REPORT TO

NSW DEPARTMENT OF EDUCATION

ON

SUPPLEMENTARY GEOTECHNICAL INVESTIGATION

FOR

NEW PRIMARY SCHOOL IN MULGOA RISE

AT

1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Date: 29 July 2021

Ref: 33177PN2rpt rev1

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ATTACHMENTS

STS Table A1: Moisture Content Test Report
STS Table B1: Shrink – Swell Test Report
STS Table C: Point Load Strength Index Test Report
Envirolab Services Certificate of Analysis No. 253067
Borehole Logs 101 to 104 Inclusive (With Core Photographs)
Cone Penetrometer Test Results Sheets CPT105 to CPT118 Inclusive
Figure 1: Site Location Plan
Figure 2: Investigation Location Plan
Vibration Emission Design Goals
Report Explanation Notes
Appendix A: Laboratory Test Results and Borehole Logs from Previous Investigation
Appendix B: GBG Australia Report, Job No. GBGA2383 dated 3 November 2020

1 INTRODUCTION

This report presents the results of a supplementary geotechnical investigation for the new primary school in Mulgoa Rise at 1-23 Forestwood Drive, Glenmore Park, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by email from Mr Max Shahin of School Infrastructure NSW by email dated 22 September 2020. The commission was on the basis of our proposal (Ref: EP52030P-P52030PN Rev1) dated 16 June 2020.

JK Geotechnics (JKG) have previously completed a preliminary investigation at the site the results of which were presented in our report (Ref: 33177PNrpt) dated 3 June 2020. The laboratory test results and borehole logs from our previous investigations are attached to this report as Appendix A. This report supersedes our previous report.

From the provided architectural drawing (Dwg Ref. 20415-NBRS-DR-A-SSDA-0110 Rev5 dated 14 July 2021) prepared by NBRS Architecture, correspondence with representatives of Richard Crookes Constructions, and discussions with Mr Kevin Christesen of Woollacotts, we understand the proposed school development will include the following:

- A 2 storey administration and library building in the north-west corner of the site.
- Two classroom blocks of two stories, located to the east of the administration building.
- A single storey hall, located towards the north-east corner of the site.
- A two level walkway linking the administration block and classroom buildings.
- An on-grade carpark at the eastern end of the site.
- A Covered Outdoor Learning Area (COLA)
- Associated playground and landscaping works.

For all of the buildings concrete and masonry construction is envisaged.

A future development comprising three additional classroom buildings may also be completed at a later date over the southern half of the site.

The purpose of the supplementary investigation was to obtain additional information on the previously identified deep fill profile, and the underlying bedrock, as a basis for providing comments and recommendations on geotechnical aspects of the proposed works including the suitability of the deep fill to support the proposed buildings, site preparation and earthworks, footing design, on-grade floor slabs, and pavement design.

This geotechnical investigation was carried out in conjunction with a detailed site investigation and salinity assessment by our environmental division, JK Environments (JKE). Reference should be made to the separate reports by JKE, Ref: E33177Prpt3-DSI and E33177Prpt4rev1-SAL, for the results of the JKE works.

2 INVESTIGATION PROCEDURE

A specialist sub-consultant, GBG Australia Pty Ltd (GBG), was engaged to completed geophysical testing along four nominated section lines using Multi-channel Analysis of Surface Waves (MASW) techniques. The purpose of the geophysical testing was to identify the depth to 'competent' rock, and to check for anomalies, e.g. low density zones or inclusions, within the fill profile. Additional details on the testing methodology and the results of the testing are presented in the GBG report which is attached as Appendix B.

Four boreholes (BH101 to BH104) were drilled to depths ranging between 12.13m (BH103) and 15.03m (BH104), respectively, using spiral auger and rotary washboring techniques with our truck-mounted JK500 and track-mounted JK300 drill rigs. All four boreholes were subsequently extended to depths between 18.04m (BH103) and 21.16m (BH104) using rotary diamond coring techniques with water flush.

Fourteen Cone Penetrometer Tests (CPT105 to CPT118) were completed to refusal at depths between 10.66m (CPT116) and 14.50m (CPT111) using our specialist truck-mounted CPT rig. We note that CPT equipment does not provide sample recovery, it does however, provide a continuous record of the resistance of the tip and sleeve of the probe as it is pushed into the ground at a constant rate. The subsurface material identification, including material strength/relative density, is by interpretation of the test plots based on nearby borehole information and empirical correlations. We note that at several locations, multiple CPTs were completed due to premature refusal of the probe at shallower than expected depths. Only the final tests, which appeared to fully penetrate the fill profile have been attached.

The compaction of the fill was assessed from the results of Standard Penetration Tests (SPTs) completed in the boreholes, and interpretation of the CPT results.

The strength of the augered bedrock was assessed from observation of the drilling resistance of a tungsten carbide (TC) drill bit attached to the augers, tactile examination of recovered rock chips, and correlation with the results of subsequent laboratory moisture content tests. We note that the assessment of strength in this manner is approximate and variation by about one order of strength should not be unexpected. The strength of the bedrock in the cored portion of the boreholes was assessed from examination of the recovered rock core and the results of subsequent laboratory Point Load Strength Index ($I_{S(50)}$) tests.

Groundwater observations were made during and on completion of drilling each borehole.

The borehole and CPT locations, as shown on the attached Test Location Plan (Figure 2) were set out using a Sokkia GCX3 GNSS GPS surveying unit. The ground surface reduced levels are shown on the top of the borehole logs and CPT test results sheets (the accuracy is generally taken as a +/-50mm horizontally and vertically). The datum of the level is Australian Height Datum (AHD). Figure 2 is based on the supplied Concept Design drawing.

Our geotechnical engineers were present full-time during the fieldwork to set out the test locations, direct the CPT testing, nominate the testing and sampling, and prepare the borehole logs. The borehole logs, with core photographs, and the interpreted CPT test results sheets, are attached to this report along, with our

Report Explanation Notes which describe the investigation techniques adopted and define the logging terms and symbols used.

Selected soil and rock core samples were returned to Soil Test Services Pty Ltd (STS) and Envirolab Services Pty Ltd (both of which are NATA accredited laboratories), for moisture content, shrink-swell index, soil pH, chloride content, sulfate content, resistivity and Point Load Strength Index testing. The results of the testing are presented on the attached STS Tables A1, B1 and C, and Envirolab 'Certificate of Analysis 253067'. The results of the Point Load Strength Index testing are also plotted on the cored borehole logs.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The site is situated within a predominantly residential area, in gentle hill terrain characterised by maximum surface gradients of about 5°. The site was bound by Deerubbin Drive to the north, Darug Avenue to the west and Forestwood Drive to the south.

At the time of the fieldwork, the entire site was grass covered with no improvements. The side graded to the north-east at about 2° overall with gentle undulations. Small trees were located within the footpath reserves to the north, west and south.

To the east of the site was an asphaltic concrete surfaced carpark and grassed playing fields.

3.2 Subsurface Conditions

The 1:100,000 geological map of Penrith (Geological Survey of NSW, Geological Series Sheet 9030) indicates that the site is underlain by Minchinbury Sandstone of the Wianamatta Group, but is close to the interface with the overlying Quaternary fluvial soils comprising gravel, sand silt and clay. The map also indicates the presence of volcanic intrusions in the vicinity of the site.

For details of the encountered subsurface profile, reference should be to the attached borehole logs, CPT test results sheets, Appendix A and Appendix B.

Fill

Fill comprising silty clay with varying proportions of gravel was encountered from surface at all of the borehole and CPT locations. In the boreholes, the fill extended to depths between 11.2m (BH103) and 14.1m (BH104), and all of the CPTs were terminated within or at the base of the fill profile at depths between 10.66m and 14.5m. The gravel in the fill predominantly comprised siltstone but sandstone gravel was also encountered. Traces of ash and brick fragments were found locally, within the upper portion of the fill profile (above 5.5m depth in BH101 and BH102).

Based on the shallow refusal of a number of CPT tests, and the results of the MASW testing indicating 'pockets' of higher density material within the fill profile, larger inclusions, e.g. cobbles and boulders, are likely to be present within the fill profile.

Based on the SPT and CPT results, the fill was assessed to be predominantly moderately or well compacted, however, pocket or layers of fill were assessed to be poorly to moderately compacted such as in CPT106 (2.1m to 2.8m depth) and CPT107 (2.85m to 4.3m depth). We note that the assessment of the compaction of fill with gravel and larger particles present can be very difficult due to scale effects, and additional zones of poorly compacted fill may be present.

Bedrock

Bedrock comprising siltstone, sandstone and laminite (thinly interbedded siltstone and sandstone) was encountered below the fill in all four boreholes from our current investigation, at depths between 11.2m (BH103) and 14.1m (BH104). From first contact, the bedrock was slightly weathered or fresh, and was predominantly of medium or high strength, however, lower strength bands were also encountered, including some thick extremely weathered seams and the GBG Australia geophysical results. Contours of the inferred RL of the bedrock surface from the boreholes and CPTs are shown on the attached Figure 2.

Based on refusal of the CPT probe, bedrock was further inferred at depths between 11.45m (CPT109) and 14.5m (CPT111). Where the CPT refused at depths above 11.45m, it is considered to have most likely refused prematurely on obstructions within the fill, as is the refusal of CPT105 (11.69m) and CPT113 (11.75m), based on poor correlation with bedrock levels from nearby boreholes.

Groundwater

Within the boreholes, groundwater seepage was encountered during auger drilling at depths between 3.8m (BH101) and 9.0m (BH103). On completion of auger drilling and CPT testing, standing groundwater was recorded at depths between 1.3m (CPT105) and 5.0m (BH103) within the boreholes and CPT holes. The standing groundwater level within CPT110 was recorded at a depth of 2.3m approximately 24 hours after completion of the test. We note that groundwater levels may not have stabilised over the relatively short observation period.

3.3 Laboratory Test Results

The results of the moisture content tests did not indicate any areas of elevated moisture contents in the fill profile, and correlated well with the field assessment of the bedrock strength. The results of the previous Atterberg limits testing confirmed the near surface clayey fill from BH4, BH16 and BH20 to be of medium plasticity. The linear shrinkage tests on the same soils indicated these to be moderately reactive to moisture content change.

The results of the shrink-swell tests completed during this investigation returned Shrink Swell Index values of between 1.04%/pF and 1.99%/pF for the near surface fill materials from BH101 to BH104.

The results of the previous four day soaked CBR tests returned CBR values of between 1.5% and 6% on the bulk samples from BH4, BH6, BH16 and BH20 when compacted to 98% of their respective Standard Maximum Dry Density (SMDD) at close to their respective Standard Optimum Moisture Content (SOMC). The samples swelled by between 1.5% and 3% during soaking, which also indicates the soils are reactive to moisture content change. The in-situ moisture content of the soils ranged from 2.4% 'dry' to 1.1% 'wet" of SOMC.

The results of the Point Load Strength Index tests correlated well with our field assessment of the in-situ bedrock strength.
The results of the previous and current Envirolab testing indicated the soils to be moderately alkaline with low chloride and sulfate content, and moderate resistivity.

4 COMMENTS AND RECOMMENDATIONS

4.1 Site History

Review of available historical aerial imagery, as referenced in the JKE report, indicates that between about 1986 and 2000 quarrying and subsequent filling operations were completed at the subject site, as well as in the surrounding area. Records detailing the depth of quarrying below original surface levels and height of fill above base of quarry level have not been made available to us. Furthermore, it is not known if there are any buried quarry faces below the site or if the base of the quarry was 'level' below the site.

4.2 Existing Fill

The boreholes and CPTs encountered fill to depths between 11.2m (BH103) and 14.5m (BH101 and CPT111) below existing surface levels, at which depths bedrock was encountered (borehole) or inferred (CPTs).

Based on the results of the CPTs, SPTs in the boreholes, and geophysical testing, the fill was predominantly assessed as being well compacted, with the possible exception of the noted 'pockets' in CPT106 and CPT107.

We have also reviewed the provided results of in-situ density testing for the upper, approximately, 1m to 2m of the fill profile, which was completed in 2012. The results of these tests returned in-situ density values of between 95% and 103.5% of SMDD at between 4% 'dry' to 2.5% 'wet' and SOMC. For clayey fill to support buildings, we normally recommend compaction to between 98% and 102% of SMDD at a moisture content within 2% of SOMC. The intention of this compaction specification is to limit the potential for both future consolidation of the fill, and avoid excessive swell movements which can occur when a clayey fill is over-compacted dry of SOMC. No compaction records have been provided for the remaining depth of the fill profile.

However, the premature refusal of a number of CPTs as well as the zones of locally higher shear wave velocity indicates the likely presence of oversize particles, e.g. boulders, within the fill profile. The presence of such obstructions can be indicative of zones of poor compaction, as the compaction equipment bridges over the large/hard particles rather than densifying the material beside the oversize material. Oversize material is also indicative of thick fill layers which would not have been properly compacted for the fill depth of the layer.

The investigations have also indicated reasonably consistent bedrock surface level over the site with an overall difference in bedrock elevation of about 2m. Whilst the geophysical testing has indicated some local changes in the depth to the bedrock surface, the changes in the bedrock surface depth are generally 'smooth' transitions rather than abrupt 'steps'. As such, differential settlements resulting from variations in fill thicknesses are expected to be relatively minor across the footprints of individual buildings.

Based on the above considerations, we regard the fill to be unsuitable as a foundation material for any structures which are sensitive to movement. For more flexible structures where movements may be tolerated, founding within the fill as discussed in Section 4.5 would be feasible.

4.3 Site Preparation and Earthworks

Whilst architectural design for the proposed school has not yet been finalised, given the sloping nature of the site, we expect that cut and fill earthworks to a maximum depth/height of 0.5m to 1m will likely be required to achieve design levels and provide level pads for each building.

The following comments and recommendations must be complemented by reference to AS3798-2007: 'Guidelines on Earthworks for Commercial and Residential Developments'.

4.3.1 Site Drainage and Stripping

The clayey fill materials at the site are expected to undergo substantial loss in strength when wet, as evident from the low CBR values and high swells during soaking. Furthermore, the clay has a moderate shrink-swell reactive potential. Therefore, it is important to provide good and effective site drainage both during construction and for long-term site maintenance. The principle aim of the drainage is to promote run-off and reduce ponding. A poorly drained clay subgrade may become untrafficable when wet. The earthworks should be carefully planned and scheduled to maintain good cross-falls during construction.

Good surface and subsurface drainage must also be provided post construction to improve the long-term performance of the structures and pavements.

4.3.2 Site Preparation

Any grass and other vegetation, as well as any topsoil or root affected soils (if encountered) must be stripped from the site. We note that no formal topsoil layer was noted in our boreholes.

Stripped topsoil/root affected soils (if encountered) must be stockpiled separately as they are considered unsuitable for reuse as engineered fill. They may however be reused for landscaping purposes. Reference should be made to the JKE reports for guidance on the offsite disposal of soil.

Where required, excavation may then be carried out to achieve design subgrade levels, and all excavation is expected to encounter the fill profile only, and will be readily completed using buckets fitted to hydraulic excavators.

Temporary batter slopes through the soil profile appear be feasible and should be cut no steeper than 1V in 1H for a maximum height of about 1.5m. Where temporary batters cannot be accommodated within the site geometry, or are not preferred, then further geotechnical advice should be sought regarding the use of a shoring system.

Any permanent batter slopes should be graded no steeper than 1V in 2H, provided the slopes are protected from erosion by quickly establishing a vegetative cover or by applying a reinforced shotcrete facing, together with surface drains at the crests of the batters to intercept surface water flows and prevent them from flowing over the face. Where access for mowing etc. is required, permanent batters will likely need to be flattened to about 1V in 4H.

4.3.3 Subgrade Preparation

Following excavation to design levels, the exposed soil subgrade should be proof rolled with at least eight passes of a smooth drum roller of at least 12 tonnes deadweight. The final passes of proof rolling should be witnessed by an experienced geotechnical engineer or earthworks superintendent for the detection of unstable or soft areas.

If soft or heaving areas are detected during proof rolling, the heaving areas should be locally removed to a stable base and replaced with engineered fill, as outlined in Section 4.3.4 below, or further geotechnical advice should be sought. Further guidance on the treatment of heaving areas must be provided by the geotechnical engineer during or following the proof rolling inspection. Based on the investigation results, heaving may occur where the in-situ soil moisture content is elevated, or in areas of the site where water has ponded on the ground surface).

If soil softening occurs after rainfall, the subgrade should be over-excavated to below the depth of moisture softening and replaced with engineered fill. Conversely, if the clayey subgrade exhibits shrinkage cracking, then the surface should be lightly watered and rolled until the shrinkage cracks are no longer evident.

4.3.4 Engineered Fill

Preferably, engineered fill should comprise an imported well graded granular material, e.g. crushed sandstone, with a maximum particle size not exceeding 75mm. Such materials are less susceptible to softening that clayey soils, and have reduced reactive movement to moisture content change. From a geotechnical perspective, the existing clayey fill materials are also considered suitable for reuse as engineered fill on condition that they are ‘clean’, free of organic matter and contain a maximum particle size not exceeding 75mm. Any imported fill must also have a maximum particle size not exceeding 75mm.

Engineered fill comprising well graded granular materials, such as imported crushed sandstone, should be compacted in maximum 200mm thick loose layers to achieve a density ratio of at least 98% of SMDD.

All clayey fill, such as site-won soils, should be compacted in maximum 200mm thick loose layers to a density ratio strictly between 98% and 102% of SMDD and within 2% of SOMC. Given the moisture contents of the materials on site, only limited moisture conditioning of the site-won clay soils is expected to be required in order to meet this specification.

In order to achieve adequate compaction at the edge of fill platforms, the outer edge of each fill layer should extend a horizontal distance of at least 1m beyond the design geometry. The roller must extend over the edge of each placed layer in order to seal the batter surface. On completion of filling, the excess under-compacted edge fill should be trimmed back to the design geometry.

Backfilling of service trenches must be carried out using engineered fill in order to reduce post-construction settlements. Due to the reduced energy output of the compaction plant that can be placed in trenches, backfilling should be carried out in maximum 100mm thick loose layers and compacted using a trench roller, a pad foot roller attachment fitted to an excavator, and/or a vertical rammer compactor (also known as a 'Wacker Packer'). Due to the reduced loose layer thickness, the maximum particle size of the backfill material should also be reduced to not more than 50mm. The compaction specifications provided above are applicable.

As for services trenches, retaining wall backfilling must also be carried out using engineered fill in order to reduce post-construction settlements. Compaction of the engineered backfill should be carried out using a trench roller or hand operated vertical rammer compactor for the lower layers and immediately behind the wall in the upper layers. Elsewhere a small static roller could be used. As per service trenches, backfilling should be carried out in 100mm thick loose layers and the maximum particle size of the backfill material should be reduced to not more than 50mm. The compaction specifications provided above are applicable.

Compaction of engineered fill immediately behind retaining walls is difficult to achieve in practice. The more common method comprises using a single sized hard, durable free draining aggregate, such as 'Blue Metal' or crushed concrete aggregate (free of fines, brick and tile fragments), which do not require significant compactive effort. Such material should be nominally compacted using a hand operated vibrating plate (sled) compactor in maximum 200mm thick loose layers. A non-woven geotextile filter fabric such as Bidim A34 should be placed as a separation layer immediately above the cut batter slope (prior to backfilling) to control subsoil erosion into the gravel. Provided the aggregate backfill is placed as recommended above, density testing would not be required in that material. The geotextile should then be wrapped over the surface of the aggregate backfill and capped with at least a 0.3m thick compacted layer of clayey engineered fill, to reduce the potential for surface water to enter the retaining wall drainage.

In-situ density tests must be carried out on the engineered fill to confirm the above specifications are achieved, as outlined below:

- The frequency of density testing for general engineered fill on a large scale lot should be at least one test per layer per 2,500m^2 or one test per 500m^3 distributed reasonably evenly throughout the full depth and area, and at least 3 tests per earthworks lot (as defined in Clause 1.2.8 of AS3798-2007), whichever requires the most tests (assumes maximum 200mm thick loose layers).
- The frequency of density testing for trench backfill should be at least one test per two layers per 40 linear metres (assumes maximum 100mm thick loose layers), with the tests fully penetrating both layers.
- The frequency of density testing for retaining wall backfill should be at least one test per two layers per 50m^2 (assumes maximum 100mm thick loose layers), with the tests fully penetrating both layers.

Where the fill will support buildings, we recommend that Level 1 control of fill placement and compaction in accordance with AS3798-2007 be carried out, including for the trench backfill. For areas outside the footprint of buildings, Level 2 testing of fill would be considered appropriate. Due to a potential conflict of interest, we strongly recommend that the geotechnical inspection and testing authority (GITA) be directly engaged by the client or builder, and not by the earthworks contractor or sub-contractors.

4.3.5 Earthworks Testing Overview

The long term successful performance of floor slabs and pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience.

In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility. This should be detailed in the tender documents.

We also recommend that the GITA be requested to provide a summary of test results, including a test location plan, and daily site reports on a fortnightly basis for review by the Project Superintendent and/or JK Geotechnics. On completion of the earthworks, the GITA should be requested to provide a Level 1 'sign off' report of the works completed under 'Level 1' control for our review, including a statement that the fill has been placed and compacted in accordance with the specification.

4.4 Retaining Wall Design

As the architectural design has not yet been completed, the location and nature of any retaining walls has not yet been confirmed. Nevertheless, we expect at least some retaining walls will be required for the development.

Free standing cantilever walls, with a maximum height of about 2m, and where minor wall movements are tolerable (e.g. when supporting soft landscaped areas) should be designed using a triangular lateral earth pressure distribution with an 'active' earth pressure coefficient, K_a, of 0.35 for the soil profile, as well as for any backfill materials, assuming a horizontal retained surface.

Cantilever walls which will be propped or restrained by structures and subsequently backfilled, should be designed using a triangular lateral earth pressure distribution with an 'at rest' earth pressure coefficient, K_0, of 0.5 for the soil profile, as well as for any backfill materials, assuming a horizontal retained surface.

As the retaining walls would be founded within fill which has not been placed and compacted as engineered fill, the retaining walls should be designed as flexible and articulated, and preferably with a slight rake from the vertical.

A bulk unit weight of $20kN/m^3$ should be adopted for the soil profile.

Any surcharge affecting the walls (e.g. traffic loading, construction loads, adjacent high level footings, sloping backfill, etc.) should be allowed for in the design using the appropriate earth pressure coefficient from above.

All retaining walls should be designed as 'drained' and measures taken to provide permanent and effective drainage of the ground behind the walls. The subsoil drains should incorporate a non-woven geotextile fabric (e.g. Bidim A34) to act as a filter against subsoil erosion.

Lateral toe restraint of cantilever walls may be achieved by passive resistance of the soil profile in front of the wall using a triangular lateral earth pressure distribution and a 'passive' earth pressure coefficient, K_P, of 3.0 for the soil and weathered bedrock profile. We note that significant movement is required in order to mobilise the full passive pressure of the resisting material, and therefore a factor of safety of at least 2 should be adopted to reduce such movements. Any localised excavations in front of the wall should be taken into account in the embedment design. Friction on the base of a wall can be calculated using a friction angle of 28˚ between the retaining wall base and the soil below, provided the base is clean, rough and 'dry' when the retaining wall footing is poured.

4.5 Footing Design

Based on the nature of the proposed buildings, anticipated structural loads, and from discussions with the project structural engineers, we expect the proposed buildings will be supported on piles founded in the underlying bedrock profile. However, for independent, flexible, and light weight structures, e.g. the COLA, low height retaining walls and the like, shallow footings founded in the fill profile may be feasible, provided shrink-swell movements of the soil profile can be accommodated.

We note that only limited testing of the existing fill has been completed. Whilst this testing has shown the fill to be generally moderately or well compacted, due to the inherent variability of fill profiles, it is possible that zones of poorly compacted material are present and which were not identified by our investigation. Therefore, the adoption of footings founded in the fill profile will require acceptance that the long term performance of the footings may be inferior when compared to footings founded in a natural soil or wholly engineered fill profile. Where possible, we recommend that all structures supported on shallow footings in the fill profile be designed to be as flexible as reasonably possible, and/or incorporate mechanisms to allow for possible future relevelling, e.g. adjustable post legs on footings.

The services connected to the buildings must also be suitably flexible to accommodate movement, and drainage pipes should have steeper than usual falls to maintain drainage following differential settlement.

4.5.1 Site Classification and Movement

Whilst AS2870 does not directly apply to this project, due to the presence of fill the site would be classified as Class 'P' in accordance with AS2870-2011. Assuming site won soils similar to those encountered on the site are used for the engineered fill, the fill profile is expected to be moderately reactive to moisture content change. Assuming the buildings would be constructed within 5 years of final cut and fill earthworks, characteristic surface movements could be in the range of those expected for a Class 'M' to Class 'H1' site in accordance with AS2879-2011, that is in the order of 40mm. However, in order to accommodate potential additional differential movements associated with the deep fill profile, we recommend the adoption of characteristic surface movements for a Class 'H2' site, that is in the order of 60mm to 75mm.

We note that AS2870-2011 is not meant to be used in the design of this type of structure, and so the standard footing designs in AS2870 are not relevant to this project, and the footing design must be carried out using engineering principles, with the above movements providing an indication to the structural engineer of the range of movements to be expected.

4.5.2 Shallow Footings

For shallow footings founded in the fill profile, either the existing fill or new fill placed under Level 1 control to the Specification in Section 4.3.4 above, an allowable able bearing pressure of 100kPa can be adopted, provided the footings are founded at a depth of at least 0.8m below surrounding ground level.

For the design of shallow footings or raft slabs, an elastic modulus of 40kPa can be adopted for the fill profile.

For piles founded in the fill profile at a depth of at least 2.5m or 4 pile diameters, whichever is deeper, an allowable bearing pressure of 200kPa could be adopted.

For linear structures, e.g. retaining walls, supported on footings founded in the fill profile, articulation at no greater than 5m centres must be adopted.

We recommend that all high level footings be excavated, cleaned, inspected and poured with minimum delay to avoid either wetting or drying of the foundation. If delays in pouring concrete are anticipated, we recommend that the base of the footings be protected with a blinding layer of concrete of at least 75mm thickness. Water should be prevented from ponding in the base of footing excavations as this will tend to soften the foundation material, resulting in further excavation and cleaning being required.

4.5.3 Piles to Bedrock

For the proposed buildings, we consider piles to the underlying bedrock profile would be the most appropriate option to support the building. For the encountered subsurface profile, we consider continuous flight auger (CFA) piles would be required due to the high groundwater level and possible collapsing nature of more gravelly portions of the fill profile. However, cased bored piles could also be considered. Due to the likely presence of larger particles (e.g. boulders) within the fill profile, we expect a large piling rig will be required. Potential piling contractors must be provided with a copy of this report to ensure appropriate piling plant is mobilised to site. It is possible that the boulders may not be able to be penetrated, even with large piling rigs. In such cases it may be necessary to drill piles either side of the obstruction, and then create a bridging beam to transfer the structural loads into the piles.

For piles socketed a nominal 0.3m into bedrock of at least low strength, an allowable end bearing pressure of 1,500kPa can be adopted, based on serviceability criteria. For rock sockets longer than this 0.3m, an allowable shaft adhesion of 150kPa in compression and 75kPa in tension (uplift) can be adopted. Higher bearing pressures would be feasible below the upper more variable bedrock, i.e. from about 2m below top of rock level based on BH102 or 2.5m below top of rock level based on BH104, however, socketing of piles to such a depth is not expected to be feasible with a CFA piling rig due to the high, and in places very high, strength of the bedrock.

The initial stages of pile drilling should be inspected be a geotechnical engineer to confirm the piles are being drilled to an appropriate depth based on the conditions encountered in the boreholes. Certification of CFA piles must be provided by the piling contractor.

All suspended on grade elements must incorporate collapsible (cardboard) void formers to protect against uplift pressures which can result from swell movements of the reactive soils.

4.6 Durability

Based on the results of pH, chloride content, sulfate content and resistivity testing, an exposure classification of 'Non-aggressive' is applicable to both concrete and steel footings, according to Table 6.4.2(C) and 6.5.2(C) of AS2159-2009.

4.7 Pavements

For external pavements, provided the subgrade has been prepared in accordance with recommendations described in Section 4.3 above, a CBR value of 1.5% can be adopted for design, or, a short term Young's Modulus of 15MPa.

Due to the possibility for differential movements to occur due to the deep fill profile, we strongly recommend against the adoption of rigid (i.e. concrete) pavements. Instead, we recommend the adoption of a flexible, asphaltic concrete, pavement, with the asphaltic concrete itself incorporating ma polymer modified bonder to improve its flexibility. Similarly, we also recommend against the adoption of recycled granular pavement materials due to the potential for these to recement after placement, and then crack in response to any differential movement.

Subgrade improvement comprising the placement and compaction imported crushed sandstone or lime stabilisation of the upper 0.3m of clay subgrade could be adopted to reduce the thickness of the granular and bound pavement layers. The thickness and quality of such a select layer, if adopted, should be taken into account in the pavement design. As a guide, assuming a minimum of 0.3m thickness of crushed sandstone or lime stabilised clay with a soaked CBR of at least 10%, over clayey fill materials, the equivalent subgrade design CBR value would increase to about 5%, however this must be confirmed.

Select fill, if adopted, must comprise a well graded, granular crushed sandstone (maximum particle size of 150mm), or similar material, with a soaked CBR value of at least 10%. If the available sandstone is assessed by tactile examination or laboratory testing to be a marginal material (i.e. achieving a CBR value of just over 10% at a compaction density ratio of 100% of SMDD), then we expect that it will break down and degrade during compaction with a heavy roller to a material with an "insitu" CBR value less than 10%. As such, we recommend that the CBR testing allow for the degradation of the crushed sandstone. The standardised RTA Specification T102 method, which attempts to replicate the degradation process by pre-treatment of the crushed sandstone with 3 cycles of repeated compaction, would be appropriate, or placement and compaction of the material in a test pad prior to sampling. All crushed sandstone select fill should be compacted in maximum 200mm thick loose layers to at least 100% of SMDD.

We recommend that all base course materials for flexible pavements comprise DGB20 in accordance with TfNSW QA Specification 3051 unbound base. The DGB20 material should be compacted in maximum 200mm thick loose layers using a large smooth drum roller to at least 98% of Modified Maximum Dry Density (MMDD). Adequate moisture conditioning to within 2% of Modified Optimum Moisture Content (MOMC) should be provided during placement.

