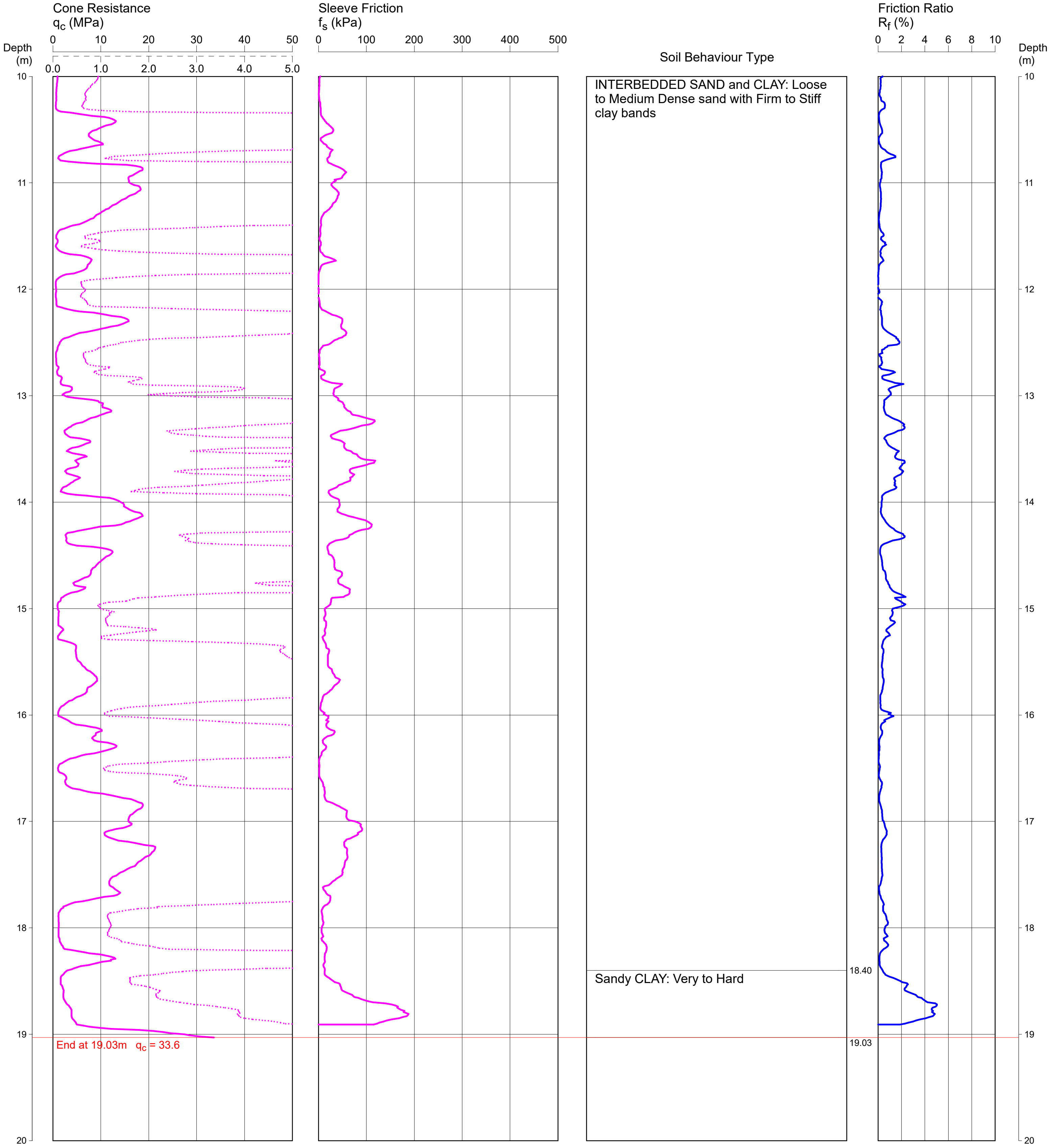
COORDINATES: 336176E 6249884N GDA94

CPT4

Page 2 of 2

DATE 15/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL;
GROUNDWATER MEASURED AT 2.3m AFTER REMOVAL OF RODS

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Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 6.2

