TTW Structural Civil Traffic Façade

Liverpool Health and Academic Precinct- Multi Storey Carpark

State Significant Development - Structural Statement

Prepared for Health Infrastructure

10 March 2020

181052

Rev 04

Taylor Thomson Whitting (NSW) Pty Ltd (ABN 81 113 578 377)
as trustee for the Taylor Thomson Whitting NSW Trust
(ABN 59 514 956 558) I Consulting Engineers
Level 3, 48 Chandos Street, St Leonards NSW 2065

Your Partner in Engineering

Table of Context

1 Background

Liverpool Hospital is located within the Liverpool Central Business District (CBD), on the corner of Elizabeth Street and Goulburn Street, Liverpool. The Hospital includes land east and west of the Main Southern Railway, which forms an eastern and western campus. The proposed works are located in the western portion of the western hospital campus. The site is legally described as Lot 501 in DP1165217.

The application seeks consent for the construction of a multi storey car park, connections to the existing road work and associated landscaping. A detailed project description is provided by Ethos Urban within the EIS.

1.1 The Site

The proposed Multideck Car Park project will be located to the northeast of the Liverpool Hospital campus at Burnside Drive at the location of the existing Ron Dunbier Building and adjacent to the Brain Injury Unit.

Figure 1. Site Plan.

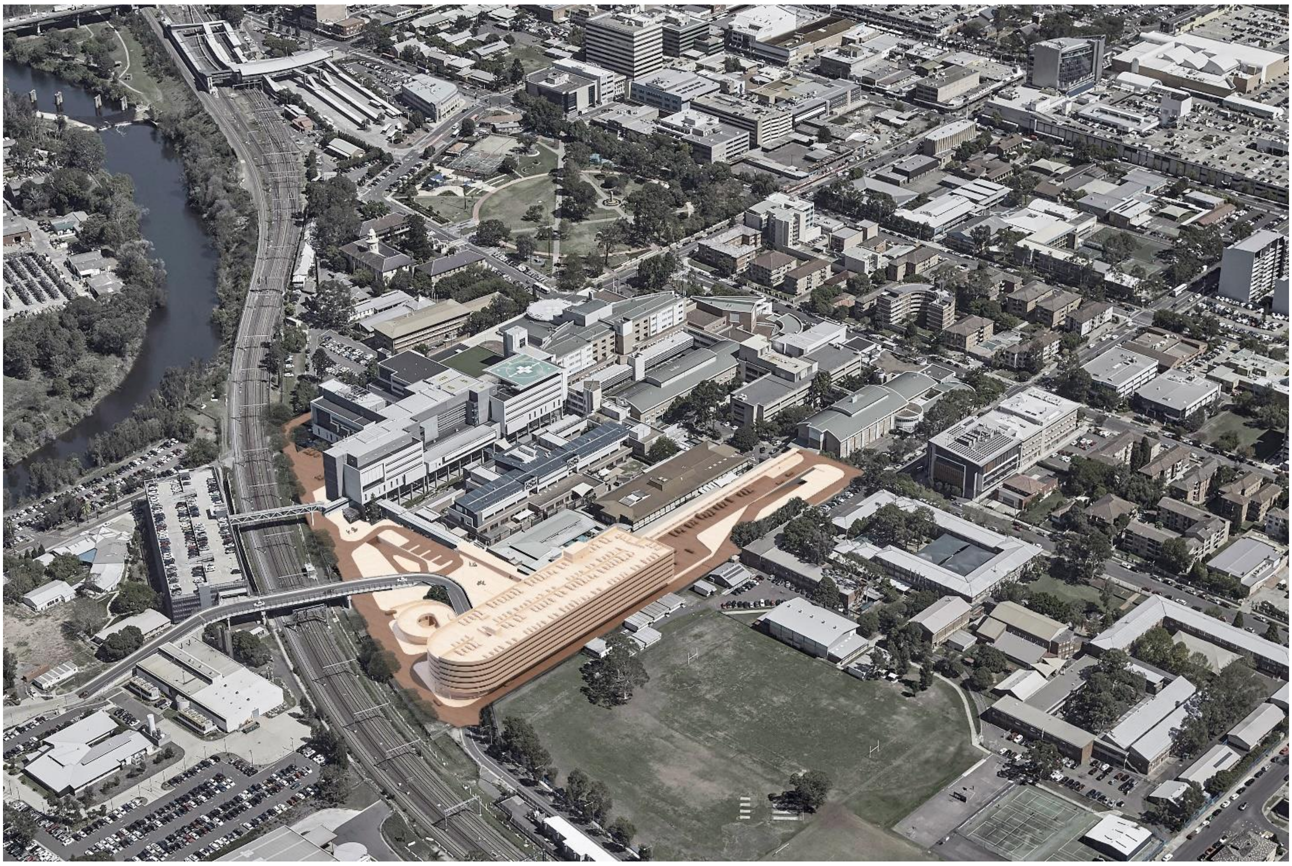


Figure 2. Proposed Multi Storey Carpark

1.2 Site Constraints

The major constraints identified include –

1.2.1 Surrounding the Site

- In order to construct new multideck carpark will require co-ordination and planning in regard to the existing surrounding structures including;
    - Campbell St to the north
    - the Brain Injury Unit to the south
    - the P2 carpark to the west which is proposed for future demolition
    - Burnside Drive to the east and co-ordination with the existing pile locations for the demolished Ron Dunbier Building.

1.2.2 Main Southern Railway

- The main Southern Railway line to the east. It is a major part of the Sydney Trains Network, and any redevelopment within 25m of the train lines will require consultation and potential approval of Sydney Trains, and specific design for train derailment loadings.

2 Geotechnical Conditions

A number of geotechnical investigation reports have been carried out on the Liverpool Hospital site with the most recent one for the proposed new multi storey carpark by JK Geotechnics Report 32160A2rpt dated 27th November 2019. This report and advice provided indicates that the soil profile for the site generally consists of the following based on Bore logs;

Fill:	0.2- 1.7m depth
Alluvial Soils:	2.3- 6.1m depth
Siltstone Bedrock:	10.5 – 16.2 m depth

A copy of the current Geotechnical report noted is attached in **Appendix A**.

3 Concept Design

3.1 Foundations

The new structure has 6 suspended levels with no basements.

Given the size of the new building and the associated column loads, piled footings socketed into the Class II/I siltstone are proposed. An allowable end bearing capacity of 3,500 kPa is recommended for piles founded in this Class II/I siltstone.

All foundations for individual buildings are proposed to be founded on a uniform bearing stratum to avoid any differential settlement issues.

3.2 Structural Layout

The structure has been designed to minimise structural depths and to keep the structure as simple as possible. The architectural layout has maximised the number of parking spaces for the length of the building by incorporating 4 parking bays per grid. Due to the larger spans in this direction post tensioned band beams have been orientated parallel to the car park aisle with post tensioned slabs in the other direction.

Columns have been positioned at locations to minimise the impact on the AS 2890.1 parking envelope requirements with no column being longer than 1000mm. Column widths are typically 300-350mm wide but due to the large grid spacing of 10.8m and the future levels, columns at the lower height levels need to be increased to 400mm wide. This results in some of the parking spots having to be designated as “small” parking spaces as the increased width of column compromises the AS 2890.1 minimum parking width of 2600 for user class 3.

Lateral loads will be resisted by the reinforced concrete stair, lift cores and shear walls.
The position of these shear walls at each end of the building can create shrinkage / crack control issues due to the use of post tensioning. To allow for this we are proposing a central permanent movement joint to split the slab into two structural zones.

The roof slab will be cast with a 1:100 fall to be co-ordinated. For thermal effects the roof slab is slightly thicker to accommodate mesh reinforcement throughout. Downpipes are not being installed in the columns and will be located outside of the parking envelopes on the edge of the building but on the inside face of the facade cladding.

