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Report on
Geotechnical Investigation

Proposed School Upgrade
Narrabeen Education Precinct, Namona Street, Narrabeen

Prepared for
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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.

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Table of Contents

Page

1. Introduction 1
2. Site Description 1
3. Regional Mapping 2
4. Previous Investigations 3
5. Field Work 3
   - 5.1 Field Work Methods 3
   - 5.2 Field Work Results 4
   - 5.3 Groundwater 4
6. Interpreted Geotechnical Model 5
7. Comments 6
   - 7.1 Proposed Development 6
   - 7.2 Site Preparation 6
   - 7.3 Excavation Conditions 8
   - 7.4 Excavation Support 8
   - 7.5 Foundations 9
     - 7.5.1 Shallow Footings 9
     - 7.5.2 Piles 10
     - 7.5.3 Floor Slabs 11
   - 7.6 Aggressivity 12
   - 7.7 Salinity 12
   - 7.8 Acid Sulphate Soils 12
   - 7.9 Ground Vibration 12
   - 7.10 Working Platform Assessment 13
   - 7.11 Pavements 13
   - 7.12 Seismic Loading 13
   - 7.13 Dilapidation Surveys 13
8. Limitations 14

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Appendix A: About This Report

Appendix B: Drawings

Appendix C: Results of Field Work

Appendix D: Laboratory Test Results

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1. Introduction

This report presents the results of geotechnical investigations undertaken for the proposed school upgrade works at Narrabeen North Public School (NNPS) and Narrabeen Sports High School (NSHS), in the Narrabeen Education Precinct, Namona Street, Narrabeen. The investigation was undertaken in accordance with Douglas Partners' (DP) proposal 86973.04.P.00.Rev1 dated 16 March 2022.

It is understood the proposed development will include the demolition of some existing buildings and construction of two new buildings in the NNPS and construction of a two-storey building at NSHS. The locations of the proposed new buildings are shown on Drawings 1 to 2 in Appendix B.

A geotechnical investigation of the site was undertaken in 2020 and reported in DP Project 86973.00.R.002.Rev0 dated March 2020. In 2022 additional test pits and shallow boreholes were undertaken as part of a detailed contamination assessment of the site which is reported separately in DP Report 86973.04.R.002.Rev0 dated 17 August 2022. This report is an update of the previous geotechnical report which includes the results of the additional tests and the current proposed development.

2. Site Description

Narrabeen North Primary School (NNPS) is located on the northern side of Namona Street, North Narrabeen and is surrounded by residential dwellings to the east, grassed sporting fields to the north and Northern Beaches Sports Centre to the west.

Narrabeen Sports High School (NSHS) is located on the southern side of Namona Street and is surrounded by Pittwater Road to the east, Pittwater Sports Centre to the south and Mullet Creek to the west. NNPS and NSHS are depicted as Lot 3 in Deposited Plan (DP) 1018621 and Lot 12 in DP 1119562, respectively.

Both school sites are occupied by low to medium rise classrooms and hall buildings, playing fields and grassed areas, hard surface open space, landscaped areas with small retaining walls and car parking areas.

The ground surface across both the sites is flat to gently undulating, with levels typically ranging between about RL 3 m and RL 5 m AHD (Australian Height Datum). It should be noted that the NNPS site is relatively flat within the existing building area, however the site is battered along the northern, southern and western boundaries, suggesting the site was previously built up on fill. Previous and recent investigations confirmed the presence of fill in this area.

3. Regional Mapping

Reference to the Sydney 1:100 000 Geological Series indicates that both the sites are in an area underlain by Quaternary alluvial and estuarine sediments. These sediments are known to include silty to peaty quartz sand, silt and clay, ferruginous and humic cementation in places, and common shell layers.

The mapping indicates that the area to south-west is underlain by bedrock of the Narrabeen Group, which typically comprises interbedded laminite, shale and quartz to quartz-lithic sandstone. An excerpt from the Sydney 1:100 000 Geological Series Sheet 9130 is shown in Figure 1.

Figure 1: Excerpt from Sydney 1:100 000 Geology Series Sheet 9130

Reference to the Sydney 1:100 000 Soil Landscape Series Sheet indicates that the sites are in an area underlain by disturbed terrain (i.e. reclaimed areas and 'man-made' fill).

Reference to the 1:25 000 Acid Sulphate Soils (ASS) Risk map indicates that the sites are located within an area of high probability of occurrence of ASS below 1 - 3 m depth.

Based on the location of the site on a low-lying area of land close to Mullet Creek, South Creek and Narrabeen Lagoon and less than 1 km from the Pacific Ocean, it is expected that the regional groundwater table would be just above sea level due to normal phreatic rise on land adjacent to the ocean or waterways.

4. Previous Investigations

In 2020 a geotechnical investigation was undertaken by DP on the site (Project 86973.00.R.002.Rev0 dated March 2020). The investigation included 20 cone penetration tests (CPTs) to depths of 8.1 m to 30.5 m and drilling of 27 boreholes to depths of 1.5 m to 8.0 m, together with the installation of 6 groundwater monitoring wells. Laboratory testing of samples for aggressivity of the sampled soil to buried steel and concrete elements and Atterberg Limit testing was also carried out.

The investigations encountered some granular fill, including some topsoil and pavement materials. The fill has been placed over alluvial and estuarine sands of variable consistency, grading to medium dense and dense with depth. At depth the alluvial deposits become interbedded clays and sands of variable consistency with bedrock expected at depths greater than 30 m on NNPS and greater than 26 m on NSHS.

Groundwater was measured in the tests at depths of 1.3 m to 4.5 m below ground level, which was equivalent to groundwater levels at RL 0.4 m to 1.0 m AHD.

5. Field Work

5.1 Field Work Methods

The recent field work carried out on 13, 14 and 19 April 2022 and 14 July 2022 for the detailed contamination investigation included:

- 22 test pits (TP1001, TP1001A, TP1003, TP1005, TP1007, TP1008, TP1017 to TP1020, TP207, TP208, TP211 to TP220) excavated to depths of between 0.3 m and 2.6 m;
- 26 shallow boreholes (BH1002, BH1004, BH1006, BH1009 to BH1016, BH1021 to BH1027, BH201 to BH206, BH209 and BH210) drilled either using hand tools or a 5-tonne excavator using a solid flight auger to depths of between 0.3 m and 2.6 m;
- 8 dynamic penetrometer tests (DPTs) were conducted within selected test pits (TP1003, TP1008, TP1017, TP207, TP212 and TP214) and boreholes (BH1006 and BH1016). In these tests a flat ended steel rod is driven into the ground using a standard weight hammer dropping a standard distance. The number of blows required to drive the rod each 150 mm into the ground is recorded and is used to assess the in-situ density of the soils. The DPTs were typically terminated at depths of 2.4 m; and
- Supervision of the drilling and logging of the test pits and boreholes by an experienced engineer.

Coordinates and surface levels for all the test locations were determined using a differential Global Positioning System (dGPS) receiver, which has a specified accuracy of 0.1 m. Coordinates are in GDA94/MGA Zone 56 format (Geocentric Datum of Australia 1994 base with Map Grid of Australia projection) and levels are relative to AHD. The test locations are shown on Drawings 1 and 2 in Appendix B.

5.2 Field Work Results

The details of the subsurface conditions encountered at the boreholes and test pits are given on the logs in Appendix C, together with notes defining descriptive terms and classification methods used. The logs of the original geotechnical investigations undertaken in 2020 are also included in Appendix C.

The general subsurface profile encountered in the recent additional shallow test locations may be summarised as follows:

- Fill - 0.7 m to 1.8 m, typically brown, silty sand, with varying proportions of gravel, silt and rootlets; underlain by
- Sand - typically fine to medium alluvial sand to the depth of the investigation.

5.3 Groundwater

Groundwater was observed during the recent investigations at NNPS in TP1001A at 1.4 m (RL 2 m, AHD),TP1008 at 2.1 m (RL 1.6 m, AHD), BH1024 at 0.9 m (RL 1.5 m, AHD) and BH1025 at 1.1 m (RL 1.9 m, AHD). Groundwater was observed at most locations within NSHS at depths of between 0.7 m and 1.8 m bgl (RL 0.6 m to RL 0.9 m AHD).

Groundwater levels were also measured in the groundwater monitoring wells installed as part of DP's 2020 investigation. The measurements were made on 22 April 2022 using an electronic oil/water interface meter and are shown in Table 1.

Table 1: Summary of Groundwater Level Measurements on 22 April 2022

Well ID	Location of Monitoring Well	Ground Level * m (AHD)	SWL m (bgl)	SWL m (AHD)
BH06	NNPS	4.65	2.85	1.80
BH106	NSHS	2.07	0.96	1.11
BH111	NSHS	2.06	1.18	0.88

Notes: *Surveyed by dGPS AHD – Australian Height Datum; SWL – standing water level; bgl – below ground level

It should be noted that groundwater levels are transient and will fluctuate with weather and tides and may be expected to rise by 1-2 m above the measured levels during periods of high tides and following heavy rainfall.

6. Interpreted Geotechnical Model

Based on both the previous and current investigations, the interpreted geotechnical model for the area comprises:

- Fill - variable depths, typically granular and including some topsoil and pavement materials;
- Alluvial and estuarine sands - of variable consistency, grading to medium dense and dense with depth;
- Alluvial deposits of interbedded clays and sands - of variable consistency; and
- Weathered bedrock - at variable and substantial depths.

Interpreted geotechnical profiles have been developed for the NNPS and NSHS sites and are presented on Drawings 3 and 4 in Appendix B.

Specifically, for each of the sites the interpreted geotechnical models are:

Narrabeen North Public School

- Surface fill – about 0.2 m to 0.9 m thick (RL 2.7 m to 4.4 m, AHD);
- Variable strength sands (alluvial and estuarine) to depths of about 2.2 m to 2.3 m (RL 2.4 to 2.5 m, AHD);
- Medium dense sands to depths of about 10.6 m to 11.2 m (RL - 5.9 to - 6.5 m, AHD); and
- Interbedded sands and clays of loose to medium dense sand and stiff to very stiff clay to depths of about 28 m (RL- 25 AHD) to where interpreted weathered rock was encountered.

Narrabeen Sports High School

- Surface fill – about 0.4 m to 1.4 m thick (RL 1.5 m to 1.7 m, AHD);
- Variable strength sands (alluvial and estuarine) to depths of about 2.7 m to 6.05 m (RL - 0.4 to RL - 4.15, AHD);
- Medium dense sand, with some loose to medium dense bands, to depths of about 11.35 m to 11.95 m (RL - 9.05 to RL - 10.05, AHD);
- Medium dense to dense sand to a depth of about 13.05 m to 15.85 m (RL - 13.5 to RL - 13.65, AHD); and
- Very stiff to hard clay to depths of about 18.7 m to 19.25 m (RL - 16.25 to RL - 17.05, AHD) to where interpreted weathered rock was encountered.

The groundwater table across the site is expected to vary between approximately RL 0 m and 2.0 m AHD. Groundwater levels will fluctuate with weather, climactic conditions and to a lesser extent tidal influences and may temporarily rise following periods of prolonged rainfall or during spring tide highs. Groundwater levels may also be impacted by human activities such as dewatering.

7. Comments

7.1 Proposed Development

The proposed Narrabeen Education Precinct development includes redevelopment of Narrabeen North Public School (NNPS) and Narrabeen Sports High School (NSHS). The Public School and High School have been identified by the NSW Department of Education (DoE) as requiring upgrade works. The proposed development on each of the sites are listed below.

Narrabeen North Public School

- Demolition of existing buildings (Blocks H and J) with refurbishment of three existing buildings (Blocks B, K and V);
- New two-storey building used for general learning spaces;
- New two-storey building containing administration facilities, multi-purpose hall and out-of-school hours care facilities on the ground floor with associated covered outdoor learning area and staff facilities and amenities on the first floor. A covered outdoor learning area (COLA) will be extended to the east and will form part of these works; and
- New pedestrian access ramps at the access gate off Namona Street.

The proposed NNPS buildings are currently located along an existing batter slope. The levels of the proposed building and whether cut or fill will be required are not known at this stage.

Narrabeen Sports High School

- Refurbishment of four existing buildings (Buildings A, B, C and K); and
- New two-storey extension to Building A containing new stage for the gymnasium and change rooms on the ground floor and general learning spaces (GLS) on the first floor.

Information on foundation types, depths, excavation depths for services, etc. were not available at the time of reporting. In general, it is understood that new buildings will be constructed at about the existing surface levels, with single storey buildings likely to be founded on shallow footings, whilst the new two-storey buildings are more likely to incorporate piled foundations.

DP is advised by the project team that the above works will follow different planning pathways. For example, the new building containing administration facilities and adjacent COLA on NNPS and the two-storey extension to Building A on NSHS will form part of a development application. Other works will be under exempt development or development without consent planning pathways. Information on planning pathways and requirements should be sought from the project planner.

7.2 Site Preparation

Any existing fill that is required to support structures and pavements will need to be reworked to reduce the potential for unacceptable settlements associated with poorly or variably compacted fill. New fill will also need to be placed in accordance with an engineering specification.

The following general procedure is suggested during earthworks activities (subject to any requirements for remediation of contamination at the site):

- Strip organic-rich (e.g. root-affected) topsoil from areas in which new engineered fill, structures and/or pavements are proposed. A nominal depth of 200 mm would be appropriate but confirmation of this will need to be made on site at the commencement of construction;
- Excavate existing fill in areas in which new engineered fill, structures and/or pavements are proposed;
- Compact the exposed surface and proof-roll using a roller of 10 t deadweight (or equivalent) in the presence of a geotechnical engineer. Any areas exhibiting unacceptable movements during the proof-roll may require further rectification;
- Place fill in maximum 250 mm thick layers and compact to achieve a dry density ratio of between 98% and 102% relative to Standard compaction. The upper 0.5 m of pavement subgrade areas should be compacted to achieve a dry density ratio of between 100% and 102% relative to Standard compaction, with moisture contents maintained within 2% of Standard optimum moisture content. If the replacement fill is sand, compact to a density index of 75% to 80%;
- Moisture conditioning (i.e. drying or wetting) may be required for compaction of filling;
- Poor trafficability should be expected across unpaved areas of the sites. A layer of granular product (e.g. roadbase, recycled crushed concrete, etc.) should be considered as the top layer of fill to improve trafficability on site; and
- Density testing should be undertaken in accordance with the requirements of AS 3798 – 2007 “Guidelines on earthworks for commercial and residential developments”.

On parts of the site where the fill depth is greater, due to the relatively shallow groundwater table, the above approach of complete removal and replacement of fill might not be a viable option for the project as it may require dewatering in some areas and the use of geo-fabrics and rock-fill material which are likely to be costly.

An alternative to complete removal and replacement of the existing fill would be to compact the material in-situ using a combination of conventional plant and impact compaction techniques. In-situ compaction techniques are only considered appropriate for the situations where the main buildings are supported by piles with only pavements and floor slabs supported on-grade.