We further recommend that all sub-base materials for flexible pavements comprise DGS40, DGS20 or DGB20 in accordance with TfNSW QA Specification 3051. The subbase material should be compacted in maximum 200mm thick loose layers using a large smooth drum roller to at least 98% of MMDD. Again, adequate moisture conditioning to within 2% of MOMC should be provided during placement.

The final pavement material and compaction specification must be determined by the pavement designer.

Density tests should be carried out on the granular pavement materials to confirm the above specifications are achieved. The frequency of density testing should be at least one test per layer per 2,500m^2; three tests per lot and three tests per visit, whichever requires the most tests. Level 2 testing of fill compaction in accordance with AS3798-2007 would be considered acceptable for the pavement layers. The geotechnical testing authority (GTA) should be directly engaged by the builder and not by the earthworks contractor or sub-contractors.

Subsoil drains should be provided below the perimeter of the proposed pavements, including any internal planters etc. with invert levels at least 200mm below subgrade level. The drainage trenches should be excavated with a continuous longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. The subgrade should be graded to promote water flow towards the subsoil drains. Discharge from the subsoil drains should be piped to the stormwater system.

4.8 Further Geotechnical Input

The following is a summary of the further geotechnical input which is required and which has been detailed in the preceding sections of this report:

- Proof rolling inspections;
- Density testing of all engineered fill, sub-base and base course materials; and
- Geotechnical inspection of footing excavations/pile drilling.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. As an example, special treatment of soft spots may be required as a result of their discovery during proof-rolling, etc. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions between the completed CPTs and boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of JK Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A1

MOISTURE CONTENT TEST REPORT

Client: JK Geotechnics
Project: Proposed Public School
Location: 1-23 Forestwood Drive, Glenwood, NSW

Ref No: 33177PN
Report: A1
Report Date: 14/10/2020

AS 1289	TEST METHOD	2.1.1
BOREHOLE NUMBER	**DEPTH m**	**MOISTURE CONTENT %**
101	0.50 - 0.75	16.1
101	1.50 - 1.95	8.8
101	3.00 - 3.45	10.5
101	4.50 - 4.95	18.8
101	6.00 - 6.45	15.5
101	7.50 - 7.60	12.8
101	8.70 - 9.15	11.8
101	10.50 - 10.95	12.7
101	12.00 - 12.20	12.7
102	0.50 - 0.85	6.5
102	1.50 - 1.95	10.1
102	3.00 - 3.45	18.4
102	4.50 - 4.95	14.1
102	6.00 - 6.45	10.6
102	10.50 - 10.95	9.7
102	14.10 - 14.40	6.0
103	0.50 - 0.95	8.1
103	1.50 - 1.95	15.6
103	3.00 - 3.45	13.0
103	4.50 - 4.95	11.4
103	6.00 - 6.45	12.5
103	7.50 - 7.95	11.6
103	10.50 - 10.95	11.6
103	11.20 - 11.70	4.9

Notes: **See page 2**

14/10/2020
Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A1

MOISTURE CONTENT TEST REPORT

Client:	JK Geotechnics	**Ref No:**	33177PN
Project:	Proposed Public School	**Report:**	A1
Location:	1-23 Forestwood Drive, Glenwood, NSW	**Report Date:**	14/10/2020
		Page 1 of 2	

AS 1289	TEST METHOD	2.1.1
BOREHOLE NUMBER	**DEPTH m**	**MOISTURE CONTENT %**
104	0.50 - 0.95	18.0
104	1.50 - 1.95	16.4
104	3.00 - 3.45	16.1
104	4.50 - 4.65	11.8
104	7.50 - 7.95	5.7
104	9.00 - 9.45	10.9
104	12.00 - 12.45	11.9
104	14.20 - 14.70	2.3

Notes:
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 09/10/2020.
- Sampled and supplied by client. Samples tested as received.

NATA

NATA Accredited Laboratory Number:1327

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14/10/2020

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE B1
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

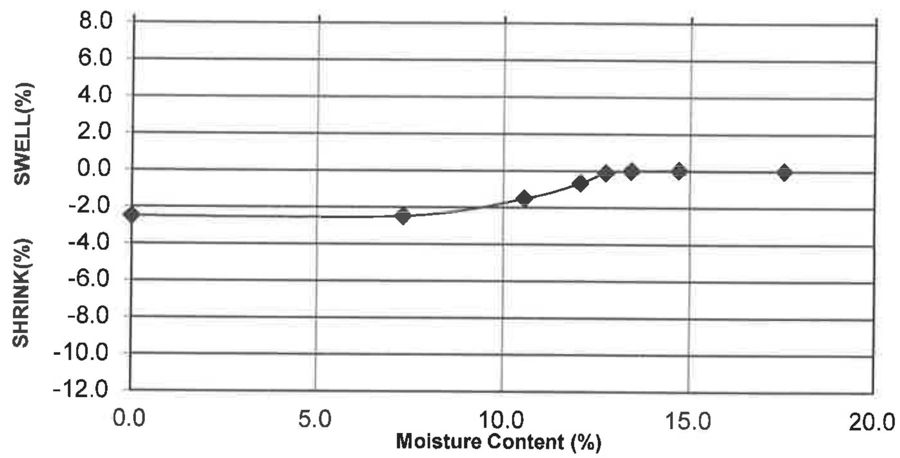
Client: JK Geotechnics
Project: Proposed Public School
Location: 1-23 Forestwood Drive, Glenwood, NSW

STS Job No: 33177PN
Report: B1
Report Date: 22/10/2020

Borehole No.: 101		Depth: 0.50 - 0.74m	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
14.7%	17.5%	>350 kPa	60.80 kPa

LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	2.4%	0.0%	2.4%

SHRINK SWELL GRAPH



SHRINK SWELL INDEX
1.36 %/pF

Notes: Sampled and supplied by client. Samples tested as received.

- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Inert Inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 09/10/2020.

NATA Accredited Laboratory Number:1327

Authorised Signature / Date
(D. Treweek)
22/10/20

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SOIL TEST SERVICES

ABN 43 002 145 173

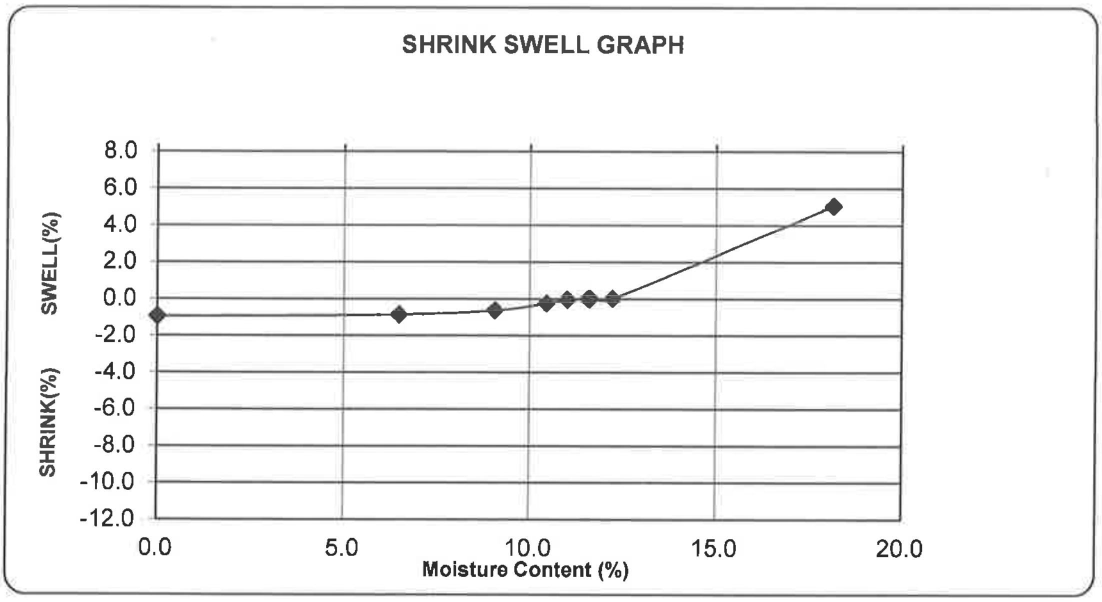
TABLE B1
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Proposed Public School
Location: 1-23 Forestwood Drive, Glenwood, NSW

STS Job No: 33177PN
Report: B1
Report Date: 22/10/2020

Borehole No.: 102		Depth: 0.50 - 0.68m	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
12.2%	18.1%	>450 kPa	250,270 kPa

LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	1.1%	5.0%	0.9%



SHRINK SWELL INDEX
1.92 %/pF

Notes: Sampled and supplied by client. Samples tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Inert Inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 09/10/2020.

NATA Accredited Laboratory Number:1327

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(D. Treweek)
22/10/20

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SOIL TEST SERVICES

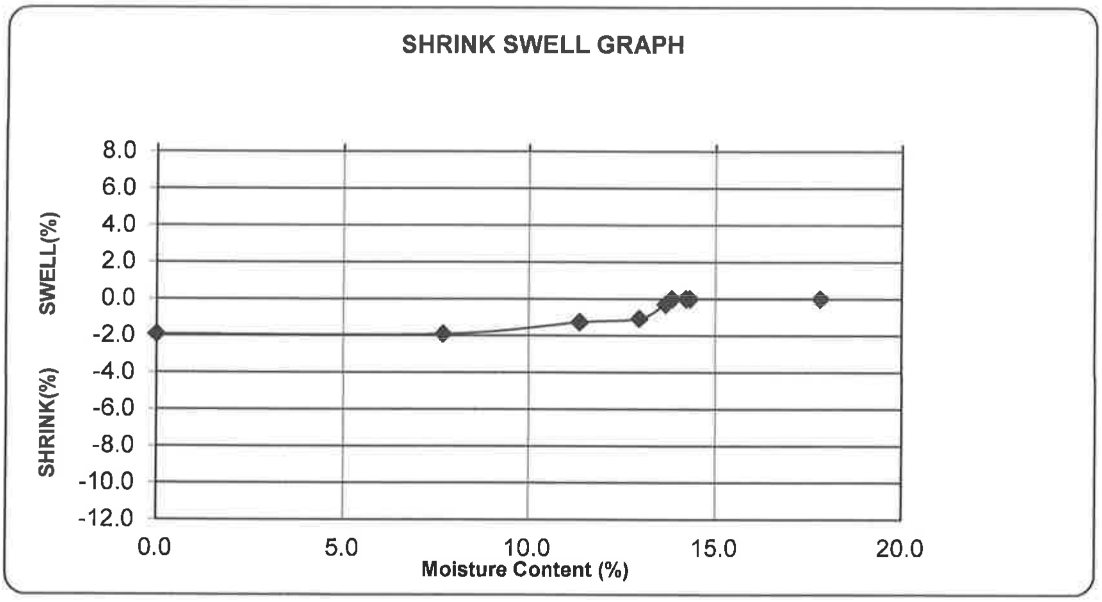
ABN 43 002 145 173

TABLE B1
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client:	JK Geotechnics	**STS Job No:**	33177PN
Project:	Proposed Public School	**Report:**	B1
Location:	1-23 Forestwood Drive, Glenwood, NSW	**Report Date:**	22/10/2020
		Page	3 of 4

Borehole No.: 103		Depth: 0.50 - 0.70m	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
13.8%	17.8%	>450 kPa	50,70 kPa

LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	-1.5%	0.0%	1.9%



SHRINK SWELL INDEX
1.04 %/pF

Notes: Sampled and supplied by client. Samples tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Inert Inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 09/10/2020.

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NATA Accredited Laboratory Number:1327

Authorised Signature / Date
(D. Treweek) 22/10/20

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SOIL TEST SERVICES

ABN 43 002 145 173

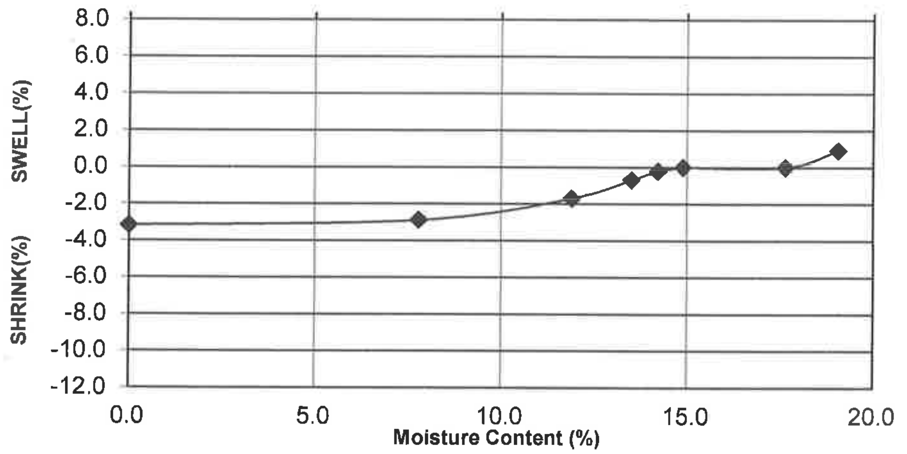
TABLE B1
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Proposed Public School
Location: 1-23 Forestwood Drive, Glenwood, NSW

STS Job No: 33177PN
Report: B1
Report Date: 22/10/2020

Borehole No.: 104		Depth: 0.50 - 0.75m	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
17.6%	19.1%	>450 kPa	210,230 kPa

LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	-0.3%	0.9%	3.1%



SHRINK SWELL INDEX
1.99 %/pF

Notes: Sampled and supplied by client. Samples tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Inert Inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 09/10/2020.

Authorised Signature / Date
(D. Treweek) 22/10/20

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SOIL TEST SERVICES

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	33177PN2
Project:	Proposed Public School	**Report:**	C
Location:	1-23 Forestwood Drive, Glenmore Park, NSW	**Report Date:**	12/10/2020
		Page 1 of 2	

BOREHOLE NUMBER	DEPTH m	$I_{S\,(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
101	13.75 - 13.78	0.7	14
	14.25 - 14.28	0.5	10
	14.67 - 14.70	0.7	14
	15.15 - 15.18	0.7	14
	15.80 - 15.84	2.2	44
	16.25 - 16.29	6.3	126
	16.74 - 16.76	2.4	48
	17.27 - 17.30	1.5	30
	17.74 - 17.77	2.1	42
	18.27 - 18.30	2.1	42
102	14.74 - 14.77	0.7	14
	15.36 - 15.39	3.5	70
	15.87 - 15.89	1.8	36
	16.27 - 16.31	3.0	60
	16.81 - 16.84	1.2	24
	17.24 - 17.27	0.7	14
	17.79 - 17.83	1.1	22
	18.11 - 18.15	1.9	38
	18.69 - 18.71	3.0	60
	19.23 - 19.27	1.1	22
	19.69 - 19.72	0.8	16
	20.14 - 20.17	0.9	18
	20.57 - 20.60	3.0	60
103	12.20 - 12.23	1.2	24
	12.69 - 12.73	1.7	34

NOTES: See Page 2 of 2

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SOIL TEST SERVICES

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	33177PN2
Project:	Proposed Public School	**Report:**	C
Location:	1-23 Forestwood Drive, Glenmore Park, NSW	**Report Date:**	12/10/2020

BOREHOLE NUMBER	DEPTH m	$I_{S\ (50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
103	13.21 - 13.24	4.5	90
	13.69 - 13.71	2.8	56
	14.27 - 14.30	1.4	28
	14.92 - 14.95	3.6	72
	15.44 - 15.47	0.7	14
	16.05 - 16.08	0.5	10
	16.57 - 16.60	2.0	40
	17.04 - 17.07	1.8	36
	17.64 - 17.67	0.6	12
104	15.12 - 15.15	0.8	16
	15.64 - 15.68	1.0	20
	16.12 - 16.15	2.0	40
	16.73 - 16.75	0.5	10
	17.15 - 17.19	0.3	6
	17.63 - 17.65	1.0	20
	18.12 - 18.15	4.4	88
	18.60 - 18.63	4.2	84
	19.00 - 19.03	0.5	10
	19.50 - 19.53	0.8	16
	20.05 - 20.07	1.1	22
	20.50 - 20.54	1.9	38
	21.07 - 21.11	3.6	72

NOTES:

1. In the above table testing was completed in the Axial direction.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RMS T223.
4. For reporting purposes, the $I_{S(50)}$ has been rounded to the nearest 0.1MPa, or to one significant figure if less than 0.1MPa
5. The Estimated Unconfined Compressive Strength was calculated from the Point Load Strength Index by the following approximate relationship and rounded off to the nearest whole number :
   U.C.S. = 20 $I_{S\ (50)}$

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CERTIFICATE OF ANALYSIS 253067

Client Details

Client	JK Geotechnics
Attention	Arthur Kourtesis
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**33177PN, Proposed Public School**
Number of Samples	8 Soil
Date samples received	09/10/2020
Date completed instructions received	09/10/2020

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	16/10/2020
Date of Issue	15/10/2020

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Results Approved By
Diego Bigolin, Team Leader, Inorganics

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		253067-1	253067-2	253067-3	253067-4	253067-5
Your Reference	UNITS	BH101	BH101	BH102	BH102	BH103
Depth		1.5-1.95	6.0-6.45	3.0-3.45	10.5-10.95	0.5-0.95
Date Sampled		06/10/2020	06/10/2020	08/10/2020	08/10/2020	07/10/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	13/10/2020	13/10/2020	13/10/2020	13/10/2020	13/10/2020
Date analysed	-	13/10/2020	13/10/2020	13/10/2020	13/10/2020	13/10/2020
pH 1:5 soil:water	pH Units	8.9	9.7	9.1	9.5	9.3
Chloride, Cl 1:5 soil:water	mg/kg	120	200	610	260	190
Sulphate, SO4 1:5 soil:water	mg/kg	180	170	260	160	150
Resistivity in soil*	ohm m	28	43	14	22	25

Misc Inorg - Soil				
Our Reference		253067-6	253067-7	253067-8
Your Reference	UNITS	BH103	BH104	BH104
Depth		3.0-3.45	1.5-1.95	6.0-6.15
Date Sampled		07/10/2020	06/10/2020	06/10/2020
Type of sample		Soil	Soil	Soil
Date prepared	-	13/10/2020	13/10/2020	13/10/2020
Date analysed	-	13/10/2020	13/10/2020	13/10/2020
pH 1:5 soil:water	pH Units	8.9	8.5	9.8
Chloride, Cl 1:5 soil:water	mg/kg	260	140	50
Sulphate, SO4 1:5 soil:water	mg/kg	260	140	110
Resistivity in soil*	ohm m	23	37	34

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 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
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	-			13/10/2020	2	13/10/2020	13/10/2020		13/10/2020	[NT]
Date analysed	-			13/10/2020	2	13/10/2020	13/10/2020		13/10/2020	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	9.7	9.7	0	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	200	200	0	99	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	170	160	6	100	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	2	43	32	29	105	[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.

JKGeotechnics

BOREHOLE LOG

EASTING: 285298.30
NORTHING: 6257342.21

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN
Method: SPIRAL AUGER / ROTARY WASHBORE
R.L. Surface: 60.93 m
Date: 6/10/20
Datum: AHD
Plant Type: JK300
Logged/Checked By: S.D./N.E.S.

Groundwater Record	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
			0			FILL: Silty clay, medium plasticity, brown, grey, orange brown and red brown, with fine to medium grained igneous, ironstone and siltstone gravel, trace of ash.	w<PL			GRASS COVER APPEARS POORLY TO MODERATELY COMPACTED
	N > 7 6,7/ 100mm REFUSAL	60	1						480 >600 >600 450 580 550	
ON COMPLETION OF AUGERING	N = 7 2,2,5	59								
			2			FILL: Gravelly silty clay, medium plasticity, grey, fine to coarse grained siltstone gravel.	w>PL			APPEARS WELL COMPACTED
	N = 13 2,5,8	58	3						370 400 350	
▶		57	4			FILL: Silty clay, medium plasticity, red brown mottled light grey and grey, trace of fine to medium grained ironstone gravel.				
	N = 9 0,4,5	56	5						350 290 320	
	N = 8 5,5,3	55	6			FILL: Silty gravelly clay, medium plasticity, grey, fine to coarse grained siltstone gravel.			150 200 170	
		54								

Samples columns: ES, U50, DB, DS

JKGeotechnics

BOREHOLE LOG

Borehole No. 101

EASTING: 285298.30
NORTHING: 6257342.21

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN
Method: SPIRAL AUGER / ROTARY WASHBORE
R.L. Surface: 60.93 m
Date: 6/10/20
Datum: AHD
Plant Type: JK300
Logged/Checked By: S.D./N.E.S.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
							FILL: Silty gravelly clay, medium plasticity, grey, fine to coarse grained siltstone gravel. *(continued)*	w>PL			
	DS	N=SPT 10/ 100mm REFUSAL								210	
			53	8							
	DS										HIGH 'TC' BIT RESISTANCE
											'TC' BIT REFUSAL COMMENCE WASHBORING
	DS	N = 10 5,5,5	52	9						300 300 260	
			51	10							
	DS	N = 15 0,5,10	50	11						280 350 350	
	DS	N > 4 4,4/ 50mm REFUSAL	49	12							HIGH WASHBORING RESISTANCE
			48	13			REFER TO CORED BOREHOLE LOG				
			47								

JKGeotechnics

CORED BOREHOLE LOG

EASTING: 285298.30
NORTHING: 6257342.21

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Core Size:** **R.L. Surface:** 60.93 m
Date: 6/10/20 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK300 **Bearing:** N/A **Logged/Checked By:** S.D./N.E.S.

Column headings: Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ (VL 0.1, L 0.3, M 1, H 3, VH 10, EH) | DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20); DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness) Specific / General | Formation

Depth scale: 13, 14, 15, 16, 17, 18 m. RL scale: 48, 47, 46, 45, 44, 43, 42 m AHD.

Water Loss\Level: 0% RETURN. Formation: Bringelly Shale.

Core Description	Weathering	Strength	Point Load $I_s(50)$
START CORING AT 12.96m			
NO CORE 0.48m			
SILTSTONE: dark grey, with occasional fine grained light grey sandstone laminae, bedded at 0-5°.	FR	M	0.70, 0.50, 0.70, 0.70
SANDSTONE: fine to medium grained, grey, bedded at 0-5°.		H	2.2
SILTSTONE: dark grey, with fine grained light grey sandstone laminae, bedded at 0-5°.			6.3, 2.4, 1.5
SANDSTONE: fine to medium grained, grey, with dark grey siltstone laminae, bedded at 0-5°.			2.1, 2.1
END OF BOREHOLE AT 18.62 m			

Defect Details (Specific):

- (13.61m) Cr, 30°, 210 mm.t
- (14.08m) J, 60 - 90°, Un, R, Cn
- (14.15m) J, 30 - 90°, St, R, Cn
- (14.19m) J, 30 - 90°, St, R, Cn
- (14.46m) XWS, 0°, 20 mm.t
- (14.59m) XWS, 0°, 5 mm.t
- (14.62m) XWS, 0°, 20 mm.t
- (14.90m) J, 40°, St, R, Cn
- (14.92m) J, 40°, Un, S, Cn
- (15.05m) J, 70°, St, R, Cn
- (15.49m) J, 40°, St, R, Cn
- (15.67m) J, 80°, St, R, Cn
- (16.10m) Be, 0°, Un, R, Cn
- (16.18m) J, 65°, St, R, Cn
- (16.89m) Be, 0°, Un, R, Cn
- (17.00m) J, 90°, P, R, Cn
- (17.51m) XWS, 0°, 15 mm.t
- (17.92m) Be, 0°, P, R, Cn
- (18.58m) J, 90°, Un, R, Cn

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 33177PN
Borehole No: BH101
Depth: 12.96m → 18.62m
KODAK Gray Scale
KODAK Color Control Patches
33177PN BH101 START CORNG AT 12.96m
12
12.96m →
13
NO CORE 0.48m
14
15
16
17
18
END OF BH101 AT 18.62m

JKGeotechnics

BOREHOLE LOG

EASTING: 285310.17
NORTHING: 6257309.56

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** 60.70 m
Date: 8/10/20 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** A.C.K./N.E.S.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
				0			FILL: Silty clay, medium plasticity, grey brown, with fine to medium grained siltstone gravel, trace of fine to medium grained ironstone and sandstone gravel.	w<PL			APPEARS WELL COMPACTED
	U50, DS	N > 32 11,19,13/ 50mm REFUSAL	60							>600 >600 >600	
				1							
	U50, DS	N = 16 8,8,8	59							400 400	
				2							
ON COMPLETION OF AUGERING			58					w>PL			
	ES, DS	N = 8 3,4,4		3						220 150 280	APPEARS MODERATELY COMPACTED
			57								
				4			as above, but trace of brick fragments.				
▶	ES, DS	N = 24 3,9,15	56							175	APPEARS WELL COMPACTED
				5							
			55				FILL: Silty clay, medium plasticity, grey brown, with fine to medium grained siltstone gravel.				
	ES, DS	N = 18 9,10,8		6							TOO FRIABLE FOR HP TESTING
			54								

JKGeotechnics

BOREHOLE LOG

Borehole No. **102**

EASTING: 285310.17
NORTHING: 6257309.56

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** 60.70 m
Date: 8/10/20 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** A.C.K./N.E.S.

Groundwater Record	SAMPLES (ES / U50 / DB / DS)	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
							FILL: Silty clayey gravel, fine to medium grained, siltstone, grey.	W			
	ES	N = 7 4,4,3	53	8							APPEARS MODERATELY COMPACTED
			52	9			FILL: Gravelly silty clay, medium plasticity, grey brown, fine to medium grained siltstone gravel.	w~PL			
	ES	N = 14 3,6,8	51								TOO FRIABLE FOR HP TESTING
				10			FILL: Silty clay, medium plasticity, grey brown, with fine to medium grained siltstone gravel.	w>PL			
	ES, DS	N = 13 4,3,10	50							220 150	
			49	11			FILL: Gravelly silty clay, medium plasticity, grey, fine to medium grained siltstone gravel.				BANDED SOIL STRENGTH TO MODERATE 'TC' BIT RESISTANCE
			48	12							
				13							
	ES	N = 13 0,4,9	47								TOO FRIABLE FOR HP TESTING

JKGeotechnics

BOREHOLE LOG

Borehole No.
102

EASTING: 285310.17
NORTHING: 6257309.56

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** 60.70 m
Date: 8/10/20 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** A.C.K./N.E.S.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
									-	Interbedded SILTSTONE and SANDSTONE: fine grained, dark grey and light grey.	SW	M		BRINGELLY SHALE MODERATE TO HIGH RESISTANCE
						46				REFER TO CORED BOREHOLE LOG				
							15							
						45								
							16							
						44								
							17							
						43								
							18							
						42								
							19							
						41								
							20							
						40								

JKGeotechnics

CORED BOREHOLE LOG

Borehole No. 102

EASTING: 285310.17
NORTHING: 6257309.56

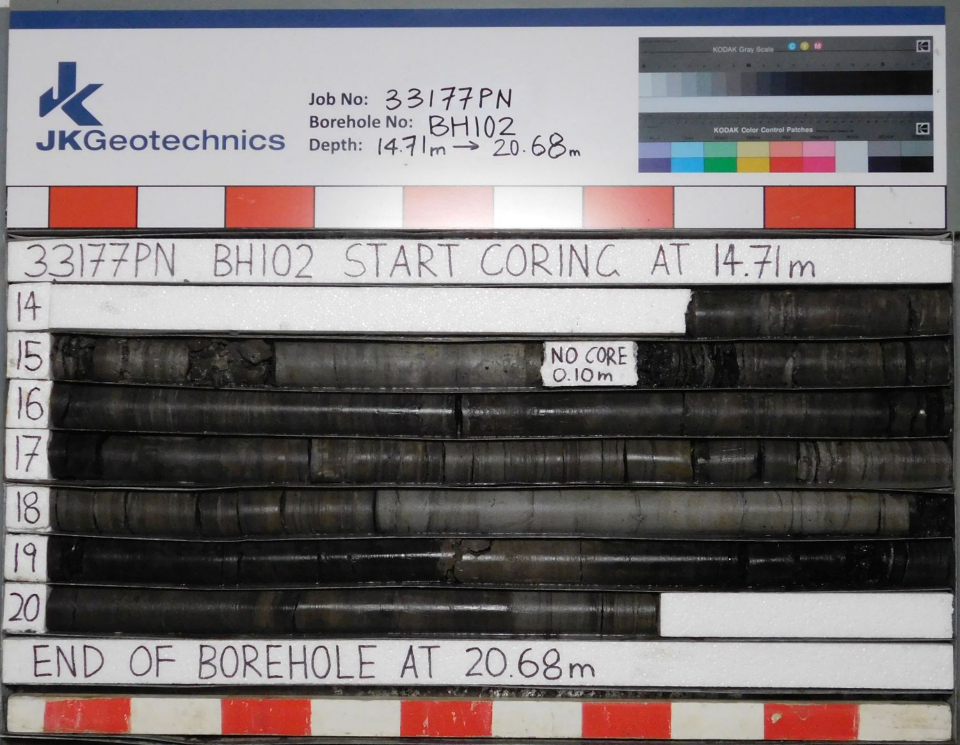
Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Core Size:** **R.L. Surface:** 60.70 m
Date: 8/10/20 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK500 **Bearing:** N/A **Logged/Checked By:** A.C.K./N.E.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS – DESCRIPTION: Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness – Specific	Formation
		46		START CORING AT 14.71m					
25% RETURN			15	SILTSTONE: dark grey, with light grey laminae, bedded at 0-5°.	SW	M	0.70	(14.96m) XWS, 0°, 7 mm.t (15.03m) J, 60°, P, R, Cn (15.08m) XWS, 5°, 8 mm.t (15.21m) J, 65°, Un, R, Cn	
				SANDSTONE: fine grained, light grey, bedded at 0-10°.		H	3.5		
		45		NO CORE 0.10m					
			16	LAMINITE: fine grained sandstone and siltstone, dark grey and light grey, bedded at 0-5°.	XW FR	Hd M - H	1.8 3.0 1.2 0.70 1.1 1.9	(15.79m) J, 65°, Un, R, Cn (16.01m) J, 25°, Un, S, Cn (16.97m) XWS, 15°, 2 mm.t (16.99m) XWS, 0°, 5 mm.t (17.38m) J, 35°, P, R, Cn (17.84m) XWS, 0°, 1 mm.t (17.86m) XWS, 0°, 1 mm.t (18.16m) XWS, 0°, 1 mm.t (18.26m) XWS, 0°, 1 mm.t	Bringelly Shale
90% RETURN		42		SANDSTONE: fine grained, light grey, bedded at 0-10°.			3.0		
			19	SILTSTONE: dark grey, with light grey laminae, bedded at 0-5°.			1.1 0.80 0.90	(18.98m) Cr, 5°, 40 mm.t (19.03m) XWS, 0°, 15 mm.t (19.48m) J, 85°, C, R, Cn (19.83m) XWS, 10°, 5 mm.t (19.90m) Cr, 0°, 30 mm.t, (COAL) (20.28m) J, 10°, P, S, Cn	
				SANDSTONE: fine grained, light grey, with siltstone laminae, bedded at 0-5°.			3.0		
		40		END OF BOREHOLE AT 20.68 m					

Point load index scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH
Spacing (mm): 600, 200, 60, 20
RL (m AHD) ticks: 46, 45, 44, 43, 42, 41, 40
Depth (m) ticks: 15, 16, 17, 18, 19, 20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 33177PN
Borehole No: BH102
Depth: 14.71m → 20.68m
KODAK Gray Scale
KODAK Color Control Patches
33177PN BH102 START CORING AT 14.71m
14
15
NO CORE 0.10m
16
17
18
19
20
END OF BOREHOLE AT 20.68m

JKGeotechnics

BOREHOLE LOG

Borehole No.
103

EASTING: 285444.36
NORTHING: 6257324.75

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** 58.97 m
Date: 7/10/20 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** A.C.K./N.E.S.