3.3 Future Expansion Opportunities

Current direction for the future provision of two additional floors added to the structure has been advised as follows;

- Foundations and columns are to be sized for additional vertical and lateral loads for the two additional levels.
- Roof slab is not to be designed for additional loading above normal loads. This would then require either;
  - Backpropping through the existing carpark for probably two levels below the roof slab, which will require disruption to the carpark operations, or
  - Constructing the new levels in a system such as structural steel frame and metal deck formwork slabs, which spans to the columns and does not require backpropping. This is likely to add height to the structure due to deeper steel beam depths and is typically on more expensive structure than post tensioned, banded slabs.
  - If required, additional shear walls or bracing systems required for lateral loads due to the extra floors could be constructed at the time of the extension works, which would require local disruptions throughout the carpark. These could be either reinforced concrete walls tied between columns and slabs, or potentially structural steel bracing systems. Structural steel systems should have cast in elements to the concrete to enable an efficient connection.

If additional shear walls are required the parking bay layout will require review and modification for compliance.

3.4 Buildability Issues

3.4.1 Access to be Maintained under the proposed carpark to the existing Burnside Drive Bridge

At the moment our design incorporates the same PT slab design as the typical floors, however there is a zone of access to be maintained under the proposed carpark ramp link where the existing Burnside Drive access passes under Level 2. It is considered this location at Level 2 may require either steel or precast deck structure designed to span over the road and be installed within a short time period to minimise disruption to traffic movement on Burnside Drive and facilitate construction over.

3.4.2 Facade Edge Supports

It is generally preferable for post tensioned slabs to be edge stressed to simplify construction and to avoid having to stress from pans formed into the top surface of the slab. This will require careful coordination with the facade fixing points. The facade contractor will need to coordinate and adjust where required the fixing points to avoid clashes with the post tensioning live end anchors.

3.4.3 Movement Joints

The car park design incorporates cores at each end of the structure so to minimise shrinkage cracking due to the restraint provided by these cores at each end it will be necessary to use a central permanent movement joint and reinforcement to meet the crack control requirements of AS3600. Movement joints & pour strips in the slabs facilitates the post tensioning prestress force to counteract the shrinkage forces. Alternatively, additional conventional reinforcement can be provided however this may not be as cost effective.

4 Safety in Design

Safety in design reviews on all aspects of the structure will be undertaken using a structural risks and solutions register. This will be completed at the following millstones during the Hospital project:

- Prior to structural trade packages for tender
- Prior to issue of structural drawings ‘for Construction

5 Design Parameters

5.1 Loads

In general, all loads and load combinations shall comply with AS/NZS 1170 Parts 0 to 4 Structural Design Actions. Live load reductions will be applied as permitted by AS/NZS 1170.1.

Generally, the design loads are:

5.1.1 Permanent Actions - Dead Loads

Dead load shall be considered as the self weight of the structure plus an allowance for services, toppings, walls and ceilings which vary significantly throughout the site.

The additional dead loads should not be less than the following:

Car park areas	0.25 kPa

Details for the facade loading are still to be confirmed but our design is based on a facade loading of 1.0 kPa which equates to approximately 2.7 kN/m. This includes the weight of a RhinoStop car park barrier.

5.1.2 Imposed Actions - Live Loads

Design floor live loadings are to generally satisfy the minimum provisions of AS 1170.1 and in particular the following:

	Uniformly Distributed Actions	Concentrated Actions
Car park areas	2.5 kPa	13.0 kN
Stairs & Landings	4.0 kPa	4.5 kN
Structural Steel Roof	0.25 kPa	1.4 kN

No live load reductions are to be applied to any floor system elements.

5.1.3 Barriers

Barriers including parapets, balustrades and railings are to be designed in accordance with Table 3.3 of AS/NZS 1170.1. Currently it is intended that proprietary barrier systems such as the RhinoStop car park barrier will be used at the edge of all parking areas.

5.1.4 Wind Loads

Wind loads are in accordance with AS1170.2 and based on the following parameters:

Region:		A2
Importance Level (BCA Table B1.2a):		2
Annual probability of exceedance (BCA Table B1.2b):		1:500 (ultimate)
		1:25 (serviceability)
Regional Wind Speed:	Ultimate limit states -	V_{500} = 45 m/s
	Serviceability limit states -	V_{25} = 37 m/s
Terrain Category (all directions):		2.5

5.1.5 Earthquake Loads

Earthquake loadings shall be in accordance with AS1170.4 – 2007 (Earthquake actions in Australia) and AS/NZS1170.0 – 2002.

Hazard Factor (Z):	0.08
Site Sub-Soil Class:	C_e (Buildings founded on soil)
Importance Level (BCA Table B1.2a):	2
Annual probability of exceedance (BCA Table B1.2b):	1:500
Earthquake Design Category:	II

An importance level of 2 has been adopted as a car park is not designated as a post disaster facility nor is it classed as a health care facility.

5.1.6 Design Standards

The structural design will be in accordance with the latest revision of all relevant Australian Design Standards, Codes and other statutory requirements. As a minimum requirement, the design shall be based on, but not limited to;

Number	**Edition**	**Title**
AS/NZS 1170.0	2002	Structural design actions Part 0: General Principles
AS/NZS 1170.1	2002	Structural design actions Part 1: Permanent, imposed and other actions
AS/NZS 1170.2	2011	Structural design actions Part 2: Wind actions
AS 1170.4	2007	Structural design actions Part 4: Earthquake loads
AS 2159	2009	Piling – Design and installation

AS/NZS 2312.1	2014	Protection of Structural Steel Part 1: Paint coatings
AS 3600	2018	Concrete Structures
AS 3700	2011	Masonry Structures
AS 4100	1998	Steel Structures

5.2 Serviceability

5.2.1 Deflection Limits

Deflection limits for the concrete structures are generally as follows.

Maximum Floor Deflection Limit				
	Dead	**Incremental**	**Live**	**DL + LL**
Parking levels	Span/360	Span/1000 [1.]	Span/500	Span/300 (20mm max.)

1. Areas supporting normal weight masonry partitions.

5.2.2 Fire Resistance Levels

The BCA type of construction required for this building is type A. Fire Resistance Levels (FRL) for the structural elements will need to be in accordance with Specification C1.1 of the BCA. Typically, the FRL (minutes) for concrete structural elements is 120/120/120. At this stage there have not been any areas identified by the team or the BCA consultant that will require an FRL in excess of 120 minutes.

5.2.3 Durability

For concrete elements this will be achieved by specifying all elements in accordance with section 4 of AS3600 which sets out requirements for reinforced and post tensioned concrete structures with a design life of 40 to 60 years. Exposure classifications are as follows.

Exposure Classification	**Elements**
B1	Carpark structure

Protective coatings to structural steel elements shall comply with AS/NZS 2312 and ISO 2063 for the long-term protection category.

6 Certification

Design certification will be issued on completion of the detailed design and documentation.

A Site Inspection Certificate will be issued after construction.

Prepared by:
TAYLOR THOMSON WHITTING (NSW) PTY LTD
in its capacity as trustee for the
TAYLOR THOMSON WHITTING NSW TRUST

Mark Sherlock

MARK SHERLOCK
Senior Engineer

Authorised by:
TAYLOR THOMSON WHITTING (NSW) PTY LTD
in its capacity as trustee for the
TAYLOR THOMSON WHITTING NSW TRUST

ROBERT MACKELLAR
Managing Director

Appendix A – Geotechnical Report

REPORT TO

HEALTH INFRASTRUCTURE

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED NEW MULTI-STOREY CAR PARK

AT

LIVERPOOL HEALTH + ACADEMIC PRECINCT
ELIZABETH STREET, LIVERPOOL, NSW

Date: 27 November 2019
Ref: 32160A2rpt

JKGeotechnics
www.jkgeotechnics.com.au

T: +61 2 9888 5000
Jeffery and Katauskas Pty Ltd trading as JK Geotechnics
ABN 17 003 550 801

Report prepared by:

Andrew Jackaman
Principal | Geotechnical Engineer

For and on behalf of
JK GEOTECHNICS
PO BOX 976
NORTH RYDE BC NSW 1670

DOCUMENT REVISION RECORD

Report Reference	Report Status	Report Date
32160A2rpt	Final Report	27 November 2019

This report (which includes all attachments and annexures) has been prepared by JK Geotechnics (JKG) for its Client, and is intended for the use only by that Client.