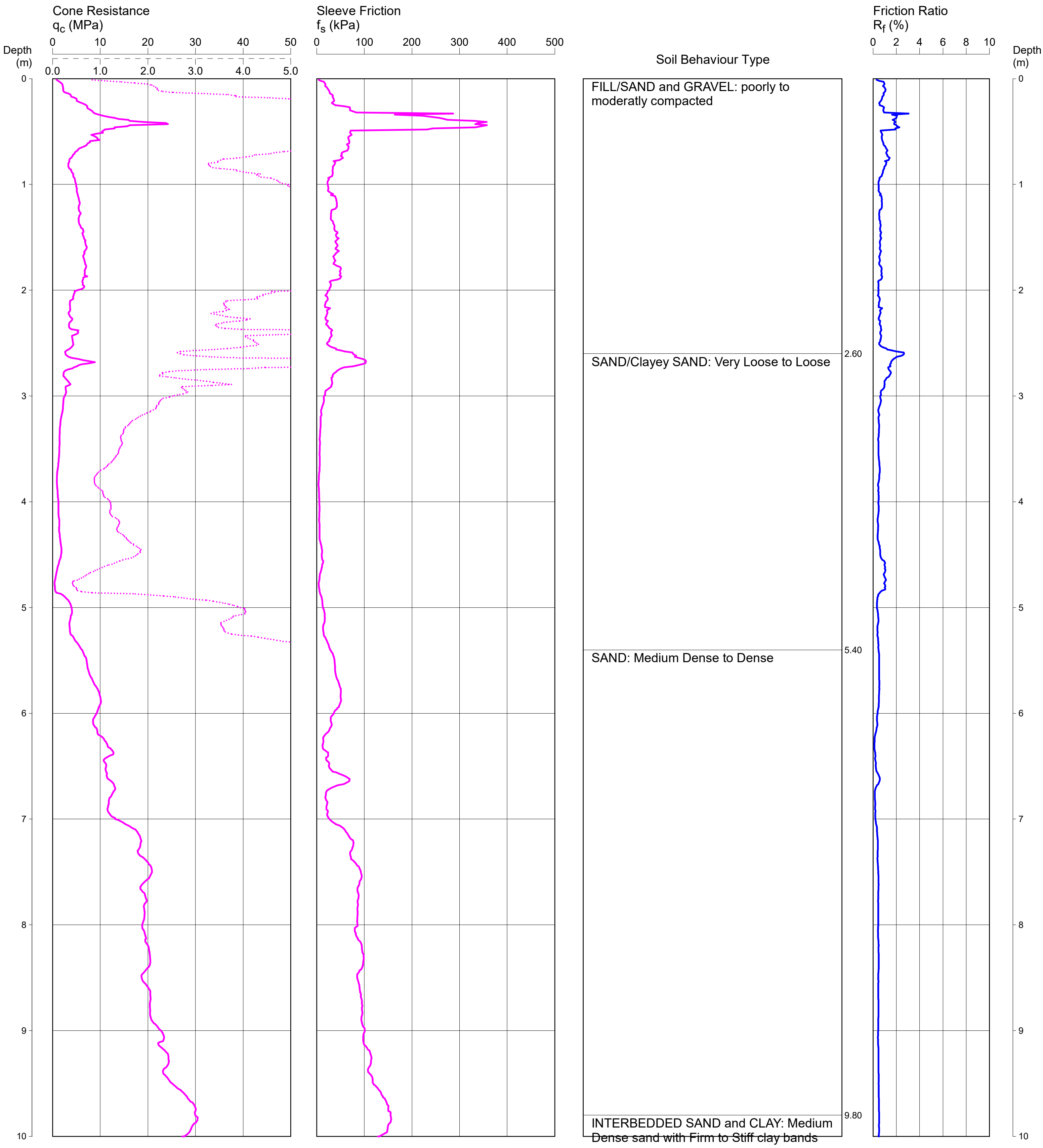
COORDINATES: 336123E 6249834N GDA94

CPT5

Page 1 of 2

DATE 15/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE SLEEVE FRICTION NEAR REFUSAL
GROUNDWATER MEASURED AT 3.7m AFTER REMOVAL OF RODS

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT5.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 6.2

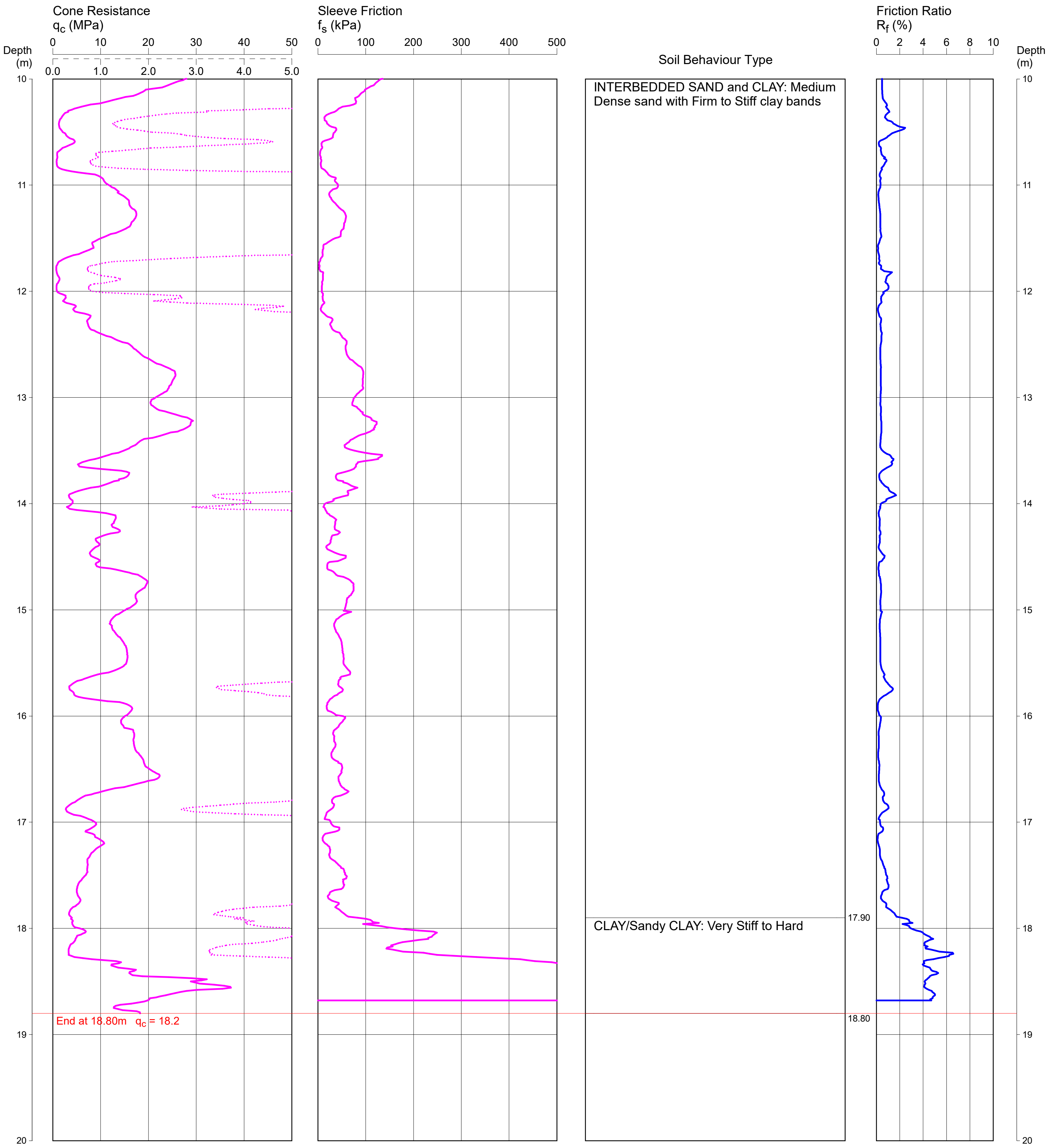
COORDINATES: 336123E 6249834N GDA94

CPT5

Page 2 of 2

DATE 15/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE SLEEVE FRICTION NEAR REFUSAL
GROUNDWATER MEASURED AT 3.7m AFTER REMOVAL OF RODS