It is considered that where the existing depth of fill is less than 0.5 m thickness, conventional rolling plant of at least 10 tonne could be used to proof roll the fill surface (i.e. beneath topsoil) to detect any soft or spongy areas that require replacement. Proof rolling should be observed by an experienced geotechnical professional.

Where existing fill depths exceed 0.5 m, in-situ compaction will generally require impact compaction methods. Impact compaction is carried out with an irregular sided roller of at least 8 tonnes, propelled at relatively high speed to impart energy to greater depths than conventional rolling plant. Impact compaction is traditionally most effective in granular soils above the water table. DP’s experience is that granular material (e.g. sand) can be improved to depths of 3 m to 4 m, above the water table.

The use of impact compaction techniques at this site would generally require a coordinated approach from the Contractor, the Geotechnical Engineer, the Structural Engineer and the Principal. A detailed proof testing programme of the finished ground surface, involving CPTs, plate load testing for the near

surface modulus and proof rolling would be required, together with a detailed review of surface settlements induced by the impact compaction. The settlement criteria for the floor slab and pavement areas should be confirmed by the Structural Engineer. As a general guide, the impact compaction technique would need to achieve a uniform compaction of the in-situ fill to a density index of 75% to 80%.

Due to the rough surface left by impact compaction plant the upper 0.3 m should be scraped off and recompacted using conventional roller plant following the previously suggested procedure for earthworks activities.

Where impact compaction is employed, due consideration should be given to the effects of vibration on adjacent structures. To reduce the risk of damaging adjacent buildings, it would be normal practice to conduct vibration monitoring trials.

Due to the nature of the sand, it is suggested that a minimum 100 mm thick layer of DGB20 (FCR) be placed beneath all slabs and pavements to aid compaction (via confinement) of the underlying subgrade material and to provide a uniform surface for concrete placement.

From a geotechnical perspective, the existing predominantly sand fill is considered to be suitable for re-use as engineered fill, provided that it is free of oversize particles (>100 mm) and deleterious material. The suitability of re-using site-won fill and natural soil should also be considered from a contamination perspective.

7.3 Excavation Conditions

Excavations may be required for footings, services trenches or other localised excavations, which would be carried out through mostly fill and natural sands. These excavations should be readily achieved using conventional earthmoving equipment such as tracked excavators.

If any excavations extend to near the groundwater levels, then it will be necessary to undertake local dewatering during excavation with appropriate trench shoring and/or battering of the sidewalls. Also, it is expected that soils below the groundwater table are acid sulphate soils (ASS) and an appropriate management plan and controls will be required. Further comments on ASS are provided in the contamination assessment report.

Careful excavation near any existing buildings will be necessary to minimise ground movements and prevent damage to the buildings.

All excavated materials to be removed from the site will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the Waste Classification Guidelines (NSW EPA, 2014).

7.4 Excavation Support

Vertical excavations within the fill and sand will not be stable. Temporary batters of 1.5H:1V (Horizontal : Vertical) of flatter could be used for the sides of the excavations above the water table, for slopes up to 3 m high. Permanent batters for excavations and embankments should be no steeper than

2H:1V and generally flatter where vegetation maintenance is required or in situations where structures or loading will be applied at the top or crest of the batter. Erosion protection should be provided for all permanent batters. Further advice should be sought if planning deep excavations or for excavations below the water table.

Surcharge loads should be placed no closer to the crest of the batter than a distance equal to the vertical height of the batter, unless specific geotechnical stability analysis shows that the loads can be placed closer.

Retaining structures may be designed for lateral earth pressures using the parameters in Table 2. It is suggested that preliminary design for cantilevered walls or walls anchored or propped with a single row of anchors be based on a triangular distribution with the lateral earth pressure being determined as a proportion of the vertical stress as given in the following formula:

$\sigma_z = K\, z\, \gamma$, where σ_z = Horizontal pressure at depth z (kPa)

K = Earth pressure coefficient

z = Depth (m)

γ = Unit weight of soil or rock (kN/m^3)

Table 2: Retaining Wall Design Parameters

Material	Unit Weight (kN/m^3)	Earth Pressure Coefficient		Coefficient of Passive Earth Pressure (K_p)
		Active (K_a)	At Rest (K_0)	
Granular Fill / Sand	20	0.35	0.5	3.0

The 'At Rest' coefficient should be used where retaining walls are near to existing structures, to limit or reduce ground (and wall) movements. Sections of the wall where some small movement is allowable can be designed for the 'active' condition. Cantilevered walls are usually not appropriate close to existing structures as they will undergo small lateral movements.

In addition to the loads resulting from soil pressures it will be necessary to incorporate hydrostatic loads due to the water table (potentially rising to the ground surface) and to allow for any superimposed loads from adjoining structure and/or traffic.

Embedment of the wall can be used to achieve passive support. A triangular passive earth pressure distribution (increasing linearly with depth) could be assumed, starting from 0.5 m below excavation toe/base level. A suitable factor of safety should be incorporated when using the K_p value shown above as this represents an ultimate, high strain/movement condition.

7.5 Foundations

7.5.1 Shallow Footings

The soils at the sites are predominantly granular (sand), which are not highly susceptible to shrink-swell movements in response to soil moisture variations. Due to the presence of fill across the site which is

to depths greater than 0.8 m in places, a site classification of Class P in accordance with AS2870 – 2011 is appropriate. Footings should, therefore, be designed based on engineering principles.

For lightly loaded structures which can tolerate some settlement, such as garden bed retaining walls up to 1 m high, light poles and security bollards, shallow strip or pad footings bearing in (natural) loose or medium dense sand, below the uncontrolled filling, may be feasible.

The allowable bearing pressure for shallow footings on sand is dependent on the size and embedment depth of the footing, the density of the foundation material and the depth to groundwater. For example, a 0.5 m by 0.5 m pad footing or a 0.5 m wide strip footing, embedded 0.5 m deep in loose or medium dense sand, with a water table at least twice the footing width below the base of the footing, may be designed for a maximum allowable bearing pressure of 100 kPa (loose sand) or 150 kPa (medium dense sand). Bearing pressures will reduce where the base of the footings approaches the water table depth.

The settlement for shallow footings founded in sand depends upon the load conditions, footing size and foundation material. The expected settlements for pad footings 0.5 m by 0.5 m and 0.5 m deep founded in loose or medium dense sand with bearing pressures of 100 kPa and 150 kPa, respectively, would be in the order of 5 mm to 10 mm.

Shallow footing excavations should be inspected by an experienced geotechnical professional prior to pouring concrete to confirm that the material is adequate for the required bearing capacity.

7.5.2 Piles

It is ‘good engineering practice’ to support all structures, particularly rigid, heavily loaded structures, on uniform foundation materials to reduce the potential for differential settlement. Depending on the proposed structures and column loads, piles founded in medium dense sand could be required.

Given the presence of sandy soils and groundwater, ‘replacement’ cast-in-situ pile types such as CFA (continuous flight auger) or cased bored piles should be appropriate. Driven piles might also be appropriate but potential vibrations and noise impacts to the nearby residents and structures would need careful consideration. Steel screw piles may also be appropriate to support lighter loads. Conventional open bored piles will be unsuitable as the uncased excavation will be prone to collapse, particularly near or below the groundwater level.

Recommended maximum pressures and elastic modulus value for the design of piles in medium dense sand are presented in Table 3. For piles, shaft adhesion values for uplift (tension) may be taken as being equal to 70% of the values for compression.

Table 3: Recommended Design Parameters for Cast-in-Situ Replacement Piles (e.g. CFA)

Foundation Stratum	Maximum Allowable Pressure		Maximum Ultimate Pressure		Elastic Modulus (MPa)
	End Bearing[1] (kPa)	Shaft Adhesion (Compression) (kPa)	End Bearing[1] (kPa)	Shaft Adhesion (Compression) (kPa)	
Medium Dense Sand	800	Ref Note 2	2500	Ref Note 2	20-40

Note: 1. End bearing pressure for sand applies to pile foundations that are founded 4 diameters below the ground surface.
2. Dependent on the length and depth of the pile, depth of the water table, and the piling methodology used. Shaft adhesion should be calculated using industry standard methods with a friction angle (ϕ') of 33 degrees for the medium dense natural sand.

To reduce the potential risk of total and differential settlement of piles, all piles should be founded at least five pile diameters above the lower strata of interbedded clays and sands.

The total settlement of piles proportioned based on the maximum allowable pressure values in Table 3 are expected to be less than 10 mm or 1% of the pile diameter, whichever is greater.

For limit state design (using ultimate pressure values), selection of the geotechnical strength reduction factor (ϕ_g) in accordance with Australian piling code AS 2159 – 2009 is based on a series of individual risk ratings (IRR), which are weighted on numerous factors and lead to an average risk rating (ARR). Therefore, it is recommended that an appropriate geotechnical strength reduction factor be calculated by the pile designer. Preliminary design could be based on a ϕ_g of 0.4 and refined as the design progresses. Footing settlements may be calculated for assessment of the serviceability limiting state using the elastic modulus values given in Table 3.

The above parameters are likely to be sufficient for loads associated with 1-2 storey buildings. Higher loads would generally need rock-socketed piles. A nominal allowable end bearing pressure of 1500 kPa and nominal allowable shaft adhesion of 150 kPa for weathered rock would be appropriate for planning purposes, however further geotechnical investigation would be required, including rock-cored boreholes, to confirm rock strength prior to detailed design.

Piling should be inspected by a geotechnical engineer to confirm that foundation conditions are suitable for the design parameters. It is noted that installation of CFA, driven and steel screw piles preclude geotechnical inspections and should be certified by the piling contractor. For CFA, driven and steel screw piles, the drilling and driving resistance and pile depths can be observed during construction and checked to see if the information correlates with adjacent borehole or CPT data. Inspection of the founding of cased bored piles below the water table is not usually possible.

7.5.3 Floor Slabs

A raft slab foundation may be feasible for some structures, however, this would be subject to detailed review and analysis of bearing pressures and settlements once specific details of the column layout and slab loadings are known.

Although relatively uniform conditions were encountered across the site, differential settlement across the raft slab footprint may occur depending on the layout and loading. A piled raft foundation could also be considered to reduce differential settlements, if required.

Raft and piled raft foundations should be supported on strata of uniform strength and stiffness to reduce differential settlements, however this will also depend on the loads and the settlement tolerances. Detailed geotechnical analysis and possibly additional investigations will be required for the design and construction of both raft slabs and piled raft slabs, if these are to be considered.

Preliminary slab design may be based on modulus of subgrade reaction, which is dependent on the size of the slab area subject to loading and the foundation material. Design parameters can be provided once the column details, loads and slab areas are known. Detailed design may require analysis using finite element computer programs to model the soil/structure interaction.

7.6 Aggressivity

Results of aggressivity testing generally indicate mildly aggressive conditions for subsurface concrete elements and non-aggressive conditions for subsurface steel elements (referring to Tables 6.4.2(C) and 6.5.2(C) of AS 2159 – 2009.

As there are likely to be potential acid sulphate soils on the site and the location of the sites close to the coast, it would be prudent to assume at least moderately aggressive conditions for both steel and concrete in-ground elements.

7.7 Salinity

The results of the laboratory testing and soil textural classification generally indicate non-saline conditions (referring to DLWC (2002) methods using the criteria outlined by Richards (1954)). One sample collected within sand (BH111 at 4.0 - 4.5 m depth) indicated slightly saline conditions. Provided that any imported fill is non-saline, standard construction practices will apply with respect to soil salinity.

7.8 Acid Sulphate Soils

The mapping indicates the sites are in an area with high probability of ASS below 1 - 3 m depth and the testing undertaken during the contamination assessment for the site indicate the presence of ASS. It is recommended that all material that is disturbed or brought to the surface from below the groundwater table should be treated as acid sulphate soil until proven otherwise. The effect of ASS on the durability of structural elements or services will need to be considered by the designers. Further comments on ASS are provided in the contamination assessment report.

7.9 Ground Vibration

During construction, it will be necessary to use appropriate methods and equipment to keep ground vibrations at adjacent buildings and structures within acceptable limits. Based on previous experience and with reference to Australian Standard AS 2670.2-1990 “Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings (1-80 Hz)”, an initial or provisional vibration limit of 8 mm/sec vector sum peak particle velocity (VSPPV) at the foundation level of adjacent

buildings for human comfort consideration is suggested. This vibration limit may need to be reduced if there are vibration-sensitive buildings (or equipment) in the area.

As the magnitude of vibration transmission is site specific, it is recommended that a vibration trial be undertaken at the commencement of piling/shoring construction and prior to earthworks (e.g. excavation and compaction/rolling). The trial may indicate that smaller or different types of piling and earthworks plant should be used.

7.10 Working Platform Assessment

Given that a piling rig is likely to be required to construct foundation piles, a working platform assessment will be required for support of the piling rig and/or mobile crane loads. The platform thickness will need to be assessed once details of piling rig or other plant loads are known.

7.11 Pavements

CBR values in the range of 12% to 17% have been recorded for samples from the site. To allow for potential variability in materials and compaction across the site, it is suggested that, provided that site preparation is carried out in accordance with the recommendations given above, a CBR of 5% may be adopted for pavement design purposes.

During construction of pavements, it is recommended that all topsoil, organic and deleterious material should be stripped and stockpiled separately for disposal or use in landscaping areas. Proof rolling of the exposed subgrade should then be carried out under the supervision of a geotechnical engineer to detect any soft or heaving areas. Any soft spots detected during proof rolling would need to be stripped to a suitable base or maximum depth of 0.5 m and replaced with engineered filling or reworked to non-deflecting conditions.

The satisfactory on-going performance of pavements is dependent on the subgrade not being allowed to become excessively wet. To improve pavement life, it is essential that sufficient subsoil drainage be installed in areas where there is potential for water to enter the subgrade, (i.e. adjacent to unsealed areas, table drains, landscaped areas etc).

7.12 Seismic Loading

In accordance with AS 1170 – 2007 “Structural Design Actions, Part 4: Earthquake Actions in Australia” a hazard factor (Z) of 0.08 and a site subsoil Class D_e are appropriate for the site.

7.13 Dilapidation Surveys

Dilapidation surveys should be carried out on adjacent buildings and pavements that may be affected by excavations, earthworks and piling. The dilapidation surveys should be undertaken before construction commences in order to document any existing defects, so that any claims for damage due to construction related activities can be accurately assessed.

8. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Narrabeen North Public School and Narrabeen Sports High School, Namona Street, Narrabeen in general accordance with DP's proposal 86973.04.P.002.Rev1 dated 16 March 2022 and acceptance received from NSW Department of Education dated 29 March 2022. The work was carried out under the agreed Standard Form Agreement SINSW02795/21 dated 7 April 2022. This report is provided for the exclusive use of 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 sites 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 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.

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

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

The scope of work for this report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the sites. Refer to the contamination assessment report undertaken in conjunction with this geotechnical investigation (DP Report 86973.04.R.002.Rev0) for further comments on contamination at the site.