This Report has been prepared pursuant to a contract between JKG and its Client and is therefore subject to:
a) JKG's proposal in respect of the work covered by the Report;
b) The limitations defined in the Client's brief to JKG;
c) The terms of contract between JKG and the Client, including terms limiting the liability of JKG.
If the Client, or any person, provides a copy of this Report to any third party, such third party must not rely on this Report, except with the express written consent of JKG which, if given, will be deemed to be upon the same terms, conditions, restrictions and limitations as apply by virtue of (a), (b), and (c) above.

Any third party who seeks to rely on this Report without the express written consent of JKG does so entirely at their own risk and to the fullest extent permitted by law, JKG accepts no liability whatsoever, in respect of any loss or damage suffered by any such third party.

At the Company's discretion, JKG may send a paper copy of this report for confirmation. In the event of any discrepancy between paper and electronic versions, the paper version is to take precedence. The USER shall ascertain the accuracy and the suitability of this information for the purpose intended; reasonable effort is made at the time of assembling this information to ensure its integrity. The recipient is not authorised to modify the content of the information supplied without the prior written consent of JKG.

Table of Contents

ATTACHMENTS

STS Table A: Moisture Content, Atterberg Limits and Linear Shrinkage Test Report
STS Table B: Point Load Strength Index Test Report
Envirolab Services 'Certificate of Analysis 227147'
Cone Penetrometer Test Results (JKG101A to JKG107A)
Borehole Logs JKG101 to JKG107 (With Rock Core Photographs)
Figure 1: Site Location Plan
Figure 2: Investigation Location Plan
Figures 3 to 5: Graphical CPT and Borehole Summaries
Figure 6: Surface of Weathered Bedrock Contour Plan
Report Explanation Notes

Appendix A:	**Borehole Logs 2 & 3, and Laboratory Test Results from 'Geotechnical Investigations for Proposed Brain Injury Unit' Report, Ref. 9014W/vm dated 11 August 1992**
Appendix B:	**Borehole Log 104 from 'Geotechnical Investigation for Proposed New Mental Health Centre' Report, Ref. M17359WArpt2 dated 3 September 2003**
Appendix C:	**Borehole Logs 1001 & 1006, and Laboratory Test Results from 'Geotechnical Investigation for Proposed Liverpool Hospital Redevelopment Project' Report, Ref. M20303ZArpt dated 13 July 2006**
Appendix D:	**Borehole Log B1, and Laboratory Test Results from 'Geotechnical Investigation for Proposed Bridges and Multi-Storey Car Park' Report, Ref. M21170ZArpt dated 9 August 2007**
Appendix E:	**Borehole Logs R2 to R5 & R13 to R16, Dynamic Cone Penetration Test Results, and Laboratory Test Results from 'Geotechnical Investigation for Proposed New Internal Roads' Report, Ref. M21956ZA2rpt dated 9 September 2009**

1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed new multi-storey car park (MSCP) at the Liverpool Health + Academic Precinct (Liverpool Hospital), Elizabeth Street, Liverpool, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by Health Infrastructure (HI) in a letter dated 20 August 2019 (Contract No. HI17455, Variation Order 12). The commission was on the basis of our revised fee proposal, Ref. 'P49626A Rev1' dated 1 July 2019.

We have been provided with the following information:

- 'MSCP Schematic Design Report' prepared by Fitzpatrick + Partners (Revision 02, dated September 2019);
- 'Multideck Car Park Schematic Design Report' prepared by Taylor Thomson Whitting (NSW) Pty Ltd (TTW) (Job No. 181052, Document No. TTW-ST-CP-RP01, dated 24 September 2019);
- Preliminary structural design drawings prepared by TTW (Job No. 181052, Drawing Nos. ST-SD-CP-0001, 1001, 1101, 2011 & 3001, Revision P4, dated 24 September 2019);
- 'Multi-Storey Car Park Schematic Design Report – Civil Engineering (Rev P2)' prepared by TTW (Job No. 181052, dated 8 November 2019);
- Preliminary civil design drawings prepared by TTW (Job No. 181052, Drawing Nos. C3000, C3010, C3011, C3012, C3041, C3042 & C3043, Issue P1, dated 20 September 2019);
- Survey drawings prepared by Cardno (Drawing No. 11870001001, Sheets 1 to 55, Revision 05, dated 14 November 2018). The survey datum is the Australian Height Datum (AHD).

The Liverpool Health + Academic Precinct (LHAP) is bisected by the Main Southern Railway, which separates the main (western) and eastern campuses. Based on the supplied information, we understand the proposed development will include demolition of the existing Ron Dunbier building, multi-storey car park, on-grade car park, and roads at the north-eastern corner of the main campus, and construction of a new MSCP (seven levels), which will be oriented east-west. Extending off the eastern end of the southern side of the new MSCP will be a circular vehicle ramp structure. We understand that two additional floors may be provided to the structure at a later stage. The proposed car park structure will be supported on piles socketed into the underlying bedrock.

The ground floor level will be constructed at RL10.5m and will require filling above existing grade to a maximum height of about 1m to achieve design subgrade level. Retaining walls will be required to support the fill platform. Lifts are proposed towards the western end of the southern side of the new car park. We have assumed that the lift pit will require excavation to a maximum depth of about 2m below design subgrade level. New asphaltic concrete paved roadways and on-grade car parking areas are proposed around the MSCP.

Since 1989, Jeffery and Katauskas Pty Ltd [now trading as JK Geotechnics (JKG)] has completed numerous geotechnical investigations in and around the proposed development area, as discussed in Section 2 below.

The purpose of the current investigation was to supplement our existing borehole information by further assessing the subsurface conditions at seven test locations. Based on the information obtained, we present our updated comments and recommendations on site preparation, earthworks, retaining walls, lift pit walls, piled footings, and on-grade pavements.

Our environmental consulting division, JK Environments (JKE), has been engaged to complete an environmental site assessment for the proposed new MSCP. Reference should be made to the separate JKE report.

This report supersedes our previous 'Preliminary Geotechnical Assessment' report, Ref. '32160Arpt' dated 13 February 2019.

2 BACKGROUND INFORMATION

As discussed in Section 1, we have completed numerous geotechnical investigations at Liverpool Hospital, including for the original hospital buildings (main campus) in 1991, and for the major redevelopments (eastern and main campuses) between 2003 and 2009. The information relevant to the proposed new MSCP is summarised below:

Year	Report Title	Report Ref.	Date	Relevant Information	Appendix
1992	Geotechnical Investigations for Proposed Brain Injury Unit	9014W/vm	11/08/92	Borehole Logs 2 & 3 Laboratory Test Results	A
2003	Geotechnical Investigation for Proposed New Mental Health Centre	M17359WArpt2	3/09/03	Borehole Log 104	B
2006	Geotechnical Investigation for Proposed Liverpool Hospital Redevelopment Project	M20303ZArpt	13/07/06	Borehole Logs 1001 & 1006 Laboratory Test Results	C
2007	Geotechnical Investigation for Proposed Bridges and Multi-Storey Car Park	M21170ZArpt	9/08/07	Borehole Log B1 Laboratory Test Results	D
2009	Geotechnical Investigation for Proposed New Internal Roads	M21956ZA2rpt	9/09/09	Borehole Logs R2 to R5 & R13 to R16 Laboratory Test Results	E

The locations of the relevant boreholes have been plotted onto the attached Figure 2. The relevant borehole logs, Dynamic Cone Penetration (DCP) test results and laboratory test results are presented in Appendices A to E for ease of reference.

3 CURRENT INVESTIGATION PROCEDURE

The fieldwork for the investigation was carried out between 16 & 20 September 2019 and comprised the scope of work outlined below. The test locations are shown on Figure 2. Prior to the commencement of the fieldwork, a specialist sub-consultant reviewed available 'Dial Before You Dig' information and electro-magnetically scanned the test locations for buried services.