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Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 5.9

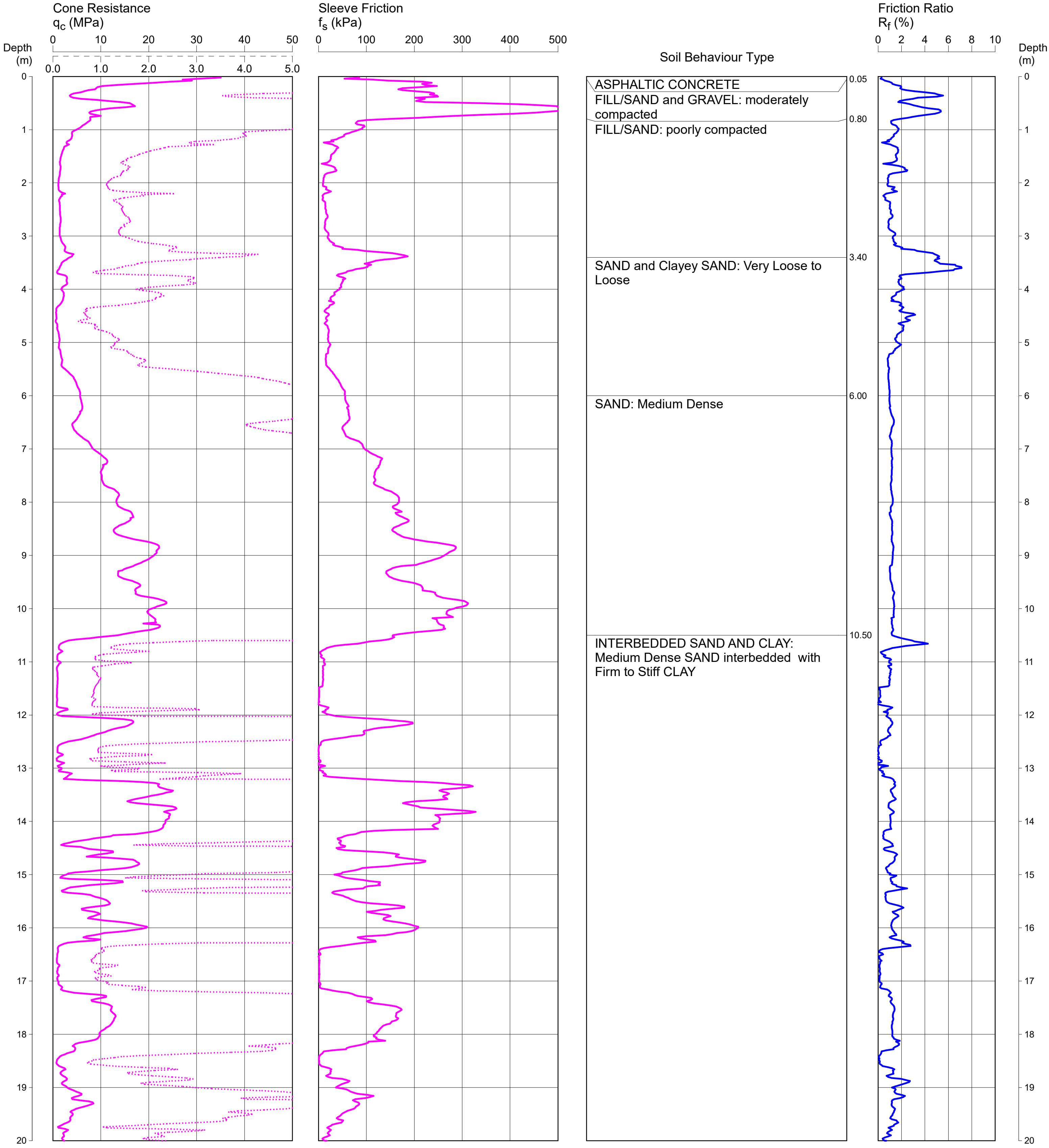
COORDINATES: 336156E 6249865N GDA94

CPT6

Page 1 of 2

DATE 24/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO SUDDEN BENDING NEAR REFUSAL
HOLE COLLAPSE MEASURED AT 4.2m AFTER REMOVAL OF RODS

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT6.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 5.9