Groundwater Record	Samples (ES / U50 / DB / DS)	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
				0			FILL: Silty clay, medium plasticity, grey brown, with fine to medium grained siltstone gravel, trace of fine to medium grained ironstone and sandstone gravel.	w<PL			APPEARS WELL COMPACTED
	U50, DS	N = 24 3,11,13								>600 >600 >600	
			58	1							
	U50, DS	N = 17 5,7,10								480 330 >600	
			57	2							
	ES, DS	N = 17 4,7,10	56	3						>600 350 >600	
			55	4							
	ES, DS	N = 15 5,7,8									TOO GRAVELLY FOR HP TESTING
ON COMPLETION OF AUGERING (▽)			54	5							
			53	6							
	ES, DS	N = 15 5,7,8								470 470	

JKGeotechnics

BOREHOLE LOG

EASTING: 285444.36
NORTHING: 6257324.75

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** 58.97 m
Date: 7/10/20 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** A.C.K./N.E.S.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES, DS	N = 8 4,4,4	51	8			FILL: Silty clay, medium plasticity, grey brown, with fine to medium grained siltstone gravel, trace of fine to medium grained ironstone and sandstone gravel. *(continued)*	w~PL		500 250 300	APPEARS MODERATELY COMPACTED
▶	ES, DS	N = 8 3,3,5	50	9				w>PL		370 170	
	ES, DS	N = 11 4,5,6	49	10			FILL Gravelly clay, medium plasticity, grey, fine to medium grained siltstone gravel.				TOO GRAVELLY FOR HP TESTING
	DS		48	11		-	SILTSTONE: dark grey, with extremely weathered bands.	SW	H		BRINGELLY SHALE MODERATE TO HIGH 'TC' BIT RESISTANCE WITH LOW BANDS
			47	12			REFER TO CORED BOREHOLE LOG				
			46	13							

JKGeotechnics

CORED BOREHOLE LOG

Borehole No. 103

3 / 3

EASTING: 285444.36
NORTHING: 6257324.75

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**Core Size:**	**R.L. Surface:** 58.97 m
Date: 7/10/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** A.C.K./N.E.S.

START CORING AT 12.13m

Depth (m)	Core Description (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components)	Weathering	Strength	Point Load Strength Index $I_s(50)$
12.13–12.53	LAMINITE: fine grained sandstone and siltstone, dark grey and light grey, bedded at 0-5°.	FR	H	1.2
12.53–14.15	SANDSTONE: fine grained, light grey, with dark grey laminae, bedded at 0-5°.	FR	H	1.7, 4.5, 2.8
14.15–16.27	LAMINITE: fine grained sandstone and siltstone, dark grey and light grey, bedded at 0-5°.	FR (to ~15.35); SW (~15.35–15.95); FR (~15.95–)	H; L - M; H	1.4, 3.6; 0.70; 0.50
16.27–16.45	SANDSTONE: fine to medium grained, light grey, irregular bedding.	FR	H	
16.45–18.04	LAMINITE: fine grained sandstone and siltstone, dark grey and light grey, bedded at 0-5°.	FR; SW (~17.50–17.72); FR (~17.72–18.04)	H; M; H	2.0, 1.8; 0.60
18.04	END OF BOREHOLE AT 18.04 m			

RL (m AHD) / Depth (m): 46 / 13; 45 / 14; 44 / 15; 43 / 16; 42 / 17; 41 / 18

Water Loss\Level: 90% RETURN

Defect spacing (mm) columns: 600, 200, 60, 20 (graphic bars, with closer spacing around 15.04–15.84 m and 17.52–18.02 m)

Defect Details – Specific
(12.15m) XWS, 0°, 2 mm.t
(13.46m) J, 55°, P, R, Cn
(15.04m) XWS, 0°, 3 mm.t
(15.08m) XWS, 0°, 8 mm.t
(15.10m) XWS, 0°, 4 mm.t
(15.14m) XWS, 0°, 2 mm.t
(15.19m) XWS, 0°, 15 mm.t
(15.22m) XWS, 0°, 2 mm.t
(15.30m) XWS, 0°, 20 mm.t
(15.34m) XWS, 0°, 1 mm.t
(15.52m) XWS, 0°, 30 mm.t
(15.56m) XWS, 0°, 1 mm.t
(15.67m) XWS, 5°, 2 mm.t
(15.84m) Cr, 0°, 30 mm.t
(17.52m) J, 40°, Ir, R, Cn
(17.99m) J, 40°, P, S, Cn
(18.02m) J, 40°, P, S, Cn

Formation: Bringelly Shale

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 33177PN
Borehole No: BH103
Depth: 12.13m → 18.04m
KODAK Gray Scale
KODAK Color Control Patches
33177PN BH103 START CORING AT 12.13m
12
13
14
15
16
17
18
END OF BOREHOLE AT 18.04m

JKGeotechnics

BOREHOLE LOG

Borehole No.
104
1 / 5

EASTING: 285329.23
NORTHING: 6257234.71

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** 62.41 m
Date: 6/10/20 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** A.C.K./N.E.S.

Groundwater Record	Samples	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	DS		62	0			FILL: Silty clay, medium plasticity, orange brown and grey brown, with fine to medium grained ironstone and siltstone gravel.	w<PL			APPEARS MODERATELY COMPACTED
	U50, DS	N = 8 3,4,4		0.5						270 490 450	
			61	1			as above, but grey brown.				
	U50, DS	N = 13 5,6,7		1.5						485 >600 >600	APPEARS WELL COMPACTED
ON COMPLETION OF AUGERING			60	2							
	ES, DS	N = 15 5,6,9	59	3						>600 >600 >600	
			58	4			FILL: Silty clay, medium plasticity, grey, with fine to medium grained siltstone gravel.				
	ES, DS	N=SPT 8/ 150mm REFUSAL		4.5							TOO FRIABLE FOR HP TESTING
			57	5							
	ES, DS	N=SPT 10/ 150mm REFUSAL	56	6							
				6.5							SOIL STRENGTH 'TC' BIT RESISTANCE WITH MODERATE TO HIGH BANDS

JKGeotechnics

BOREHOLE LOG

Borehole No.
104

EASTING: 285329.23
NORTHING: 6257234.71

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** 62.41 m
Date: 6/10/20 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** A.C.K./N.E.S.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
			55				FILL: Silty clay, medium plasticity, grey, with fine to medium grained siltstone gravel. *(continued)*	w<PL			
	ES, DS	N = 19 2,9,10		8							
▶			54					w>PL			
	ES, DS	N = 15 3,6,9	53	9						170 230	
			52	10			FILL: Gravelly silty clay, medium plasticity, grey, fine to medium grained siltstone gravel.				
	ES, DS	N = 17 5,9,8	51	11							TOO GRAVELLY FOR HP TESTING
	ES, DS	N = 12 4,5,7	50	12							
			49	13							
	ES, DS	N = 17 4,6,11					as above, but trace of fine to medium grained sandstone gravel.				

JKGeotechnics

BOREHOLE LOG

Borehole No.
104

EASTING: 285329.23
NORTHING: 6257234.71

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** 62.41 m
Date: 6/10/20 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** A.C.K./N.E.S.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
											w>PL			
						48			-	SILTSTONE: dark grey.	SW	H		HIGH RESISTANCE
						47	15			REFER TO CORED BOREHOLE LOG				
						46	16							
						45	17							
						44	18							
						43	19							
						42	20							

JKGeotechnics

CORED BOREHOLE LOG

EASTING: 285329.23
NORTHING: 6257234.71

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**Core Size:**	**R.L. Surface:** 62.41 m
Date: 6/10/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** A.C.K./N.E.S.

Columns: Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH) | DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20) | DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness) Specific / General | Formation

RL (m AHD): 48, 47, 46, 45, 44, 43, 42
Depth (m): 15, 16, 17, 18, 19, 20

Water Loss\Level: 70% RETURN

Depth	Core Description	Weathering	Strength	Point Load $I_s(50)$	Defect Details
15.03	START CORING AT 15.03m				
15.03	SILTSTONE: dark grey, with light grey fine grained sandstone seams, bedded at 0-5°.	FR	M - H	0.80, 1.0, 2.0	(15.52m) J, 85°, C, R, Cn (15.86m) Cr, 15°, 20 mm.t (16.02m) XWS, 10°, 5 mm.t (16.32m) XWS, 5°, 10 mm.t
	NO CORE 0.12m				
	SILTSTONE: dark grey, with light grey fine grained sandstone seams, bedded at 0-5°.	XW	Hd		
		FR	M	0.50, 0.30	(16.69m) XWS, 5°, 2 mm.t
			H - VH	1.0	
	SANDSTONE: fine grained, light grey, with grey laminae, bedded at 0-5°.			4.4	
	LAMINITE: fine grained sandstone and siltstone, light grey and dark grey, bedded at 0-5°.			4.2	
			M	0.50, 0.80	(19.43m) XWS, 5°, 3 mm.t
			H - VH	1.1, 1.9	

Formation: Bringelly Shale

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
104

EASTING: 285329.23
NORTHING: 6257234.71

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN
Core Size:
R.L. Surface: 62.41 m
Date: 6/10/20
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: A.C.K./N.E.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	SPACING (mm)	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness — Specific / General	Formation
					SANDSTONE: fine to medium grained, light grey. *(continued)*	FR	H	•3.6			
					END OF BOREHOLE AT 21.16 m						
		41									
			22								
		40									
			23								
		39									
			24								
		38									
			25								
		37									
			26								
		36									
			27								
		35									

Strength scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH. Spacing scale: 600, 200, 60, 20.

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 33177PN
Borehole No: BH104
Depth: 15.03m → 21.16m
KODAK Gray Scale
KODAK Color Control Patches
33177PN BH104 START CORING AT 15.03m
15
16
NO CORE 0.12m
17
18
19
20
21
END OF BOREHOLE AT 21.16m

JKGeotechnics

CONE PENETROMETER TEST RESULTS

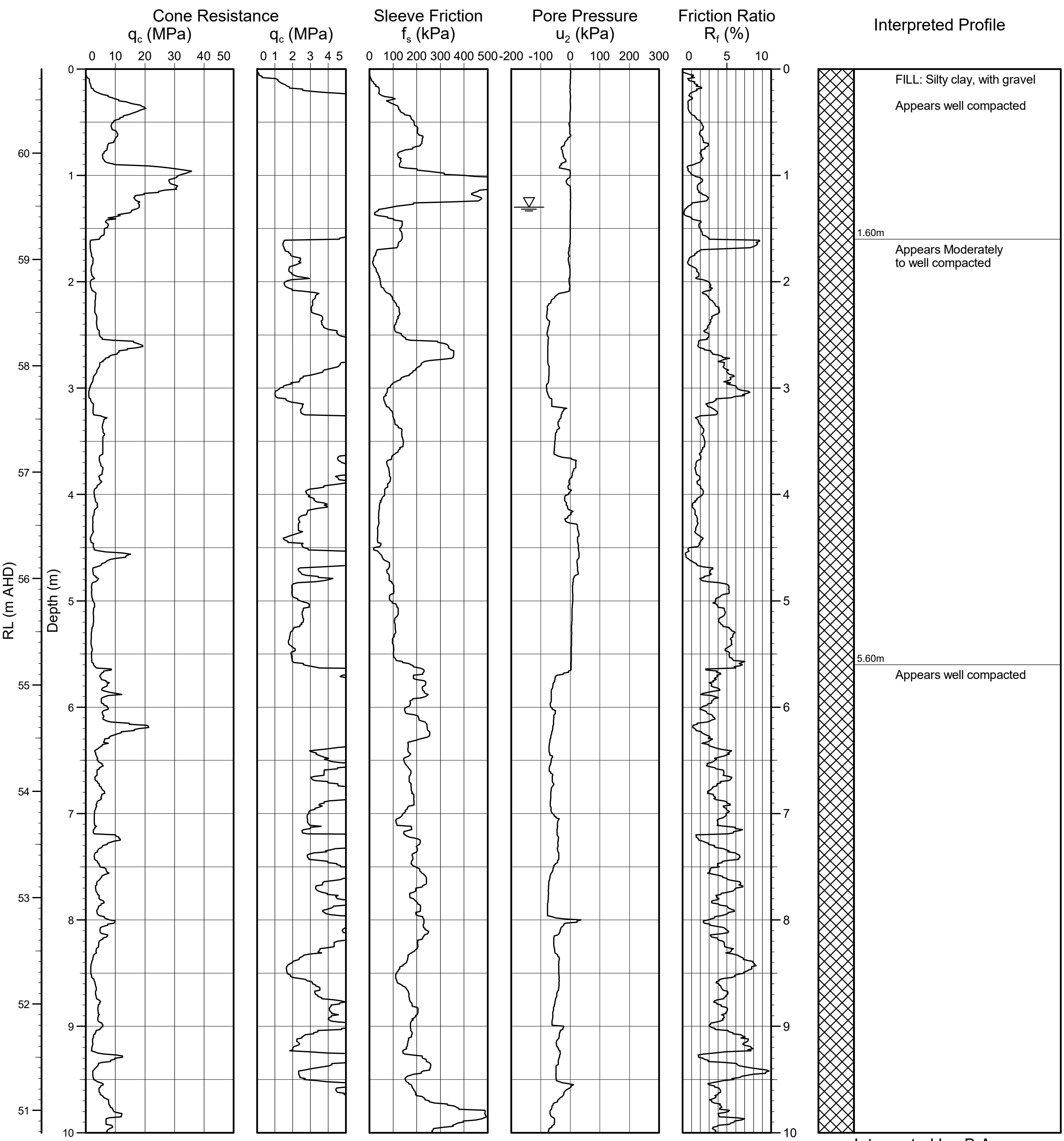
CPT No. 105

1 / 2

EASTING: 285303.45
NORTHING: 6257340.69

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN | **R.L. Surface:** 60.79 m | **Data File:** J:\6f \33177PN Glenmore Park
Date: 7/10/20 | **Datum:** AHD | **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

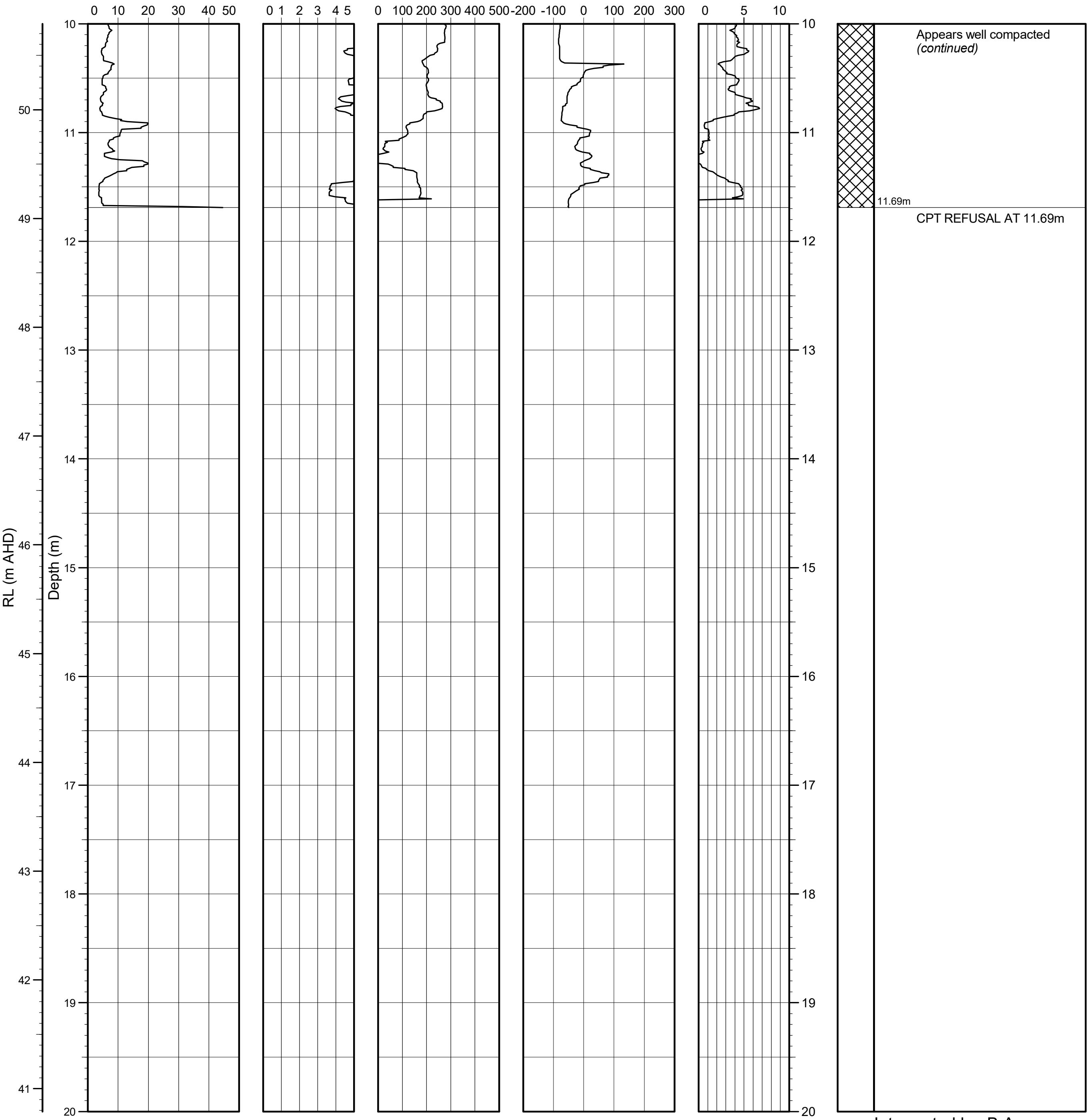
CONE PENETROMETER TEST RESULTS

CPT No. 105
2 / 2

EASTING: 285303.45
NORTHING: 6257340.69

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **R.L. Surface:** 60.79 m **Data File:** J:\6f \33177PN Glenmore Park
Date: 7/10/20 **Datum:** AHD **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

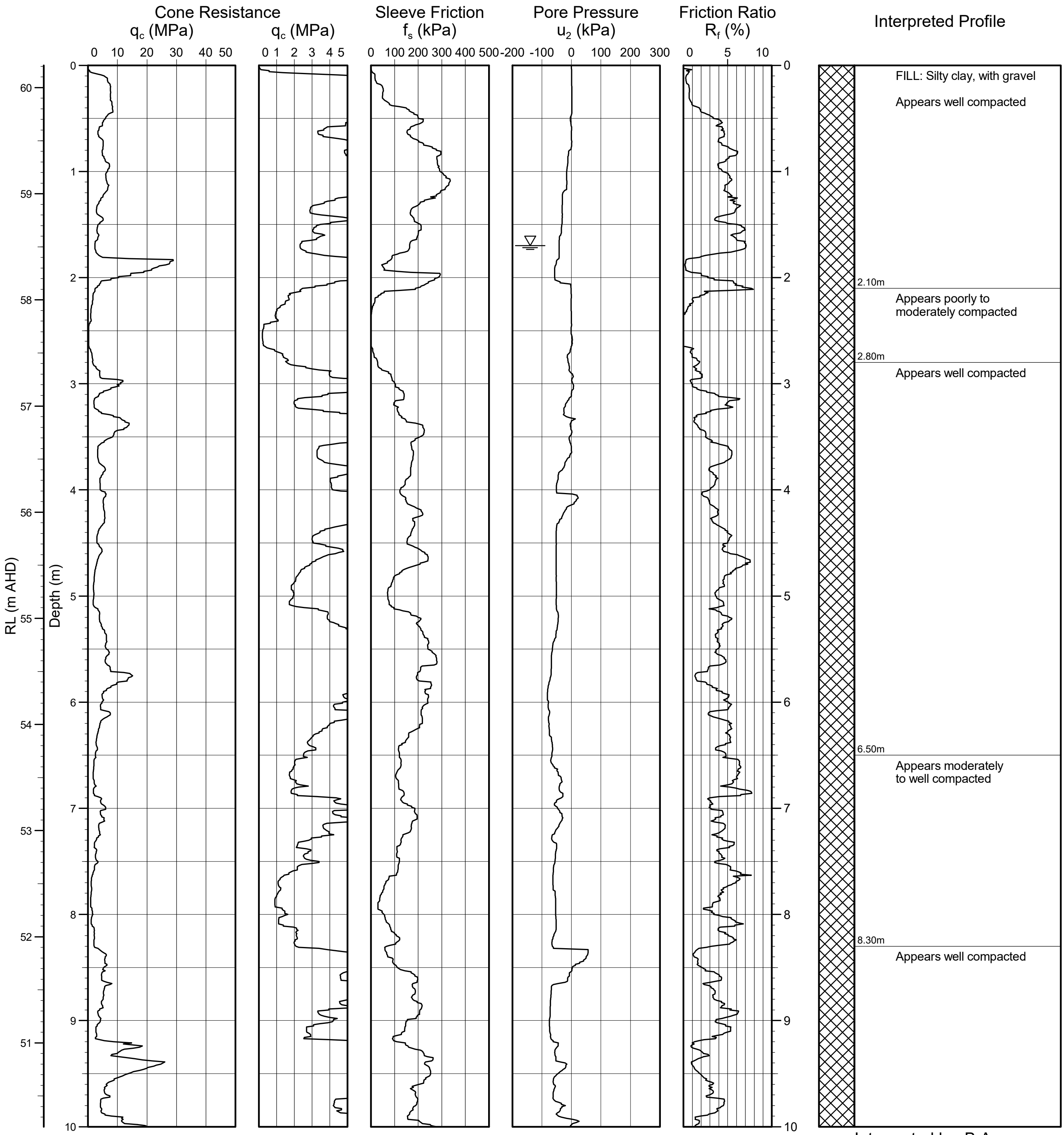
CONE PENETROMETER TEST RESULTS

CPT No.
106
1 / 2

EASTING: 285337.69
NORTHING: 6257338.38

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 60.21 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 8/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No. **106**

2 / 2

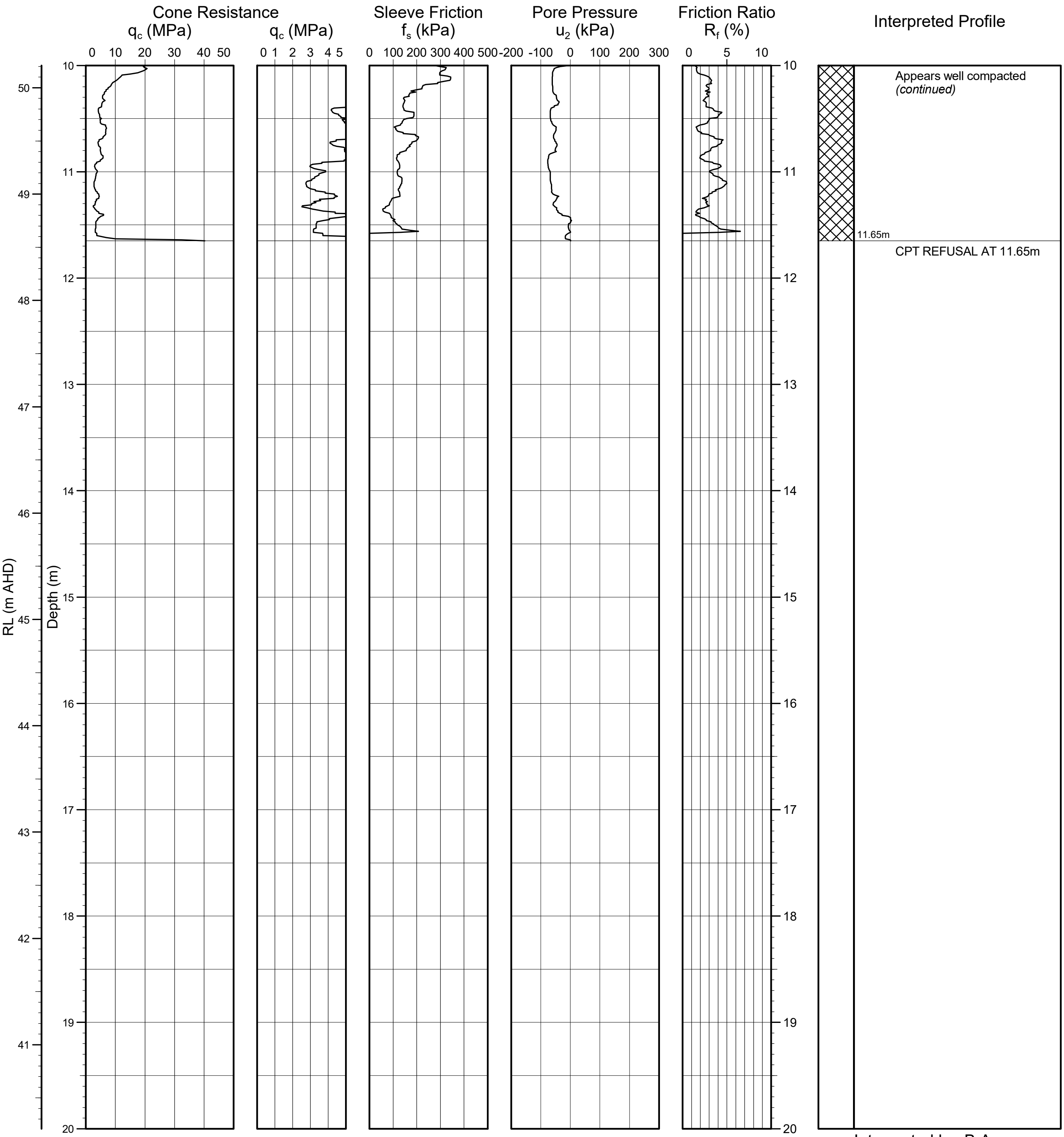
EASTING: 285337.69
NORTHING: 6257338.38

Client: NSW DEPARTMENT OF EDUCATION

Project: PROPOSED PUBLIC SCHOOL

Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 60.21 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 8/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

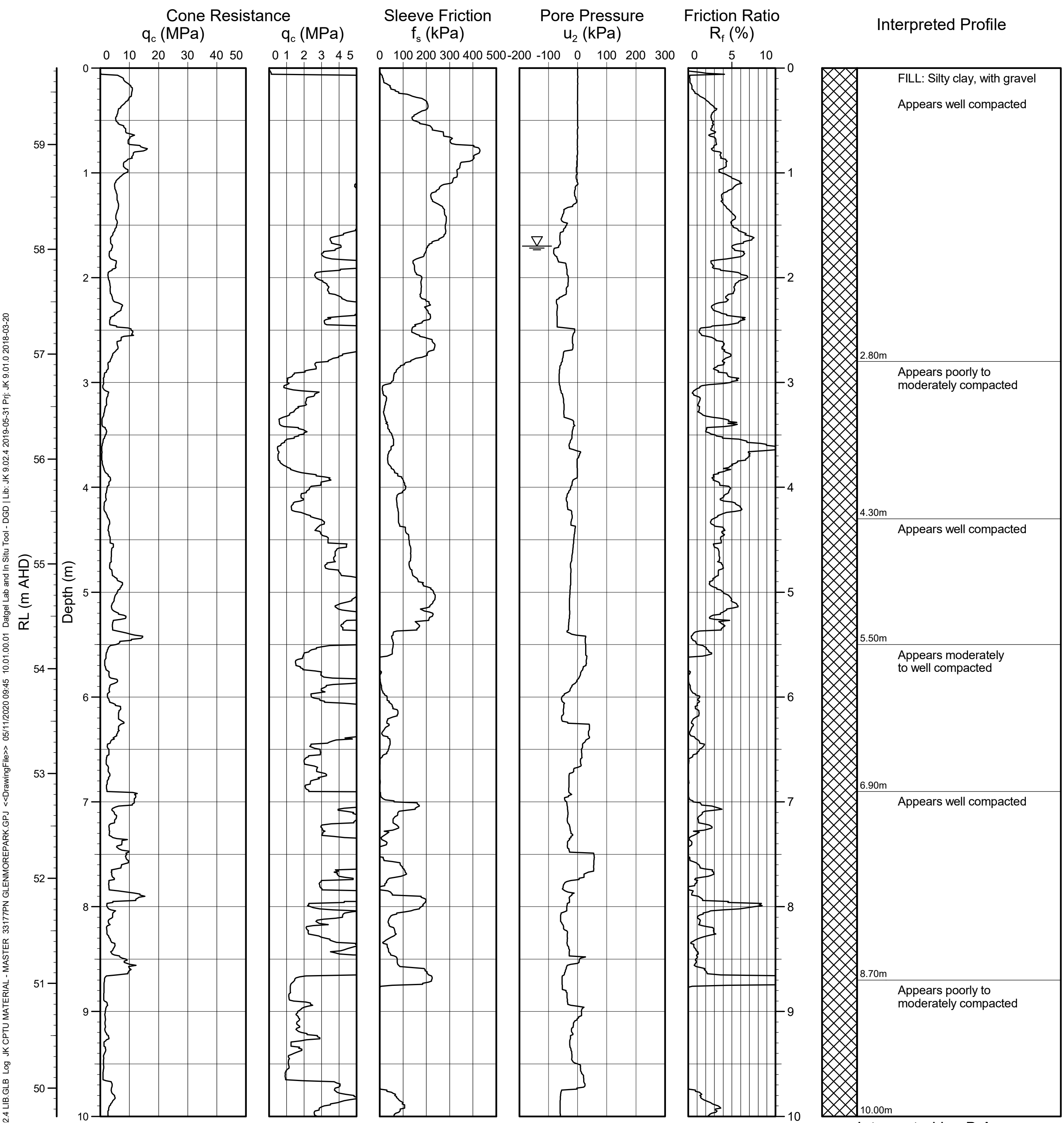
CONE PENETROMETER TEST RESULTS

CPT No.
107
1 / 2

EASTING: 285374.91
NORTHING: 6257334.49

Client:	NSW DEPARTMENT OF EDUCATION
Project:	PROPOSED PUBLIC SCHOOL
Location:	1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 59.73 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 9/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