- Seven Cone Penetrometer Tests (JKG101A to JKG107A) were completed to refusal depths between 11.55m (JKG104A) and 15.95m (JKG107A) below existing grade, using our 24 tonne truck mounted Cone Penetrometer Test (CPT) rig. The CPT probing provides a continuous plot of soil type and strength with depth, but does not provide soil samples. For CPT's, the identification of subsurface material and material strength is by interpretation of the test results based on empirical correlations, and from borehole information. The pavement (where encountered) and upper fill profile were penetrated using a dummy probe.

- Adjacent to each CPT location, a borehole (JKG101 to JKG107) was drilled to depths between 20.7m and 25.0m below existing grade, using either our truck mounted JK500 drill rig or track mounted JK305 drill rig, which are equipped for site investigation purposes. Existing pavements (where encountered) were diatube cored with water flush. The soil and upper weathered bedrock profiles were spiral auger drilled. Limited soil samples were obtained from the boreholes for soil identification purposes and to obtain samples for laboratory testing. The strength of the underlying bedrock was assessed by observation of auger penetration resistance when using a twin-pronged tungsten carbide (TC) bit, together with examination of recovered rock cuttings. At depths between 11.82m (JKG104) and 16.20m (JKG105), the boreholes were extended into the bedrock to their final depths by rotary diamond coring techniques, using an NMLC triple tube core barrel with water flush. The strength of the cored bedrock was assessed by examination of the recovered rock cores, together with correlations with subsequent laboratory Point Load Strength Index ($I_{S(50)}$) test results. Groundwater observations were made in the boreholes.

The test locations were set out by tape measurements from existing surface features. The surface RL's indicated on the attached CPT results sheets and borehole logs were interpolated between spot level heights and ground contour lines shown on the supplied survey plans, and are therefore approximate. The survey datum is AHD. An available Nearmap aerial image forms the basis of Figure 2.

Further details of the methods and procedures employed in the investigation, including the limitations of the CPT, are presented in the attached Report Explanation Notes.

Our geotechnical engineers were present full-time during the fieldwork to set out the test locations, direct the electro-magnetic scanning, direct the CPT operation, nominate borehole sampling, and prepare the attached borehole logs. The CPT results were interpreted by our geotechnical engineers. The Report Explanation Notes define the logging terms and symbols used.

Selected soil samples were returned to a NATA accredited laboratory, Soil Test Services Pty Ltd (STS), for moisture content, Atterberg Limits and linear shrinkage testing. The results are summarised in the attached STS Table A.

Selected soil samples were returned to a NATA accredited analytical laboratory (Envirolab Services Pty Ltd) for soil pH, sulfate, chloride and resistivity testing. The results are presented in the attached Envirolab Services 'Certificate of Analysis 227147'.

The recovered rock cores were photographed and returned to STS for Point Load Strength Index testing. The rock core photographs are enclosed with the borehole logs. The Point Load Strength Index test results are plotted on the borehole logs and summarised in the attached STS Table B. The unconfined compressive strengths (UCS), as estimated from the Point Load Strength Index test results, are also summarised in STS Table B.

4 RESULTS OF THE INVESTIGATION

4.1 Site Description

The site is located in relatively flat alluvial topography and in the north-eastern corner of the main campus. Burnside Drive enters the site at its north-eastern corner. Liverpool Girls' High School and the Main Southern Railway bound the site to the north and east, respectively. The Georges River is located approximately 200m to the south of the site.

The western end of the site contained an existing on-grade, asphaltic concrete (AC) surfaced car park and access roads, concrete footpaths, as well as landscaped/garden areas. The eastern end of the site contained the three storey Ron Dunbier building, which is of concrete frame and brick wall construction. The Ron Dunbier building was surrounded by lawns and concrete footpaths. Trees were scattered across the site, particularly around the Ron Dunbier building. Based on the supplied survey plans, a maximum elevation relief of about 1.5m exists across the site area.

The western end of the site is located in close proximity to the existing multi-storey (four level) car park and the Brain Injury Unit, which is a single level brick building with a partial basement level at its eastern end. The south-eastern end of the site is located in close proximity to the road bridge which extends over the Main Southern Railway to the eastern campus.

A services tunnel extends in a westerly direction from the Central Energy building in the eastern campus, below the Main Southern Railway, into the main campus. The tunnel is set back approximately 10m from the southern end of the Ron Dunbier building. The exact details of the services tunnel (eg. precise location, width, invert level, etc.) are unknown.

4.2 Subsurface Conditions

The 1:100,000 series geological map of Penrith (Geological Survey of NSW, Geological Series Sheet 9030) indicates the site to be underlain by Tertiary alluvium (associated with the nearby Georges River), and then Bringelly Shale of the Wianamatta Group.

Generally, the boreholes encountered, and the CPT's indicated, a subsurface profile comprising AC pavements and/or fill, overlying interbedded and variable alluvial soils, then siltstone (shale) bedrock at depths in excess of 11.8m. Reference should be made to the attached borehole logs and interpreted CPT results sheets for specific details at each location. Graphical CPT and borehole summaries are presented as Figures 3 to 5. A summary of the subsurface conditions encountered in the current boreholes and indicated by the CPT's is provided below:

Pavements

A 50mm thick AC surfacing was encountered in JKG101 to JKG104. No roadbase layers were encountered below the AC surfacing.

Fill

Fill, comprising predominantly clayey soils, and to a lesser extent sandy soils, was encountered below the AC surfacing in JKG101 to JKG104, and from the surface in the remaining boreholes to depths generally between 0.2m (JKG107) and 0.7m (JKG101). However in JKG105, the fill was 1.7m deep. Inclusions of siltstone, sandstone and igneous gravel, concrete and wood fragments, ash and slag were found in the fill. In JKG106, a 150mm thick concrete layer (possibly a buried slab) was encountered at 0.1m depth. At JKG105 to JKG107, the fill was grass covered. The upper fill profile in JKG106 resembled imported topsoil. Where penetrated using the CPT (in lieu of the dummy cone), the fill in JKG101, JKG103 and JKG106 was assessed to be well compacted, with moderate to well compaction indicated in JKG105.

Alluvial Soils

The alluvial soil profile generally comprised an upper profile comprising mostly silty clays, and to a lesser extent sandy clays, to depths between 2.3m (JKG103) and 6.1m (JKG104). These were underlain by a variable alluvial profile comprising interbedded silty sand, clayey sand, sand, silty clay and sandy clay.

The upper alluvial clays were generally of medium to high plasticity and of stiff to hard strength.

The clays within the lower alluvial profile were also of stiff to hard strength. The alluvial sands were generally loose to very dense. In JK103A however, very loose to loose sands were encountered between 5.1m and 5.6m depth.

Siltstone Bedrock

Siltstone bedrock (formerly referred to as shale) was encountered in our previous BH104, BH1001, BH1006 and B1, and in our current JKG101 to JKG107, at the depths and RL's tabulated below:

Borehole	Approximate Surface RL (mAHD)	Depth to Weathered Bedrock Surface below Surface Level	Approximately Weathered Bedrock Surface RL (mAHD)
BH104	10.0	10.5	-0.5
BH1001	10.0*	15.6	-5.6
BH1006	9.4*	15.8	-6.4
B1	9.4	16.2	-6.8
JKG101	9.7	15.0	-5.3
JKG102	9.7	15.5	-5.8
JKG103	9.8	14.8	-5.0
JKG104	10.1	11.3	-1.2
JKG105	10.1	15.2	-5.1
JKG106	9.6	14.6	-5.0
JKG107	9.2	15.9	-6.7

* Surface RL's were approximated based on our knowledge of the hospital grounds and the current survey information.