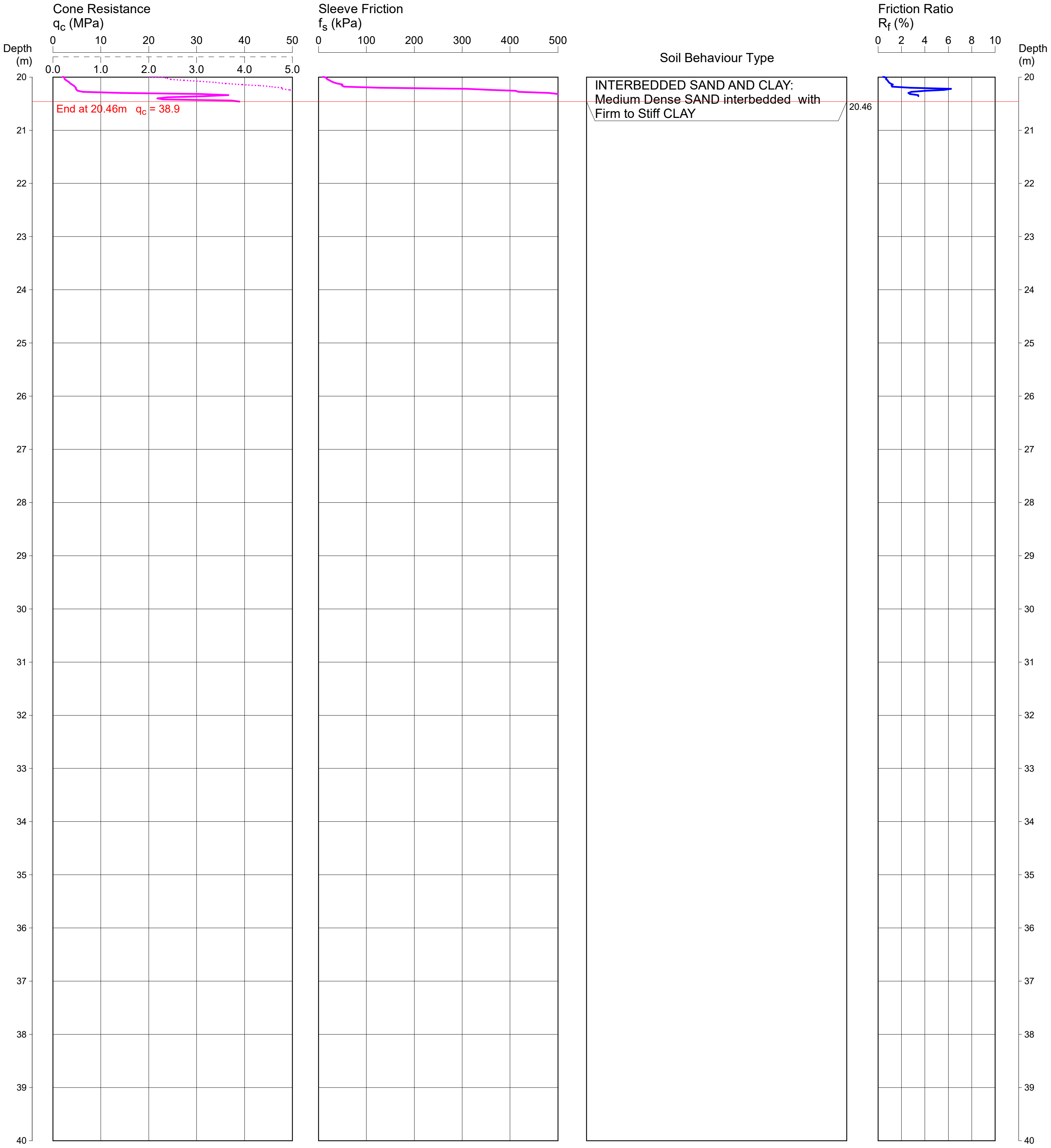
COORDINATES: 336156E 6249865N GDA94

CPT6

Page 2 of 2

DATE 24/01/2020

PROJECT No: 99538.00



REMARKS: TEST DISCONTINUED DUE TO SUDDEN BENDING NEAR REFUSAL
HOLE COLLAPSE MEASURED AT 4.2m AFTER REMOVAL OF RODS

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT6.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 4.1