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

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

Appendix B

Drawings

LOCALITY MAP

Notes:
1. Base Site Plan from DJRD Architects, Project No. 19420, Drawing No. A-SITE_A0.1001, Revision 6 (dated 09/06/2020)
2. Test locations shown are approximate only
3. CPTs were also undertaken at some borehole locations (refer to geotechnical report)

Legend

- NNPS Boundary
- Proposed Buildings
- AMP Zone

Cross-Section

- A

Approximate Test Locations

- 86973-04 NNPS Test Pits
- 86973-04 NSHS Boreholes

Previous Test Locations

- Borehole
- CPT
- Borehole and CPT

0 20 40 60 m

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: School Infrastructure NSW	TITLE: **Site and Test Location Plan**	PROJECT No: 86973.05
	OFFICE: Sydney / DRAWN BY: MG	**Narrabeen Education Precinct**	DRAWING No: 1
	SCALE: 1:1000 @ A3 / DATE: 25.08.2022	**Namona Street, North Narrabeen**	REVISION: 1

Notes:
1. Drawing projection
2. Latest available aerial imagery sourced from metromap.com accessed 10/06/2022
3. Test locations shown are approximate only

Legend

- NNPS Boundary
- NSHS Originally Proposed Buildings
- Cross-Section

Current Investigation Locations

- Test Pit
- Borehole

Previous Test Locations

- Borehole and CPT

0 20 40 60 80 m

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	School Infrastructure NSW		
OFFICE:	Sydney	DRAWN BY:	LT
SCALE:	1:1400 @ A3	DATE:	25.08.2022

TITLE: **Site and Test Location Plan**
Narrabeen Education Precinct
Namona Street, North Narrabeen

N

PROJECT No:	86973.05
DRAWING No:	2
REVISION:	1

A

A'

APPROXIMATE SITE BOUNDARY

APPROXIMATE SITE BOUNDARY

EXTENTS OF PROPOSED NEW BUILDINGS

FILL

Approximate Standing Water Level

SAND (VARIABLE)

SAND (MEDIUM DENSE OR DENSER)

CLAY AND SAND

WEATHERED ROCK

BH1011 Offset 1.4m, Bottom Depth 1 m

TP1008 Offset 19.4m, Bottom Depth 2.6 m

TP1020 Offset 19.0m, Bottom Depth 1.5 m

CPT6 Offset 3.9m, Bottom Depth 25 m

BH06 Offset 3.9m, Bottom Depth 6 m

TP1019 Offset 29.6m, Bottom Depth 1 m

BH1006 Offset 5.6m, Bottom Depth 1.5 m

TP1003 Offset 18.7m, Bottom Depth 1.4 m

CPT5 Offset 12.9m, Bottom Depth 25 m

BH05 Offset 12.9m, Bottom Depth 3 m

BH1002 Offset 3.1m, Bottom Depth 1.5 m

TP1001A Offset 22.5m, Bottom Depth 2.3 m

CPT4 Offset 3.4m, Bottom Depth 28.06 m

BH04 Offset 3.3m, Bottom Depth .8 m

ELEVATION (AHD)

DISTANCE ALONG PROFILE (m)

LEGEND

- Filling
- Sand
- Sandy Clay
- Silty Sand
- Asphaltic Concrete

TESTS / OTHER

- Interpreted geotechnical boundary
- Water level

SOIL CONSISTENCY

vs - Very Soft
s - Soft
f - Firm
st - Stiff
vst - Very Stiff
h - Hard

SOIL DENSITY

vl - Very Loose
l - Loose
md - Medium Dense
d - Dense
vd - Very Dense

NOTES

1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

Horizontal Scale (metres) 0 10

Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: NSW Department of Education		TITLE: **Cross-section A-A'**	PROJECT No: 86973.05
OFFICE: Sydney	DRAWN BY: CJ	**Proposed School Upgrade**	DRAWING No: 3
SCALE: 1:500 (H) 1:250 (V) @ A3	DATE: 25.08.2022	**Namona Street, North Narrabeen**	REVISION: 1

B

B'

EXTENTS OF PROPOSED BUILDINGS

FILL

SAND (VARIABLE)

SAND (LOOSE TO MEDIUM DENSE)

CLAY AND SAND

WEATHERED ROCK

CPT105 Offset 1.0m
BH105 Offset 0.9m
Bottom Depth 2.5 m
Bottom Depth 19.42 m

CPT104 Offset 6.3m
BH104 Offset 6.2m
BH206 Offset - 1.6m
Bottom Depth 1.5 m
Bottom Depth 8 m
Bottom Depth 18.7 m

CPT103 Offset - 14.7m
BH103 Offset - 14.7m
Bottom Depth 1.5 m
Bottom Depth 24.28 m

ELEVATION (AHD)

DISTANCE ALONG PROFILE (m)

LEGEND

- Asphaltic Concrete
- Concrete
- Filling
- Sand
- Silty Sand
- Interpreted geotechnical boundary
- Water level

SOIL CONSISTENCY

vs	-	Very Soft
s	-	Soft
f	-	Firm
st	-	Stiff
vst	-	Very Stiff
h	-	Hard

SOIL DENSITY

vl	-	Very Loose
l	-	Loose
md	-	Medium Dense
d	-	Dense
vd	-	Very Dense

NOTES

1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

Horizontal Scale (metres) 0 10

Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: NSW Department of Education		TITLE: **Cross-section B-B'**	PROJECT No: 86973.05
OFFICE: Sydney	DRAWN BY: CJ	**Proposed School Upgrade**	DRAWING No: 4
SCALE: 1:500 (H) 1:250 (V) @ A3	DATE: 25.08.2022	**Namona Street, North Narrabeen**	REVISION: 1

Appendix C

Results of Field Work

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 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

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

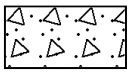
Symbols & Abbreviations

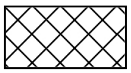
Graphic Symbols for Soil and Rock

General

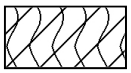

Asphalt

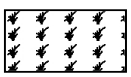

Road base

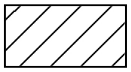

Concrete

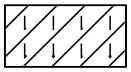

Filling

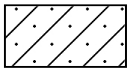
Soils


Topsoil

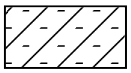

Peat

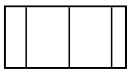

Clay

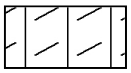

Silty clay

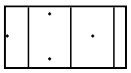

Sandy clay

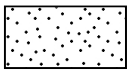

Gravelly clay

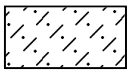

Shaly clay

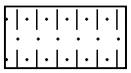

Silt


Clayey silt


Sandy silt

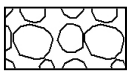

Sand

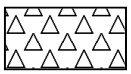

Clayey sand


Silty sand


Gravel

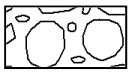

Sandy gravel


Cobbles, boulders

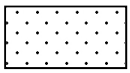

Talus

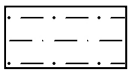
Sedimentary Rocks

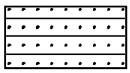

Boulder conglomerate

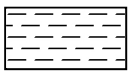

Conglomerate


Conglomeratic sandstone

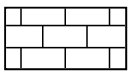

Sandstone


Siltstone

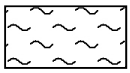

Laminite

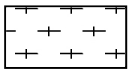

Mudstone, claystone, shale

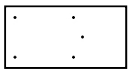

Coal


Limestone

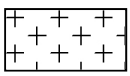
Metamorphic Rocks

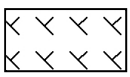

Slate, phyllite, schist

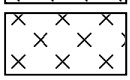

Gneiss

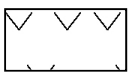

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Cone Penetration Tests

Douglas Partners

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

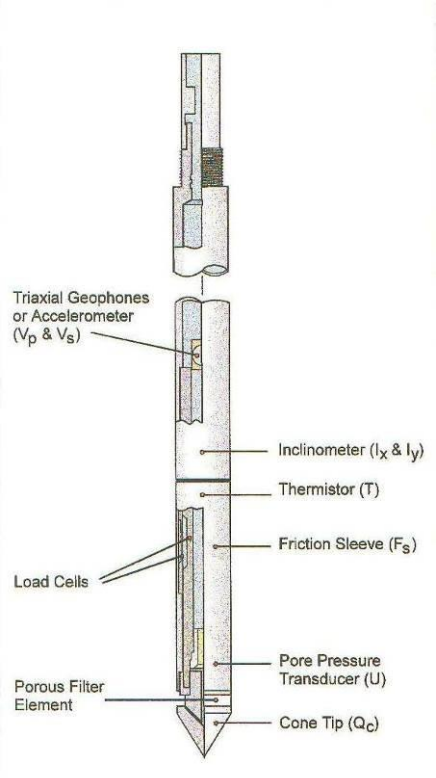


Figure 1: Cone Diagram

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)

Cone Penetration Tests

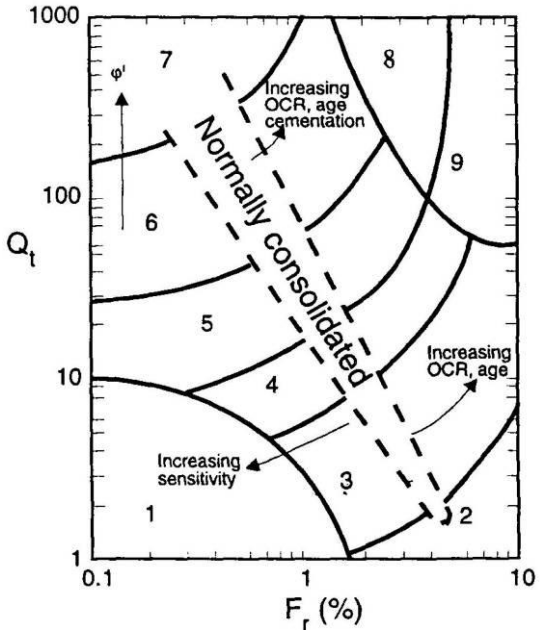


Figure 3: Soil Classification Chart

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.

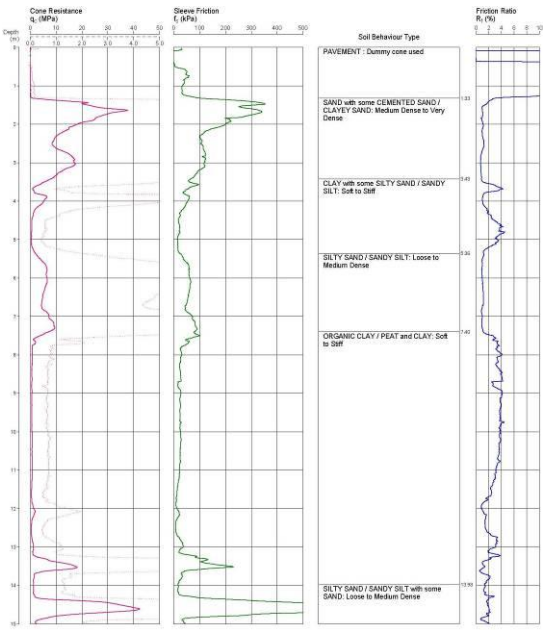


Figure 4: Sample Cone Plot

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Narrabeen Education Project
LOCATION: Namona St, North Narrabeen

SURFACE LEVEL: 2.9 AHD
EASTING: 342213.9
NORTHING: 6270007.2
DIP/AZIMUTH: 90°/--

BORE No: BH04
PROJECT No: 86973.01
DATE: 21/1/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.1	FILL/TOPSOIL (Silty SAND) SM: fine to coarse, dark brown, trace rootlets, moist		E	0.0		PID<1ppm		Well Plug and Flush Gatic Cover Concrete 0-0.15m
				E*	0.1		PID<1ppm		
	0.3	FILL/Gravelly CLAY CH: medium to high plasticity, orange-brown, ironstone, sandstone, igneous, trace silt, w~PL			0.3				
				E	0.4		PID<1ppm		Bentonite 0.15-0.9m
					0.5				Plain PVC 0-1.5m
		SAND SP: fine to medium, grey, moist, alluvial and estuarine		E	0.9		PID<1ppm		
		- From 0.4m: fine, pale grey			1.0				
				E	1.5		PID<1ppm		
					1.6				
	2.1	- From 2.0m: wet							
		SAND SP: fine to medium, brown and dark brown, indurated, wet, alluvial and estuarine		E**	2.4		PID<1ppm		
					2.5				Gravel 0.9-4.5m
									Machine Slotted PVC Screen 1.5-4.5m
					3.5				
	3.6	Sandy CLAY CL: low plasticity, brown and dark brown, fine to medium sand, trace sub-rounded gravel, wet, alluvial and estuarine		E			PID<1ppm		
					4.0				
					4.5				End Cap
				E			PID<1ppm		
					5.0				
	5.2	SAND SP: fine to medium, yellow-brown, trace sub-rounded gravel, saturated, alluvial and estuarine			5.5				
				E			PID<1ppm		
					6.0				
					6.5				
				E			PID<1ppm		
					7.0				
					7.5				
				E			PID<1ppm		
	8.0	Bore discontinued at 8.0m - Target Depth Reached			8.0				

RIG: MD-200 **DRILLER:** Tightsite **LOGGED:** LT **CASING:** Uncased

TYPE OF BORING: Push tube to 2.0m, Solid flight augers (TC-bit) to 8.0m

WATER OBSERVATIONS: Free groundwater observed whilst push tubing at 2.0m

REMARKS: Location coordinates are in MGA94 Zone 56. *Blind replicate sample BD4/20200121 taken from 0.1-0.3m, **Blind replicate sample BD5/20200121 taken from 2.4-2.5m

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: NSW Department of Education
PROJECT: Narrabeen Education Project
LOCATION: Namona St, North Narrabeen

SURFACE LEVEL: 4.7 AHD
EASTING: 342193.8
NORTHING: 6269948.2
DIP/AZIMUTH: 90°/--

BORE No: BH05
PROJECT No: 86973.01
DATE: 22/1/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.15	FILL/TOPSOIL (Silty SAND) SM: fine to coarse, brown, trace rootlets, gravel, moist		E	0.0 0.1		PID<1ppm		
		FILL/Silty SAND SM: fine to coarse, grey, trace ash and charcoal, moist		E	0.4 0.5		PID<1ppm		
	0.8	Silty SAND SM: fine to medium, grey and pale grey, moist, alluvial and estuarine		E	0.9 1.0		PID<1ppm		
				E	1.4 1.5		PID<1ppm		
	1.5	Silty SAND SM: fine to medium, brown, trace rootlets, moist, alluvial and estuarine		E	1.9 2.0		PID<1ppm		
		- From 2.4m: red-brown							
	3.0	Bore discontinued at 3.0m - Target Depth Reached		E*	2.9 3.0		PID<1ppm		