A contour plan of the weathered bedrock surface is presented as Figure 6. This contour plan is based on the above borehole information and should be used as a guide only. In our previous BH104, BH1001 and BH1006, the siltstone on first contact was extremely weathered to distinctly weathered and of extremely low strength and very low strength; in accordance with AS1726-1993 'Geotechnical Site Investigations'. In the current JKG102 to JKG107, the CPT indicated a capping layer of extremely weathered siltstone of hard (soil) strength; in accordance with AS1726:2017 'Geotechnical Site Investigations'. This 'weak' profile ranged in thickness between 0.05m (JKG107) and 2.5m (BH104).

The underlying siltstone bedrock in JKG102 to JKG107, and the siltstone from first contact in JKG101, was generally highly to moderately weathered (distinctly weathered) and of very low, low and medium strength.

Below the upper weathered profile in BH104, BH1001, BH1006, and JKG101 to JKG107, and from first contact in B1, the siltstone was generally fresh and of medium and high strength. In JKG106 and JKG107, high to very high strength siltstone was encountered at depths of 18.0m (0.3m thick layer) and 22.0m (1.4m thick layer), respectively.

From the cored lengths of the boreholes, the siltstone generally contained very few rock defects (ie. clay seams, crushed seams, extremely weathered seams and joints), except in JKG103, JKG104, JKG106 and JKG107 where numerous defects were encountered down to depths of 20.3m, 16.8m, 16.2m and 17.5m, respectively. In JKG103, a 60mm thick 'no core' (core loss) zone was encountered within the deeper fresh siltstone at 18.7m depth; presumably a 'weaker' band washed out by the drill flush water.

An indicative engineering classification of the siltstone (shale) bedrock has been carried out for the previous and current cored boreholes (in accordance with 'Classification of Sandstones and Shales in the Sydney Region: A Forty Year Review' by Pells et al., Australian Geomechanics, June 2019) and is tabulated below:

Borehole	Approx. Surface RL (mAHD)	Indicative Engineering Classification of Siltstone (Shale) Bedrock Depths (m) [RL at top of Unit (mAHD)]			
		Class V	Class IV	Class III	Class II/I
BH104	10.0	10.50-13.00 [-0.5]	-	13.00-13.60 [-3.0]	13.60-16.65 [-3.6]
BH1001	10.0	15.55-16.25 [-5.6]	-	16.25-16.70 [-6.3]	16.70-19.25 [-6.7]
BH1006	9.4	15.75-16.00 [-6.4]	-	16.00-17.90 [-6.6]	17.90-19.90 [-8.5]
B1	9.4	-	-	16.16-16.40 [-6.8]	16.40-18.83 [-7.0]
JKG101	9.7	15.0-15.1 [-5.3]		15.1-15.5 [-5.4]	15.5-23.88 [-5.8]
JKG102	9.7	-	15.8-15.9 [-6.1]	-	15.9-24.26 [-6.2]
JKG103	9.8	15.1-15.2 [-5.3]	15.2-20.3 [-5.4]	-	20.3-23.32 [-10.5]
JKG104	10.1	11.8-12.8 [-1.7]	-	-	12.8-20.70 [-2.7]
JKG105	10.1	15.3-16.5 [-5.2]	-	-	16.5-24.67 [-6.4]
JKG106	9.6	-	14.9-15.1 [-5.3]	15.1-16.3 [-5.5]	16.3-24.43 [-6.7]
JKG107	9.2	-	15.8-17.5 [-6.6]	-	17.5-25.00 [-8.3]

Groundwater

Because of the limited soil sampling completed in the boreholes, groundwater seepage during auger drilling was only observed in JK101, JK103, JK105, JK106 and JK107 at depths between 5.8m (JKG107) and 12.5m (JKG103). The groundwater measurements made on completion of rock coring were most likely influenced by the introduced drill flush water. The groundwater levels would not have stabilised within the limited observation period. For the current investigation, no long-term groundwater level monitoring was carried out.

JKE had previously installed a groundwater monitoring well (MW/JKE122) adjacent to JKG104. On 16 August 2019, the groundwater level in the well was measured by JKE at 8.1m depth.

4.3 Laboratory Test Results

4.3.1 Previous Tests

Of relevance to the proposed development are the results of the soaked CBR testing completed as part of our 2009 investigation (refer to Section 2). The four day soaked CBR tests carried out on alluvial silty clay samples from R5, R15 & R16 resulted in values of 3.0%, 2.0% and 2.5%, respectively, when compacted at either 97% or 98% of Standard Maximum Dry Density (SMDD) and surcharged with 9kg.

4.3.2 Current Tests

The moisture content and Atterberg Limits test results confirmed our field classification of the site soils. The Atterberg Limits and linear shrinkage test results generally indicated the sampled alluvial silty clays of medium plasticity from JKG101 and JKG107, and silty clay fill of medium plasticity from JKG105, to have a moderate to high potential for shrink-swell reactivity with changes in moisture content.

The results of the soil aggression testing are tabulated below:

Borehole	Sample Depth (m)	Alluvial Soil Description	Soil pH	Soil Chloride (mg/kg)	Soil Sulfate (mg/kg)	Resistivity in Soil (ohm m)
JKG102	0.8-1.0	Silty Clay	7.5	38	210	54
	2.8-3.0	Silty Clay	5.6	210	220	32
	5.4-5.6	Clayey Silty Sand	6.4	170	280	39
	6.0-6.2	Clayey Silty Sand	8.2	710	100	21
	8.5-8.7	Silty Sand	8.4	590	80	23
JKG106	0.8-1.0	Silty Clay	8.3	92	530	24
	2.8-3.0	Silty Sand	7.7	290	300	27
	5.5-6.0	Silty Sand	7.0	210	59	49
	8.5-9.0	Sand	8.2	650	88	19

The results of the Point Load Strength Index tests carried out on the recovered rock cores from JKG101 to JKG107 correlated well with our field assessment of bedrock strength. The estimated UCS's, based on the correlation provided in AS1726:2017 (ie. UCS = 20 x $I_{S(50)}$), generally ranged from 6MPa to 66MPa.

5 COMMENTS AND RECOMMENDATIONS

5.1 Site Preparation

The proposed development will require demolition of the existing Ron Dunbier building, multi-storey car park, on-grade car park, access roads and concrete footpaths, removal of trees (including their root balls) and garden areas, and stripping of grass, topsoil, root affected soils, and any deleterious or contaminated existing fill. Stripped topsoil and root affected soils should be stockpiled separately as they are not suitable for reuse as engineered fill. They may however be reused for landscaping purposes subject to approval by JKE. Reference should be made to the JKE report for guidance on the offsite disposal of excavated soils.

Section 5.2.2 of AS1170.4-2007 'Structural Design Actions, Part 4: Earthquake Actions in Australia) states:

> "*Footings supported on piles … that are located in or on soils with a maximum vertical ultimate bearing value of less than 250kPa shall be restrained in any horizontal direction by ties or other means, to limit differential horizontal movement during an earthquake*."

The existing fill is considered to be 'uncontrolled' and not suitable for an ultimate bearing pressure of 250kPa. In order to satisfy the above, all existing fill will need to be excavated, from below the proposed MSCP footprint and replaced with engineered fill (to Level 1 control), as discussed below in Section 5.2.3.

Care should be taken during site stripping and excavation of existing fill not to undermine or remove support from the site boundaries, particularly the adjoining Brain Injury Unit and rail corridor.

We note that the existing trees have likely caused localised 'drying out' of the surrounding clay soils. Removal of the trees will lead to the recovery of the soil moisture content, resulting in differential swell movements in the vicinity of the trees and their root systems (which can extend for a significant distance from the trunk). The swell movements generated by the removal of the trees are in addition to the shrink-swell movements which can occur in the clay soils due to weather related natural moisture changes and by the reduction in surface evaporation subsequent to covering the site with the proposed ground floor pavement, as outlined in AS2870-2011 'Residential Slabs and Footings'.

It is likely that moisture equilibrium in the clay soils, following removal of the tree stumps and roots, could take at least one to two years to develop. In order to reduce the effects that removal of the trees will have on the proposed development, we strongly recommend they be removed as early as possible ahead of construction.