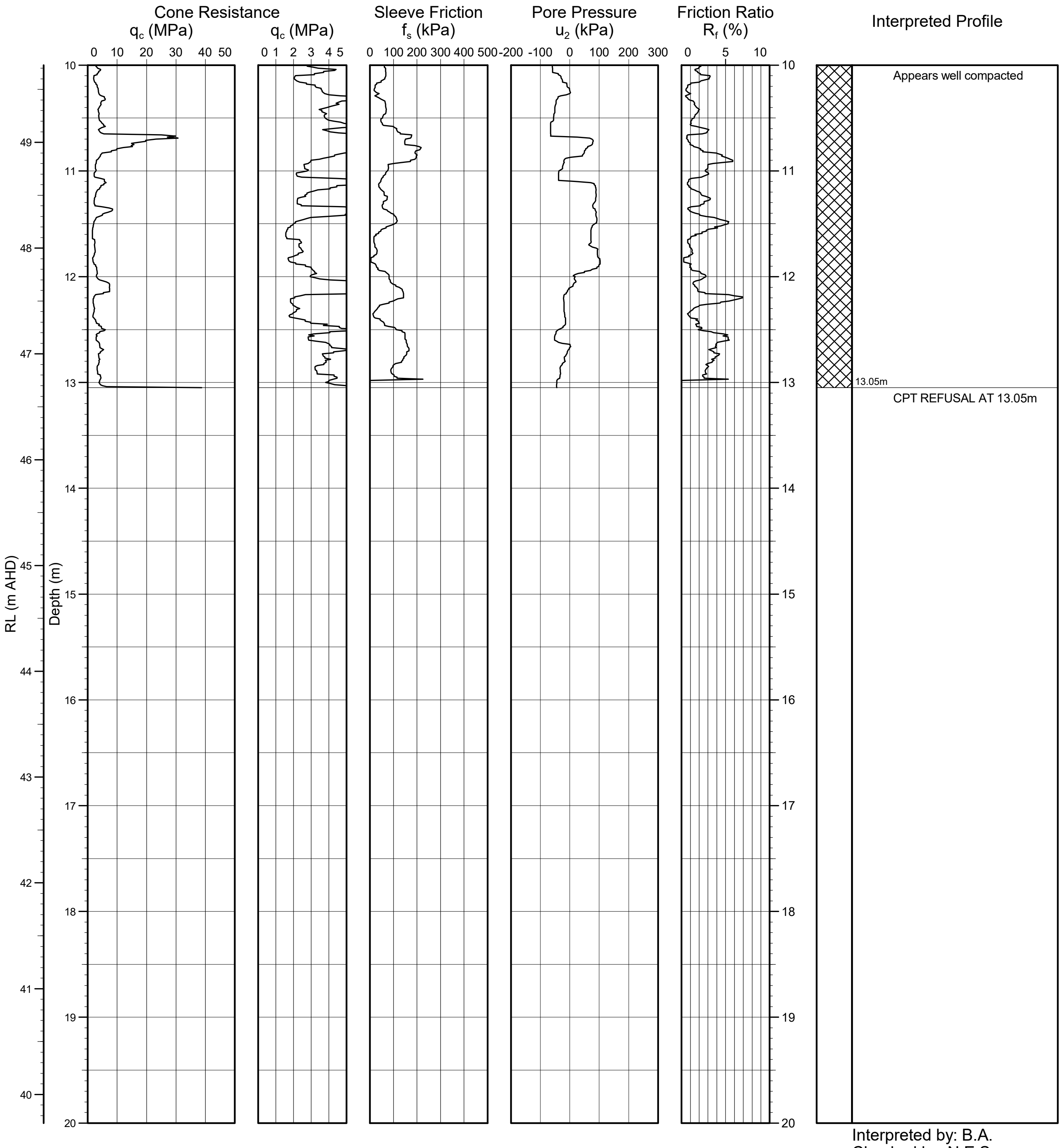
CONE PENETROMETER TEST RESULTS

CPT No.
107
2 / 2

EASTING: 285374.91
NORTHING: 6257334.49

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 59.73 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 9/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No. 108

1 / 2

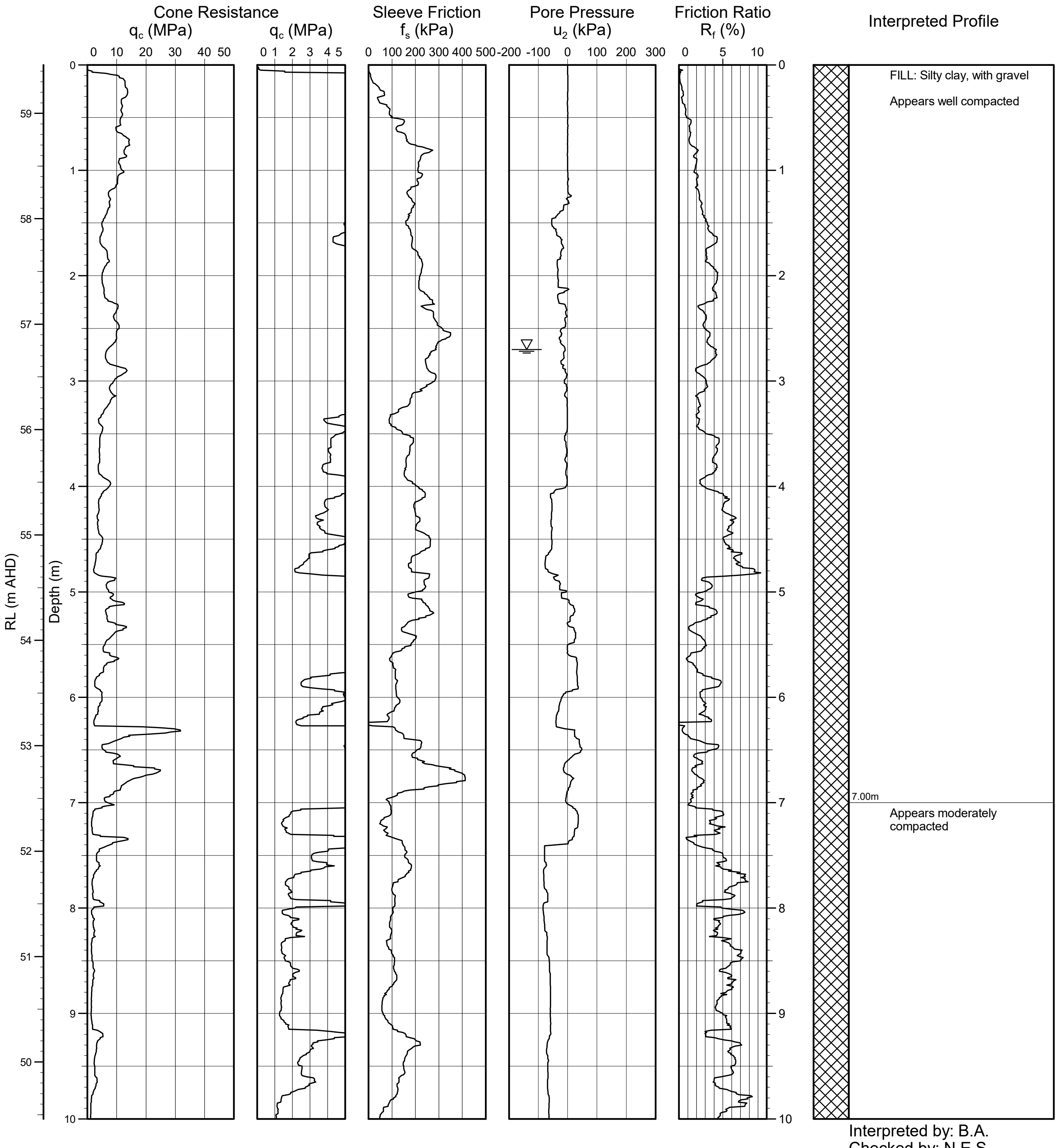
EASTING: 285401.74
NORTHING: 6257329.79

Client: NSW DEPARTMENT OF EDUCATION

Project: PROPOSED PUBLIC SCHOOL

Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 59.46 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 8/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

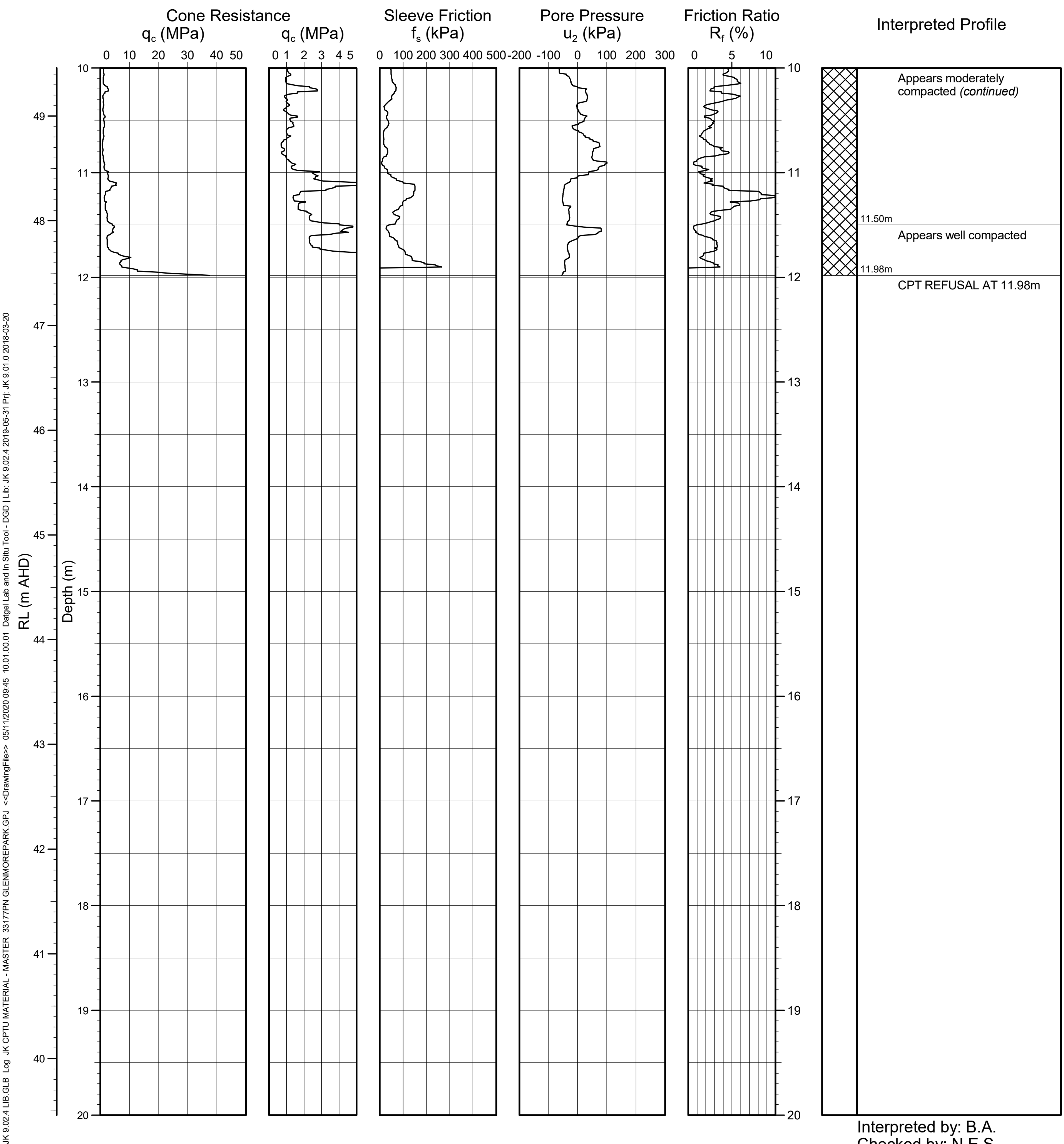
CONE PENETROMETER TEST RESULTS

CPT No.
108
2 / 2

EASTING: 285401.74
NORTHING: 6257329.79

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **R.L. Surface:** 59.46 m **Data File:** J:\6f \33177PN Glenmore Park
Date: 8/10/20 **Datum:** AHD **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

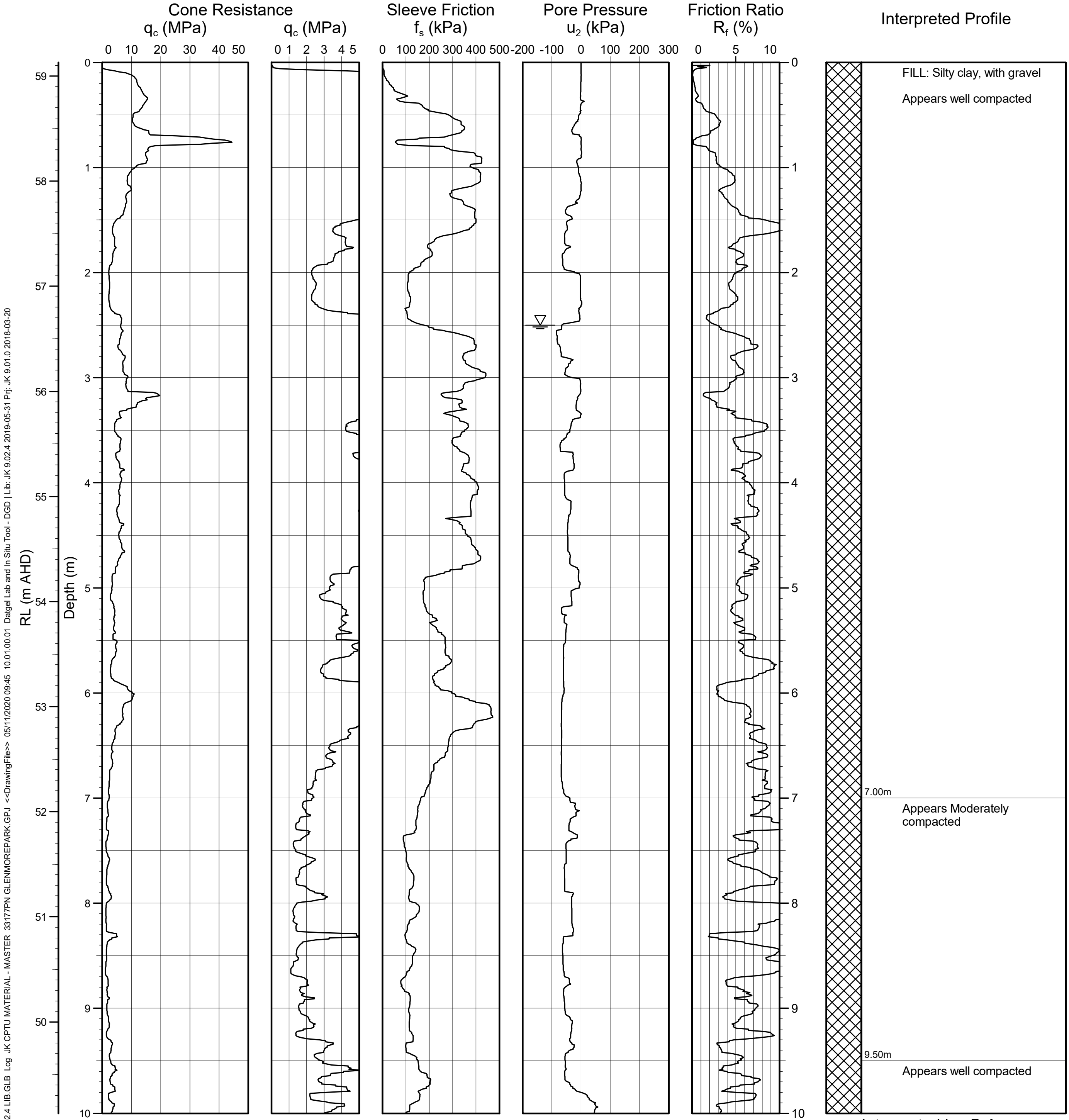
CPT No. 109

1 / 2

EASTING: 285440.71
NORTHING: 6257316.06

Client:	NSW DEPARTMENT OF EDUCATION
Project:	PROPOSED PUBLIC SCHOOL
Location:	1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 59.13 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 6/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JK 9.02.4 LIB.GLB Log JK CPTU MATERIAL - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 05/11/2020 09:45 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

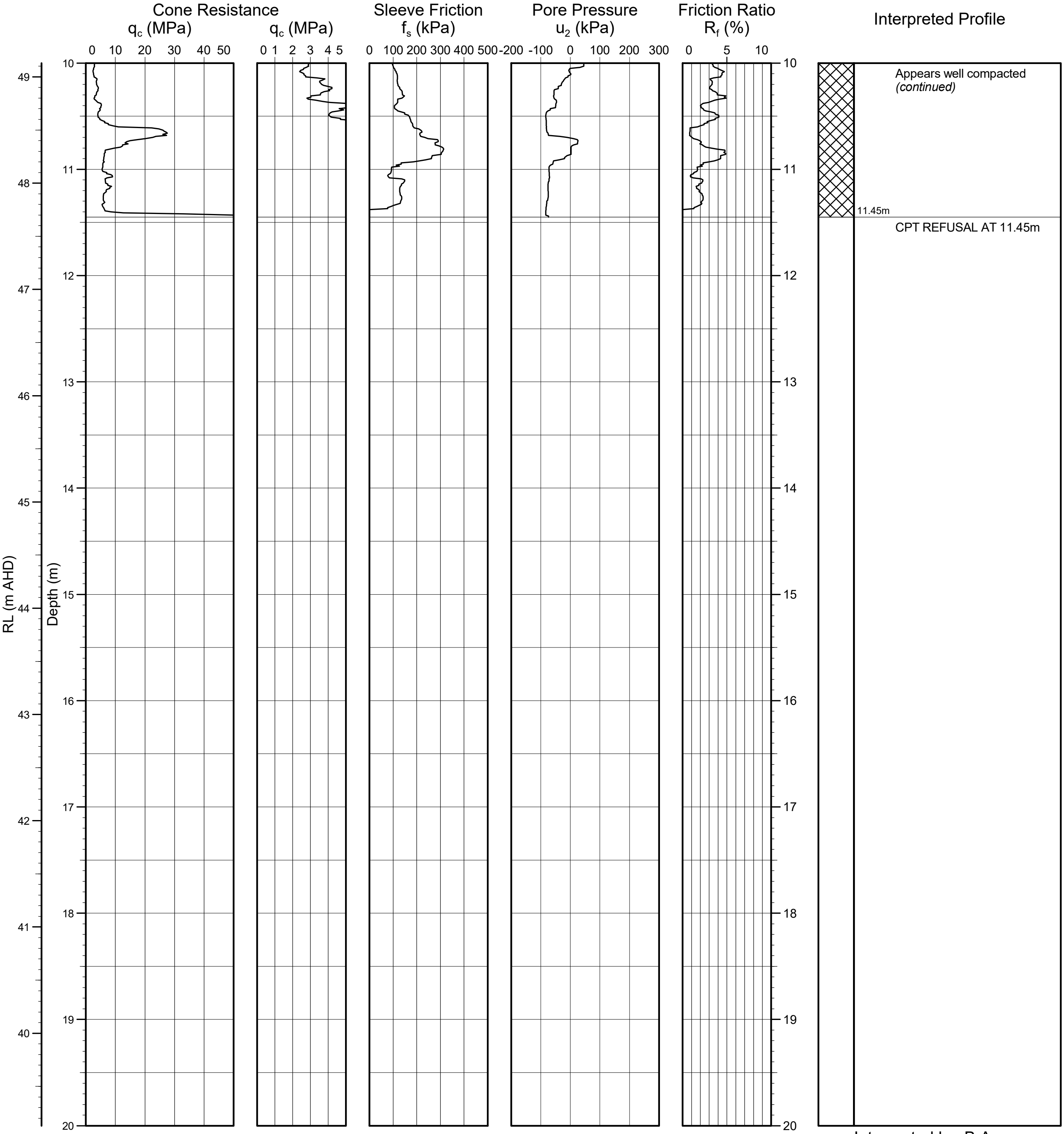
CONE PENETROMETER TEST RESULTS

CPT No.
109
2 / 2

EASTING: 285440.71
NORTHING: 6257316.06

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN | **R.L. Surface:** 59.13 m | **Data File:** J:\6f \33177PN Glenmore Park
Date: 6/10/20 | **Datum:** AHD | **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

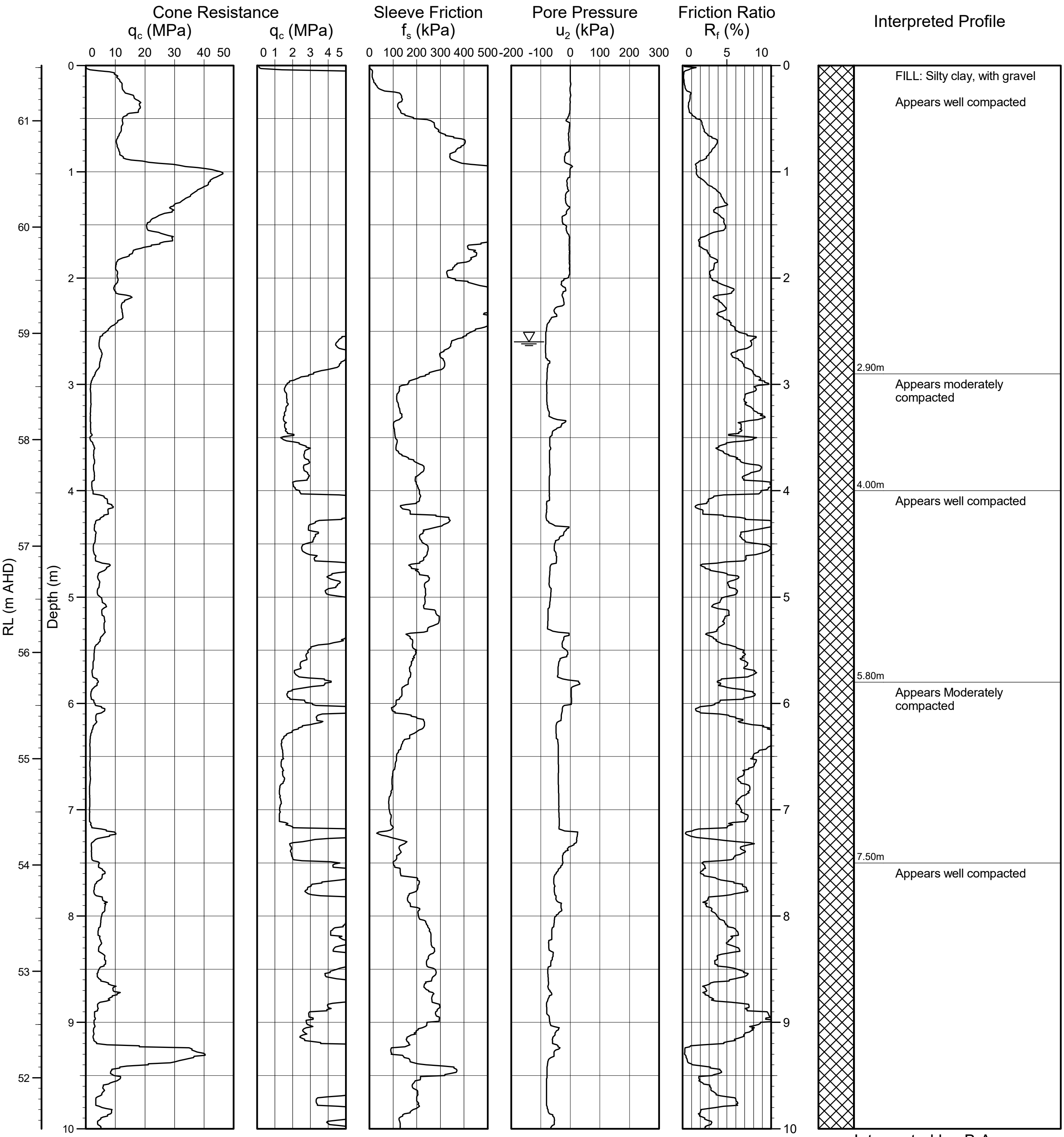
CONE PENETROMETER TEST RESULTS

CPT No.
110
1 / 2

EASTING: 285294.65
NORTHING: 6257311.33

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN | **R.L. Surface:** 61.52 m | **Data File:** J:\6f \33177PN Glenmore Park
Date: 6/10/20 | **Datum:** AHD | **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

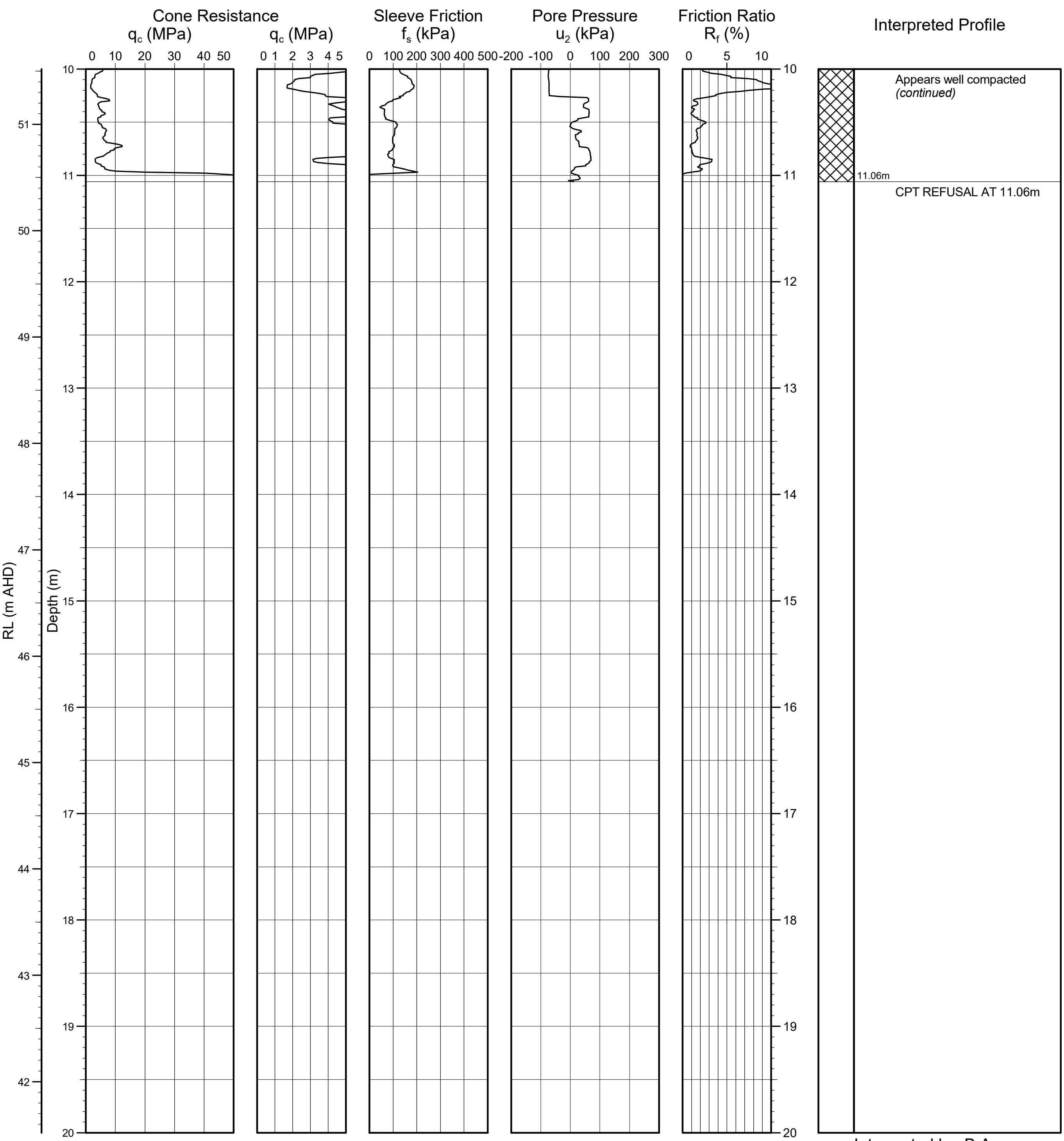
CPT No. **110**

2 / 2

EASTING: 285294.65
NORTHING: 6257311.33

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **R.L. Surface:** 61.52 m **Data File:** J:\6f \33177PN Glenmore Park
Date: 6/10/20 **Datum:** AHD **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