RIG: MD-200 **DRILLER:** Tightsite **LOGGED:** LT **CASING:** Uncased

TYPE OF BORING: Push tube to 3.0m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 56. *Blind replicate sample BD8/20200122 taken from 2.9-3.0m

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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Narrabeen Education Project
LOCATION: Namona St, North Narrabeen

SURFACE LEVEL: 4.7 AHD
EASTING: 342195.8
NORTHING: 6269907.2
DIP/AZIMUTH: 90°/--

BORE No: BH06
PROJECT No: 86973.01
DATE: 22/1/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.03	ASPHALTIC CONCRETE		E	0.05 0.15		PID<1ppm		Well Plug and Flush Gatic Cover Concrete 0-0.15m
	0.2	FILL/Silty SAND SM: fine to medium, dark grey, trace ash, moist		E	0.4 0.5		PID<1ppm		
		SAND SP: fine to medium, grey, moist From 0.7m: pale grey		E	0.9 1.0		PID<1ppm		Backfill 0.15-1.3m
				E*	1.4 1.5		PID<1ppm		Plain PVC 0-2.8m
				E	1.9 2.0		PID<1ppm		Bentonite 1.3-2.3m
	2.3	SAND SP: fine to medium, brown and red-brown, indurated, moist, alluvial and estuarine		A	2.4 2.5		PID<1ppm		
	3.2	SAND SP: fine to medium, pale grey, moist, alluvial and estuarine						▼	Gravel 2.3-5.8m Machine slotted PVC Screen 2.8-5.8m
	6.0	Bore discontinued at 6.0m - Target Depth Reached							End Cap

RIG: MD-200 **DRILLER:** Tightsite **LOGGED:** LT **CASING:** Uncased

TYPE OF BORING: Push tube to 3.0m, Solid flight augers (TC-bit) to 6.0m

WATER OBSERVATIONS: Free groundwater observed whilst augering at 4.0m

REMARKS: Location coordinates are in MGA94 Zone 56. *Blind replicate sample BD4/20200122 taken from 1.4-1.5m

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: NSW Department of Education
PROJECT: Narrabeen Education Project
LOCATION: Namona St, North Narrabeen

SURFACE LEVEL: 1.9 AHD
EASTING: 342186.3
NORTHING: 6269783
DIP/AZIMUTH: 90°/--

BORE No: BH103
PROJECT No: 86973.01
DATE: 20/1/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.03	ASHPALTIC CONCRETE							
	0.12	CONCRETE: grey with aggregate <20mm		A	0.15 0.25		PID=5ppm		
	0.4	FILL/SAND SW: fine to coarse, brown, with sandstone gravels and cobbles, trace shells, moist		A	0.4 0.5		PID<1ppm		
		SAND SP: fine to medium, pale grey, moist, alluvial and estuarine		E	1.0				
	1.5	Bore discontinued at 1.5m - Target Depth Reached		E*	1.4 1.5		PID<1ppm	▼	

RIG: MD-200 **DRILLER:** Tightsite **LOGGED:** LT **CASING:** Uncased

TYPE OF BORING: Solid flight augers (TC-bit) to 0.5m, Push Tube to 1.5m

WATER OBSERVATIONS: Free groundwater observed whilst push tubing at 1.5m

REMARKS: Location coordinates are in MGA94 Zone 56. *Blind replicate sample BD1/20200120 taken at 1.4-1.5m

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: NSW Department of Education
PROJECT: Narrabeen Education Project
LOCATION: Namona St, North Narrabeen

SURFACE LEVEL: 2.3 AHD
EASTING: 342153.3
NORTHING: 6269733.5
DIP/AZIMUTH: 90°/--

BORE No: BH104
PROJECT No: 86973.01
DATE: 21/1/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILL/TOPSOIL (Silty SAND) SM: fine to medium, dark brown, trace rootlets, moist		A*	0.0 0.1		PID<1ppm		Well Plug and Flush Gatic Cover
		FILL/SAND SW: fine to coarse, pale brown, with shell fragments, moist		A	0.4 0.5		PID<1ppm		Concrete 0-0.15m Bentonite 0.15-1.1m Plain PVC 0-1.1m
	0.9			A	0.9		PID<1ppm		
	0.95	FILL/Silty CLAY CL-CH: low to medium plasticity, dark brown, trace rootlets and organic matter, moist (possible original topsoil)		E	0.95 1.0		PID<1ppm		
	1.38	FILL/SAND SW: fine to coarse, pale yellow-brown, with shell fragments, moist		E	1.4 1.5		PID<1ppm	▼	
		Silty SAND SM: fine to medium, grey, trace shells, moist, alluvial and estuarine - From 1.6m: dark grey, wet		E	1.9 2.0		PID<1ppm		
		- From 2.3m: with organic matter		E	2.4 2.5		PID<1ppm		
	2.7	SAND SP: fine to medium, dark grey, trace shells, wet, alluvial and estuarine							
		- From 3.5m: saturated		E	3.5		PID<1ppm		Gravel 1.1-6.0m Machine Slotted PVC Screen 1.1-6.0m
					4.0				
				E	4.5		PID<1ppm		
					5.0				
				E	5.5		PID<1ppm		
					6.0				End Cap
		- From 6.5m: brown and grey		E	6.5		PID<1ppm		
	7.0	Silty SAND SM: fine to medium, brown, trace shell fragments, saturated, alluvial and estuarine			7.0				
				E	7.5		PID<1ppm		
	8.0	Bore discontinued at 8.0m - Target Depth Reached			8.0				

RIG: MD-200 **DRILLER:** Tightsite **LOGGED:** LT **CASING:** HW Cased to 6.0m

TYPE OF BORING: Solid flight augers (TC-bit) to 0.5m, Push tube to 6.0m, Wash bore to 8.0m

WATER OBSERVATIONS: Free groundwater observed whilst push tubing at 1.6m

REMARKS: Location coordinates are in MGA94 Zone 56. *Blind replicate sample BD3/20200120 taken from 0-0.1m

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: NSW Department of Education
PROJECT: Narrabeen Education Project
LOCATION: Namona St, North Narrabeen

SURFACE LEVEL: 2.2 AHD
EASTING: 342146.9
NORTHING: 6269682.5
DIP/AZIMUTH: 90°/--

BORE No: BH105
PROJECT No: 86973.01
DATE: 20/1/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILL/TOPSOIL (Silty SAND) SM: fine to medium, dark brown, trace rootlets, moist		A	0.0 0.1		PID<1ppm		
		FILL/SAND SW: fine to coarse, brown, trace shells and gravel, moist		A	0.4 0.5		PID<1ppm		
				E	0.9 1.0		PID=1ppm		
	1.4	- From 1.3m : dark brown		E	1.3		PID<1ppm		
		Silty SAND SM: fine to medium, grey, moist, alluvial and estuarine		E	1.4 1.5		PID<1ppm	▼	
		- From 1.62m: wet		E	1.9 2.0		PID<1ppm		
	2.5	Bore discontinued at 2.5m - Target Depth Reached		E	2.4 2.5		PID<1ppm		

RIG: MD-200 **DRILLER:** Tightsite **LOGGED:** LT **CASING:** Uncased

TYPE OF BORING: Solid flight augers (TC-bit) to 0.5m, Push tube to 2.5m

WATER OBSERVATIONS: Free groundwater observed whlist push tubing at 1.62m

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 2.8 AHD
EASTING: 342163
NORTHING: 6269740.5
DIP/AZIMUTH: 90°/--

BORE No: BH206
PROJECT No: 86973.04
DATE: 20/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.13	CONCRETE SLAB							
		FILL/SAND: fine to medium, brown, trace silt, shells and gravel, moist		E*	0.2 0.3		PID < 1 ppm		
				E	0.7 0.8		PID < 1 ppm		
	1.1	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine Below 1.4 m: wet		E	1.2 1.3		PID < 1 ppm	▼	
	1.5	Bore discontinued at 1.5m Target depth reached							

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Dia-core (300 mm) to 0.13 m, solid flight auger (300 mm) to 1.5 m.

WATER OBSERVATIONS: Groundwater observed at 1.4 m.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS. *Blind replicate BD14/20220420 taken from 0.2-0.3 m.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.6 AHD
EASTING: 342206.6
NORTHING: 6269964.3
DIP/AZIMUTH: 90°/--

BORE No: BH1002
PROJECT No: 86973.04
DATE: 13/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
4.6	0.01	MULCH							
		FILL/Silty SAND: fine to medium, dark grey-brown, trace rootlets and charcoal, moist		E	0.1 0.2		PID < 1 ppm		
	0.4	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine		E	0.5 0.6		PID < 1 ppm		
		Below 0.7 m: pale grey							
	1			E	1.0 1.1		PID < 1 ppm		1
		Below 1.3 m: brown, with silt, trace clay							
	1.5	Bore discontinued at 1.5m Target depth reached							

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (150 mm) to 1.5 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.7 AHD
EASTING: 342207.9
NORTHING: 6269937.9
DIP/AZIMUTH: 90°/--

BORE No: BH1004
PROJECT No: 86973.05
DATE: 13/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.03	ASPHALTIC CONCRETE							
	0.1	FILL/Gravelly SAND: fine to coarse, brown, angular to subangular igneous gravel, with silt, moist		E	0.2		PID < 1 ppm		
		FILL/Silty SAND: fine to medium, brown, trace rootlets, moist			0.3				
4	0.7	SAND SP: fine to medium, pale grey, trace silt, moist, alluvial and estuarine		E	0.8		PID < 1 ppm		
	1	Below 1.0 m: pale yellow-grey			0.9				1
		Below 1.2 m: with nodules of indurated brown sand, silt and clay (coffee rock)		E	1.3		PID < 1 ppm		
3					1.4				
	2			E	1.8				2
					1.9				
				E	2.3				
					2.4				
	2.5	Bore discontinued at 2.5m Target depth reached							
2									
	3								3
1									
	4								4
0									

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (150 mm) to 2.5 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.8 AHD
EASTING: 342196.8
NORTHING: 6269922.8
DIP/AZIMUTH: 90°/--

BORE No: BH1006
PROJECT No: 86973.05
DATE: 13/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.01	MULCH							
		FILL/Silty SAND: fine to medium, dark grey-brown, moist		E	0.1 0.2		PID < 1 ppm		
	0.4	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine		E	0.6 0.7		PID < 1 ppm		
				E*	1.1 1.2		PID < 1 ppm		
	1.5	Bore discontinued at 1.5m Target depth reached							

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

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (150 mm) to 1.5 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS. *Blind replicate BD2/20220413 taken from 1.1-1.2 m.

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

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.6 AHD
EASTING: 342203.6
NORTHING: 6269898.5
DIP/AZIMUTH: 90°/--

BORE No: BH1009
PROJECT No: 86973.05
DATE: 14/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
4.6	0.025	ASPHALTIC CONCRETE							
4.5	0.1	FILL/Gravelly SAND: fine to coarse, grey-brown, with silt, angular to subangular igneous gravel, moist		E*	0.2 0.3		PID < 1 ppm		
		FILL/Silty SAND: fine to medium, dark grey, trace fine igneous gravel, moist							
4.1	0.5	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine		E	0.7 0.8		PID < 1 ppm		
3.6	1	Below 1.0 m: reducing silt		E	1.2 1.3		PID < 1 ppm		1
2.8	1.8			E	1.8 1.9				
2.6	2.0	Bore discontinued at 2.0m Target depth reached							2
	3								3
	4								4

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (300 mm) to 2.0 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS. *Blind replicate BD3/20220414 taken from 0.2-0.3 m.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.4 AHD
EASTING: 342217.2
NORTHING: 6269905.9
DIP/AZIMUTH: 90°/--

BORE No: BH1010
PROJECT No: 86973.05
DATE: 14/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.03	ASPHALTIC CONCRETE							
	0.1	FILL/Gravelly SAND: fine to coarse, grey-brown, with silt, angular to subangular igneous gravel, moist		E	0.2 0.3		PID < 1 ppm		
		FILL/Silty SAND: fine to medium, dark grey, trace fine igneous gravel, moist							
	0.6	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine		E*	0.7 0.8		PID < 1 ppm		
	1	Below 1.0 m: reducing silt							1
				E	1.2 1.3		PID < 1 ppm		
	1.5	Bore discontinued at 1.5m Target depth reached							
	2								2
	3								3
	4								4

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (300 mm) to 1.5 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS. *Blind replicate BD4/20220414 taken from 0.7-0.8 m.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 3.5 AHD
EASTING: 342192.8
NORTHING: 6269875.6
DIP/AZIMUTH: 90°/--

BORE No: BH1011
PROJECT No: 86973.05
DATE: 19/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILL/Silty SAND: fine to medium, dark brown, trace rootlets, moist		E	0.0 0.1		PID < 1 ppm		
	0.4	SAND SP: fine to medium, grey, moist, trace silt, alluvial and estuarine		E	0.6 0.7		PID < 1 ppm		
	1.0	Bore discontinued at 1.0m Target depth reached							

RIG: Hand Tools **DRILLER:** HD **LOGGED:** HD **CASING:** -

TYPE OF BORING: Hand auger to 1.0 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.3 AHD
EASTING: 342210.4
NORTHING: 6269871.3
DIP/AZIMUTH: 90°/--

BORE No: BH1012
PROJECT No: 86973.05
DATE: 19/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILL/Silty SAND: fine to medium, dark brown, trace rootlets, moist		E	0.0 0.1		PID < 1 ppm		
	0.5	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine		E	0.6 0.7		PID < 1 ppm		
	1.0	Bore discontinued at 1.0m Target depth reached							

RIG: Hand Tools **DRILLER:** HD **LOGGED:** HD **CASING:** -

TYPE OF BORING: Hand auger to 1.0 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.1 AHD
EASTING: 342250.9
NORTHING: 6269886.1
DIP/AZIMUTH: 90°/--

BORE No: BH1013
PROJECT No: 86973.05
DATE: 14/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.03	ASPHALTIC CONCRETE							
	0.2	FILL/Gravelly SAND: fine to coarse, grey-brown, fine to medium angular to subangular igneous gravel, with silt and asphalt, trace brick, moist		E	0.1 0.2		PID < 1 ppm		
		SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine		E	0.3 0.4		PID < 1 ppm		
		Below 0.4 m: reducing silt							
	1.0	Bore discontinued at 1.0m Target depth reached		E	0.9 1.0		PID < 1 ppm		

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (300 mm) to 1.0 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.0 AHD
EASTING: 342264.8
NORTHING: 6269877.8
DIP/AZIMUTH: 90°/--

BORE No: BH1014
PROJECT No: 86973.05
DATE: 14/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
4	0.03	ASPHALTIC CONCRETE		E	0.05		PID < 1 ppm		
	0.15	FILL/Gravelly SAND: fine to coarse, grey-brown, with silt and asphalt, angular to subangular igneous gravel, moist			0.15				
		SAND SP: fine to medium, grey, with silt, moist, alluvial and estuarine		E	0.4		PID < 1 ppm		
		Below 0.5 m: trace silt			0.5				
				E*	0.9		PID < 1 ppm		
3	1 1.0	Bore discontinued at 1.0m Target depth reached			1.0				1
2	2								2
1	3								3
0	4								4