5.2 Earthworks

5.2.1 Site Drainage

The clay subgrade at the site is expected to undergo substantial loss in strength when wet as evident from the low CBR values. Furthermore, the clay subgrade is expected to have a moderate to high 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 untraffickable when wet. The earthworks should be carefully planned and scheduled to maintain good cross-falls during construction.

5.2.2 Subgrade Preparation

Following stripping and excavation, the exposed subgrade should be proof rolled with at least six passes of a static (non-vibratory) smooth drum roller of at least 12 tonnes deadweight. The final pass of proof rolling should be carried out under the direction of an experienced geotechnical engineer for the detection of unstable or soft areas.

Subgrade heaving during proof rolling may occur in areas where the clays have become ‘saturated’ and/or where under-compacted existing fill may exist. Heaving areas should be locally removed to a stable base and replaced with engineered fill, as outlined below. Alternative subgrade improvement options, as appropriate, should be provided by the geotechnical engineer following the proof rolling inspection.

If soil softening occurs after rainfall periods, then the clay subgrade should be over-excavated to below the depth of moisture softening and replaced with engineered fill. If the clay subgrade exhibits shrinkage cracking, then the surface must be moistened with a water cart and rolled until the shrinkage cracks are no longer evident. Care must be taken not to over-water the subgrade as this will result in softening.

Engineered fill must be reused to raise site levels.

5.2.3 Engineered Fill

General

From a geotechnical perspective, excavated clayey and sandy soils are 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. Excavated sandy soils should be thoroughly blended with the clayey soils in order to improve the workability of the latter soil type.

Raising of site levels will require the importation of Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM), as approved by JKE. To simplify the earthworks, our preference would be to import a well graded, durable granular material (ie. crushed or processed sandstone), which is free of organic matter and contains a maximum particle size not exceeding 75mm.

Engineered fill comprising site won clayey and sandy soils should be compacted in maximum 250mm thick loose layers using a large static (non-vibratory) pad-foot roller (say, at least 15 tonnes deadweight) to a density ratio of at least 98% of SMDD and at a moisture content within 2% of Standard Optimum Moisture Content (SOMC).

Engineered fill comprising imported crushed or processed sandstone should also be compacted in maximum 250mm thick loose layers using a large static roller to a density ratio of at least 98% of SMDD.

Our preference is to carry out all compaction using the static mode of the roller due to the potential for vibration induced damage and nuisance to the Brain Injury Unit, Don Everett Building and nearby Liverpool Girls' High School buildings.

Edge Compaction

In order to achieve adequate edge compaction for the proposed fill platform, we recommend that the outer edge of each fill layer extend a horizontal distance of at least 0.5m 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.

Service Trenches

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 compaction plant that can be placed in trenches, backfilling should be carried out in maximum 150mm 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 reduce to 50mm. The compaction specifications provided above are applicable.

Retaining Wall and Lift Pit Backfill

As for services trenches, backfilling behind retaining walls and the lift pit walls 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 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, space permitting. As per services trenches, backfilling should be carried out in 150mm thick loose layers and the maximum particle size of the backfill material should be no more than 50mm. The compaction specifications provided above are applicable.

For the retaining walls and assuming that the lift pit walls are designed as (externally) drained, an alternative backfilling option would be the use of a single sized durable aggregate, such as 'Blue Metal' gravel or crushed concrete aggregate (free of fines), which do not require significant compactive effort; at least in the lower layers. Such material should be nominally compacted using a hand operated vibrating plate (sled) compactor in maximum 200mm thick loose layers. This would expedite the backfilling process. 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), refer to Section 5.2.4 below, to control subsoil erosion. Provided the aggregate backfill is placed and compacted as recommended above, density testing would not be required. 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 engineered fill (ie. similar material to what was provided below design subgrade level).

If the lift pit walls are designed to withstand full (external) lateral hydrostatic pressures, then an alternative could be to backfill behind the walls using cement stabilised sand (at least 5% cement by dry weight). This also would expedite the backfilling process. As a ‘dry mix’, the cement stabilised sand should be rigorously compacted in maximum 200mm thick layers using a vibrating plate (sled) compactor. As a ‘wet mix’, a concrete vibratory poker should be used during placement. Density testing of cement stabilised sand backfill is not required. The cement stabilised sand backfill should be capped with at least a 0.3m thick compacted layer of engineered fill (ie. similar material to what was provided below design subgrade level).

Earthworks Inspection and Testing

Density tests should 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 should be at least one test per layer per 500m^2, or one test per 100m^3 distributed reasonably evenly throughout the full depth and area, or 3 tests per visit, whichever requires the most tests (assumes maximum 250mm 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 150mm thick loose layers). This implies that at each test location, two compacted layers will be tested simultaneously.
- The frequency of density testing for retaining wall and lift pit backfill (for material other than single sized aggregate and cement stabilised sand) should be at least one test per two layers per 50m^2 (assumes maximum 150mm thick loose layers). Again, this implies that at each test location, two compacted layers will be tested simultaneously.

Based on the scale of the proposed earthworks, we recommend that Level 1 control of fill placement and compaction in accordance with Section 8 of AS3798-2007 be carried out, including for the trench, retaining wall and lift pit backfill. Due to a potential conflict of interest, the geotechnical inspection and testing authority (GITA) should be directly engaged by HI (or their representative) or by the Head Contractor, and not by the earthworks contractor or service installation sub-contractors.

5.2.4 Warning

The long-term successful performance of the ground floor and external 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.

5.2.5 Batter Slopes

Temporary cuts for the construction of retaining walls and the lift pit should be battered at no steeper than 1 Vertical (V) on 1 Horizontal (H). Surcharge loads (including plant and soil stockpiles) must be kept well clear from the crests of temporary batter slopes.

Where permanent batter slopes are proposed around the sides of the fill platform, we recommend that they be graded at no steeper than 1V on 2H. Surface erosion protection (eg. quick establishing grass, turf, etc.) should be provided to the permanent batter slopes. Kerbs and gutters, or dish drains should also be provided along the crest of all permanent batter slopes to intercept surface water run-off. Discharge should be piped to the stormwater system.

5.3 Retaining Walls and Lift Pit Walls

Free-standing cantilevered retaining walls supporting areas where some movement can be tolerated and which are independent of the proposed MSCP structure, should be designed using a triangular lateral earth pressure distribution and an ‘active’ earth pressure coefficient (K_a) of 0.33 for the soil profile, assuming a horizontal backfill/retained surface.

Free-standing cantilevered retaining walls supporting areas where movements are undesirable (eg. if movement sensitive buried services are present behind the wall, etc.) or are incorporated into the proposed MSCP structure, should be designed using a triangular lateral earth pressure distribution and an ‘at-rest’ earth pressure coefficient (K_0) of 0.5 for the soil profile, assuming a horizontal backfill/retained surface. The lift pit walls should be designed using this K_0 value.

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

Any surcharge loads affecting the retaining walls (eg. construction traffic, pavement loads, compaction stresses during backfilling, inclined backfill/retained surfaces, etc.) should be allowed in the design using the appropriate earth pressure coefficient from above.

The retaining walls and the external lift pit walls should be designed as permanently drained. Subsurface drains behind free-standing cantilevered retaining walls should incorporate (1) an appropriately sized ‘ag’ pipe with filter sock, surrounded by (2) free draining, single size, durable aggregate, such as ‘Blue Metal’ gravel or crushed concrete aggregate, and encapsulated within (3) a non-woven geotextile filter fabric such as Bidim A34 to control subsoil erosion. All drainage water should be piped to the stormwater system. For the lift pit, detailing of the outlets will require careful consideration to avoid potential back-charging of the backfill. Alternatively, if no drainage provisions are proposed behind the lift pit, then the walls should be designed to withstand full (external) lateral hydrostatic pressures.

Free-standing cantilevered retaining walls independent of the proposed MSCP structure and founded in engineered fill (to Level 1 control, and not underlain by existing 'uncontrolled' fill) and/or alluvial clays of at least stiff strength may be designed for an allowable bearing pressure of 100kPa.