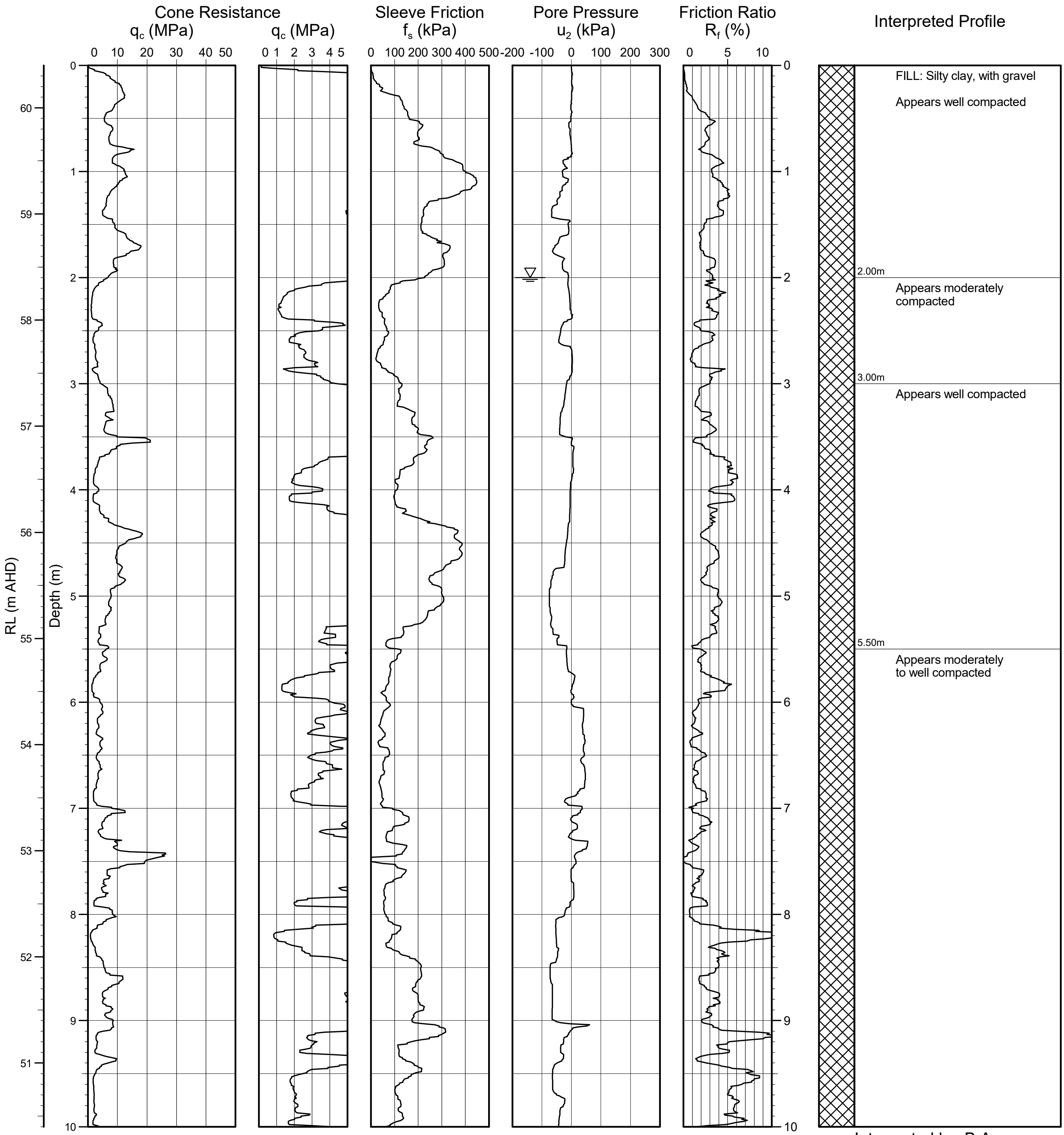
CONE PENETROMETER TEST RESULTS

CPT No.
111
1 / 2

EASTING: 285335.25
NORTHING: 6257305.67

Client:	NSW DEPARTMENT OF EDUCATION
Project:	PROPOSED PUBLIC SCHOOL
Location:	1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 60.40 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 8/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JK 9.02.4 LIB.GLB Log JK CPTU MATERIAL - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 05/11/2020 09:45 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

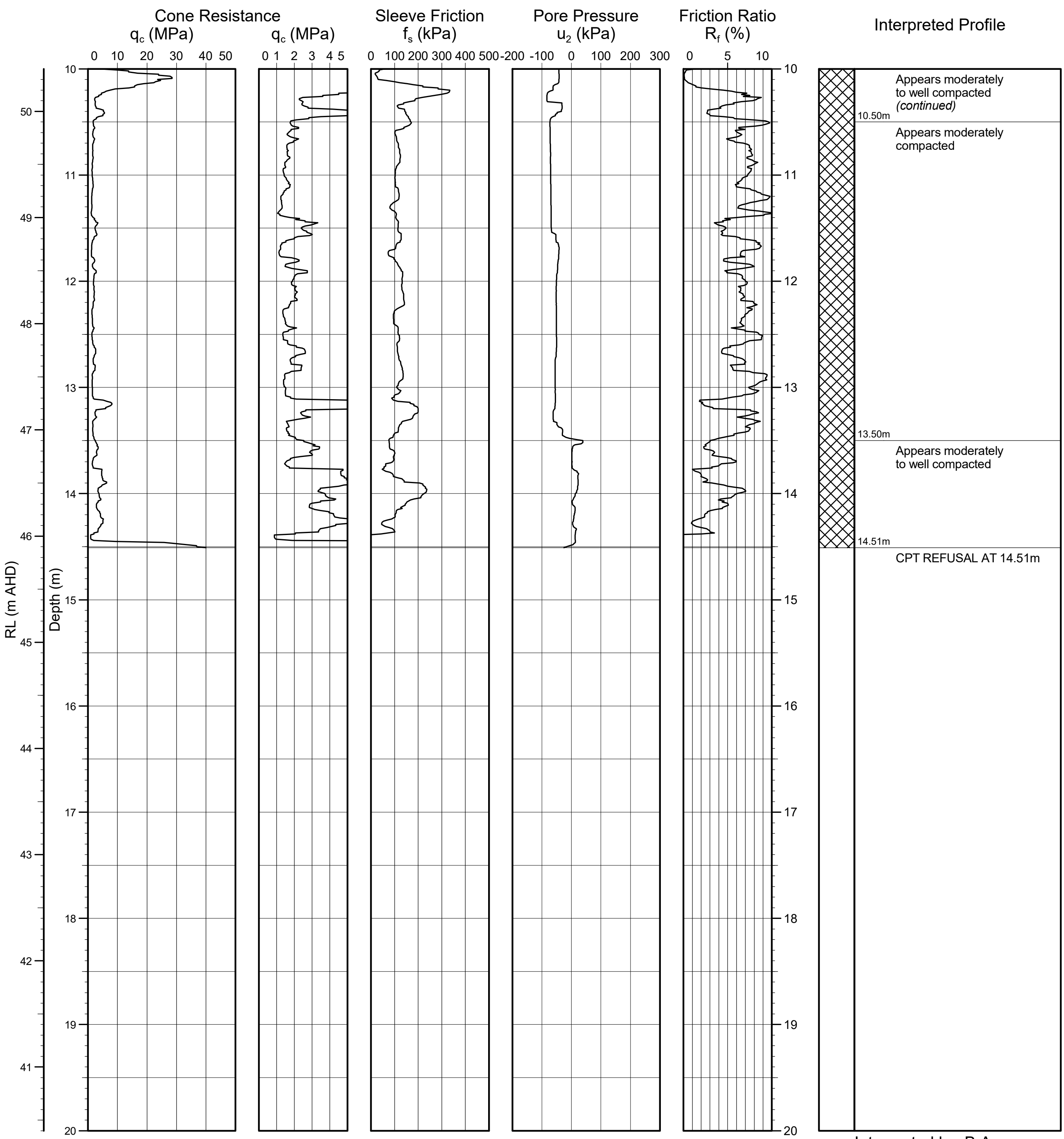
CONE PENETROMETER TEST RESULTS

CPT No.
111

EASTING: 285335.25
NORTHING: 6257305.67

Client:	NSW DEPARTMENT OF EDUCATION
Project:	PROPOSED PUBLIC SCHOOL
Location:	1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 60.40 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 8/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

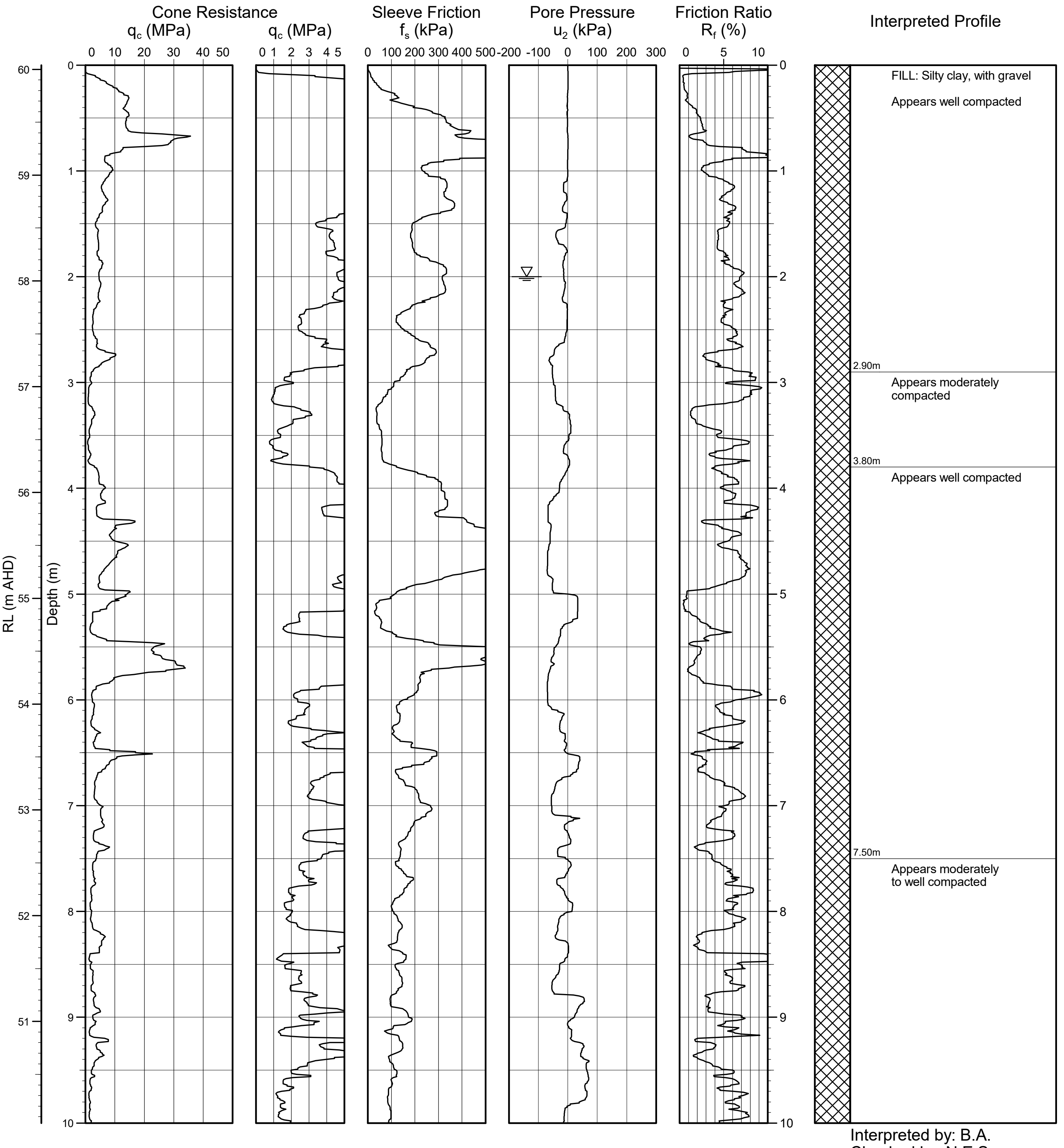
CPT No. 112

1 / 2

EASTING: 285370.38
NORTHING: 6257306.39

Client:	NSW DEPARTMENT OF EDUCATION
Project:	PROPOSED PUBLIC SCHOOL
Location:	1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 60.04 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 8/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JK 9.02.4 LIB.GLB Log JK CPTU MATERIAL - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 05/11/2020 09:46 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

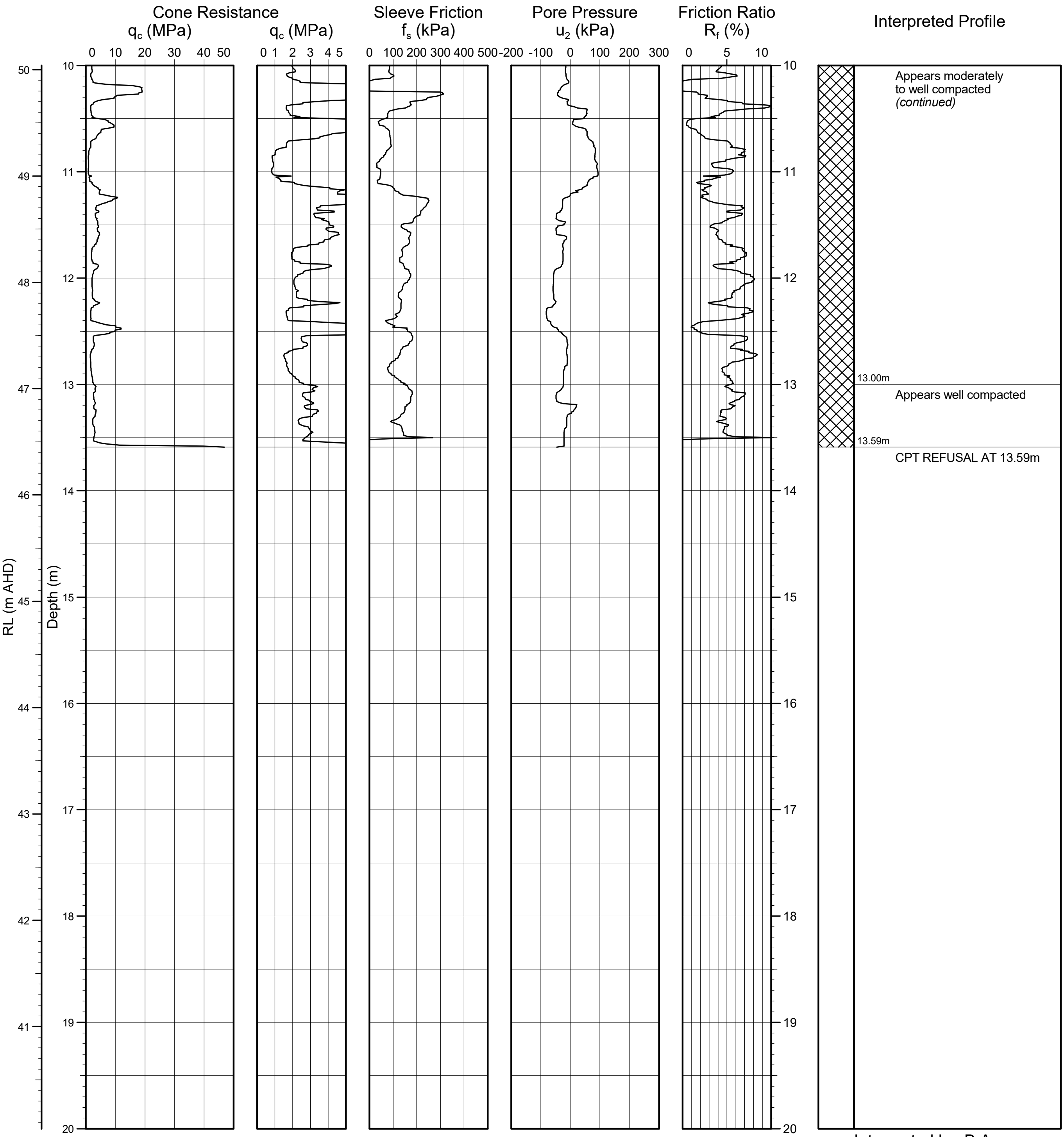
CONE PENETROMETER TEST RESULTS

CPT No.
112
2 / 2

EASTING: 285370.38
NORTHING: 6257306.39

Client:	NSW DEPARTMENT OF EDUCATION
Project:	PROPOSED PUBLIC SCHOOL
Location:	1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 60.04 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 8/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JK 9.02.4 LIB.GLB Log JK CPTU MATERIAL - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 05/11/2020 09:46 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

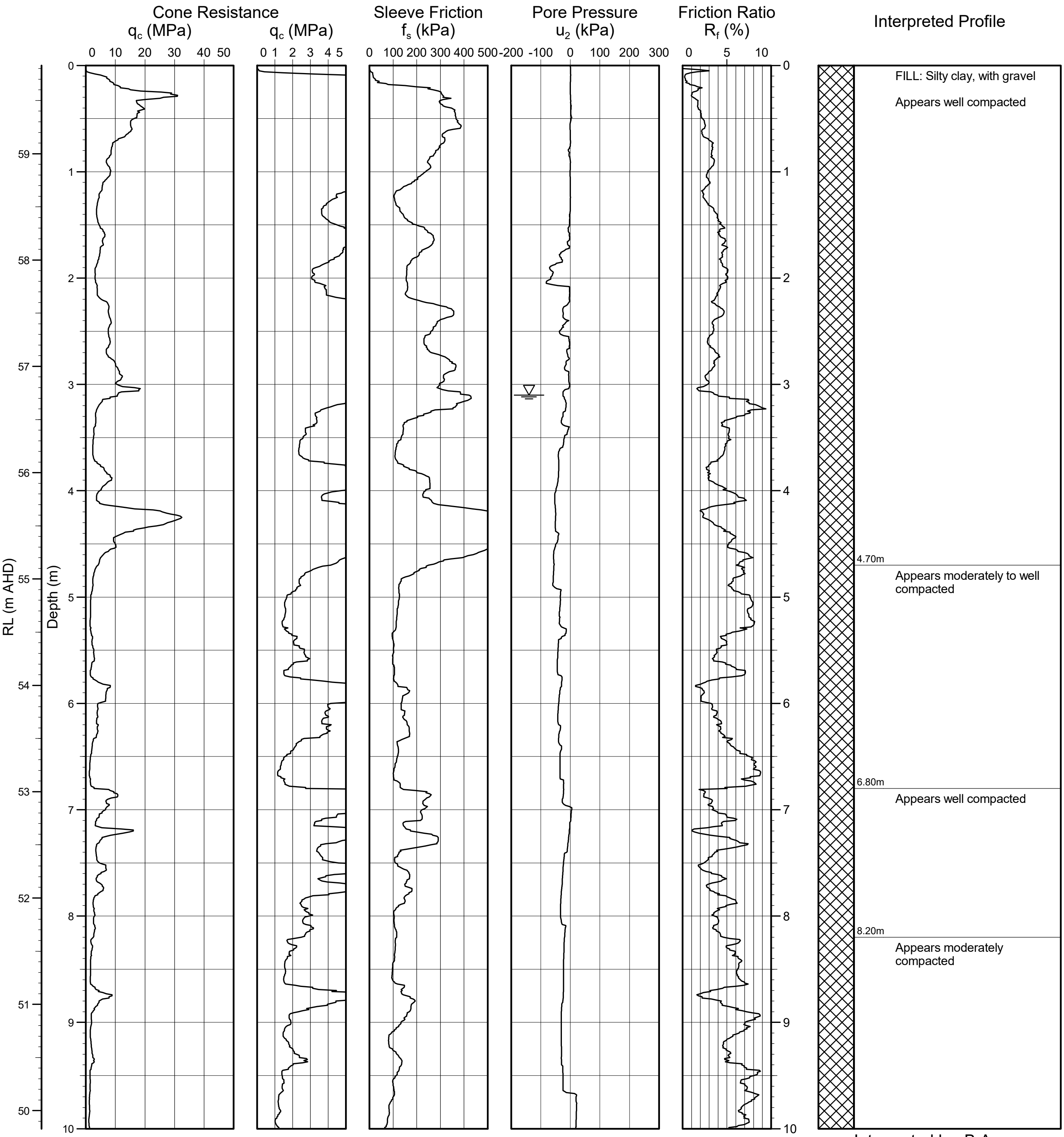
CONE PENETROMETER TEST RESULTS

CPT No.
113
1 / 2

EASTING: 285397.23
NORTHING: 6257303.60

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 59.83 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 9/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JK 9.02.4 LIB.GLB Log JK CPTU MATERIAL - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 05/11/2020 09:46 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

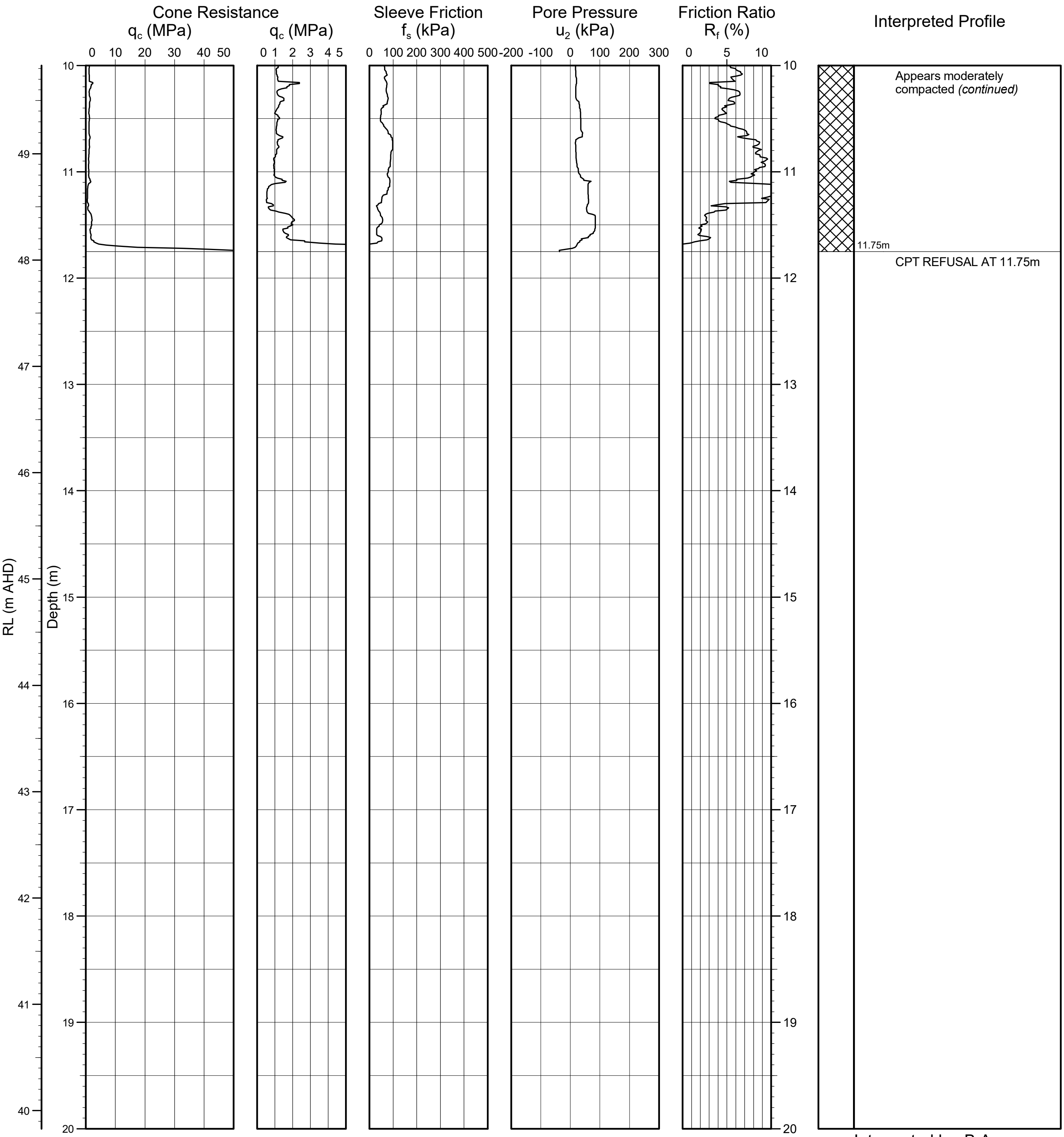
CONE PENETROMETER TEST RESULTS

CPT No.
113
2 / 2

EASTING: 285397.23
NORTHING: 6257303.60

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 59.83 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 9/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JK 9.02.4 LIB.GLB Log JK CPTU MATERIAL - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 05/11/2020 09:46 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

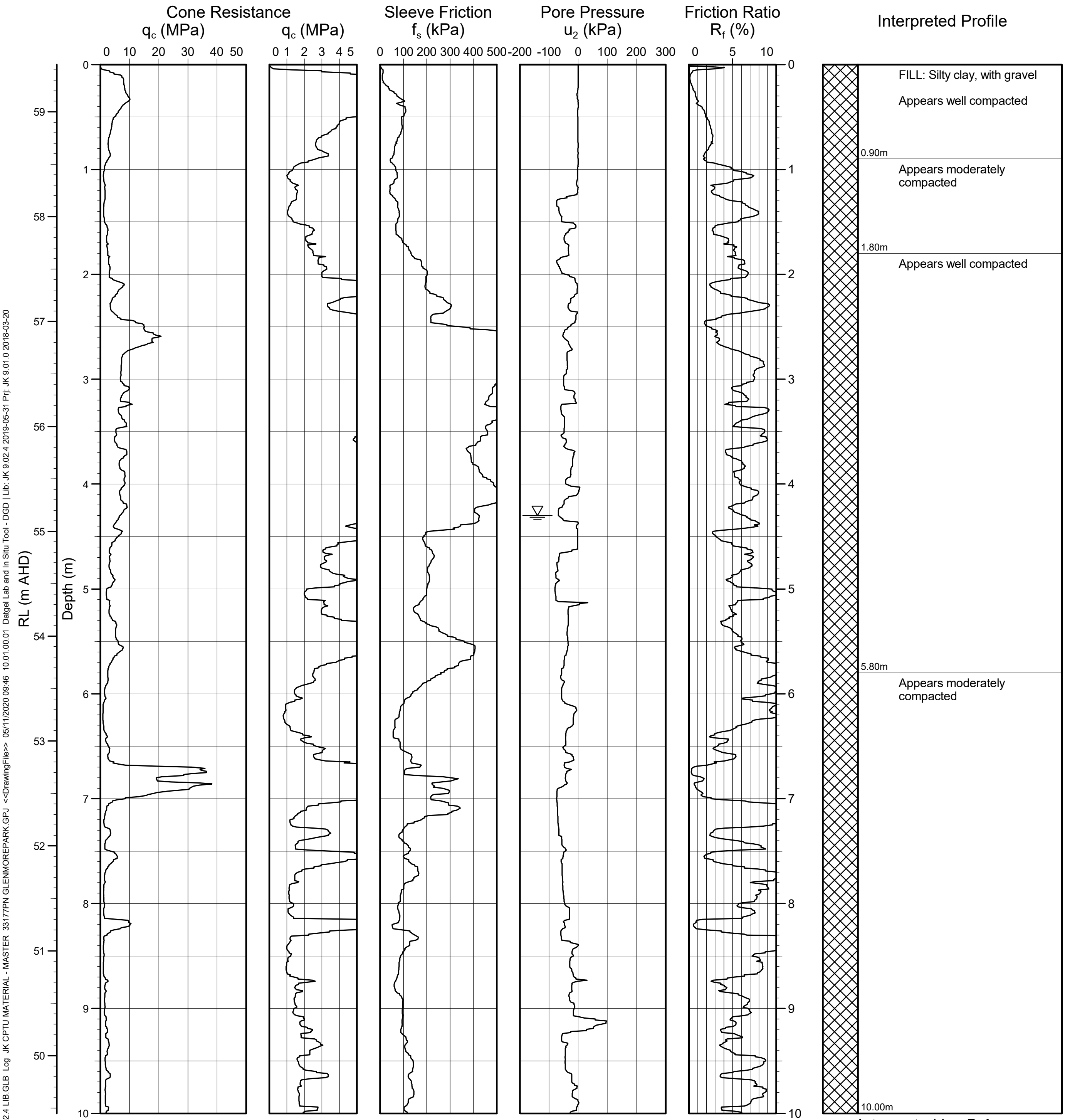
CONE PENETROMETER TEST RESULTS

CPT No. 114

EASTING: 285438.86
NORTHING: 6257298.57

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **R.L. Surface:** 59.45 m **Data File:** J:\6f \33177PN Glenmore Park
Date: 6/10/20 **Datum:** AHD **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

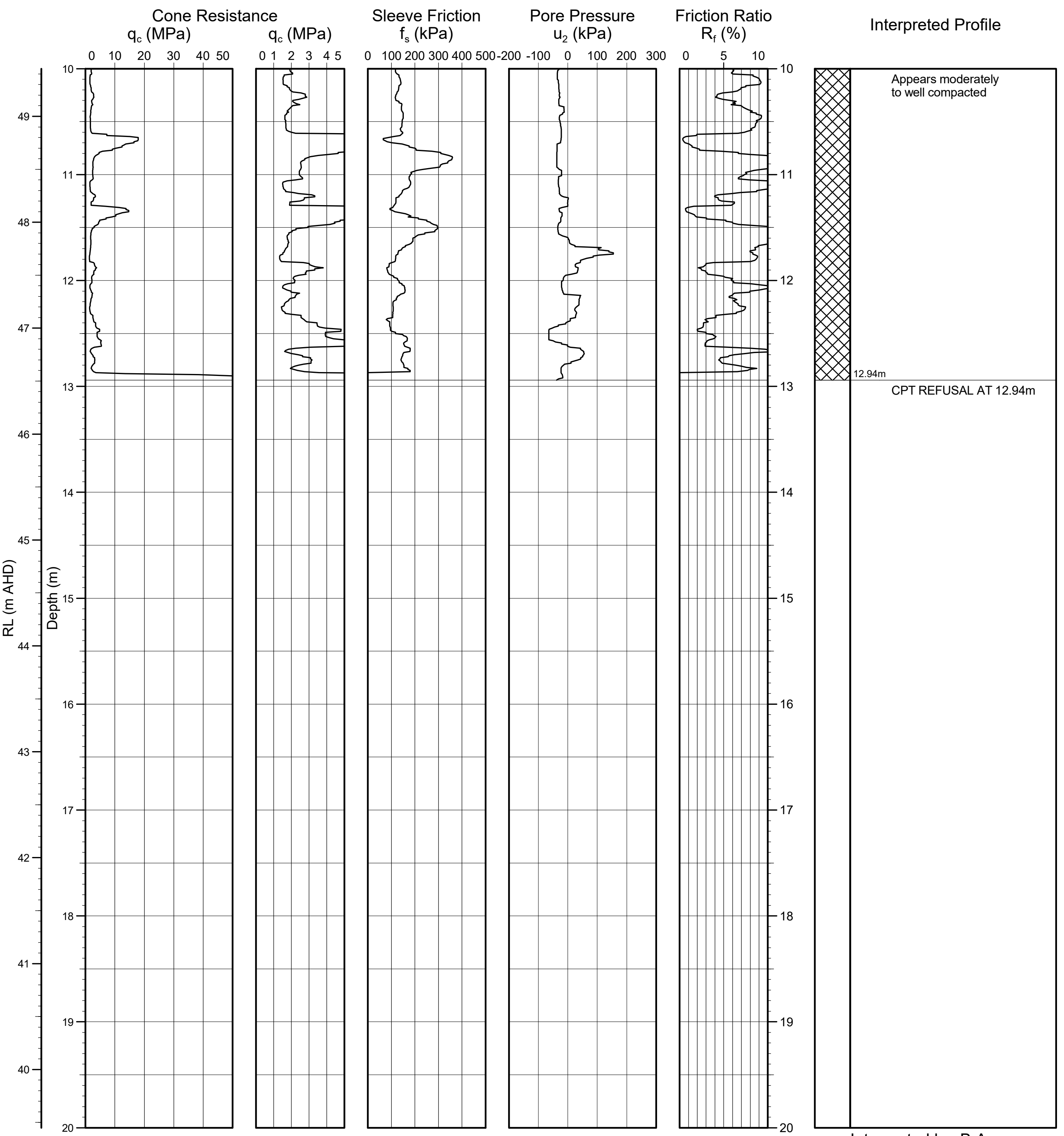
CONE PENETROMETER TEST RESULTS

CPT No. 114

EASTING: 285438.86
NORTHING: 6257298.57

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **R.L. Surface:** 59.45 m **Data File:** J:\6f \33177PN Glenmore Park
Date: 6/10/20 **Datum:** AHD **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