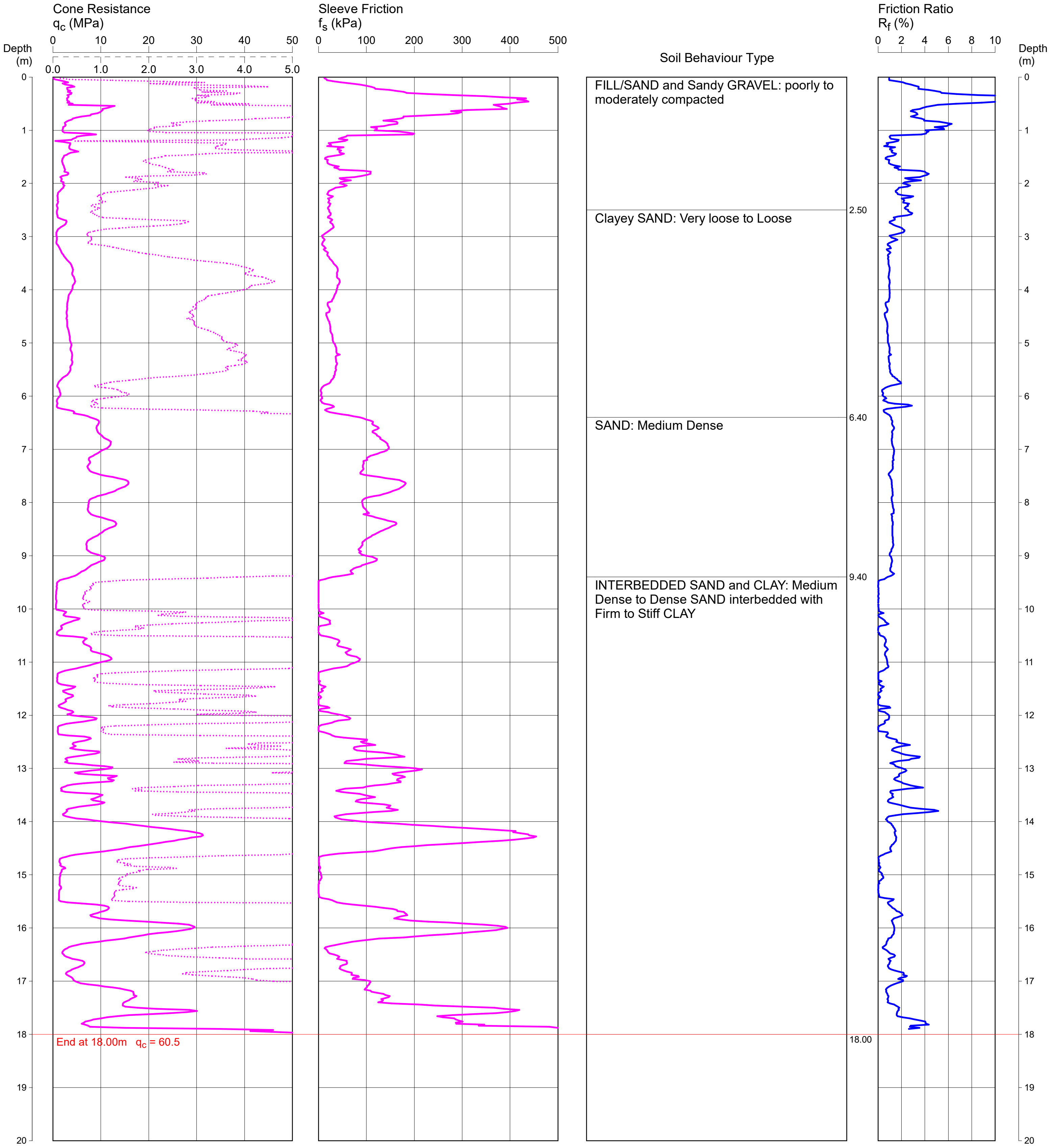
COORDINATES: 336185E 6249883N

CPT7

Page 1 of 1

DATE 24/01/2020

PROJECT No: 99538



FILL/SAND and Sandy GRAVEL: poorly to moderately compacted

Clayey SAND: Very loose to Loose

SAND: Medium Dense

INTERBEDDED SAND and CLAY: Medium Dense to Dense SAND interbedded with Firm to Stiff CLAY

REMARKS: HAND AUGERED TO 0.5m; TEST DISCONTINUED DUE TO CONE TIP REFUSAL
GROUNDWATER MEASURED AT 2.6m AFTER REMOVAL OF RODS

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT7.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 4.1

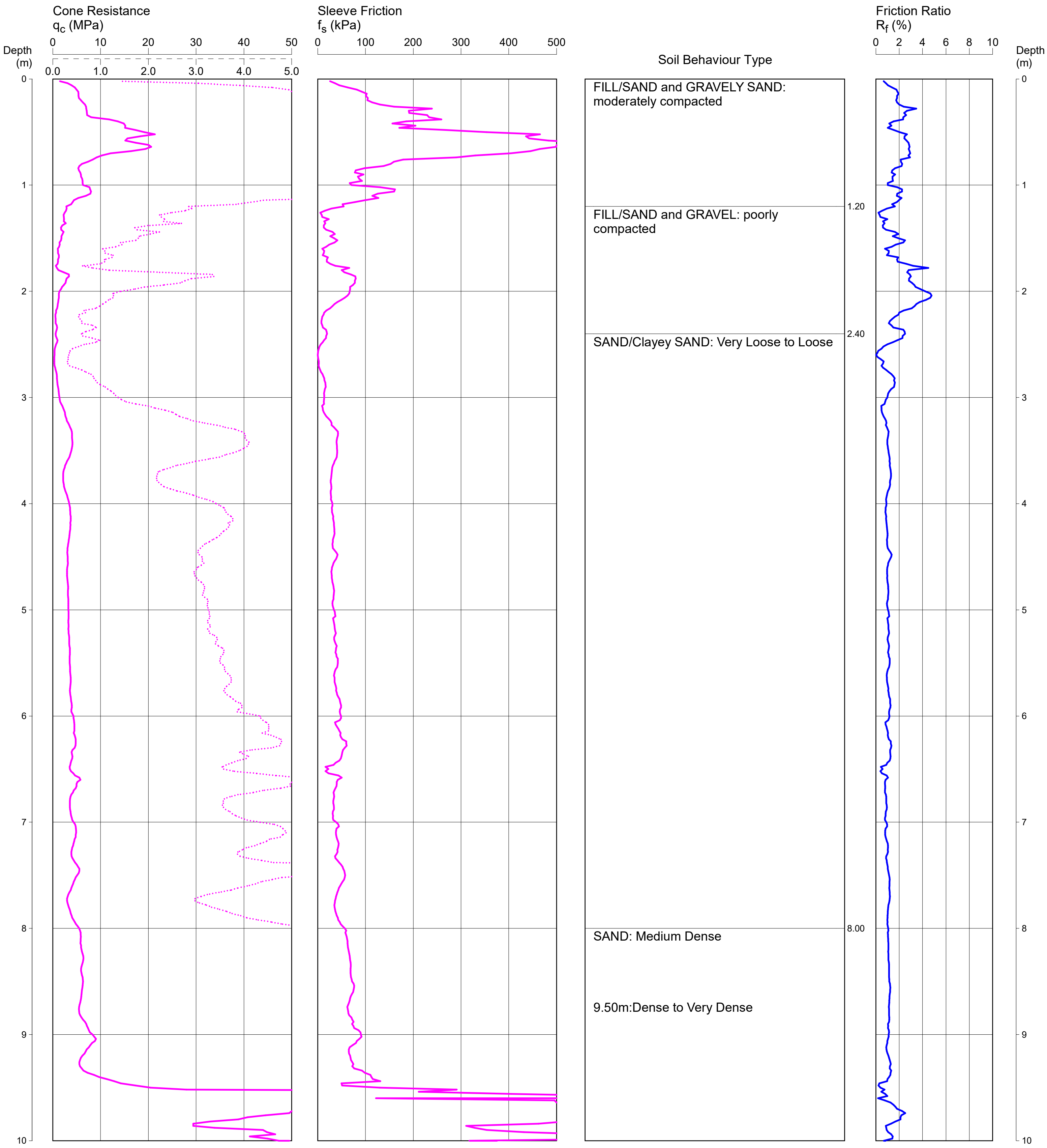
COORDINATES: 336209E 6249872N GDA94

CPT8

Page 1 of 2

DATE 24/01/2020

PROJECT No: 99538.00



REMARKS: HAND AUGERED TO 0.5m; TEST DISCONTINUED DUE TO CONE TIP REFUSAL
HOLE COLLAPSE MEASURED AT 0.8m AFTER REMOVAL OF RODS

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT8.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: SYDNEY GRAMMAR SCHOOL