The passive lateral toe resistance for free-standing cantilevered retaining walls independent of the proposed MSCP structure and founded in engineered fill (as above) and/or alluvial clays of at least stiff strength may be estimated using a 'passive' earth pressure coefficient (K_p) of 3.0 (but with a Factor of Safety of at least 2.0 to limit deformations), assuming horizontal ground in front of the wall. The embedment depth design must take into account any nearby localised excavations in front of the wall, such as for footings and service trenches.

The retaining wall footing excavations should be cleaned out, inspected by a geotechnical engineer (prior to the installation of the reinforcement cage), and poured without delay. If delays in pouring are envisaged, then we recommend that a concrete blinding layer be provided over the bases to reduce deterioration due to weathering.

5.4 Piled Footings

5.4.1 Geotechnical Design

Based on the results of the investigation and anticipated pile loads, the proposed MSCP structure will need to be supported on piles founded in Class II/I siltstone. The primary geotechnical issues for the design and construction of piles include the presence of a deeply weathered siltstone profile in the vicinity of JKG103, and relatively shallow Class II/I siltstone in JKG104. For the current MSCP design, JKG101 to JKG107, B1 and BH1006 are relevant. In these boreholes, Class II/I siltstone was generally encountered between RL-5.8m (JKG101) and RL-8.5m (BH1006). However, at JKG103 and JKG104, the Class II/I siltstone was encountered at RL-10.5m and RL-2.7m, respectively.

In order to better identify the surface of the Class II/I siltstone for piling, we recommend that at least five additional cored boreholes be completed once site possession has been obtained. By referencing Figure 2, the five boreholes would be located between JKG101 and JKG103, between R4 and JKG104, between JKG103 and JKG104, adjacent to R5, and adjacent to R15. We can provide a fee proposal to complete the additional cored boreholes if requested to do so.

Due to the presence of collapsible sandy soils and groundwater, we recommend that the proposed MSCP structure be supported on continuous flight auger (CFA) piles. Consideration could also be given to the use of bored piles with temporary segmental casing, where the casing is incrementally installed down to the bedrock surface using rotary and vibratory techniques.

CFA piles and bored piles socketed at least 0.3m into the underlying Class II/I siltstone may be designed for an allowable end bearing pressure of 3,500kPa. Sockets formed below the minimum 0.3m length requirement may be designed for allowable shaft adhesion values of 350kPa in compression and 175kPa in tension, on condition that the pile shaft is suitably roughened, as discussed further below. The provided pressures are based upon serviceability criteria of deflections at the pile toe of less than 1% of the pile diameter. These pile settlements will be of an elastic nature and are expected to occur as construction proceeds.

For ultimate limit state design, an ultimate bearing pressure of 30MPa and an ultimate compressive pile shaft adhesion value of 600kPa may be adopted for the Class II/I siltstone. Settlement limitations to the structure will still need to be satisfied and can be estimated using an Elastic Modulus of 1,000MPa for the Class II/I siltstone. It should be noted that the ultimate bearing pressures must be used in conjunction with an appropriate 'Basic Geotechnical Strength Reduction Factor' (ϕ_{gb}), as defined in Section 4.3.2 of AS2159-2009 'Piling – Design and Installation'. Based on our assessment, which assumes that the foundation material at each pile location will be assessed/inspected by a competent geotechnical engineer, we recommend a ϕ_{gb} value of 0.67 for a low redundancy system.

The shaft adhesion values provided above are on condition that the pile shaft is suitably roughened to a Roughness Class equivalent to at least R2. R2 roughness is defined as grooves of depth 1mm to 4mm, and width greater than 2mm, and at a spacing of 50mm to 200mm. If the piling contractor cannot confirm that at least R2 roughness can be achieved for CFA piles, then the above recommended shaft adhesion values will need to reduce. In this scenario, further advice should be sought from JKG.

For lateral pile design, we recommend that the following subsoil parameters be adopted for the soil profile:

Material	**Undrained Shear Strength, C_u (kPa)**	**Effective Cohesion, C' (kPa)**	**Effective Friction Angle, ø'**	**Bulk Unit Weight (kN/m^3)**	**Elastic Modulus, E (MPa)**
Engineered Fill to Level 1 control, comprising site won clayey soils	100	-	-	19	20
Engineered Fill to Level 1 control, comprising imported crushed/processed sandstone	-	2	33	20	20
Alluvial Clays – stiff strength	50	-	-	19	10
Alluvial Clays – very stiff and hard strength	150	-	-	20	40
Alluvial Sands – loose to medium dense	-	0	30	19	15
Alluvial Sands – medium dense, dense and very dense	-	0	33	20	40

Below groundwater, the effective (submerged) unit weight for each soil profile equals the bulk unit weight minus 10kN/m^3. A Poisson's ratio of 0.3 can be adopted for each of the above soil types. The tabulated soil parameters are only applicable for non-repetitive (single) application of load and may require adjustment for repetitive or cyclic loadings.

For the Class V and Class IV siltstone, an allowable lateral toe resistance of 300kPa, a bulk unit weight of 21kN/m^3, an Elastic Modulus of 50MPa, and a Poisson's ratio of 0.25, can be adopted for design. For the Class III and better quality siltstone, an allowable lateral toe resistance of 1,000kPa, a bulk unit weight of 23kN/m^3, an Elastic Modulus of 700MPa, and a Poisson's ratio of 0.15, can be adopted for design.

For individual piles in clayey soils, the ultimate lateral resistance is equal to 9 x C_u below a depth of 1.5 pile diameters from design subgrade level. For individual piles in sandy soils and engineered fill comprising crushed/processed sandstone, the ultimate lateral resistance is equal to 3 x K_p x σ'_v where:

K_p = 'passive' lateral earth pressure coefficient
σ'_v = effective vertical stress

A Factor of Safety of at least 2.0 should be applied to the design to reduce deformations. The upper 2m should be ignored in lateral pile design due to potential shrink-swell effects in the upper clay profile.

Due to the shrink-swell nature of the clay soils, we recommend that any ground beams between pile heads in contact with the subgrade be poured over void formers. The void formers must be able to accommodate heave movements of 50mm.

All CFA piling should be witnessed and compared to the borehole information by a geotechnical engineer to confirm that a satisfactory bearing stratum has been achieved. All CFA piles must be certified by the piling contractor.

If bored piles with temporary segmental casing are used, then they should be cleaned out, inspected and tremie poured on the same day as drilling. The roughness of the rock socket must be inspected using a downhole camera system. All pile holes should be cleaned out using a cleaning bucket (for all pile diameters) for effective removal of sludge and loose material. Due to the expected groundwater seepage, the piles should only be cleaned out when concrete is ready to be tremie poured. All piles must be inspected by a geotechnical engineer, and compared to the cored borehole information, to confirm that a satisfactory bearing stratum has been achieved.

5.4.2 Earthquake Design Parameters

The following parameters should be adopted for earthquake design in accordance with AS1170.4-2007 (including Amendment Nos. 1 & 2):

- Hazard Factor (Z) = 0.09
- Site Subsoil Class = Class C_e

5.4.3 Soil Aggression

The soil pH test results have indicated slightly acidic to alkaline subsoil conditions. The soil sulfate and chloride test results have indicated low sulfate and chloride contents. The calculated soil resistivity values have indicated mildly aggressive conditions to steel piles.

In accordance with Table 6.4.2(C) of AS2159-2009, the exposure classification to concrete piles is 'mild'. In accordance with Table 6.5.2(C) of AS2159-2009, the exposure classification to steel piles is 'mild'.

5.5 On-Grade Pavements

5.5.1 Design

Based on the previous laboratory test results, we recommend that all proposed new pavements be designed for a CBR value of 2% or a short-term Young's modulus of 16MPa for the compacted clay subgrade.

Where site levels are to be raised with better quality imported material (eg. crushed or processed sandstone), then a higher equivalent CBR value could be justified provided that the CBR values of the imported material (compacted to a density ratio of at least 98% of SMDD) are provided, and that the material is placed and compacted in a uniformly thick layer. We could review the supplied CBR test information, and calculate the equivalent CBR value for a minimum thickness of the better quality imported material, if commissioned to do so.