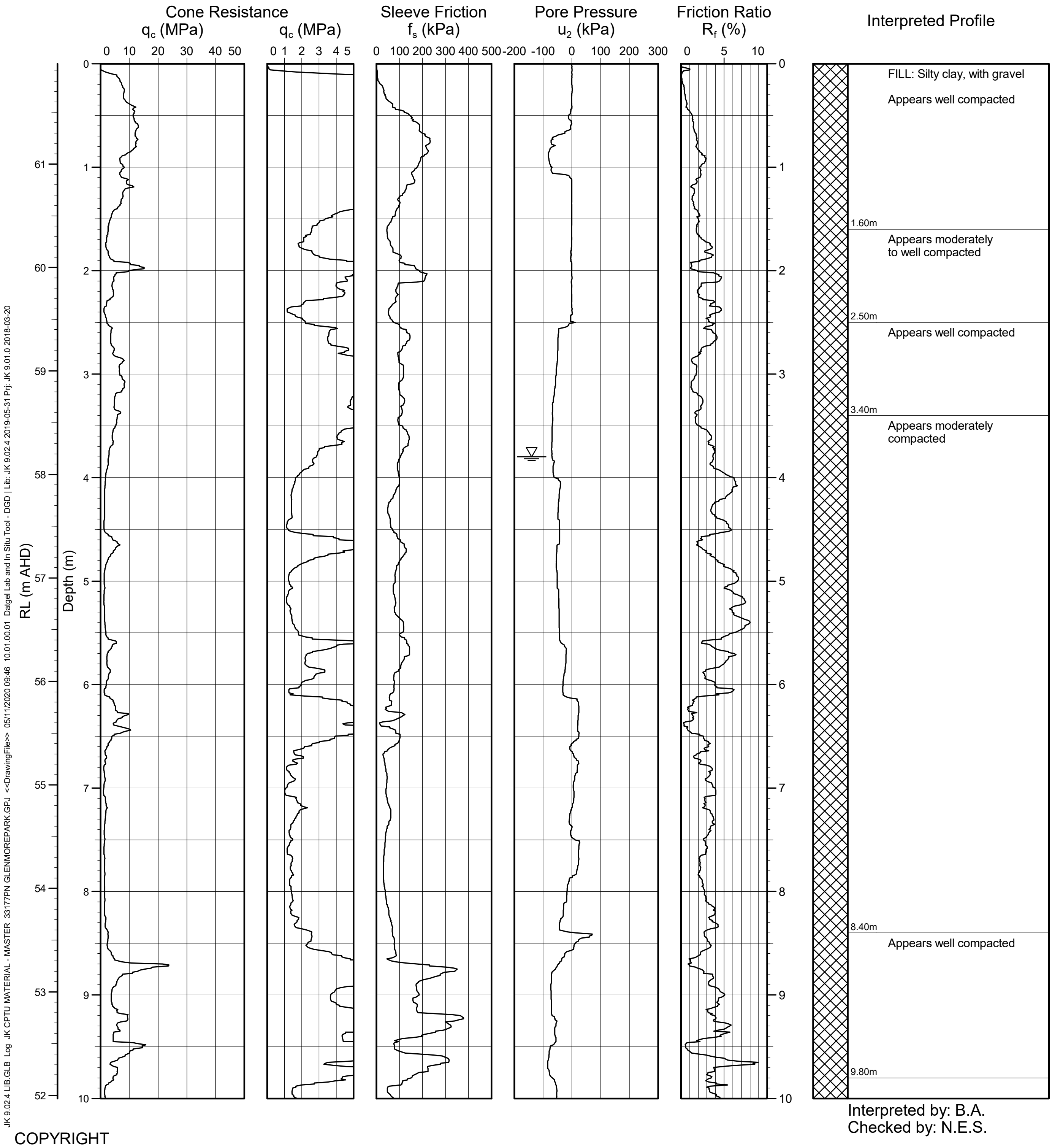
CPT No. 115

1 / 2

EASTING: 285292.73
NORTHING: 6257280.57

Client:	NSW DEPARTMENT OF EDUCATION
Project:	PROPOSED PUBLIC SCHOOL
Location:	1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 61.97 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 7/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No. 115

2 / 2

EASTING: 285292.73
NORTHING: 6257280.57

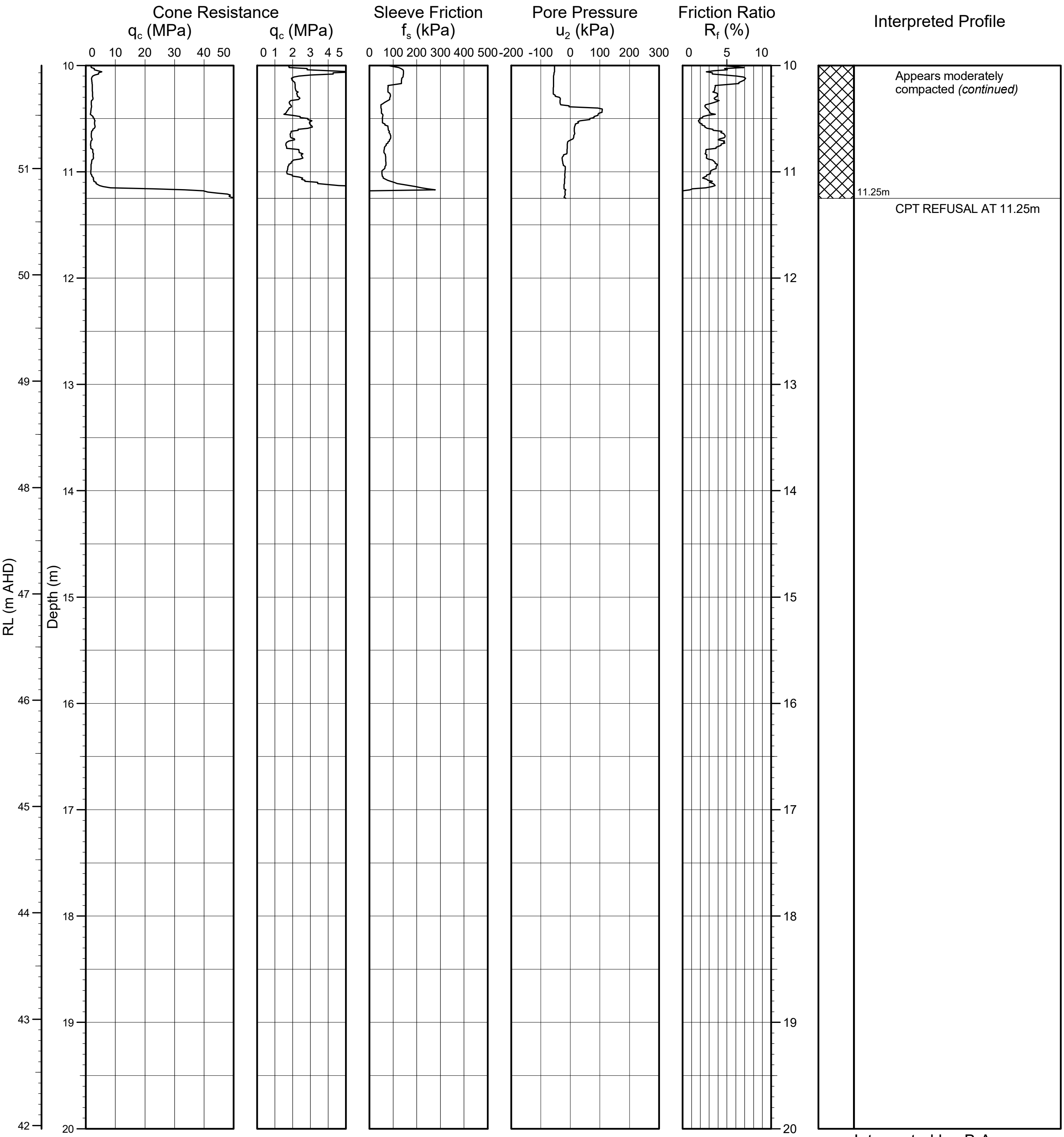
Client: NSW DEPARTMENT OF EDUCATION

Project: PROPOSED PUBLIC SCHOOL

Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **R.L. Surface:** 61.97 m **Data File:** J:\6f \33177PN Glenmore Park

Date: 7/10/20 **Datum:** AHD **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

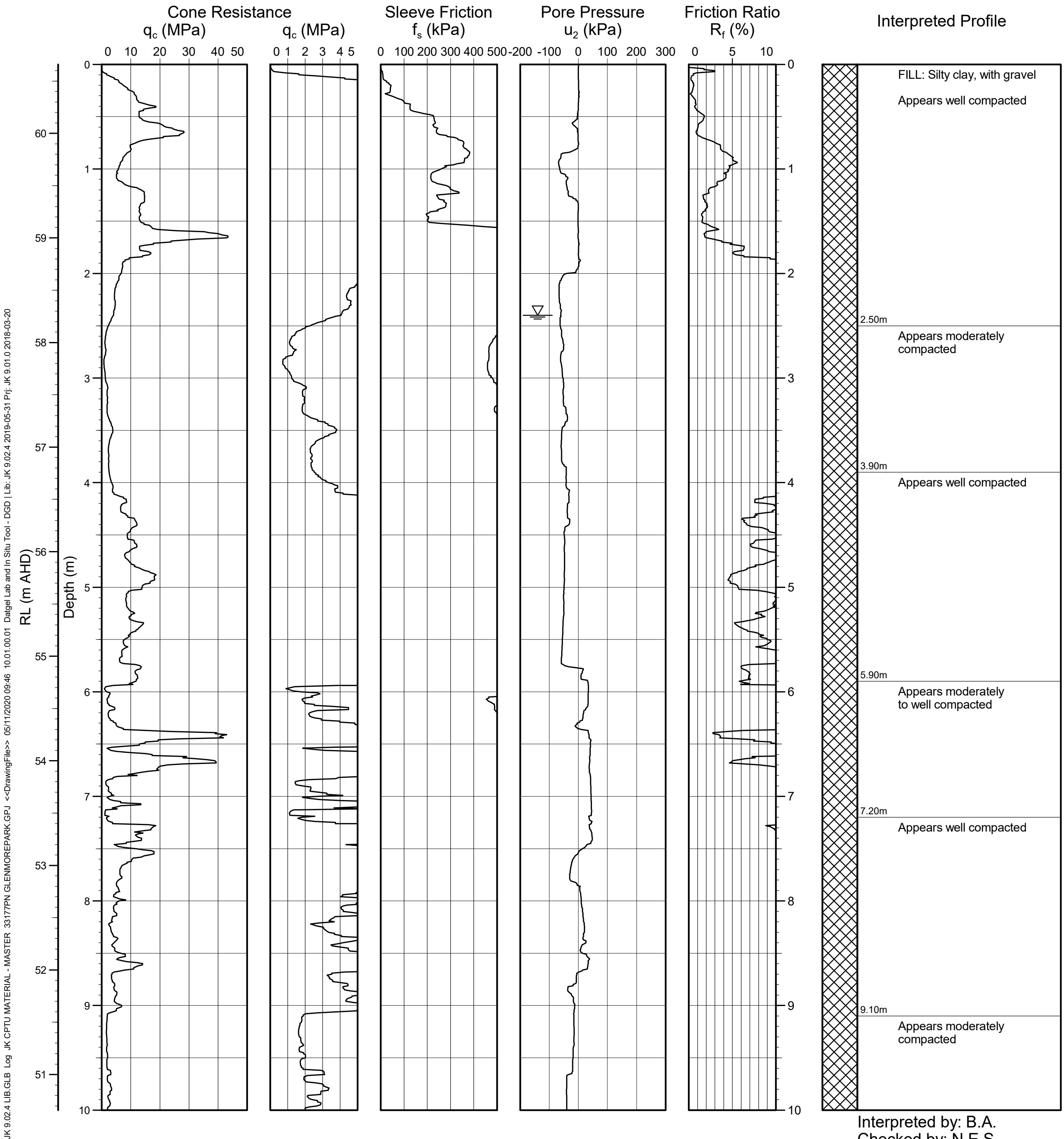
CONE PENETROMETER TEST RESULTS

CPT No.
116

EASTING: 285333.20
NORTHING: 6257273.46

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 60.66 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 9/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

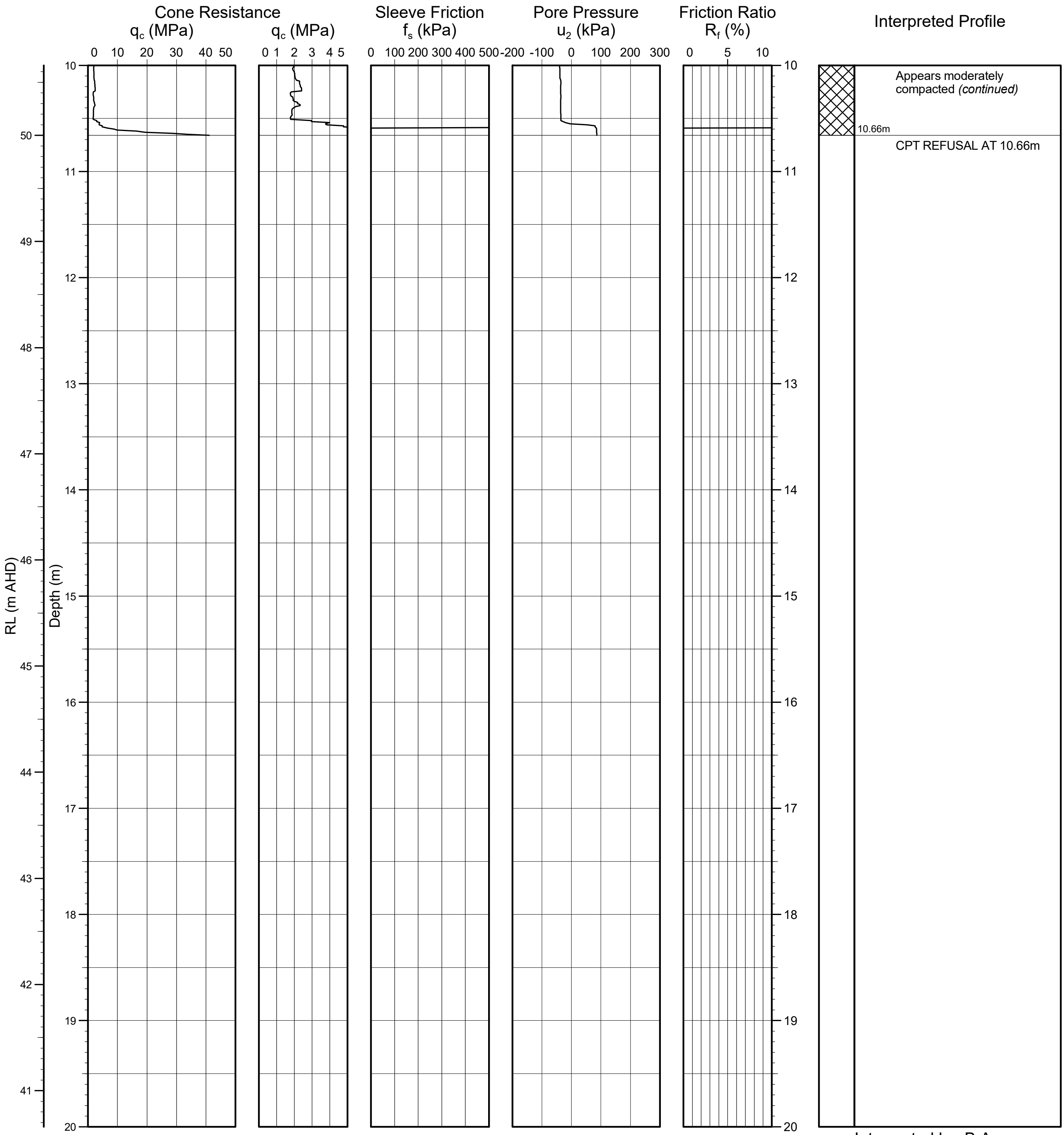
CONE PENETROMETER TEST RESULTS

CPT No. **116**

EASTING: 285333.20
NORTHING: 6257273.46

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **R.L. Surface:** 60.66 m **Data File:** J:\6f \33177PN Glenmore Park
Date: 9/10/20 **Datum:** AHD **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

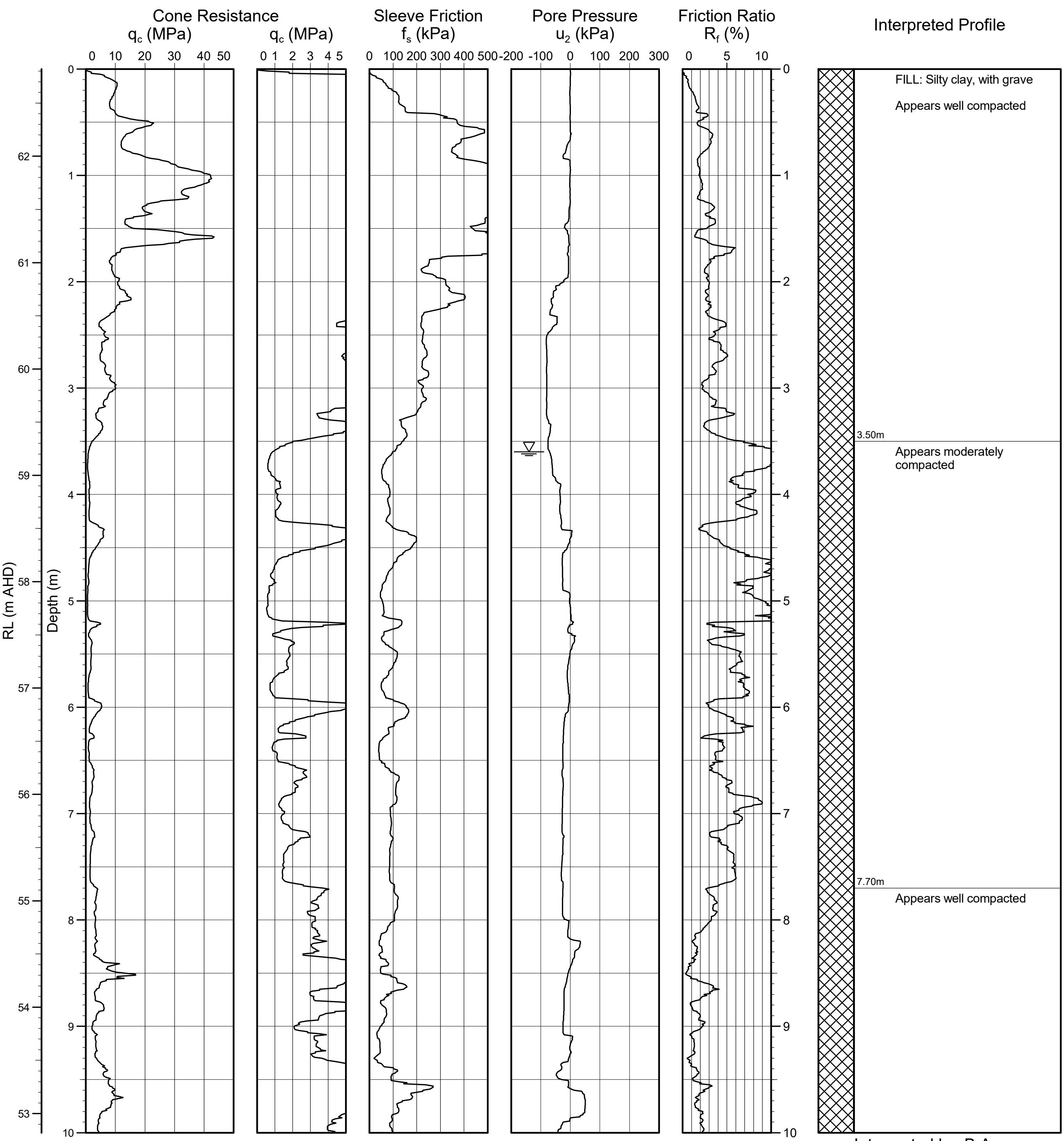
CPT No. 117

1 / 2

EASTING: 285287.89
NORTHING: 6257248.42

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 62.82 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 7/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

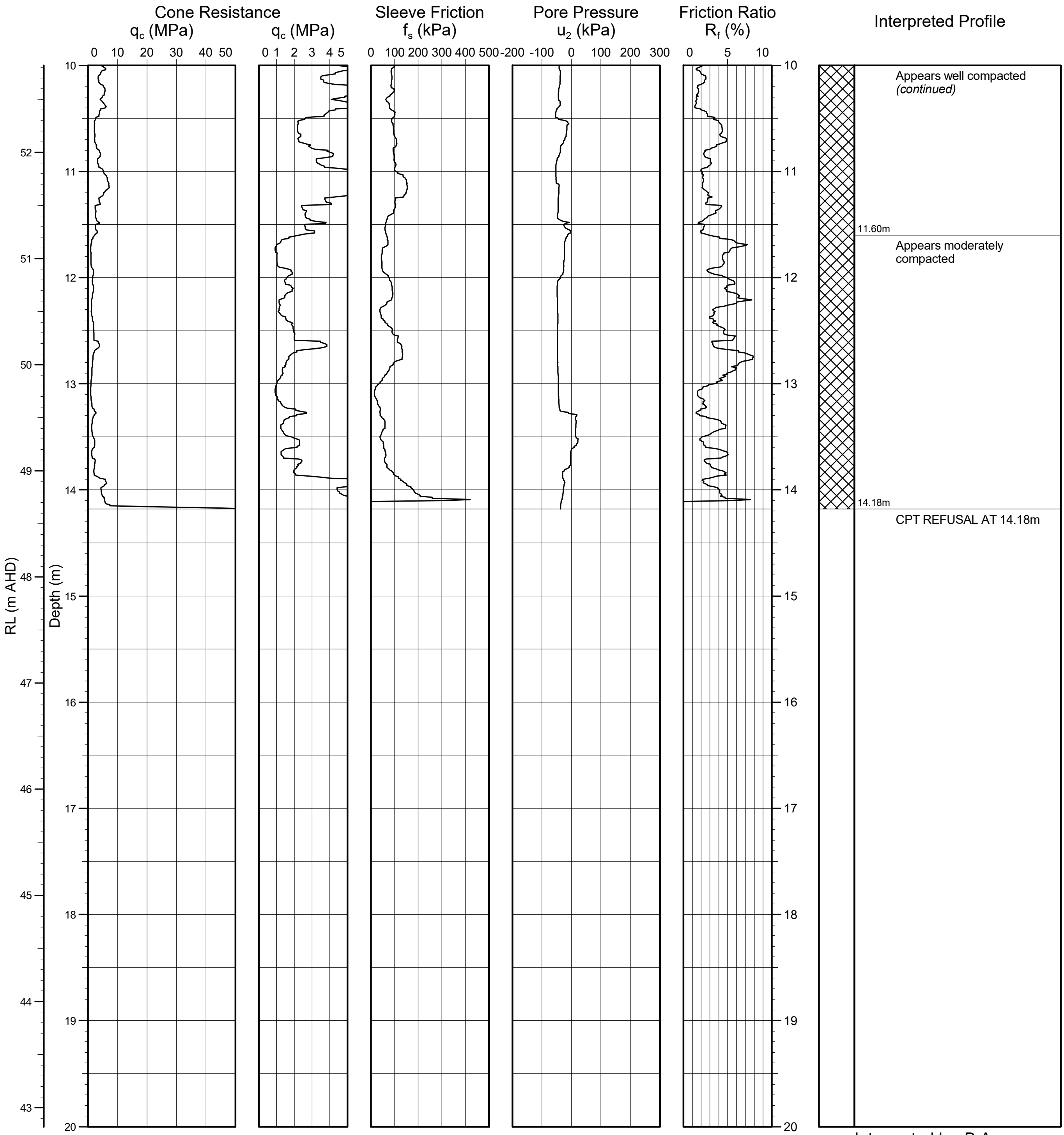
CONE PENETROMETER TEST RESULTS

CPT No.
117
2 / 2

EASTING: 285287.89
NORTHING: 6257248.42

Client:	NSW DEPARTMENT OF EDUCATION
Project:	PROPOSED PUBLIC SCHOOL
Location:	1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 62.82 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 7/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JK 9.02.4 LIB.GLB Log JK CPTU MATERIAL - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 05/11/2020 09:46 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

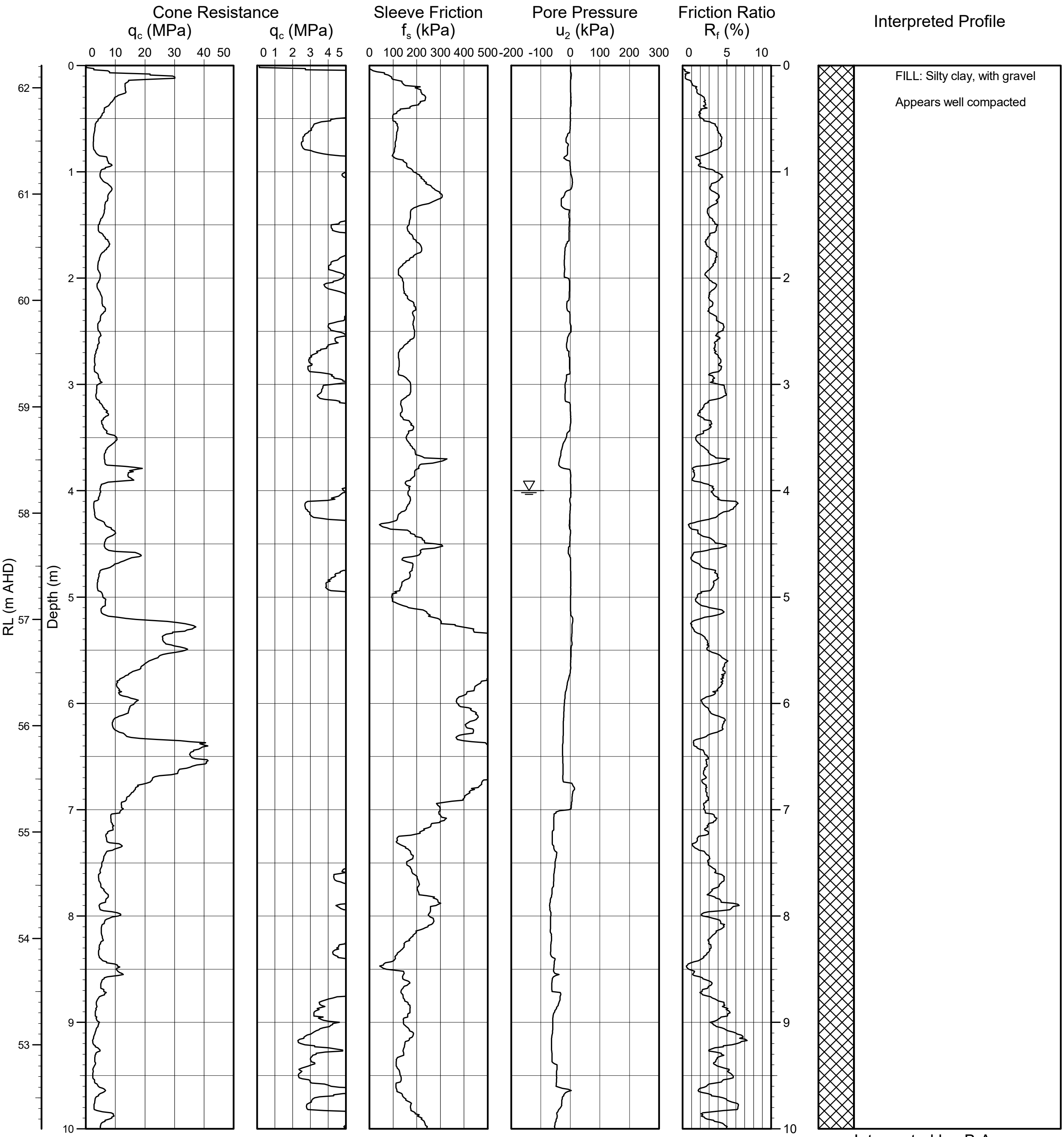
CONE PENETROMETER TEST RESULTS

CPT No.
118
1 / 2

EASTING: 285328.63
NORTHING: 6257239.16

Client:	NSW DEPARTMENT OF EDUCATION
Project:	PROPOSED PUBLIC SCHOOL
Location:	1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN	**R.L. Surface:** 62.21 m	**Data File:** J:\6f \33177PN Glenmore Park
Date: 7/10/20	**Datum:** AHD	**Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JKGeotechnics

CONE PENETROMETER TEST RESULTS

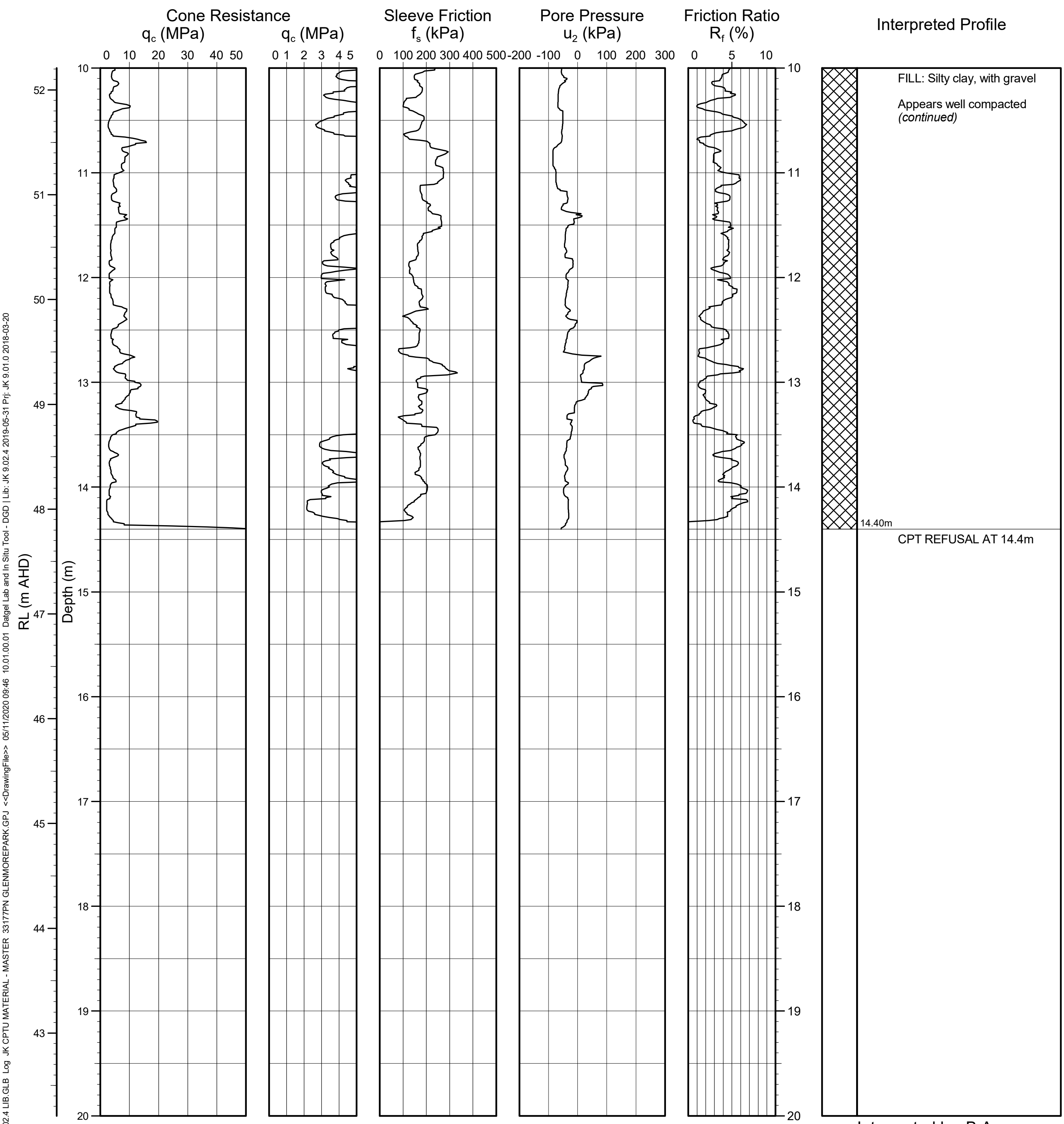
CPT No. 118

2 / 2

EASTING: 285328.63
NORTHING: 6257239.16

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **R.L. Surface:** 62.21 m **Data File:** J:\6f \33177PN Glenmore Park
Date: 7/10/20 **Datum:** AHD **Operator:** B.A.