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (300 mm) to 1.0 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS. *Blind replicate BD5/20220414 taken from 0.9-1.0 m.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.4 AHD
EASTING: 342235
NORTHING: 6269851.8
DIP/AZIMUTH: 90°/--

BORE No: BH1015
PROJECT No: 86973.05
DATE: 14/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILL/Silty SAND: fine to medium, dark brown, trace roots, rootlets and terracotta fragments, moist		E*	0.0 0.2		PID < 1 ppm		
	0.4	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine		E	0.6 0.7		PID < 1 ppm		
				E	1.1 1.2		PID < 1 ppm		
	1.5	Bore discontinued at 1.5m Target depth reached							

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (300 mm) to 1.5 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey. *Blind replicate BD6/20220414 taken from 0-0.2 m.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.2 AHD
EASTING: 342237.1
NORTHING: 6269842.4
DIP/AZIMUTH: 90°/--

BORE No: BH1016
PROJECT No: 86973.05
DATE: 14/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILL/Silty SAND: fine to medium, dark brown, with roots and rootlets, trace mulch, moist		E	0.0 0.2		PID < 1 ppm		
	0.5	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine		E*	0.5 0.6		PID < 1 ppm		
				E	1.0 1.1		PID < 1 ppm		
	1.5	Bore discontinued at 1.5m Target depth reached							

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (300 mm) to 1.5 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey. *Blind replicate BD7/20220414 taken from 0.5-0.6 m.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.6 AHD
EASTING: 342237.3
NORTHING: 6269938.1
DIP/AZIMUTH: 90°/--

BORE No: BH1021
PROJECT No: 86973.05
DATE: 19/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILL/Silty SAND: fine to medium, dark brown, with rootlets, moist		E	0.1 0.2		PID < 1 ppm		
	0.25	Bore discontinued at 0.25m Refusal on gravel and geofabric							

RIG: Hand Tools **DRILLER:** HD **LOGGED:** HD **CASING:** -

TYPE OF BORING: Hand auger to 0.25 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 5.1 AHD
EASTING: 342242.5
NORTHING: 6269937
DIP/AZIMUTH: 90°/--

BORE No: BH1022
PROJECT No: 86973.05
DATE: 19/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
5		FILL/Silty SAND: fine to medium, dark brown, with rootlets, moist			0.1				
		Below 0.1 m: trace rootlets		E	0.2		PID < 1 ppm		
					0.6				
				E			PID < 1 ppm		
	0.7				0.7				
4		Bore discontinued at 0.7m							
		Refusal on gravel and geofabric							
	1								1
3									
	2								2
2									
	3								3
1									
	4								4

RIG: Hand Tools **DRILLER:** HD **LOGGED:** HD **CASING:** -

TYPE OF BORING: Hand auger to 0.7 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.6 AHD
EASTING: 342240.5
NORTHING: 6269914.9
DIP/AZIMUTH: 90°/--

BORE No: BH1023
PROJECT No: 86973.05
DATE: 13/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.01	MULCH							
		FILL/Silty SAND: fine to medium, brown, trace rootlets and fine gravel, moist		E	0.1 0.2		PID < 1 ppm		
		Below 0.3 m: dark brown		E	0.4 0.5		PID < 1 ppm		
	0.7	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine		E	0.9 1.0		PID < 1 ppm		
				E	1.4		PID < 1 ppm		
	1.5	Bore discontinued at 1.5m Target depth reached			1.5				

RIG: 5 Tonne Excavator **DRILLER:** A&A Hire Service **LOGGED:** HD **CASING:** -

TYPE OF BORING: Solid flight auger (150 mm) to 1.5 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 2.4 AHD
EASTING: 342188.4
NORTHING: 6269990.3
DIP/AZIMUTH: 90°/--

BORE No: BH1024
PROJECT No: 86973.04
DATE: 14/07/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	FILL/Silty CLAY: medium to high plasticity, brown mottled red, trace ironstone, rootlets and fine igneous gravel, w~PL		E	0.0		PID = 2 ppm		
	0.2				0.2				
	0.3	Silty SAND SM: fine to medium, dark grey-brown, moist, alluvial and estuarine			0.3				
	0.4			E*	0.4		PID = 2 ppm		
	0.6				0.6				
	0.9	Below 0.9 m: wet		E	0.9		PID = 1 ppm	▼	
	1.1	Bore discontinued at 1.1m Target depth reached			1.1				

RIG: Hand Tools **DRILLER:** HD **LOGGED:** HD **CASING:** -

TYPE OF BORING: Hand auger to 1.1 m.

WATER OBSERVATIONS: Groundwater observed at 0.9 m.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS. *Blind replicate BD22/20220714 taken from 0.4-0.6 m.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 3.0 AHD
EASTING: 342198.4
NORTHING: 6269993
DIP/AZIMUTH: 90°/--

BORE No: BH1025
PROJECT No: 86973.04
DATE: 14/07/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3	0.0	FILL/SAND: fine to medium, grey, trace clay, fine to coarse gravel, brick and concrete fragments, moist, reworked natural		E	0.0		PID = 2 ppm		
					0.2				
				E	0.5		PID = 1 ppm		
					0.7				
	0.8	FILL/Sandy CLAY: medium to high plasticity, yellow mottled red, trace silt and ironstone, w~PL			0.9				
2	1			E			PID = 1 ppm		1
	1.1	Silty SAND SM: fine to medium, dark grey-brown, trace rootlets, wet, alluvial and estuarine			1.1			▼	
					1.2				
				E			PID = 1 ppm		
					1.4				
	1.7	Bore discontinued at 1.7m Target depth reached							
1	2								2
0	3								3
-1	4								4

RIG: Hand Tools **DRILLER:** HD **LOGGED:** HD **CASING:** -

TYPE OF BORING: Hand auger to 1.7 m.

WATER OBSERVATIONS: Groundwater observed at 1.1 m.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 3.5 AHD
EASTING: 342210.9
NORTHING: 6269985.5
DIP/AZIMUTH: 90°/--

BORE No: BH1026
PROJECT No: 86973.04
DATE: 14/07/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	FILL/SAND: fine to medium, grey, trace clay, silt, brick, tile and plastic fragments, moist, possibly reworked natural		E*	0.0 - 0.2		PID = 1 ppm		
	0.9	Below 0.9 m: brown, with silt and clay, trace clay nodules		E	0.9 - 1.1		PID = 2 ppm		
	1.1	SAND SP: fine to medium, dark grey-brown, moist, alluvial and estuarine		E	1.2 - 1.4		PID = 1 ppm		
	1.5	Bore discontinued at 1.5m Target depth reached							

RIG: Hand Tools **DRILLER:** HD **LOGGED:** HD **CASING:** -

TYPE OF BORING: Hand auger to 1.5 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Approximate coordinates obtained via DGPS. Approximate levels inferred by comparison with nearby boreholes. *Blind replicate BD23/20220714 taken from 0-0.2 m.

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: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.0 AHD
EASTING: 342199.8
NORTHING: 6270003.5
DIP/AZIMUTH: 90°/--

BORE No: BH1027
PROJECT No: 86973.04
DATE: 14/07/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
4		FILL/Silty SAND: fine to medium, brown, trace fine igneous gravel, rootlets and asbestos containing material, moist		E	0.0 0.2		PID = 2 ppm		
	0.6	SAND SP: fine to medium, grey, moist, alluvial and estuarine		E	0.6 0.8		PID = 3 ppm		
3	1	Below 1.2 m: indurated brown sand, silt and clay (coffee rock)		E	1.2 1.4		PID = 3 ppm		1
	1.6	Bore discontinued at 1.6m Target depth reached							
2	2								2
1	3								3
0	4								4

RIG: Hand Tools **DRILLER:** HD **LOGGED:** HD **CASING:** -

TYPE OF BORING: Hand auger to 1.6 m.

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 56. Coordinates and levels obtained via DGPS.

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: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

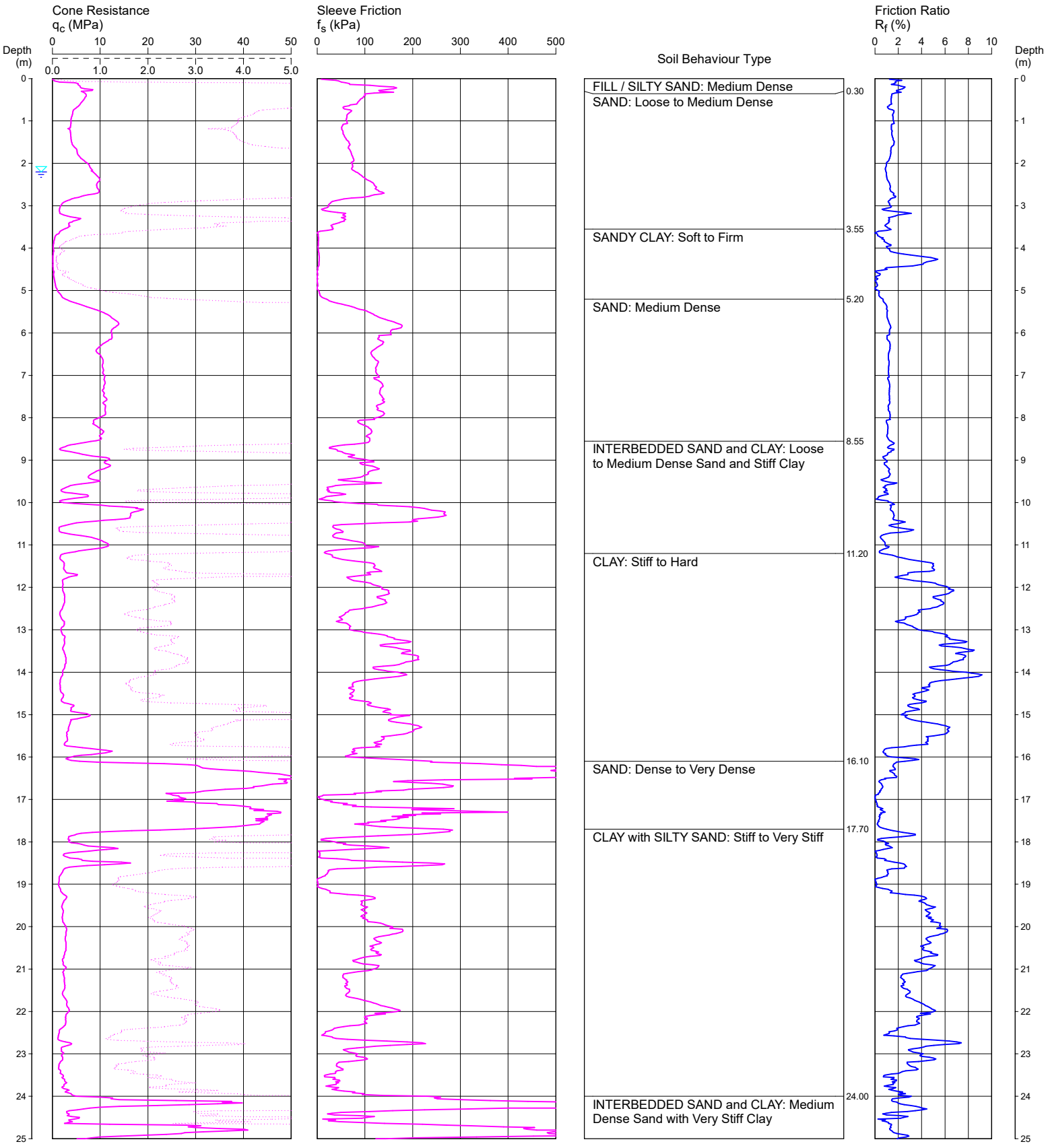
REDUCED LEVEL: 2.9 AHD

COORDINATES: 342213.9E 6270007.2N

CPT4

DATE 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE BENDING NEAR REFUSAL
GROUNDWATER MEASURED AT 2.2m AFTER REMOVAL OF RODS

Water depth after test: 2.20m depth (measured)

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT4.CP5

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

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

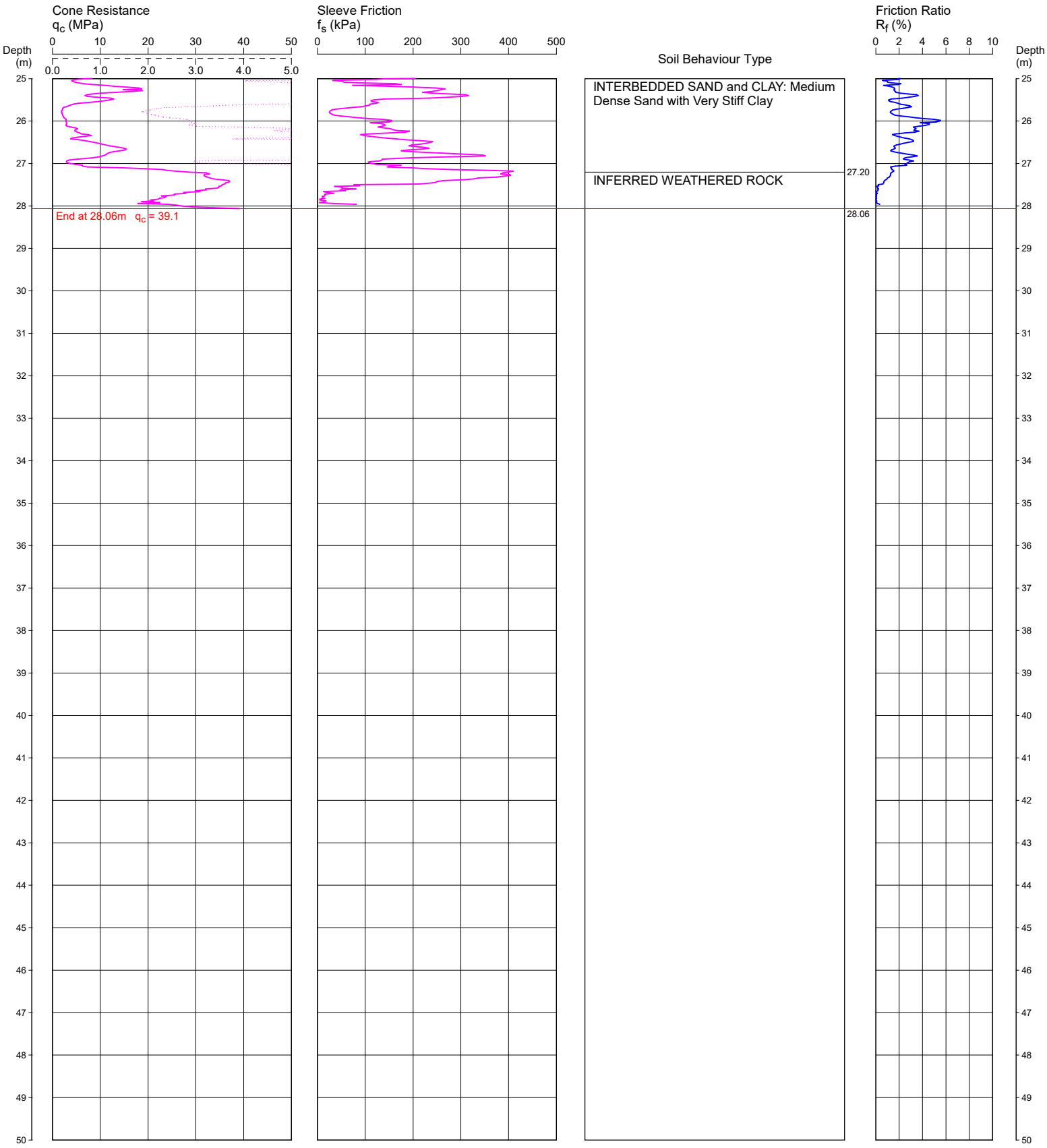
REDUCED LEVEL: 2.9 AHD

COORDINATES: 342213.9E 6270007.2N

CPT4

DATE 15/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE BENDING NEAR REFUSAL
GROUNDWATER MEASURED AT 2.2m AFTER REMOVAL OF RODS