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

REDUCED LEVEL: 4.1

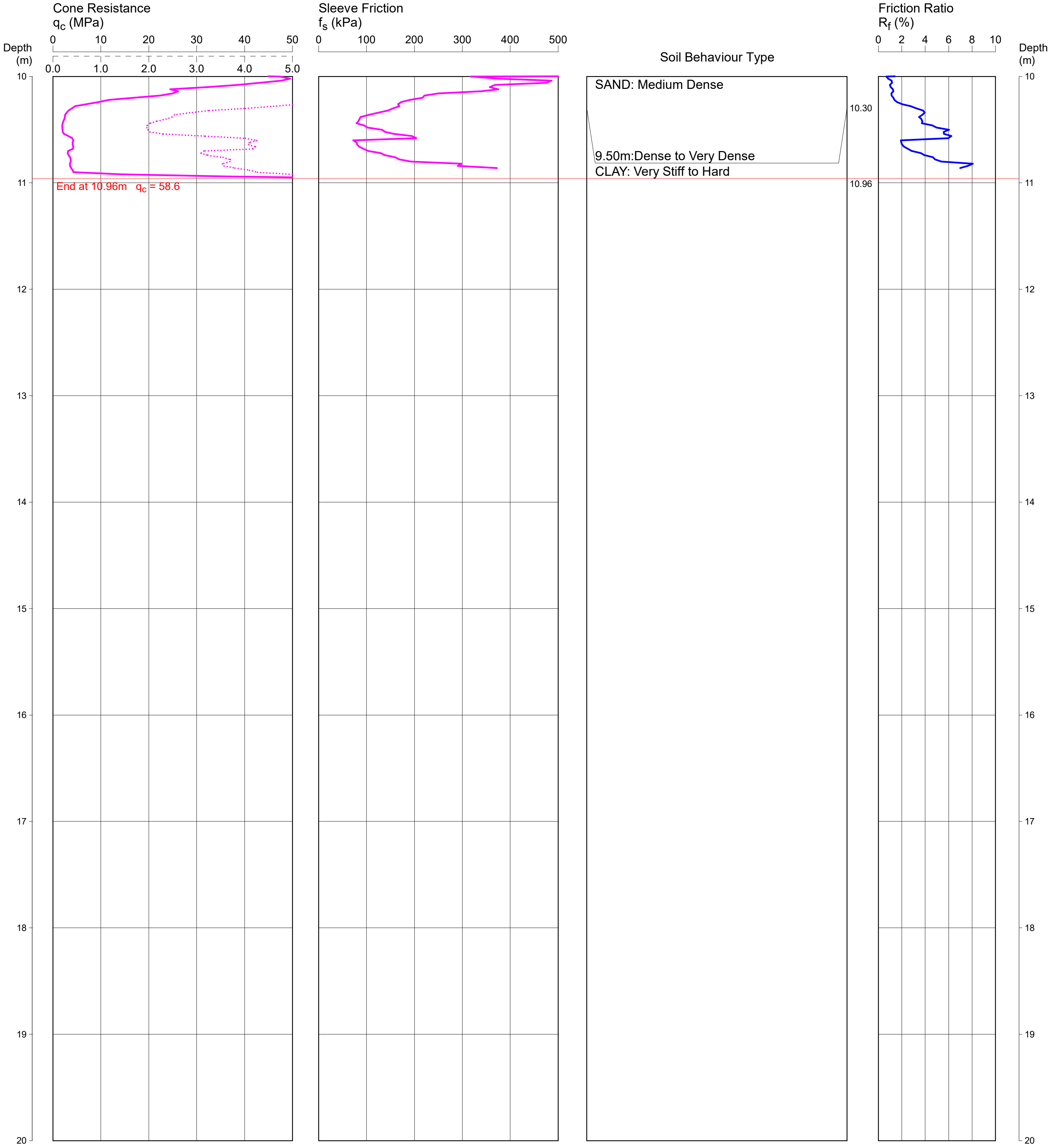
COORDINATES: 336209E 6249872N GDA94

CPT8

Page 2 of 2

DATE 24/01/2020

PROJECT No: 99538.00



REMARKS: HAND AUGERED TO 0.5m; TEST DISCONTINUED DUE TO CONE TIP REFUSAL
HOLE COLLAPSE MEASURED AT 0.8m AFTER REMOVAL OF RODS

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT8.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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Appendix D

Laboratory Test Results

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200   fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 234873

Client Details

Client	Douglas Partners Pty Ltd
Attention	Adam Teoh
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**99538.00, Paddington**
Number of Samples	3 Soil, 1 Water
Date samples received	20/01/2020
Date completed instructions received	20/01/2020

Analysis Details

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

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

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

Report Details

Date results requested by	28/01/2020
Date of Issue	28/01/2020

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Nick Sarlamis, Inorganics Supervisor
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Soil Aggressivity				
Our Reference		234873-1	234873-2	234873-3
Your Reference	UNITS	BH4 7.0-7.45	BH5 0.9-1.0	BH6 7.0-7.45
Date Sampled		18/12/2019	18/12/2019	15/01/2020
Type of sample		Soil	Soil	Soil
pH 1:5 soil:water	pH Units	8.2	9.3	7.7
Electrical Conductivity 1:5 soil:water	µS/cm	21	62	15
Chloride, Cl 1:5 soil:water	mg/kg	10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	10	<10

Miscellaneous Inorganics		
Our Reference		234873-4
Your Reference	UNITS	BH1
Date Sampled		20/12/0219
Type of sample		Water
Date prepared	-	20/01/2020
Date analysed	-	20/01/2020
pH	pH Units	6.0
Electrical Conductivity	µS/cm	1,100
Chloride, Cl	mg/L	260
Sulphate, SO4	mg/L	38

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

QUALITY CONTROL: Soil Aggressivity						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	8.2	8.2	0	101	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	21	25	17	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	10	20	67	96	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	10	0	92	[NT]