Interpreted by: B.A.
Checked by: N.E.S.

JK 9.02.4 LIB.GLB Log JK CPTU MATERIAL - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 05/11/2020 09:46 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SITE LOCATION PLAN**

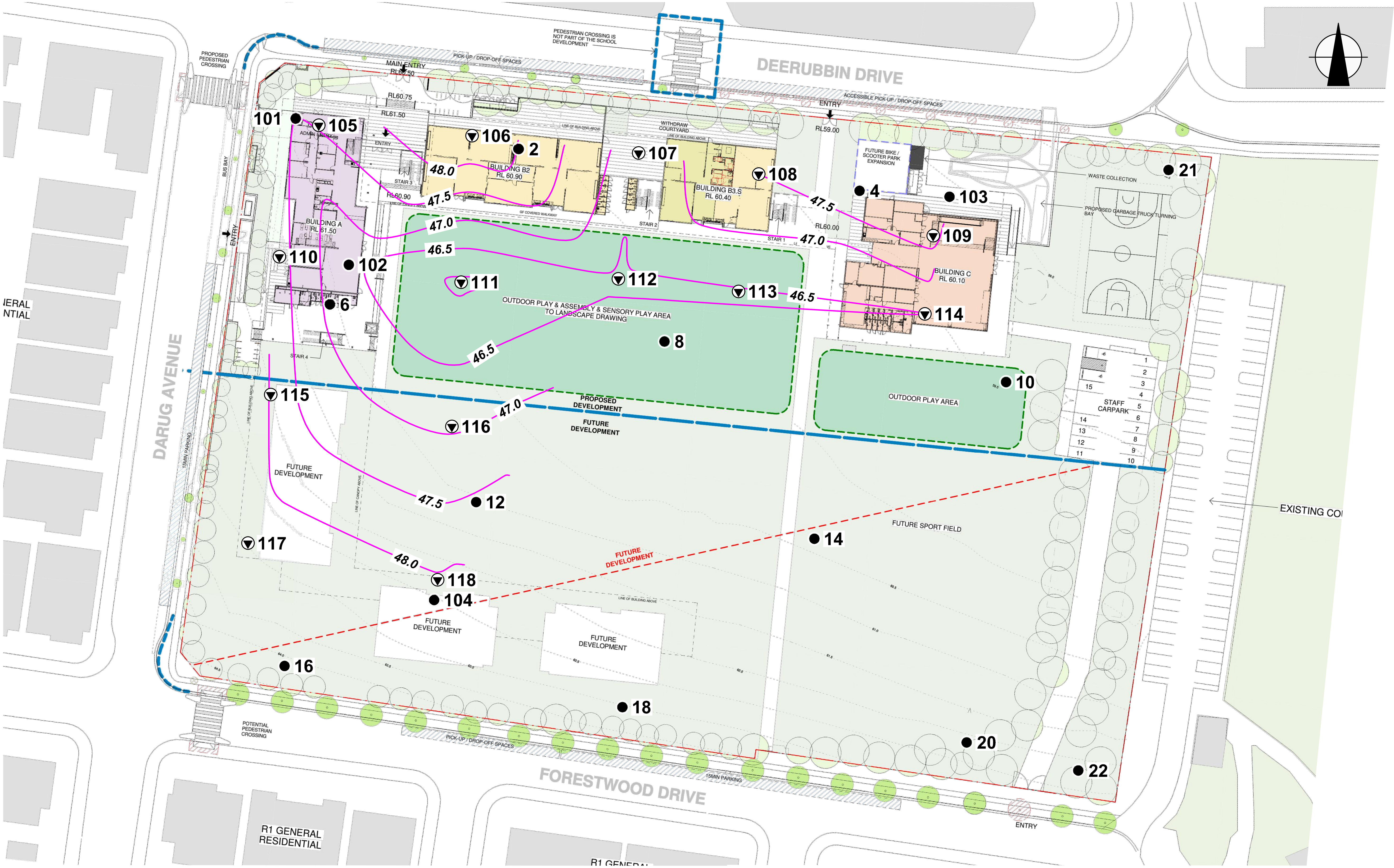
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Report No: 33177PN

Figure No: 1

JKGeotechnics

PLOT DATE: 15/05/2020 2:28:18 PM DWG FILE: Y:\33000'S\33177PN GLENMORE PARK\CAD\33177PN.DWG



LEGEND

- ● BOREHOLE
- ▼ CONE PENETROMETER TEST (CPT)
- 47.0 (RL MAHD) OF TOP OF BEDROCK

SCALE 1:800 @A3 METRES (0, 8, 16, 24, 32, 40)

This plan should be read in conjunction with the JK Geotechnics report.

Title: **INVESTIGATION LOCATION PLAN**

Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Report No: 33177PN

Figure No: 2

JKGeotechnics

PLOT DATE: 28/07/2021 3:14:05 PM DWG FILE: Y:\33000'S\33177PN GLENMORE PARK\CAD\REV2\33177PN.DWG

VIBRATION EMISSION DESIGN GOALS

German Standard DIN 4150 – Part 3: 1999 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, OR, maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 1 below.

It should be noted that peak vibration velocities higher than the minimum figures in Table 1 for low frequencies may be quite 'safe', depending on the frequency content of the vibration and the actual condition of the structure.

It should also be noted that these levels are 'safe limits', up to which no damage due to vibration effects has been observed for the particular class of building. 'Damage' is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should damage be observed at vibration levels lower than the 'safe limits', then it may be attributed to other causes. DIN 4150 also states that when vibration levels higher than the 'safe limits' are present, it does not necessarily follow that damage will occur. Values given are only a broad guide.

Table 1: DIN 4150 – Structural Damage – Safe Limits for Building Vibration

Group	Type of Structure	Peak Vibration Velocity in mm/s			
		At Foundation Level at a Frequency of:			Plane of Floor of Uppermost Storey
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 and 2 and have intrinsic value (eg. buildings that are under a preservation order).	3	3 to 8	8 to 10	8

Note: For frequencies above 100Hz, the higher values in the 50Hz to 100Hz column should be used.

REPORT EXPLANATION NOTES

INTRODUCTION

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

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

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'Geotechnical Site Investigations'*. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

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

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

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

Relative Density	SPT 'N' Value (blows/300mm)
Very loose (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

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

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	Strength not attainable – soil crumbles	

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'shale' is used to describe fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) is referred to as 'laminite'.

SAMPLING

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

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

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shrink-swell behaviour, strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

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

INVESTIGATION METHODS

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

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

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

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

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

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be assessed from the cuttings, together with some information from "feel" and rate of penetration.

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

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'*.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

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

  N = 13
  4, 6, 7

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

  N > 30
  15, 30/40mm

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

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

Cone Penetrometer Testing (CPT) and Interpretation: The cone penetrometer is sometimes referred to as a Dutch Cone. The test is described in Australian Standard 1289.6.5.1–1999 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Mechanical and Electrical Cone or Friction-Cone Penetrometer'*.

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck. The CPT does not provide soil sample recovery.

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

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa. There are two scales presented for the cone resistance. The lower scale has a range of 0 to 5MPa and the main scale has a range of 0 to 50MPa. For cone resistance values less than 5MPa, the plot will appear on both scales.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

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

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

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

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

There are limitations when using the CPT in that it may not penetrate obstructions within any fill, thick layers of hard clay and very dense sand, gravel and weathered bedrock. Normally a 'dummy' cone is pushed through fill to protect the equipment. No information is recorded by the 'dummy' probe.

Flat Dilatometer Test: The flat dilatometer (DMT), also known as the Marchetti Dilometer comprises a stainless steel blade having a flat, circular steel membrane mounted flush on one side.

The blade is connected to a control unit at ground surface by a pneumatic-electrical tube running through the insertion rods. A gas tank, connected to the control unit by a pneumatic cable, supplies the gas pressure required to expand the membrane. The control unit is equipped with a pressure regulator, pressure gauges, an audio-visual signal and vent valves.

The blade is advanced into the ground using our CPT rig or one of our drilling rigs, and can be driven into the ground using an SPT hammer. As soon as the blade is in place, the membrane is inflated, and the pressure required to lift the membrane (approximately 0.1mm) is recorded. The pressure then required to lift the centre of the membrane by an additional 1mm is recorded. The membrane is then deflated before pushing to the next depth increment, usually 200mm down. The pressure readings are corrected for membrane stiffness.

The DMT is used to measure material index (I_D), horizontal stress index (K_D), and dilatometer modulus (E_D). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient (K_o), over-consolidation ratio (OCR), undrained shear strength (C_u), friction angle (ϕ), coefficient of consolidation (C_h), coefficient of permeability (K_h), unit weight (γ), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity (V_s). Using established correlations, the SDMT results can also be used to assess the small strain modulus (G_o).

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod with a 20mm diameter cone end with a 9kg hammer dropping 510mm. The test is described in Australian Standard 1289.6.3.2–1997 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – 9kg Dynamic Cone Penetrometer Test'*.

The results are used to assess the relative compaction of fill, the relative density of granular soils, and the strength of cohesive soils. Using established correlations, the DCP test results can also be used to assess California Bearing Ratio (CBR).

Refusal of the DCP can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Vane Shear Test: The vane shear test is used to measure the undrained shear strength (C_u) of typically very soft to firm fine grained cohesive soils. The vane shear is normally performed in the bottom of a borehole, but can be completed from surface level, the bottom and sides of test pits, and on recovered undisturbed tube samples (when using a hand vane).

The vane comprises four rectangular blades arranged in the form of a cross on the end of a thin rod, which is coupled to the bottom of a drill rod string when used in a borehole. The size of the vane is dependent on the strength of the fine grained cohesive soils; that is, larger vanes are normally used for very low strength soils. For borehole testing, the size of the vane can be limited by the size of the casing that is used.

For testing inside a borehole, a device is used at the top of the casing, which suspends the vane and rods so that they do not sink under self-weight into the 'soft' soils beyond the depth at which the test is to be carried out. A calibrated torque head is used to rotate the rods and vane and to measure the resistance of the vane to rotation.

With the vane in position, torque is applied to cause rotation of the vane at a constant rate. A rate of 6° per minute is the common rotation rate. Rotation is continued until the soil is sheared and the maximum torque has been recorded. This value is then used to calculate the undrained shear strength. The vane is then rotated rapidly a number of times and the operation repeated until a constant torque reading is obtained. This torque value is used to calculate the remoulded shear strength. Where appropriate, friction on the vane rods is measured and taken into account in the shear strength calculation.

LOGS

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

The terms and symbols used in preparation of the logs are defined in the following pages.

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

GROUNDWATER

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

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

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised at intervals ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

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

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

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soils for Engineering Purposes'* or appropriate NSW Government Roads & Maritime Services (RMS) test methods. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

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

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.
- Details of the development that the Company could not reasonably be expected to anticipate.

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

SITE ANOMALIES

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

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

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

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

REVIEW OF DESIGN

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

SITE INSPECTION

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

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types and appropriate footing or pile founding depths, or

iii) full time engineering presence on site.

SYMBOL LEGENDS

SOIL

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

ROCK

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

OTHER MATERIALS

- BRICKS OR PAVERS
- CONCRETE
- ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
ine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

$$C_U = \frac{D_{60}}{D_{10}} \quad \text{and} \quad C_C = \frac{(D_{30})^2}{D_{10}\,D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

NOTES:

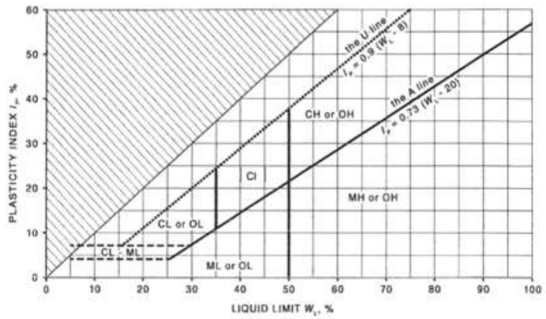
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

2 Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.

3 Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.

4 The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



LOG SYMBOLS

Log Column	Symbol	Definition
Groundwater Record		Standing water level. Time delay following completion of drilling/excavation may be shown.
	C	Extent of borehole/test pit collapse shortly after drilling/excavation.
		Groundwater seepage into borehole or test pit noted during drilling or excavation.
Samples	ES U50 DB DS ASB ASS SAL	Sample taken over depth indicated, for environmental analysis. Undisturbed 50mm diameter tube sample taken over depth indicated. Bulk disturbed sample taken over depth indicated. Small disturbed bag sample taken over depth indicated. Soil sample taken over depth indicated, for asbestos analysis. Soil sample taken over depth indicated, for acid sulfate soil analysis. Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60° solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25 PID = 100	Vane shear reading in kPa of undrained shear strength. Photoionisation detector reading in ppm (soil sample headspace test).
Moisture Condition (Fine Grained Soils)	*w* > PL *w* ≈ PL *w* < PL *w* ≈ LL *w* > LL	Moisture content estimated to be greater than plastic limit. Moisture content estimated to be approximately equal to plastic limit. Moisture content estimated to be less than plastic limit. Moisture content estimated to be near liquid limit. Moisture content estimated to be wet of liquid limit.
(Coarse Grained Soils)	D M W	DRY – runs freely through fingers. MOIST – does not run freely but no free water visible on soil surface. WET – free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS S F St VSt Hd Fr ( )	VERY SOFT – unconfined compressive strength ≤ 25kPa. SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa. FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa. STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa. VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa. HARD – unconfined compressive strength > 400kPa. FRIABLE – strength not attainable, soil crumbles. Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** — **SPT 'N' Value Range (Blows/300mm)**
	VL	VERY LOOSE — ≤ 15 — 0 – 4
	L	LOOSE — > 15 and ≤ 35 — 4 – 10
	MD	MEDIUM DENSE — > 35 and ≤ 65 — 10 – 30
	D	DENSE — > 65 and ≤ 85 — 30 – 50
	VD	VERY DENSE — > 85 — > 50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other assessment.
Hand Penetrometer Readings	300 250	Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.

Log Column	Symbol	Definition
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as:
		RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock.
		EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock.
		ALLUVIAL – soil deposited by creeks and rivers.
		ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents.
		MARINE – soil deposited in a marine environment.
		AEOLIAN – soil carried and deposited by wind.
		COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits.
		LITTORAL – beach deposited soil.

Classification of Material Weathering

<table>
<tr><th colspan="2">Term</th><th colspan="2">Abbreviation</th><th>Definition</th></tr>
<tr><td colspan="2">Residual Soil</td><td colspan="2">RS</td><td>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.</td></tr>
<tr><td colspan="2">Extremely Weathered</td><td colspan="2">XW</td><td>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.</td></tr>
<tr><td>Highly Weathered</td><td rowspan="2">Distinctly Weathered (Note 1)</td><td>HW</td><td rowspan="2">DW</td><td>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.</td></tr>
<tr><td>Moderately Weathered</td><td>MW</td><td>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.</td></tr>
<tr><td colspan="2">Slightly Weathered</td><td colspan="2">SW</td><td>Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Fresh</td><td colspan="2">FR</td><td>Rock shows no sign of decomposition of individual minerals or colour changes.</td></tr>
</table>

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'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 weathering products in pores'*. There is some change in rock strength.

Rock Material Strength Classification

			Guide to Strength	
Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Point Load Strength Index $Is_{(50)}$ (MPa)	Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Abbreviations Used in Defect Description

Cored Borehole Log Column		Symbol Abbreviation	Description
Point Load Strength Index		• 0.6	Axial point load strength index test result (MPa)
		x 0.6	Diametral point load strength index test result (MPa)
Defect Details	– Type	Be	Parting – bedding or cleavage
		CS	Clay seam
		Cr	Crushed/sheared seam or zone
		J	Joint
		Jh	Healed joint
		Ji	Incipient joint
		XWS	Extremely weathered seam
	– Orientation	Degrees	Defect orientation is measured relative to normal to the core axis (ie. relative to the horizontal for a vertical borehole)
	– Shape	P	Planar
		C	Curved
		Un	Undulating
		St	Stepped
		Ir	Irregular
	– Roughness	Vr	Very rough
		R	Rough
		S	Smooth
		Po	Polished
		Sl	Slickensided
	– Infill Material	Ca	Calcite
		Cb	Carbonaceous
		Clay	Clay
		Fe	Iron
		Qz	Quartz
		Py	Pyrite
	– Coatings	Cn	Clean
		Sn	Stained – no visible coating, surface is discoloured
		Vn	Veneer – visible, too thin to measure, may be patchy
		Ct	Coating ≤ 1mm thick
		Filled	Coating > 1mm thick
	– Thickness	mm.t	Defect thickness measured in millimetres

APPENDIX A

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A

MOISTURE CONTENT, ATTERBERG LIMIT AND LINEAR SHRINKAGE TEST REPORT

Client: JK Geotechnics
Project: Proposed Public School
Location: 1-23 Forestwood Drive, Glenmore Park, NSW

Ref No: 33177PN
Report: A
Report Date: 1/06/2020

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	**DEPTH m**	**MOISTURE CONTENT %**	**LIQUID LIMIT %**	**PLASTIC LIMIT %**	**PLASTICITY INDEX %**	**LINEAR SHRINKAGE %**
4	0.50 - 0.95	8.4	42	14	28	13.0
6	3.00 - 3.45	14.2	-	-	-	-
6	6.00 - 6.45	12.1	-	-	-	-
6	10.50 - 10.95	13.5	-	-	-	-
6	12.00 - 12.45	25.5	-	-	-	-
16	0.50 - 0.95	16.6	40	14	26	11.5
20	0.50 - 0.95	13.7	41	15	26	11.5
20	3.00 - 3.45	12.2	-	-	-	-
20	6.00 - 6.45	9.8	-	-	-	-
20	9.00 - 9.45	11.7	-	-	-	-
20	12.00 - 12.45	17.8	-	-	-	-

Notes:
- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 14/05/2020.
- Sampled and supplied by client. Samples tested as received.

NATA

NATA Accredited Laboratory Number:1327

01/06/2020
Authorised Signature / Date
(D. Treweek)

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
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Email: dtreweek@jkgroup.net.au

SOIL TEST SERVICES
ABN 43 002 145 173

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client: JK Geotechnics
Project: Proposed Public School
Location: 1-23 Forestwood Drive, Glenmore Park, NSW

Ref No: 33177PN
Report: B
Report Date: 26/05/2020

BOREHOLE NUMBER	BH 4	BH 6	BH 16	BH 20
DEPTH (m)	0.50 - 1.30	0.50 - 1.50	0.50 - 1.50	0.50 - 1.50
Surcharge (kg)	9.0	9.0	9.0	9.0
Maximum Dry Density (t/m^3)	1.88 STD	1.97 STD	1.86 STD	1.91 STD
Optimum Moisture Content (%)	11.9	11.4	14.2	13.6
Moulded Dry Density (t/m^3)	1.83	1.93	1.83	1.86
Sample Density Ratio (%)	98	98	98	98
Sample Moisture Ratio (%)	100	98	99	98
Moisture Contents				
Insitu (%)	10.1	9.0	15.3	13.6
Moulded (%)	11.9	11.2	14.1	13.3
After soaking and				
After Test, Top 30mm(%)	20.9	14.6	19.8	21.2
Remaining Depth (%)	19.2	13.2	16.8	17.6
Material Retained on 19mm Sieve (%)	1*	2*	1*	2*
Swell (%)	3.0	1.5	1.5	2.0
C.B.R. value: @2.5mm penetration	1.5	6	4.0	2.0

NOTES: Sampled and supplied by client. Samples tested as received.
- Refer to appropriate Borehole logs for soil descriptions
- Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
- Date of receipt of sample: 14/05/2020.
- * Denotes not used in test sample.

NATA
NATA Accredited Laboratory Number:1327

Approved Signatory / Date
(D. Treweek) 26/5/20

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CERTIFICATE OF ANALYSIS 243024

Client Details

Client	JK Geotechnics
Attention	Joanne Lagan
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**33177PN, Glenmore Park**
Number of Samples	4 Soil
Date samples received	15/05/2020
Date completed instructions received	15/05/2020

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	22/05/2020
Date of Issue	21/05/2020

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

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil					
Our Reference		243024-1	243024-2	243024-3	243024-4
Your Reference	UNITS	BH6	BH6	BH20	BH20
Depth		1.5-1.95	6-6.45	1.5-1.95	6-6.45
Date Sampled		11/05/2020	11/05/2020	12/05/2020	12/05/2020
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	19/05/2020	19/05/2020	19/05/2020	19/05/2020
Date analysed	-	19/05/2020	19/05/2020	19/05/2020	19/05/2020
pH 1:5 soil:water	pH Units	9.4	9.7	8.8	9.5
Chloride, Cl 1:5 soil:water	mg/kg	25	120	150	260
Sulphate, SO4 1:5 soil:water	mg/kg	53	160	230	400
Resistivity in soil*	ohm m	54	26	29	21

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 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
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	-			19/05/2020	[NT]	[NT]	[NT]	[NT]	19/05/2020	[NT]
Date analysed	-			19/05/2020	[NT]	[NT]	[NT]	[NT]	19/05/2020	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	113	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	120	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[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.

Report Comments

MISC_INORG_DRY:pH:Samples#1 and #2 were out of the recommended holding time for this analysis.

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BOREHOLE LOG

Borehole No. 2

1 / 1

SDUP2: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~60 m
Date: 11/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION				0			FILL: Silty clay, medium plasticity, brown, trace of medium to coarse grained igneous gravel.	w<PL			GRASS COVER TOP 100mm ROOT AFFECTED
		N = 24 6,9,15					FILL: Silty clay, med plasticity, brown mottled red brown and light grey, trace of fine to medium grained igneous, ironstone and siltstone gravel, and ash.			>600 >600 >600	APPEARS WELL COMPACTED
			59	1							
		N = 15 6,6,9								370 360 240	
			58	2							
		N = 8 2,3,5	57	3			FILL: Silty clay, medium plasticity, grey and brown, with fine to medium grained igneous and siltstone gravel.	w~PL		150 120 140	APPEARS MODERATELY COMPACTED
			56	4			FILL: Silty clay, medium plasticity, brown mottled red brown, trace of fine to medium grained igneous and siltstone gravel.				
		N = 27 4,11,16								300 430 470	APPEARS WELL COMPACTED
▶			55	5			FILL: Gravelly silty clay, medium plasticity, light grey and grey, medium to coarse grained igneous and siltstone gravel.	w<PL / w>PL			
		N = 13 5,5,8	54	6						200 400 470	
							END OF BOREHOLE AT 6.45 m				

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 02/06/2020 12:26 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

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BOREHOLE LOG

Borehole No.
4
1 / 1

SDUP4: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~59.2 m
Date: 11/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION		59	0			FILL: Silty clay, medium plasticity, brown, with medium to coarse grained igneous and siltstone gravel, trace of fine to medium grained sand, roots and root fibres.	w<PL			GRASS COVER TOP 100mm ROOT AFFECTED
	N = 29 9,16,13								>600 >600 >600	APPEARS WELL COMPACTED
		58	1			as above, but low to medium plasticity, brown mottled red brown.				
	N = 21 10,8,13	57	2						>600 >600 >600	
	N = 26 12,13,13	56	3						>600 >600 >600	
		55	4			FILL: Silty clay, medium plasticity, brown and grey mottled red brown, with fine to coarse grained siltstone and igneous gravel.	w~PL			
	N = 20 4,9,11	54	5						420 260 300	
	N = 20 8,8,12	53	6							
						END OF BOREHOLE AT 6.45 m				

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 02/06/2020 12:26 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

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BOREHOLE LOG

Borehole No. 6

1 / 2

SDUP6: 0.0m-0.1m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN | **Method:** SPIRAL AUGER | **R.L. Surface:** ~60.9 m
Date: 11/5/20 | **Datum:** ASSUMED
Plant Type: JK500 | **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	Field Tests	RL (m ASSUMED)	Depth (m)	Description	Moisture Condition/ Weathering	Hand Penetrometer Readings (kPa)	Remarks
			0	FILL: Silty clay, medium plasticity, brown, trace of fine to coarse grained igneous, ironstone and siltstone gravel, roots and root fibres.	w<PL		GRASS COVER TOP 100mm ROOT AFFECTED
	N = 26 8,14,12	60	1			>600 >600 >600	APPEARS WELL COMPACTED
	N = 14 5,6,8	59	2	FILL: Silty clay, medium plasticity, brown and grey, with coarse grained igneous and siltstone gravel, trace of fine grained sand.		480 500	
	N = 7 3,4,3	58	3		w~PL	480 190 450	APPEARS MODERATELY COMPACTED
ON COMPLETION	N > 10 2,4,6/ 10mm REFUSAL	57, 56	4, 5			320 380 390	APPEARS WELL COMPACTED
	N = 17 3,7,10	55	6	FILL: Silty clay, medium plasticity, grey and brown, with medium to coarse grained igneous and siltstone gravel.	w<PL	450 520 430	
▶		54			w>PL		APPEARS MODERATELY COMPACTED

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BOREHOLE LOG

Borehole No. 6

SDUP6: 0.0m-0.1m

Client: NSW DEPARTMENT OF EDUCATION

Project: PROPOSED PUBLIC SCHOOL

Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~60.9 m

Date: 11/5/20 **Datum:** ASSUMED

Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
							FILL: Silty clay, medium plasticity, grey and brown, with medium to coarse grained igneous and siltstone gravel. *(continued)*	w>PL			APPEARS MODERATELY COMPACTED
			53	8							
	ES		52	9							
	ES		51	10							
	DS	N = 9 5,4,5	50	11						70 40 60	
	ES		49	12							
	DS	N = 8 2,3,5								170 180 140	
			48	13			END OF BOREHOLE AT 12.45 m				
			47								

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BOREHOLE LOG

Borehole No. 8

1 / 1

SDUP8: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~60 m
Date: 11/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record: DRY ON COMPLETION; AFTER 1 HR ON 7 DAYS

Depth (m)	RL (m ASSUMED)	Field Tests	DESCRIPTION	Moisture Condition/ Weathering	Hand Penetrometer Readings (kPa)	Remarks
0.0	60		FILL: Silty clay, medium plasticity, brown mottled red brown, trace of medium to coarse grained igneous and siltstone gravel, roots and root fibres.	w<PL		GRASS COVER TOP 100mm ROOT AFFECTED APPEARS WELL COMPACTED
0.5		N = 20 3,10,10			>600 >600 >600	
1	59					
1.5		N = 25 8,8,17			>600 >600 >600	
2	58					
2.8			FILL: Gravelly silty clay, medium plasticity, grey and brown, medium to coarse grained igneous and siltstone gravel.			
3	57	N = 15 9,8,7				
4	56					GROUNDWATER MONITORING WELL INSTALLED TO 6.0m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 3.0m TO 6.0m. CASING 0.1m TO 3.0m. 2mm SAND FILTER PACK 2.4m TO 6.0m. BENTONITE SEAL 0.1m TO 2.4m. COMPLETED WITH A CONCRETED GATIC COVER.
4.2			FILL: Silty clay, medium plasticity, brown mottled orange brown and grey, trace of fine to medium grained siltstone gravel.	w>PL		
4.5		N = 12 2,5,7			210 220 260	
5	55					
5.6			FILL: Gravelly silty clay, medium plasticity, grey, medium to coarse grained siltstone gravel.			APPEARS MODERATELY COMPACTED
6	54	N = 5 2,2,3			150 160	
6.45			END OF BOREHOLE AT 6.45 m			

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BOREHOLE LOG

Borehole No.
10
1 / 2

SDUP10: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~59.3 m
Date: 11/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	Field Tests	Depth (m)	DESCRIPTION	Moisture Condition/ Weathering	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION		0	FILL: Silty clay, medium plasticity, brown, trace of medium to coarse grained igneous and siltstone gravel, fine grained sand, roots and root fibres.	w<PL		GRASS COVER TOP 100mm ROOT AFFECTED
	N = 23 7,10,13				>600 >600 >600	APPEARS WELL COMPACTED
	N = 27 14,14,13		as above, but brown and grey, with medium to coarse grained igneous, sandstone and siltstone gravel.		>600 >600 >600	
	N = 21 6,9,12		as above, but brown and grey mottled red brown.	w~PL	>600 >600 >600	
	N = 14 6,6,8		FILL: Silty clay, medium to high plasticity, grey, red brown and orange brown, with medium to coarse grained siltstone gravel.		300 310 350	
	N = 10 5,4,6		FILL: Silty clay, low plasticity, brown, with fine to medium grained siltstone gravel.	w<PL	>600 >600	APPEARS MODERATELY COMPACTED
				w>PL	120 110	

RL (m ASSUMED): 59, 58, 57, 56, 55, 54, 53
Depth (m): 1, 2, 3, 4, 5, 6

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BOREHOLE LOG

Borehole No.
10

SDUP10: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~59.3 m
Date: 11/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	SAMPLES (ES / U50 / DB / DS)	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
▶	ES		52				FILL: Silty clay, medium plasticity, yellow brown, trace of fine grained sand, and fine to medium grained ironstone gravel.	w>PL			APPEARS MODERATELY COMPACTED
			51	8							
	ES										
	DS	N = 6 2,2,4	50	9						100 80 150	
			49	10							
			48	11			FILL: Silty clay, low plasticity, grey and dark grey, with medium to coarse grained siltstone gravel.				APPEARS WELL COMPACTED
	ES			12							
	DS	N = 22 5,15,7	47							110 120 150	
			46	13			END OF BOREHOLE AT 12.45 m				

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BOREHOLE LOG

Borehole No. 12

1 / 1

SDUP12: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION

Project: PROPOSED PUBLIC SCHOOL

Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~60.8 m

Date: 12/5/20 **Datum:** ASSUMED

Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	Field Tests	RL (m ASSUMED)	Depth (m)	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION			0	FILL: Silty clay, medium plasticity, brown grey, trace of fine to medium grained igneous and ironstone gravel, roots and root fibres.	w<PL			GRASS COVER TOP 100mm ROOT AFFECTED
	N = 22 4,9,13	60		FILL: Silty clay, medium plasticity, grey and brown, with medium to coarse grained siltstone gravel, trace of fine to medium grained ironstone gravel.			>600 >600 >600	APPEARS WELL COMPACTED
	N = 12 5,5,7	59	1–2	FILL: Silty clay, medium plasticity, brown and grey, with medium to coarse grained igneous, ironstone and siltstone gravel.	w~PL		380 390 360	
	N = 7 4,3,4	58–57	3				280 250 220	APPEARS MODERATELY COMPACTED
	N = 21 12,10,11	56–55	4–5	FILL: Silty clay, medium plasticity, grey, with medium to coarse grained siltstone gravel.	w<PL		>450 >600 >600	APPEARS WELL COMPACTED
	N=SPT 10/ 20mm REFUSAL	54	6	END OF BOREHOLE AT 6.02 m				SPT REFUSAL ON OBSTRUCTION IN FILL

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BOREHOLE LOG

Borehole No.
14
1 / 1

SDUP14: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~60.1 m
Date: 12/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION		60	0			FILL: Silty clay, medium plasticity, brown and grey, with fine to coarse grained igneous, ironstone and siltstone gravel.	w<PL			GRASS COVER TOP 100mm ROOT AFFECTED
	N = 16 5,6,10								>600 >600 >600	APPEARS WELL COMPACTED
		59	1							
	N = 17 8,7,10								>600 >600 >600	
		58	2							
	N = 22 8,12,10	57	3						>600 >600 >600	
		56	4							
	N = 12 7,6,6								>600 >600 450	
		55	5							
	N = 8 3,3,5	54	6				w>PL		200 290 240	APPEARS MODERATELY COMPACTED
						END OF BOREHOLE AT 6.45 m				

Samples (ES, U50, DB, DS) indicated graphically.