Water depth after test: 2.20m depth (measured)

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT4.CP5

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

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

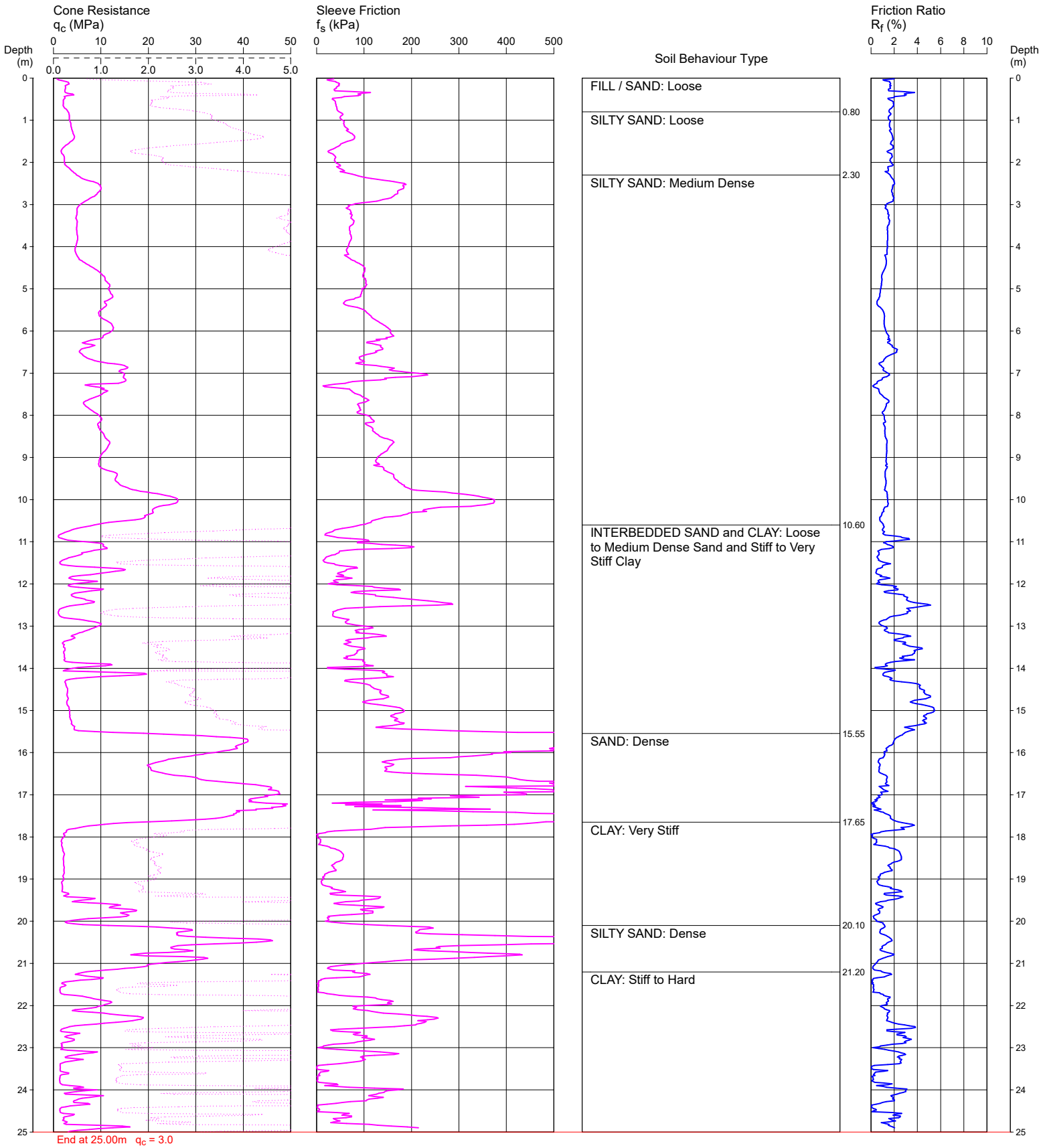
REDUCED LEVEL: 4.7 AHD

COORDINATES: 342193.8E 6269948.2N

CPT5

DATE 16/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH
HOLE COLLAPSE MEASURED AT 2.0m AFTER REMOVAL OF RODS

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT5.CP5
Cone ID: 170707 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

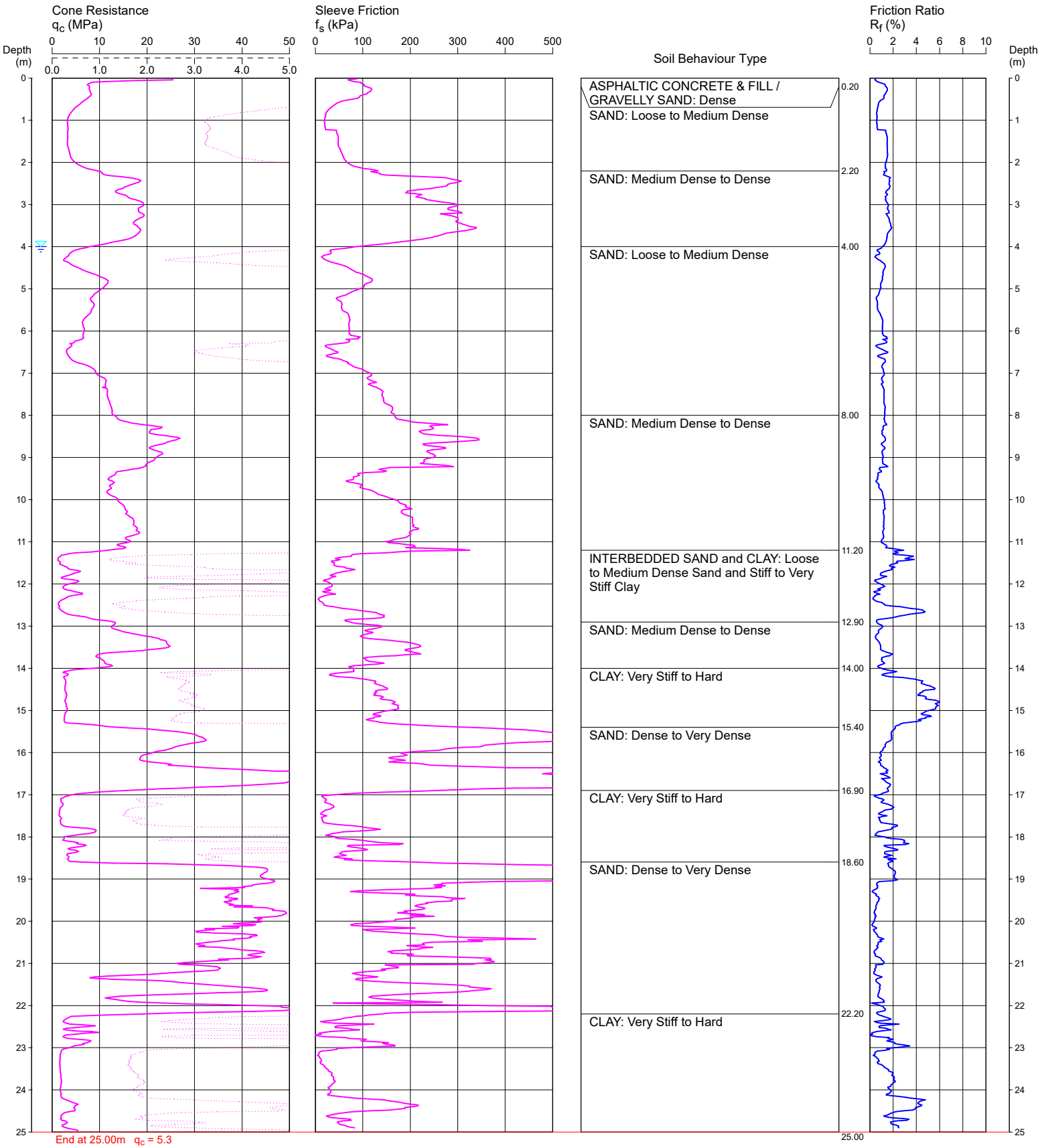
REDUCED LEVEL: 4.7 AHD

COORDINATES: 342195.8E 6269907.2N

CPT6

DATE 16/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED AT TARGET DEPTH
GROUNDWATER MEASURED AT 4.0m AFTER REMOVAL OF RODS

Water depth after test: 4.00m depth (measured)

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT6.CP5

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

ConePlot Version 5.9.2

Douglas Partners
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CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

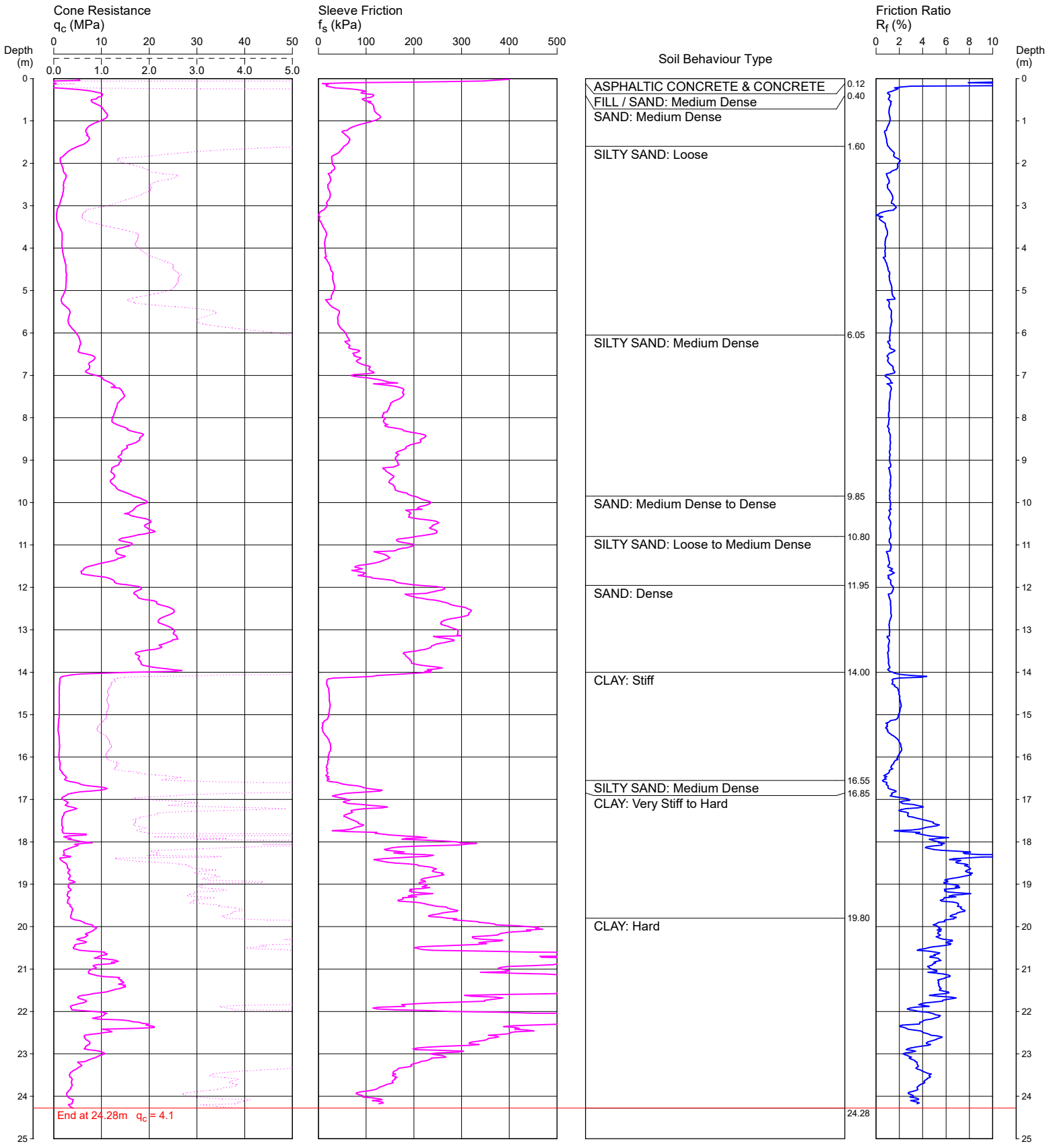
REDUCED LEVEL: 1.9 AHD

COORDINATES: 342186.3E 6269783.0N

CPT103

DATE 14/01/2020

PROJECT No: 86973



REMARKS: DUMMY CONE TO 0.3m TO PENETRATE PAVEMENT; TEST DISCONTINUED DUE TO EXCESSIVE ROD BOWING
HOLE COLLAPSE MEASURED AT 1.3m AFTER REMOVAL OF RODS

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT103.CP5
Cone ID: 160626 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