QUALITY CONTROL: Miscellaneous Inorganics					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			20/01/2020	[NT]	[NT]	[NT]	[NT]	20/01/2020	[NT]
Date analysed	-			20/01/2020	[NT]	[NT]	[NT]	[NT]	20/01/2020	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	102	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	96	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	110	[NT]

Result Definitions

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

Quality Control Definitions

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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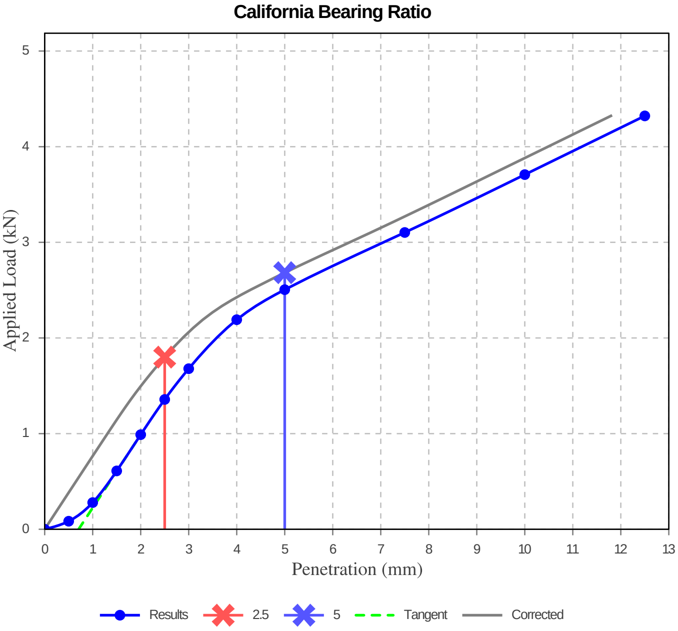
Accredited for compliance with ISO/IEC 17025 - Testing

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

Report Number:	**99538.00-1**
Issue Number:	1
Date Issued:	29/01/2020
Client:	Sydney Grammar School C/- Morgan & Moore Associates Pty Ltd, Pymble NSW 2073
Contact:	Brad Campbell
Project Number:	99538.00
Project Name:	Grammar Edgecliff Sports Area
Project Location:	11 Alma St, Paddington
Work Request:	5456
Sample Number:	SY-5456A
Date Sampled:	15/01/2020
Dates Tested:	20/01/2020 - 28/01/2020
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Sample Location:	**BH6 (0.4-0.8m)**
Material:	Sand Fill

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**14**		
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)	1.61		
Optimum Moisture Content (%)	15.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	99.5		
Dry Density after Soaking (t/m^3)	1.60		
Field Moisture Content (%)	6.9		
Moisture Content at Placement (%)	14.8		
Moisture Content Top 30mm (%)	21.3		
Moisture Content Rest of Sample (%)	17.7		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1.4		



Appendix E

Estimate of Pile Capacity

PILE CAPACITY ESTIMATE

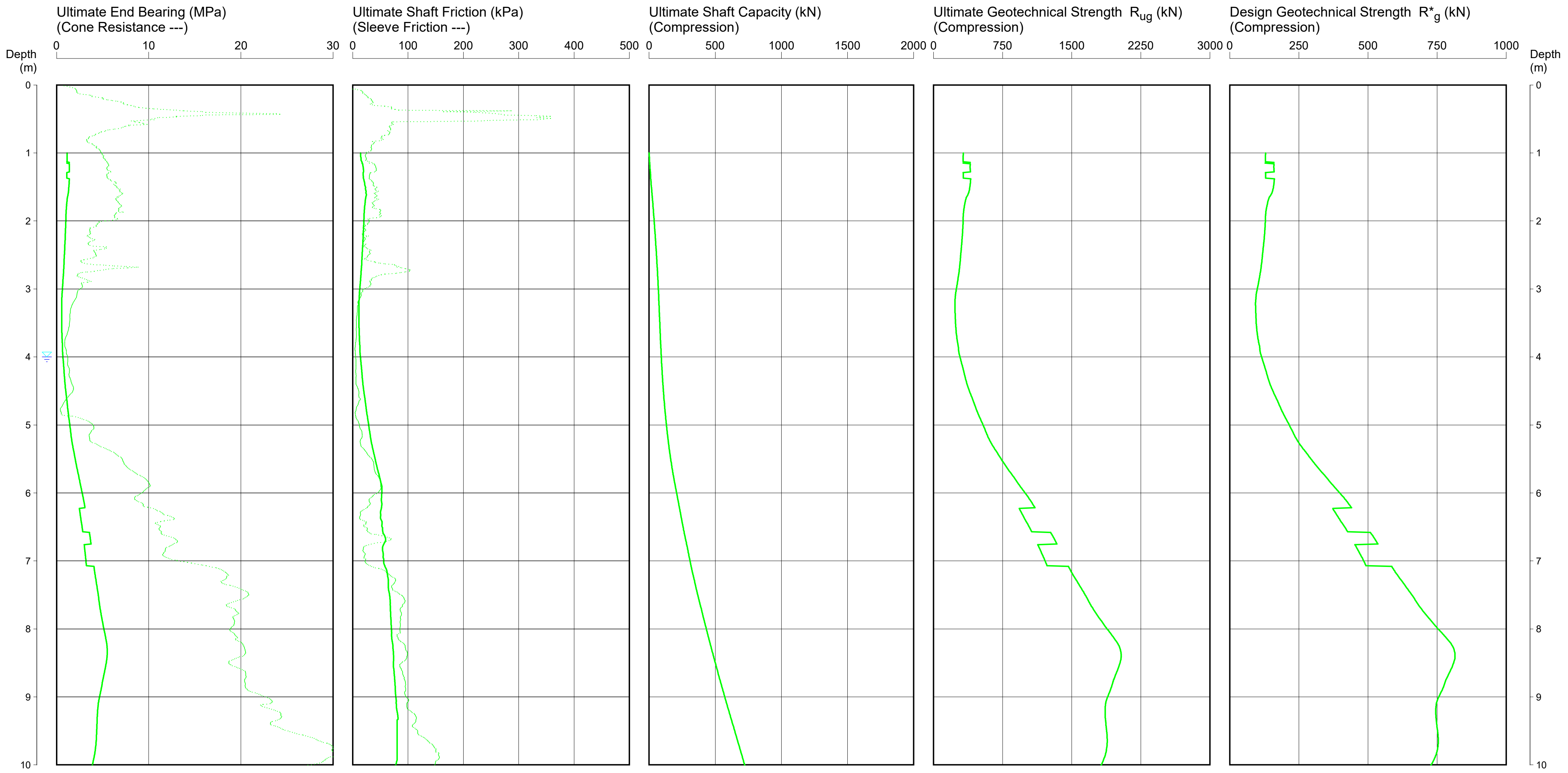
PILE TYPE: Grout-Injected
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.40
CALCULATION METHOD: Douglas Method