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BOREHOLE LOG

Borehole No.
16
1 / 2

SDUP16: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~63.8 m
Date: 12/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION							FILL: Silty clay, medium plasticity, brown, trace of igneous, ironstone, sandstone and siltstone gravel, and fine grained sand.	w<PL			GRASS COVER TOP 100mm ROOT AFFECTED
		N = 5 4,3,2	63	1				w~PL		410 250 260	APPEARS POORLY TO MODERATELY COMPACTED
		N = 18 5,8,10	62	2			FILL: Silty clay, medium plasticity, grey and brown, with medium to coarse grained igneous and ironstone gravel.	w<PL		>600 >600 >600	APPEARS WELL COMPACTED
		N = 7 3,3,4	61	3			FILL: Silty clay, medium to high plasticity, brown and grey, with fine to coarse grained igneous, ironstone and siltstone gravel.	w~PL		270 310 360	APPEARS MODERATELY COMPACTED
▶		N = 12 2,6,6	60, 59	4, 5			FILL: Gravelly silty clay, medium plasticity, grey mottled brown, with medium to coarse grained siltstone gravel, trace of fine to medium grained ironstone gravel.	w>PL		210 150 160	APPEARS MODERATELY TO WELL COMPACTED
		N = 11 5,5,6	58, 57	6			FILL: Silty clay, medium plasticity, grey and brown, with fine to coarse grained siltstone gravel, trace of fine to medium grained ironstone gravel.			220 270 210	

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BOREHOLE LOG

SDUP16: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~63.8 m
Date: 12/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	SAMPLES (ES / U50 / DB / DS)	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
			56	8			FILL: Silty clay, medium plasticity, grey and brown, with fine to coarse grained siltstone gravel, trace of fine to medium grained ironstone gravel. *(continued)*	w>PL			APPEARS MODERATELY TO WELL COMPACTED
	ES		55				FILL: Gravelly silty clay, medium plasticity, grey, fine to coarse grained sandstone and siltstone gravel.				APPEARS WELL COMPACTED
	DS	N = 18 5,5,13	54	9							TOO GRAVELLY FOR HP TESTING
	ES		53	10 11			FILL: Silty clay, medium to high plasticity, grey mottled brown, with medium to coarse grained siltstone gravel, trace of fine to medium grained ironstone gravel.				
	DS	N = 23 5,11,12	52	12						380 430 400	
			51 50	13			END OF BOREHOLE AT 12.45 m				

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BOREHOLE LOG

Borehole No.
18
1 / 1

SDUP18: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~62.7 m
Date: 12/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION							FILL: Silty clay, medium plasticity, brown, trace of fine to medium grained igneous, ironstone and siltstone gravel, roots and root fibres.	w<PL			GRASS COVER TOP 100mm ROOT AFFECTED
		N = 14 7,5,9	62				FILL: Silty clay, medium plasticity, brown and grey, with fine to medium grained igneous, ironstone and siltstone gravel.			>600 >600 >600	APPEARS WELL COMPACTED
				1							
		N = 16 4,6,10	61							>600 >600 >600	
				2							
			60								
		N = 14 8,6,8		3						360 420 390	
			59								
				4							
		N = 28 6,11,17	58							>600 >600 >600	
				5							
			57								
		N = 27 7,11,16		6						>600 >600 >600	
			56				END OF BOREHOLE AT 6.45 m				

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BOREHOLE LOG

Borehole No. 20

1 / 2

SDUP20: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION

Project: PROPOSED PUBLIC SCHOOL

Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~61.8 m

Date: 12/5/20 **Datum:** ASSUMED

Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Depth (m)	RL (m ASSUMED)	Groundwater Record	Field Tests	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
0		DRY ON COMPLETION				FILL: Silty clay, medium plasticity, brown, trace of fine to medium grained igneous and ironstone gravel, roots and root fibres.	w<PL			GRASS COVER TOP 100mm ROOT AFFECTED
0.4						FILL: Silty clay, medium plasticity, brown, trace of medium to coarse grained igneous, ironstone and siltstone gravel.	w~PL			APPEARS MODERATELY COMPACTED
0.5	61		N = 6 3,3,3						400 >600 480	
1.5	60		N = 6 2,3,3						150 210 200	
2.0						FILL: Silty clay, medium plasticity, brown and grey, trace of fine to coarse grained ironstone and siltstone gravel.	w<PL			APPEARS MODERATELY TO WELL COMPACTED
3.0	59 / 58		N = 13 6,6,7						>600 330 350	
4.5	57		N = 9 5,4,5						400 400 410	
5.6	56					FILL: Silty clay, medium plasticity, grey mottled brown, with fine to coarse grained siltstone gravel, trace of fine to medium grained ironstone gravel.				APPEARS WELL COMPACTED
6.0	55		N = 24 6,10,14						410 510 500	

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BOREHOLE LOG

Borehole No. 20

SDUP20: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~61.8 m
Date: 12/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES		54	8			FILL: Silty clay, medium plasticity, grey mottled brown, with fine to coarse grained siltstone gravel, trace of fine to medium grained ironstone gravel. *(continued)*	w<PL			
	ES, DS	N = 8 2,3,5	53	9			FILL: Silty clay, medium plasticity, grey mottled brown, trace of fine to medium grained ironstone and siltstone gravel.	w~PL		550 190 220	APPEARS MODERATELY TO WELL COMPACTED
	ES, DS	N = 10 2,4,6	52, 51, 50	10, 11, 12			FILL: Silty clay, medium to high plasticity, brown mottled light grey and red brown, trace of fine to medium grained ironstone and siltstone gravel.			240 350 250	
			49, 48	13			END OF BOREHOLE AT 12.45 m				

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BOREHOLE LOG

Borehole No.
21
1 / 1

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~58.3 m
Date: 11/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION			58	0			FILL: Silty clay, medium plasticity, brown, trace of fine to medium grained igneous, ironstone, sandstone and siltstone gravel, fine grained sand, roots and root fibres.	w<PL			GRASS COVER TOP 100mm ROOT AFFECTED
	DS	N = 23 6,11,12								>600 >600 >600	APPEARS WELL COMPACTED
			57	1			as above, but brown and light grey, with medium to coarse grained igneous and siltstone gravel.				
	DS	N = 25 7,10,15	56	2						>600 >600 >600	
			55	3			as above, but mottled yellow brown, with medium to coarse grained ironstone gravel, and trace of fine grained sand.	w~PL			APPEARS MODERATELY COMPACTED
	DS	N = 8 4,3,5								390 390 500	
			54	4			FILL: Silty clay, low to medium plasticity, dark brown and grey, with medium to coarse grained ironstone and siltstone gravel.				
	DS	N = 9 2,4,5	53	5						300 130 210	
			52	6			FILL: Silty clay, medium plasticity, light brown, with medium to coarse grained ironstone and siltstone gravel.	w>PL			
	DS	N = 6 2,3,3								150 150 180	
							END OF BOREHOLE AT 6.45 m				

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 33177PN GLENMOREPARK.GPJ <<DrawingFile>> 02/06/2020 12:27 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

BOREHOLE LOG

Borehole No. 22

1 / 1

SDUP22: 0.0m-0.2m

Client: NSW DEPARTMENT OF EDUCATION
Project: PROPOSED PUBLIC SCHOOL
Location: 1-23 FORESTWOOD DRIVE, GLENMORE PARK, NSW

Job No.: 33177PN **Method:** SPIRAL AUGER **R.L. Surface:** ~61.8 m
Date: 12/5/20 **Datum:** ASSUMED
Plant Type: JK500 **Logged/Checked By:** J.L./N.E.S.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m ASSUMED)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION	ES			0			FILL: Silty clay, medium plasticity, brown mottled orange brown, trace of fine to medium grained igneous, ironstone, sandstone and siltstone gravel, fine to medium grained sand, roots and root fibres.	w<PL			GRASS COVER TOP 100mm ROOT AFFECTED
	DS	N = 18 8,8,10	61				FILL: Silty clay, medium plasticity, grey and brown, with medium to coarse grained siltstone gravel, trace of fine to medium grained ironstone gravel.			>600 >600 >600	APPEARS WELL COMPACTED
	ES			1							
	DS	N = 22 7,10,12	60							>600 >600 >600	
	ES			2							
	ES		59								
	DS	N = 14 7,8,6		3						>600 510 450	
			58	4							
	ES										
	DS	N = 12 6,6,6	57	5						450 450 >600	
	ES		56	6							
	DS	N = 18 7,8,10								>600 >600 >600	
			55				END OF BOREHOLE AT 6.45 m				

APPENDIX B

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Draft Report

Glenmore Park Geophysical Investigation.

Date: 3 November 2020
Job Number: GBGA2383

DOCUMENT HISTORY

DETAILS

Project Number: GBGA2383
Document Title: Glenmore Park Geophysical Investigation.
Site Address: 1-23 Forestwood Drive, Glenmore Park, NSW
Report prepared for: Nicholas Smith

STATUS AND REVIEW

Revision	Prepared by	Reviewed by	Date issued
Draft	Aaron Tomkins	Simon Williams	03/11/20

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DISCLAIMER

The results of this investigation are based on non-destructive testing. Although every effort has been made to accurately determine the site conditions and location of buried objects, GBG Australia cannot guarantee that all relevant information has been obtained. The findings are limited to those locations specifically detailed in the report and are subject to the scope, assumptions and limitations of the equipment as set out in the report. Many of the findings are drawn from the interpretation of electrical, electromagnetic, or acoustic signals in conjunction with information supplied by the client. The conclusions drawn represent the best professional opinions of the authors, based on their experience and on previous results from other investigations on similar materials. The opinions, conclusions and any recommendations in this report are based on condition at the time of testing and do not consider events or changes after the time of testing.

1 INTRODUCTION

At the request of JK Geotechnics, GBG Australia Pty Ltd (GBG) carried out a geophysical subsurface investigation on September 29th, 2020. The survey area was on a grassy site where a proposed school is to be placed. The area is generally flat and sloping upwards towards the south. GBG Completed an MASW survey, finishing 4 lines within the site boundary.

2 GEOPHYSICAL INVESTIGATION – SITE

The geophysical investigations were undertaken in the area shown below in figure 1. Four seismic profiles were collected in a predefined pattern, agreed by the client prior to arriving to site. A site map showing the acquired geophysical profiles is provided in drawings GBGA2383_01 in appendix A of this report.

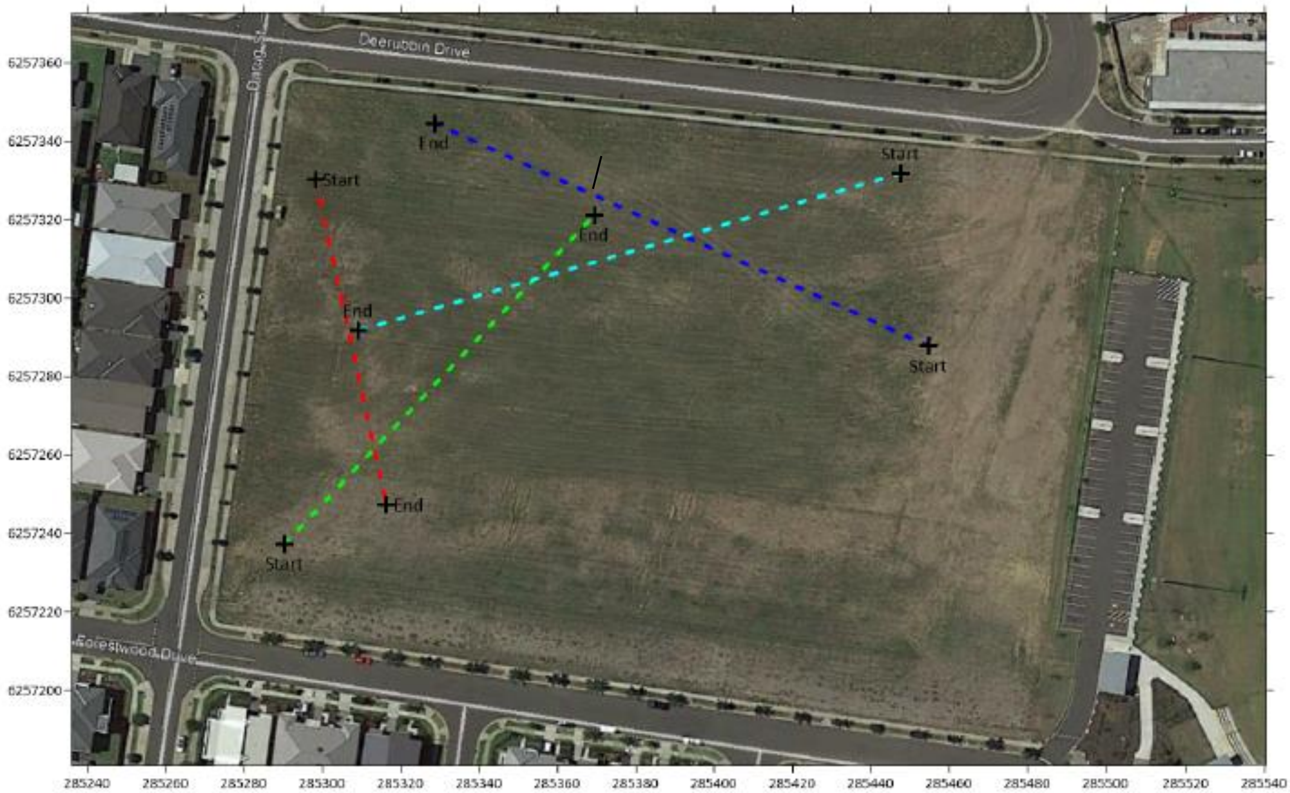


Figure 1. *Aerial site photo outlining the investigation area at Glenmore Park (Google 2020).*

2.1 Aim

GBG Australia understands the aim of the investigation was to assess ground subsurface conditions using a non-destructive seismic method. JK Geotechnics nominated the use of MASW to identify the shear wave velocity of rock to be used in conjunction with later intrusive borehole logs. MASW was therefore used to identify the following:

- Depth to competent rock.
- Inclusion of any foreign objects/floaters within the top 10m of fill.

3 DATA ACQUISITION AND PROCESSING

The following section outlines the survey setup, methodology, and equipment for the techniques utilised in this project.

3.1 Seismic Multi-channel Analysis of Surface Waves (MASW) Profiles

For this investigation 4 profiles were collected, ranging from 160m to 80m in length. Due to the ground conditions MASW data collection and quality was excellent. MASW collection consisted of stacked end shots along an array set out on a land streamer. The geophones were attached to plates and were at 2m centres making profile depth of 20m possible. The array was towed forward at 4m intervals to the extents of each profile.

Data was recorded digitally using a Geometrics Geode seismograph system. The specifications were as follows:

- Geophones – 4.5 Hz frequency / spacing 2m on rock plates
- Geometrics Seismograph recording digitally SEG2 files
- Record length – 2 seconds
- Sample interval – 0.5 sec

The shot energy source providing the seismic energy was a 9kg sledgehammer on a 25mm thick rubber plate, sitting on a steel plate.

On completion of the survey all shot points and geophone positions were corrected for chainage for future data processing. The start and end points were marked on the ground and later recorded using GPS at the survey completion.

The SEG2 data collected was processed using SurfSeis V6.2 (Kansas Geological Society). This is a tomographic processing software package that produces shear wave velocity models after processing and production of 1d velocity models.

More information on the MASW method is available in Appendix B attached to this report.

4 RESULTS AND INTERPRETATION

The results of the geophysical investigation carried out for the Glenmore Park site have been provided in the following drawings supplied at the end of this report.

- GBGA2383_01 – Site plan with position of collected Seismic profiles, and locations of boreholes.
- GBGA2383_02 – MASW profiles with line specific borehole depths to siltstone referenced.

4.1 Borehole Results

JK Geotechnics provided borehole results across the site post seismic data collection. 4 boreholes were completed across the site, with each borehole hitting siltstone between 11m and 15m. The boreholes can be grouped into two main layers for the aim of this investigation. They are:

- Fill: Silty clay, medium plasticity, grey brown, with fine to medium grained siltstone gravel, trace of fine to medium grained ironstone and sandstone gravel.
- Siltstone with minor interbedded sandstone.

In addition to the boreholes, JK Geotechnics outlined circumstantial evidence of boulders or floaters being within the fill layer.

4.2 MASW results

The produced seismic profiles are outlined in GBGA2383_02. Data was of textbook quality therefore confidence in the dataset and profiles is high. The MASW profiles produce similar results across the site outlining the following:

- A low velocity fill zone in the upper ~10m of each profile.
- A 420m/s shear wave velocity bedrock interface ~15m throughout the site.

4.2.1 Low velocity fill zone

The low velocity zone (Green colour stretch) within the top 10m of the site can be seen to consist of compacted less stiff materials. These materials exhibit responses consistent with layered compacted fill. Within this layer it can be seen that there are areas of higher velocities. We are confident these are not velocity inversions or artefacts in the data due to its quality and are more likely to infer they may be boulders or hard fill (concrete/bricks/stone).

4.2.2 Bedrock interface

MASW results were compared with borehole results and subsequently corrected for contours to highlight the siltstone interface along the profiles. This can be seen in GBGA2383_2 as the major contour horizon for weathered siltstone. The horizon is delineated along the 420m/s horizon which is consistent with shear wave values for weathered siltstone/mudstone (Rucker et al. (2005)). An example of the interface can be seen in Line 4 where BH102 depth to siltstone (-14.1m) lines up with the contour interval at 420m/s. All profiles were therefore corrected to this interval.

BH103 outlines a contact closer to the surface which is conformable with bedrock rising toward the surface to the east. We can interpret that the bedrock may be quite weathered throughout this area giving slightly lower than expected shear wave values.

5 CONCLUSIONS

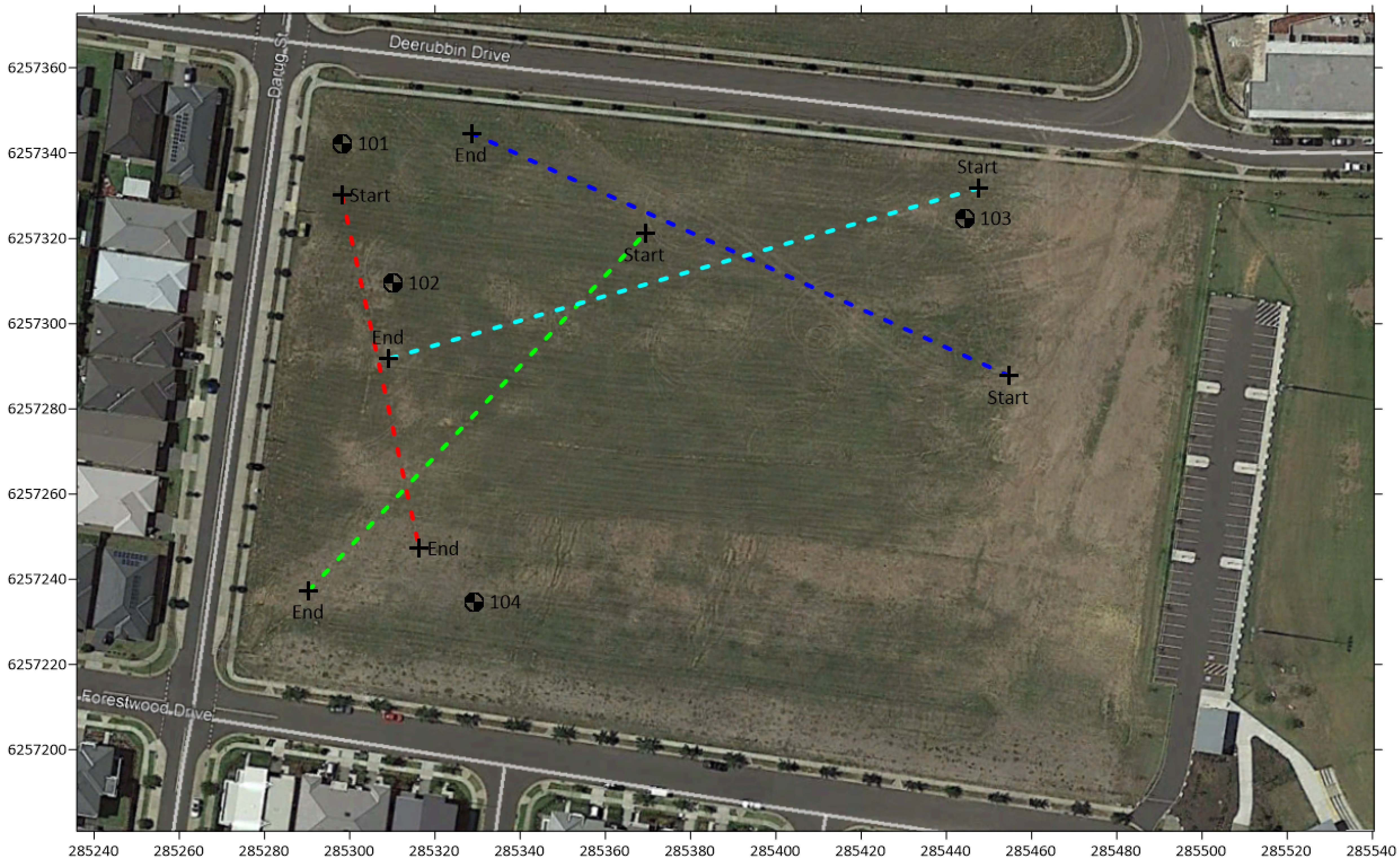
Seismic profiles outline a clear change in fill materials overlying siltstone from 0m to ~12m. This can be seen at the 420m/s shear wave boundary. Silestone can then be seen extending deeper within the profiles. The bedrock extends throughout the site typical of alluvial based siltstones, undulating throughout the profiles. Line 1 exhibits rocks raising slightly towards the east of the site. Higher velocity fill areas can be seen within the fill layer exhibiting classic signatures of boulders/hardfill areas.

For and on behalf of GBG Australia

Aaron Tomkins

Operations Manager - BSc (Geology/Geophysics), MSc (Structural Geology)

Glenmore Park - Geophysical Investigation



Legend

Line 1 Line 3 JK Borehole locations

Line 2 Line 4

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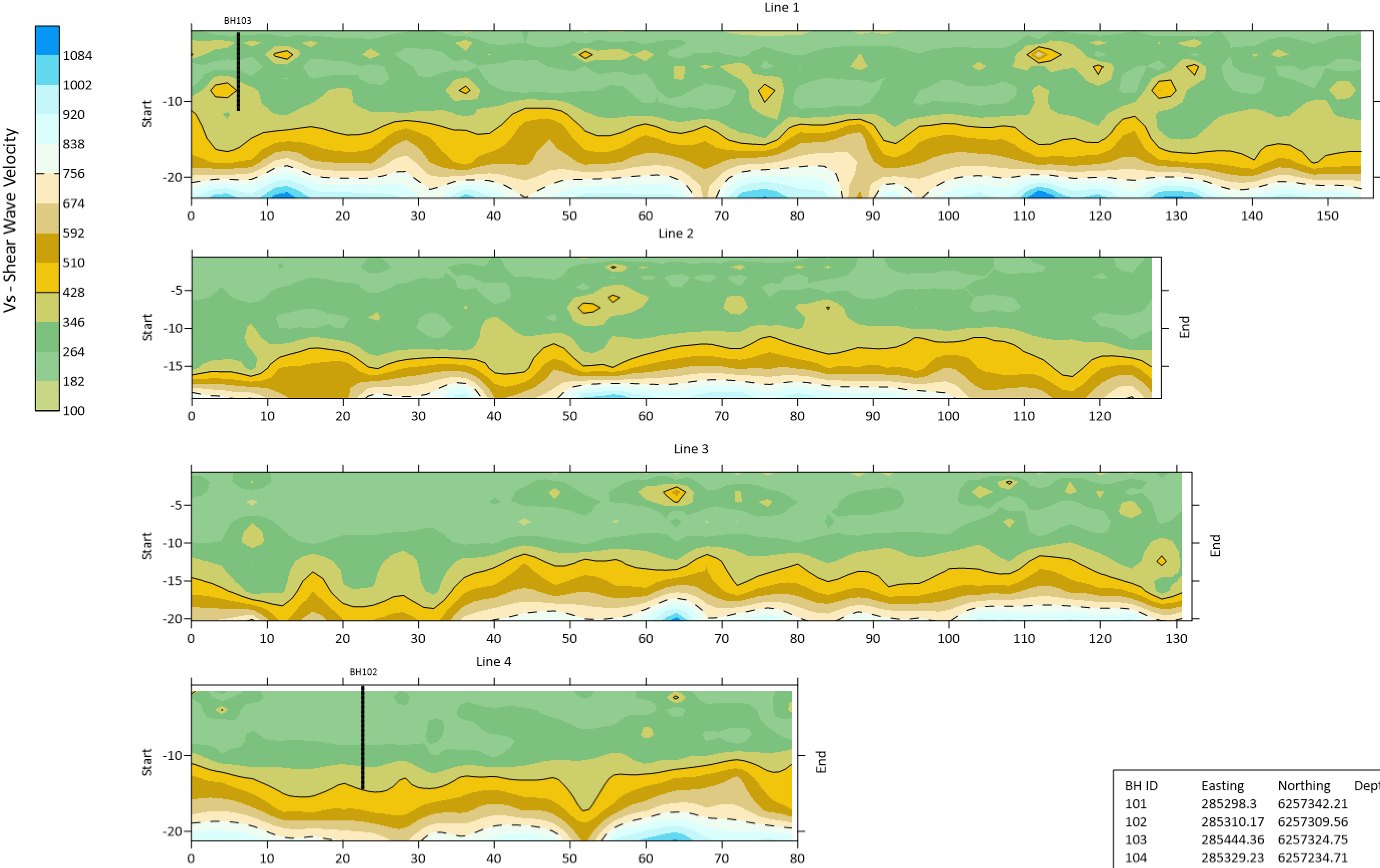
CLIENT: JK Geotechnics		
TITLE: Glenmore Park MASW - Base Map		
DRAWN: AT	PROJECT MANAGER: AT	DATUM: UTM
SCALE: 1:10	DATE: 02/11/2020	DRG No: GBGA2383_01
		REV: B / A3

GBG Australia

Glenmore Park - Geophysical Investigation



BH ID	Easting	Northing	Depth to Siltstone
101	285298.3	6257342.21	-13.5
102	285310.17	6257309.56	-14.1
103	285444.36	6257324.75	-11.2
104	285329.23	6257234.71	-14.2

Legend

Major contour horizon
Vs - 420m/s horizon
Weathered Siltstone

Major contour horizon
Vs - 750m/s horizon
Competant Bedrock

Borehole depth to Siltstone

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CLIENT: JK Geotechnics
TITLE: Glenmore Park MASW - Lines 1 - 4

DRAWN: AT	PROJECT MANAGER: AT	DATUM: UTM
SCALE: 1:5	DATE: 02/11/2020	DRG No: GBGA2383_02
		REV: B / A3