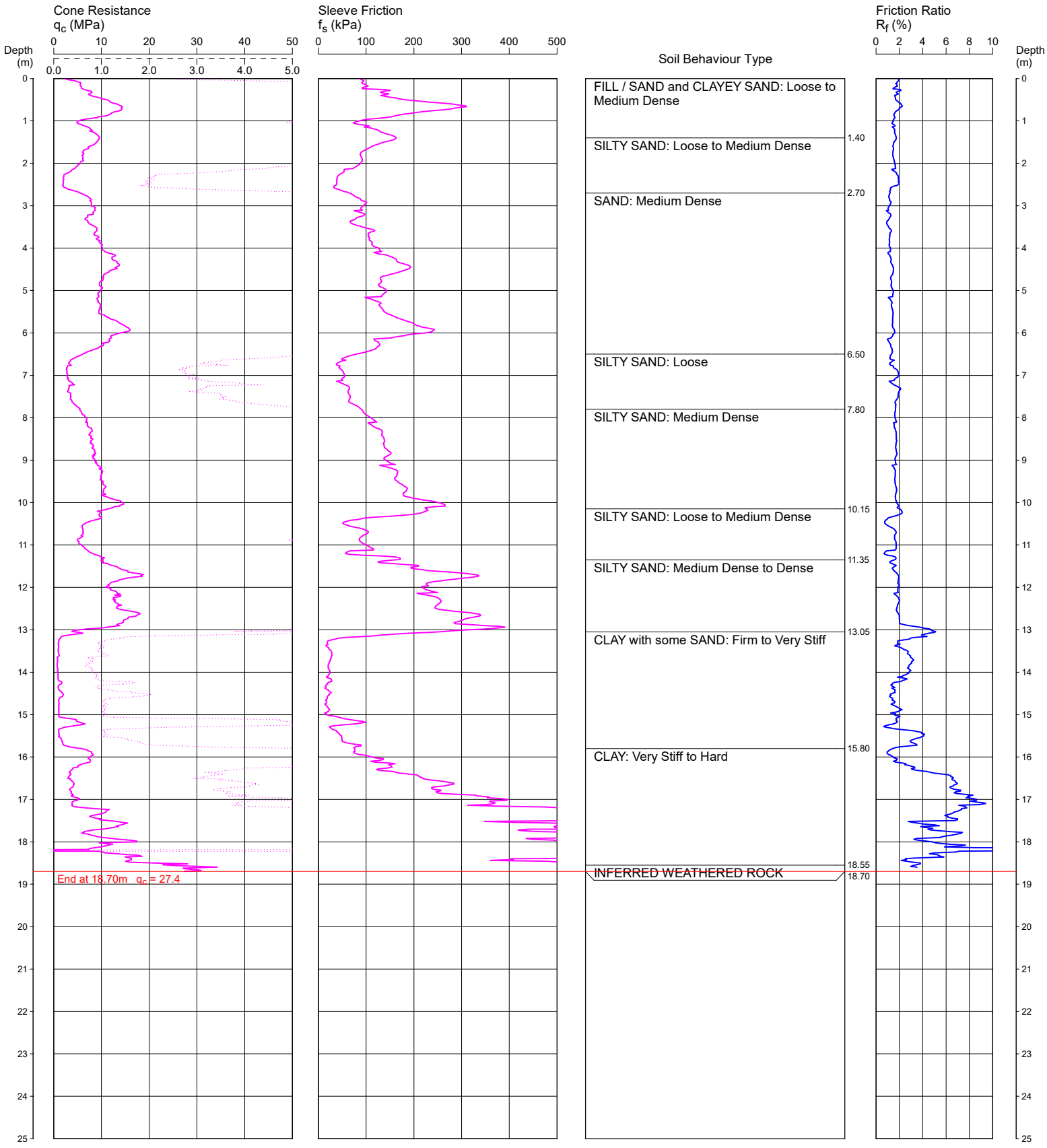
REDUCED LEVEL: 2.3 AHD

COORDINATES: 342153.3E 6269733.5N

CPT104

DATE 14/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE ROD BOWING NEAR REFUSAL
HOLE COLLAPSE MEASURED AT 0.5m AFTER REMOVAL OF RODS

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT104.CP5
Cone ID: 161225 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: NSW DEPARTMENT OF EDUCATION

PROJECT: NARRABEEN EDUCATION PRECINCT

LOCATION: NORTH NARRABEEN, NAMONA STREET

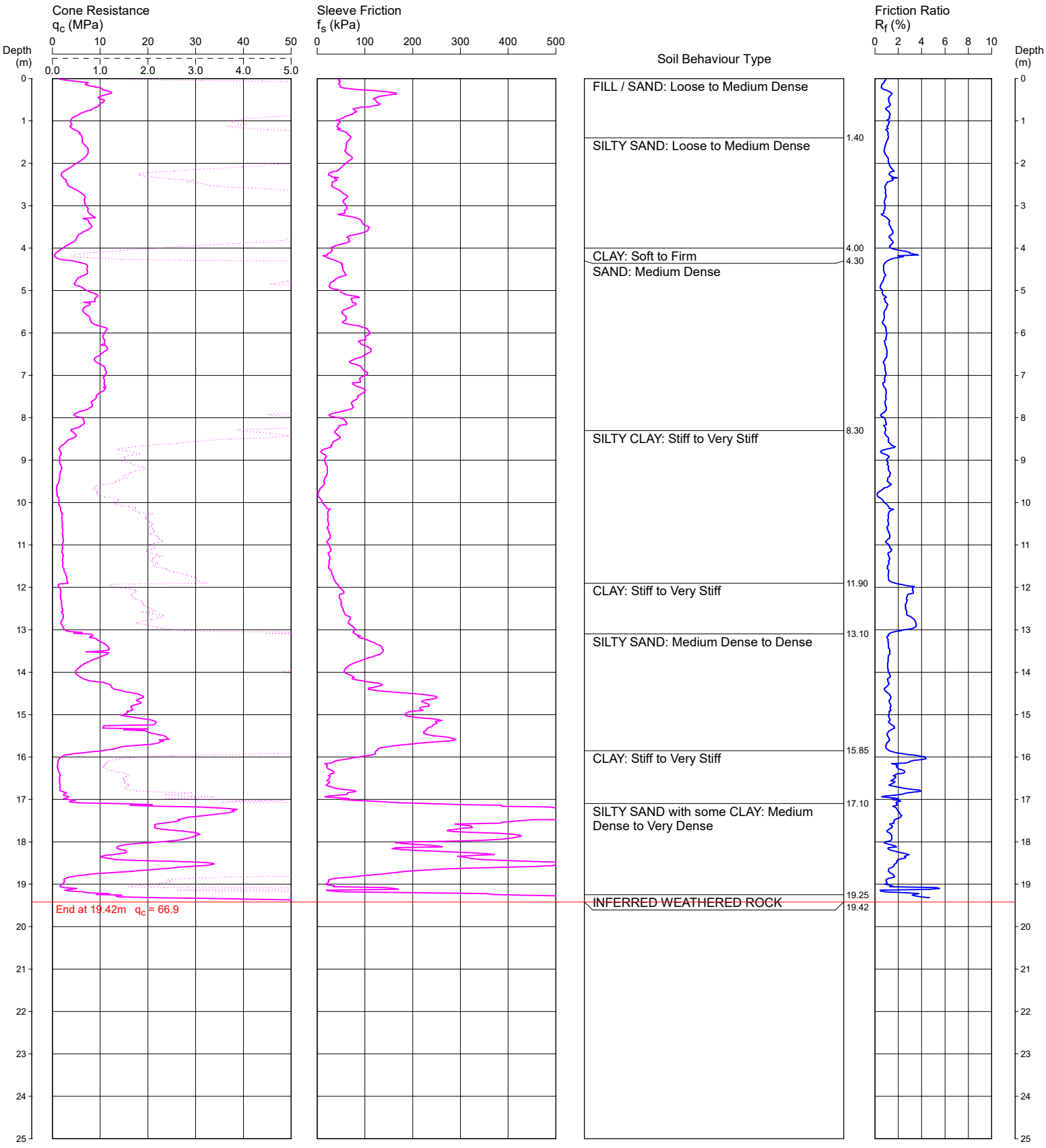
REDUCED LEVEL: 2.2 AHD

COORDINATES: 342146.9E 6269682.5N

CPT105

DATE 14/01/2020

PROJECT No: 86973



REMARKS: TEST DISCONTINUED DUE TO CONE TIP REFUSAL
HOLE COLLAPSE MEASURED AT 1.7m AFTER REMOVAL OF RODS

File: P:\86973.00 - NARRABEEN, Public and High School, Geo\4.0 Field Work\4.2 Testing\CPT105.CP5
Cone ID: 161225 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 2.2 AHD
EASTING: 342153.7
NORTHING: 6269726.5

PIT No: TP207
PROJECT No: 86973.05
DATE: 20/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	FILL/Silty SAND: fine to medium, dark brown, trace rootlets, moist		E*	0.0		PID < 1 ppm		
	0.2	FILL/SAND: fine to medium, brown, trace brick and plastic fragments, moist			0.2				
				E	0.4		PID < 1 ppm		
					0.5				
				E	0.9		PID < 1 ppm		
					1.0				
	1.2	SAND SP: fine to medium, pale grey, trace silt, moist, alluvial and estuarine						▼	
		Below 1.3 m: wet		E	1.4		PID < 1 ppm		
					1.5				
		Below 1.7 m: dark grey, sulfuric odour		E	1.9		PID < 1 ppm		
					2.0				
				E	2.4				
	2.5	Pit discontinued at 2.5m Test pit collapse			2.5				

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Groundwater observed at 1.3 m.

REMARKS: Location coordinates are in MGA Zone 56. Coordinates and levels obtained via DGPS. *Blind replicate BD15/20220420 taken from 0-0.2 m.

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.2 AHD
EASTING: 342193.1
NORTHING: 6269969.1

PIT No: TP1001
PROJECT No: 86973.05
DATE: 13/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
4	0.0	FILL/Silty SAND: fine to medium, grey-brown, trace charcoal and asphalt fragments, moist		E	0.0		PID < 1 ppm		
	0.2				0.2				
3	0.3	Pit discontinued at 0.3m Possible service encountered							
2	1								1
1	2								2
0	3								3
	4								4

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

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA Zone 56. Coordinates and levels obtained via DGPS.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.1 AHD
EASTING: 342188.6
NORTHING: 6269974

PIT No: TP1001A
PROJECT No: 86973.05
DATE: 19/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
					0.0		PID < 1 ppm		
		FILL/Silty SAND: fine to medium, brown, with organics, trace rootlets, moist		E*					
	0.2				0.2		PID < 1 ppm		
		FILL/SAND: fine to medium, grey-brown, trace clay, brick, tile, plastic, concrete and asbestos-containing fibre cement sheet fragments, moist		E	0.3				
					0.8		PID < 1 ppm		
	0.9			E	0.9				
		SAND SP: fine to medium, pale grey, with nodules of indurated brown sand, silt and clay (coffee rock), moist, alluvial and estuarine							
		Below 1.1 m: brown, with silt, trace clay			1.3		PID < 1 ppm		
				E	1.4				
					1.8		PID < 1 ppm		
				E	1.9				
		Below 2.1 m: wet						▼	
				E	2.2				
	2.3	Pit discontinued at 2.3m			2.3				
		Test pit collapse							

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Groundwater observed at 2.1 m.

REMARKS: Location coordinates are in MGA Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey. *Blind replicate BD10/20220419 taken from 0-0.2 m.

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.7 AHD
EASTING: 342186.9
NORTHING: 6269942.3

PIT No: TP1003
PROJECT No: 86973.05
DATE: 13/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	FILL/Silty SAND: fine to medium, grey-brown, trace charcoal, moist		E	0.0		PID < 1 ppm		
	0.2	FILL/Silty SAND: fine to medium, grey-brown, moist		E	0.2 0.3 0.4		PID < 1 ppm		
	0.5	SAND SP: fine to medium, pale grey, trace silt, moist, alluvial and estuarine		E	0.7 0.8		PID < 1 ppm		
		Below 0.9 m: with nodules of indurated brown sand, silt and clay (coffee rock)		E*	1.1 1.2		PID < 1 ppm		
	1.4	Pit discontinued at 1.4m Target depth reached							

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA Zone 56. Coordinates and levels obtained via DGPS. *Blind replicate BD1/20220413 taken from 1.1-1.2 m.

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.3 AHD
EASTING: 342175.1
NORTHING: 6269928

PIT No: TP1005
PROJECT No:86973.05
DATE: 13/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
									5 10 15 20
		FILL/Silty SAND: fine to medium, grey-brown, trace rootlets, moist		E	0.0		PID < 1 ppm		
	0.2	SAND SP: fine to medium, pale grey, trace silt, moist, alluvial and estuarine			0.2				
				E	0.5		PID < 1 ppm		
					0.6				
	1			E	1.0		PID < 1 ppm		1
					1.1				
				E	1.5				
					1.6				
	2			E	2.0				2
	2.1	Pit discontinued at 2.1m Test pit collapse			2.1				
	3								3
	4								4

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA Zone 56. Coordinates and levels obtained via DGPS.

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.0 AHD
EASTING: 342176.3
NORTHING: 6269912.9

PIT No: TP1007
PROJECT No: 86973.05
DATE: 13/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
									5 10 15 20
		FILL/Silty SAND: fine to medium, dark brown, with roots and rootlets, trace plastic fragments, moist		E	0.0		PID < 1 ppm		
					0.2				
	0.3	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine							
		Below 0.5 m: pale grey, reducing silt		E	0.5		PID < 1 ppm		
					0.6				
	1			E	1.0		PID < 1 ppm		1
					1.1				
	1.5	Pit discontinued at 1.5m Target depth reached							
	2								2
	3								3
	4								4

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey.

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 3.0 AHD
EASTING: 342178
NORTHING: 6269895.4

PIT No: TP1008
PROJECT No: 86973.05
DATE: 13/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
									5 10 15 20
		FILL/Silty SAND: fine to medium, dark brown, with roots and rootlets, moist		E	0.0		PID < 1 ppm		
					0.2				
	0.3	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine							
				E	0.5		PID < 1 ppm		
					0.6				
	1	Below 0.9 m: with nodules of indurated brown sand, silt and clay (coffee rock)		E	1.0		PID < 1 ppm		1
					1.1				
		Below 1.4 m: wet						▼	
				E	1.5				
					1.6				
	2			E	2.0				2
					2.1				
				E	2.5				
	2.6	Pit discontinued at 2.6m Test pit collapse			2.6				
	3								3
	4								4

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Groundwater observed at 1.4 m.

REMARKS: Location coordinates are in MGA Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey.

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.2 AHD
EASTING: 342245.1
NORTHING: 6269856.7

PIT No: TP1017
PROJECT No: 86973.05
DATE: 14/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	FILL/Silty SAND: fine to medium, brown, trace clay, rootlets and terracotta fragment, moist		E	0.0		PID < 1 ppm		
	0.2	FILL/Silty SAND: fine to medium, dark grey-brown, trace rootlets, moist			0.2				
				E	0.4		PID < 1 ppm		
	0.6	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine			0.5				
				E	0.9		PID < 1 ppm		
					1.0				
				E*	1.4		PID < 1 ppm		
	1.5	Pit discontinued at 1.5m Target depth reached			1.5				

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey. *Blind replicate BD8/20220414 taken from 1.4-1.5 m.

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.0 AHD
EASTING: 342256.8
NORTHING: 6269842.9

PIT No: TP1018
PROJECT No: 86973.05
DATE: 14/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
									5 10 15 20
		FILL/Silty SAND: fine to medium, dark brown, trace rootlets, moist		E*	0.0		PID < 1 ppm		
					0.2				
	0.3	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine							
				E	0.5		PID < 1 ppm		
					0.6				
		Below 0.8 m: pale grey							
3	1			E	1.0		PID < 1 ppm		1
					1.1				
		Below 1.2 m: trace nodules of indurated brown sand, silt and clay (coffee rock)							
				E	1.5				
					1.6				
2	2			E	2.0				2
	2.1	Pit discontinued at 2.1m			2.1				
		Test pit collapse							
1	3								3
0	4								4

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA Zone 56. Coordinates obtained via DGPS. Approximate levels inferred from provided survey. *Blind replicate BD9/20220414 taken from 0-0.2 m.