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA
LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL
CLIENT: SYDNEY GRAMMAR SCHOOL

CPT5

Page 1 of 2

DATE 15-Jan-20
PROJECT No: 99538.00
SURFACE RL: 6.2



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Water depth after test: 4.00m depth

Coordinates: 336123 6249834

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT5.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePile Version 5.9.1

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PILE CAPACITY ESTIMATE

PILE TYPE: Grout-Injected
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR Ø$_g$: 0.40
CALCULATION METHOD: Douglas Method

PROJECT: GRAMMAR EDGECLIFF SPORTS AREA

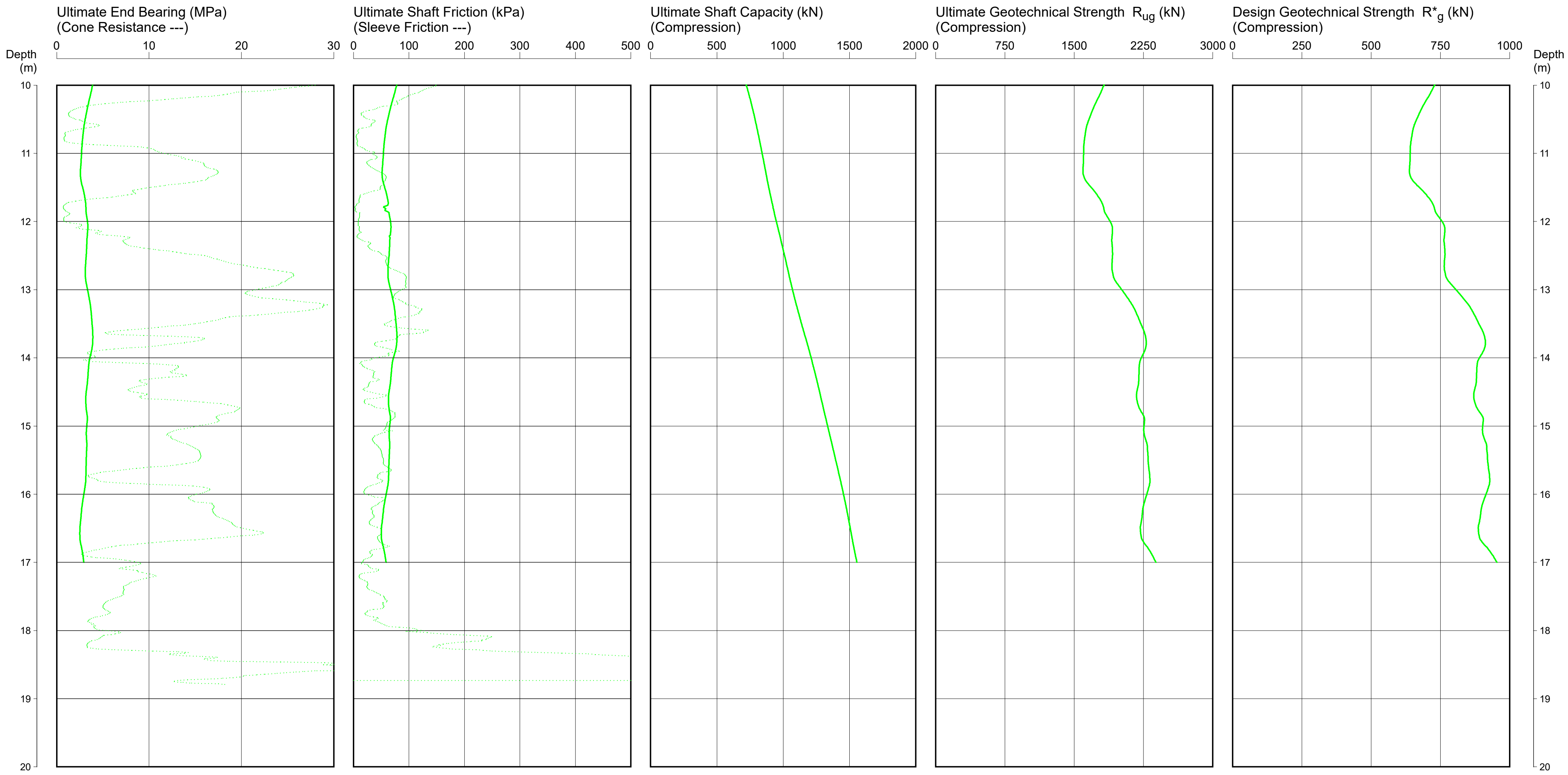
LOCATION: PADDINGTON, SYDNEY GRAMMAR SCHOOL

CLIENT: SYDNEY GRAMMAR SCHOOL

CPT5

Page 2 of 2

DATE 15-Jan-20
PROJECT No: 99538.00
SURFACE RL: 6.2



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Water depth after test: 4.00m depth

Coordinates: 336123 6249834

File: P:\99538.00 - PADDINGTON, Sydney Grammar School\4.0 Field Work\4.2 Testing\CPT\Converted NewSyd\CPT5.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePile Version 5.9.1

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