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.0 AHD
EASTING: 342172.1
NORTHING: 6269921.1

PIT No: TP1019
PROJECT No: 86973.05
DATE: 19/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.0	FILL/Silty SAND: fine to medium, brown, with organics, trace rootlets, glass, brick, terracotta, concrete and plastic fragments, moist		E	0.0		PID < 1 ppm		
	0.2	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine			0.2				
				E	0.3		PID < 1 ppm		
		Below 0.6 m: pale grey			0.4				
				E	0.9		PID < 1 ppm		
	1.0	Pit discontinued at 1.0m Target depth reached			1.0				

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA Zone 56. Approximate levels inferred from provided survey.

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: NSW Department of Education
PROJECT: Proposed School Upgrade
LOCATION: Namona Street, North Narrabeen

SURFACE LEVEL: 4.0 AHD
EASTING: 342180.1
NORTHING: 6269905.5

PIT No: TP1020
PROJECT No: 86973.05
DATE: 19/4/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.0	FILL/Silty SAND: fine to medium, brown, with organics, trace rootlets, moist		E	0.0		PID < 1 ppm		
	0.2	FILL/SAND: fine to medium, with silt, grey-brown, trace gravel, rootlets and slag, moist			0.2				
				E	0.4		PID < 1 ppm		
					0.5				
	0.7	SAND SP: fine to medium, grey, trace silt, moist, alluvial and estuarine							
				E	0.9		PID < 1 ppm		
	1				1.0				1
				E*	1.4		PID < 1 ppm		
	1.5	Pit discontinued at 1.5m Target depth reached			1.5				
	2								2
	3								3
	4								4

RIG: 5 Tonne Excavator with 300 mm wide bucket

LOGGED: HD

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA Zone 56. Approximate levels inferred from provided survey. *Blind replicate BD11/20220419 taken from 1.4-1.5 m.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix D

Laboratory Test Results

Material Test Report

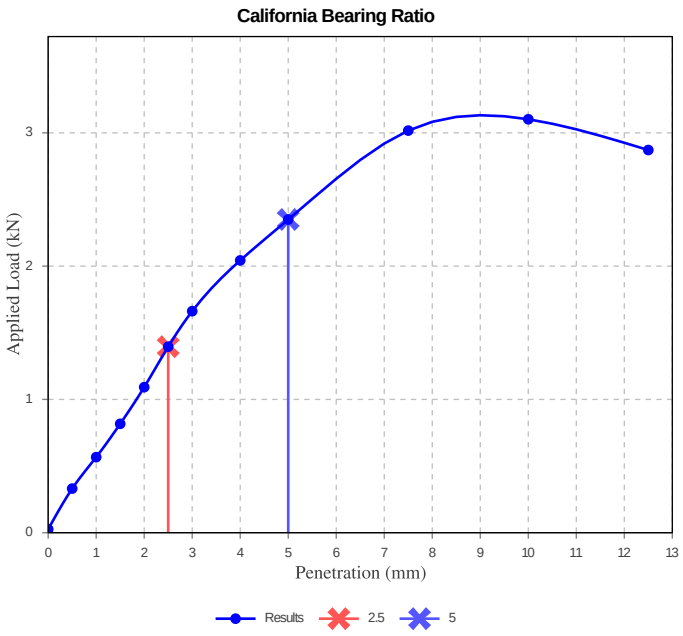
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: norman.weimann@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Norman Weimann
dp-norman.weimann
NATA Accredited Laboratory Number: 828

Report Number: **86973.00-1**
Issue Number: 2 - *This version supersedes all previous issues*
Reissue Reason: *Include PI report*
Date Issued: 19/02/2020
Client: School Infrastructure NSW/ Department of Education
10 Coral Crescent, Gateshead NSW 2325
Contact: Claudia Nolte
Project Number: 86973.00
Project Name: Narrabeen Education Precinct
Project Location: Namona St, North Narrabeen
Work Request: 5522
Sample Number: SY-5522A
Date Sampled: 20/01/2020
Dates Tested: 31/01/2020 - 11/02/2020
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH102 (0.5-1.0)**
Material: FILL/SAND: pale brown

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**12**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.63		
Optimum Moisture Content (%)	10.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	97.0		
Dry Density after Soaking (t/m^3)	1.64		
Field Moisture Content (%)	2.4		
Moisture Content at Placement (%)	9.9		
Moisture Content Top 30mm (%)	18.8		
Moisture Content Rest of Sample (%)	19.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	2		
Swell (%)	-0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)			



Material Test Report

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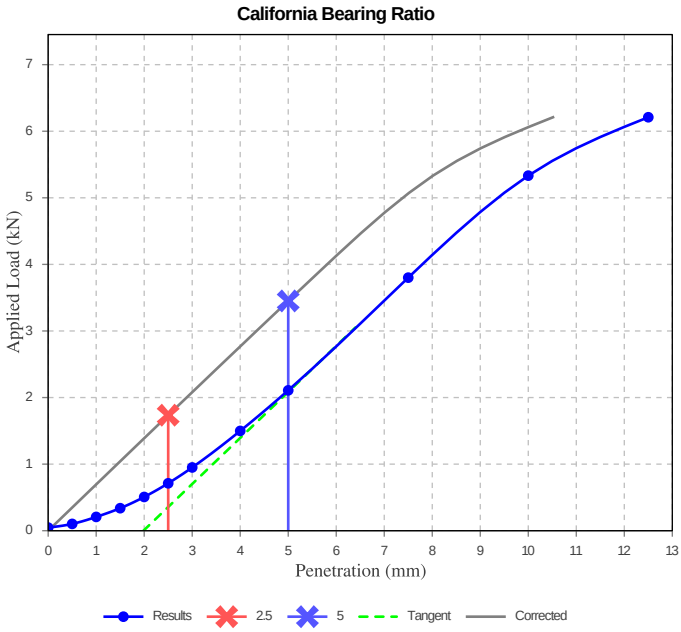
Date Issued: 19/02/2020
Client: School Infrastructure NSW/ Department of Education
10 Coral Crescent, Gateshead NSW 2325
Contact: Claudia Nolte
Project Number: 86973.00
Project Name: Narrabeen Education Precinct
Project Location: Namona St, North Narrabeen
Work Request: 5522
Sample Number: SY-5522B
Date Sampled: 20/01/2020
Dates Tested: 31/01/2020 - 11/02/2020
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH9 (0.2-0.8m)**
Material: FILL/Silty SAND: dark grey

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**17**		
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)	1.59		
Optimum Moisture Content (%)	17.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.59		
Field Moisture Content (%)	9.8		
Moisture Content at Placement (%)	17.4		
Moisture Content Top 30mm (%)	20.4		
Moisture Content Rest of Sample (%)	19.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	2		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)			



Material Test Report

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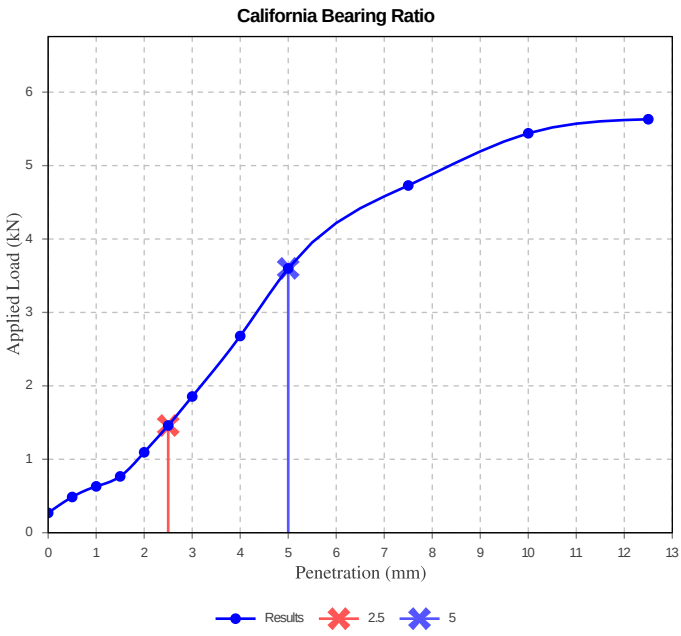
10 Coral Crescent, Gateshead NSW 2325
Contact: Claudia Nolte
Project Number: 86973.00
Project Name: Narrabeen Education Precinct
Project Location: Namona St, North Narrabeen
Work Request: 5522
Sample Number: SY-5522C
Date Sampled: 20/01/2020
Dates Tested: 31/01/2020 - 11/02/2020
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH11 (0.6-1.0m)**
Material: FILL/SILTY SAND: grey

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**18**		
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)	1.59		
Optimum Moisture Content (%)	15.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.59		
Field Moisture Content (%)			
Moisture Content at Placement (%)	15.6		
Moisture Content Top 30mm (%)	21.0		
Moisture Content Rest of Sample (%)	19.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	2		
Swell (%)	-0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)			



Material Test Report

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Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

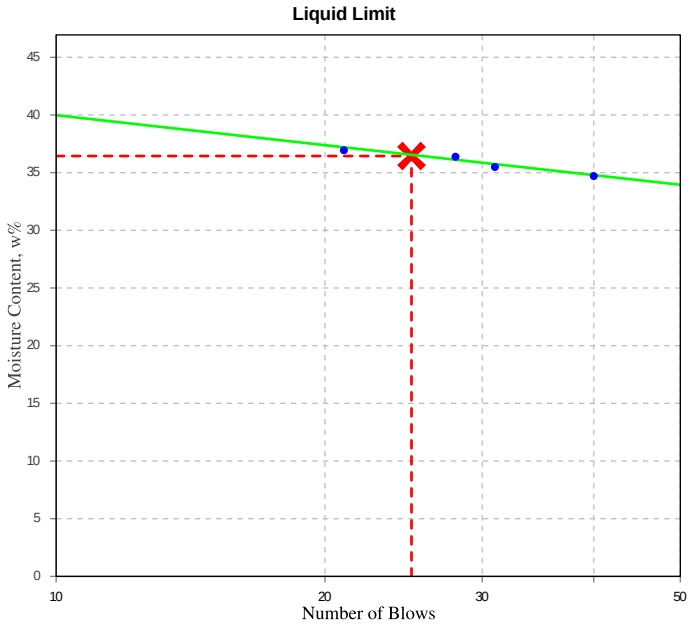
Approved Signatory: Norman Weimann
dp-norman.weimann
NATA Accredited Laboratory Number: 828

Report Number: **86973.00-1**
Issue Number: 2 - *This version supersedes all previous issues*
Reissue Reason: *Include PI report*
Date Issued: 19/02/2020
Client: School Infrastructure NSW/ Department of Education
10 Coral Crescent, Gateshead NSW 2325
Contact: Claudia Nolte
Project Number: 86973.00
Project Name: Narrabeen Education Precinct
Project Location: Namona St, North Narrabeen
Work Request: 5522
Sample Number: SY-5522D
Date Sampled: 20/01/2020
Dates Tested: 31/01/2020 - 10/02/2020
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH106 (0.9-1.0m)**
Material: FILL/Sandy CLAY:mottled yellow-brown, red and pale brown

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	36		
Plastic Limit (%)	17		
Plasticity Index (%)	**19**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	9.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	17.5



Envirolab Services Pty Ltd
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ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 235584-A

Client Details

Client	Douglas Partners Pty Ltd
Attention	Matthew Bennett
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86973.00, Narrabeen**
Number of Samples	39 Soil
Date samples received	29/01/2020
Date completed instructions received	31/01/2020

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	07/02/2020
Date of Issue	07/02/2020

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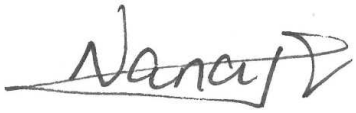
Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		235584-A-4	235584-A-6	235584-A-8	235584-A-16	235584-A-24
Your Reference	UNITS	BH4/0.9-1.0	BH4/2.4-2.5	BH4/4.5-5.0	BH9/0.4-0.5	BH9/4.5-5.0
Date Sampled		21/01/2020	21/01/2020	21/01/2020	22/01/2020	22/01/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	05/02/2020	05/02/2020	05/02/2020	05/02/2020	05/02/2020
Date analysed	-	05/02/2020	05/02/2020	05/02/2020	05/02/2020	05/02/2020
pH 1:5 soil:water	pH Units	8.0	6.8	6.2	4.1	5.7
Electrical Conductivity 1:5 soil:water	µS/cm	8	20	42	52	17
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	<10	25	<10	<10

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: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			05/02/2020	[NT]	[NT]	[NT]	[NT]	05/02/2020	[NT]
Date analysed	-			05/02/2020	[NT]	[NT]	[NT]	[NT]	05/02/2020	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	87	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	99	[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.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

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.

Envirolab Services Pty Ltd
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12 Ashley St Chatswood NSW 2067
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customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 235573-A

Client Details

Client	Douglas Partners Pty Ltd
Attention	Matthew Bennett
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86973.00, Narrabeen**
Number of Samples	51 Soil, 1 Material
Date samples received	29/01/2020
Date completed instructions received	31/01/2020

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.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	07/02/2020
Date of Issue	06/02/2020

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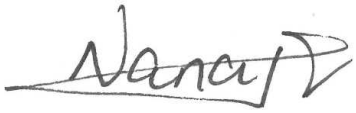
Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		235573-A-10	235573-A-13	235573-A-16	235573-A-31	235573-A-34
Your Reference	UNITS	BH104/0.4-0.5	BH104/2.4-2.5	BH104/5.5-6.0	BH111/1.4-1.5	BH111/4.0-4.5
Date Sampled		20/01/2020	21/01/2020	21/01/2020	20/01/2020	20/01/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	05/02/2020	05/02/2020	05/02/2020	05/02/2020	05/02/2020
Date analysed	-	05/02/2020	05/02/2020	05/02/2020	05/02/2020	05/02/2020
pH 1:5 soil:water	pH Units	8.7	8.1	9.1	8.7	9.1
Electrical Conductivity 1:5 soil:water	µS/cm	79	26	97	77	130
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	10	40	<10	65

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: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			05/02/2020	31	05/02/2020	05/02/2020		05/02/2020	[NT]
Date analysed	-			05/02/2020	31	05/02/2020	05/02/2020		05/02/2020	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	31	8.7	8.7	0	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	31	77	82	6	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	31	<10	<10	0	87	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	31	<10	<10	0	99	[NT]

Result Definitions

NT	Not tested
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INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
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The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

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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.

Report Comments

pH#
Samples were out of the recommended holding time for this analysis.