5.5.2 Concrete Pavements

If proposed concrete pavements are to be supported on an unbound granular sub-base, then it should be at least 100mm thick and comprise DGB20 (RMS QA Specification 3051 unbound granular material) and compacted to a density ratio of 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 so as to reduce the potential for material breakdown during compaction. The sub-base material would provide more uniform slab support and would reduce 'pumping' of subgrade 'fines' at joints due to vehicular movements. Slab joints should be designed to resist shear forces but not bending moments by providing dowelled or keyed joints.

5.5.3 Asphaltic Concrete Pavements

For new AC pavements, we recommend that all base course materials comprise DGB20 (RMS QA Specification 3051). The base course material should be compacted in maximum 200mm thick loose layers using a large static smooth drum roller to at least 98% of MMDD. Adequate moisture conditioning to within 2% of MOMC should be provided during placement.

We further recommend that all sub-base materials comprise DGS20 or DGS40 (RMS QA Specification 3051). The sub-base material should be compacted in maximum 200mm thick loose layers using a large static smooth drum roller to at least 95% of MMDD. Again, adequate moisture conditioning to within 2% of MOMC should be provided during placement.

5.5.4 Density Testing

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 1000m^2, or three tests per layer, or three tests per visit, whichever requires the most tests. Level 2 testing of fill compaction is the minimum permissible in AS3798-2007. The geotechnical testing authority (GTA) should be directly engaged by HI (or their representative) or by the Head Contractor.

5.5.5 Subsoil Drains

In order to protect the pavement edges, subsoil drains should be provided along the perimeter of all proposed pavement areas, including around any internal landscaping areas, with invert levels of at least 200mm below design subgrade level. The drainage trenches should be excavated with a uniform/consistent 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.

5.6 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:

- Additional cored boreholes in the vicinity of JKG103, JKG104 and R5 to confirm the depth of the Class II/I siltstone.
- Pre-construction meeting to discuss the earthworks.
- Proof rolling inspections.
- Density testing of all engineered fill, including trench, retaining wall and lift pit backfill, to Level 1 control.
- Retaining wall footing inspections.
- Witnessing of all CFA pile installations or inspections of all bored piles.
- Review of CBR test information of all imported materials being used to raise site levels.
- Density testing of all granular pavement materials to at least Level 2 control.

6 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 JKG 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 CPT's 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 JKG. 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.

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 New Multi-Storey Carpark and Roadways
Location: Western Campus, Liverpool Hospital, NSW

Ref No: 32160A2
Report: A
Report Date: 11/10/2019
Page 1 of 1

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 %**
JKG101	0.80 - 1.00	17.7	42	13	29	11.0
JKG105	1.30 - 1.50	14.8	46	15	31	14.5
JKG107	0.30 - 0.40	19.7	47	13	34	13.0

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: 27/09/2019.
- Sampled and supplied by client.

11/10/2019

NATA

NATA Accredited Laboratory Number:1327

Accredited for compliance with ISO/IEC 17025 - Testing.
This document shall not be reproduced except
In full without approval of the laboratory. Results relate only to
the items tested or sampled.

Authorised Signature / Date
(D. Treweek)

115 Wicks Road
Macquarie Park NSW 2113
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client: JK Geotechnics
Project: Proposed New Multi-Storey Carpark and Roadways
Location: Western Campus, Liverpool Hospital, NSW
Ref No: 32160A2
Report: B
Report Date: 2/10/2019
Page 1 of 6

BOREHOLE NUMBER	DEPTH m	$I_{S\,(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
JKG101	15.14 - 15.17	1.7	34
	15.55 - 15.58	1.3	26
	15.83 - 15.86	0.9	18
	16.08 - 16.10	1.1	22
	16.81 - 16.84	1.0	20
	17.11 - 17.14	1.8	36
	17.74 - 17.77	1.2	24
	18.10 - 18.13	1.6	32
	18.71 - 18.74	1.2	24
	19.06 - 19.09	0.7	14
	19.82 - 19.85	1.0	20
	20.07- 20.10	0.7	14
	20.85 - 20.88	0.8	16
	21.07 - 21.09	1.0	20
	21.89 - 21.92	1.6	32
	22.14 - 22.17	2.0	40
	22.78 - 22.81	1.1	22
	23.08 - 23.11	0.7	14
	23.75 - 23.78	0.6	12
JKG102	15.92 - 15.96	1.0	20
	16.15 - 16.19	1.0	20
	16.78 - 16.80	0.7	14
	17.15 - 17.18	1.5	30
	17.72 - 17.74	1.3	26
	18.12 - 18.14	0.9	18

NOTES: See Page 6 of 6

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	32160A2
Project:	Proposed New Multi-Storey Carpark and Roadways	**Report:**	B
		Report Date:	2/10/2019
Location:	Western Campus, Liverpool Hospital, NSW	**Page 2 of 6**	

BOREHOLE NUMBER	DEPTH m	$I_{S\ (50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
JKG102	18.71 - 18.74	1.5	30
	19.12 - 19.14	1.6	32
	19.75 - 19.78	0.3	6
	20.18 - 20.21	1.9	38
	20.78 - 20.80	1.5	30
	21.16 - 21.19	3.1	62
	21.82 - 21.85	2.8	56
	22.13 - 22.15	2.4	48
	22.82 - 22.85	1.8	36
	23.24 - 23.26	1.7	34
	23.81 - 23.84	1.2	24
	24.00 - 24.03	1.2	24
JKG103	15.17 - 15.20	0.2	4
	15.37 - 15.39	0.6	12
	15.80 - 15.83	0.9	18
	16.14 - 16.17	1.4	28
	16.73 - 16.76	1.1	22
	17.11 - 17.14	1.1	22
	17.68 - 17.71	0.6	12
	18.27 - 18.30	1.6	32
	18.90 - 18.92	0.6	12
	19.12 - 19.15	0.9	18
	19.77 - 19.80	0.8	16
	20.12 - 20.15	0.3	6
	20.71 - 20.74	0.8	16

NOTES: See Page 6 of 6

115 Wicks Road
Macquarie Park NSW 2113
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	32160A2
Project:	Proposed New Multi-Storey Carpark and Roadways	**Report:**	B
		Report Date:	2/10/2019
Location:	Western Campus, Liverpool Hospital, NSW	**Page 3 of 6**	

BOREHOLE NUMBER	DEPTH m	$I_{S\ (50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
JKG103	21.17 - 21.20	1.6	32
	21.81 - 21.84	1.7	34
	22.11 - 22.14	1.7	34
	22.80 - 22.83	1.0	20
	23.09 - 23.12	1.9	38
JKG104	12.14 - 12.18	0.06	1
	12.77 - 12.81	1.0	20
	13.21 - 13.25	1.2	24
	13.91 - 13.94	1.1	22
	14.28 - 14.31	0.8	16
	14.95 - 14.99	1.7	34
	15.37 - 15.40	1.7	34
	15.77 - 15.81	1.1	22
	16.14 - 16.17	0.7	14
	16.47 - 16.51	1.7	34
	16.95 - 16.99	2.5	50
	17.37 - 17.40	1.8	36
	17.79 - 17.82	2.6	52
	18.24 - 18.28	2.4	48
	18.80 - 18.84	2.2	44
	19.39 - 19.42	2.2	44
	19.90 - 19.94	2.1	42
	20.33 - 20.37	2.7	54
JKG105	16.52 - 16.54	0.4	8
	16.81 - 16.84	0.7	14

NOTES: See Page 6 of 6

115 Wicks Road
Macquarie Park NSW 2113
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client: JK Geotechnics
Project: Proposed New Multi-Storey Carpark and Roadways
Location: Western Campus, Liverpool Hospital, NSW
Ref No: 32160A2
Report: B
Report Date: 2/10/2019
Page 4 of 6

BOREHOLE NUMBER	DEPTH m	$I_{S\ (50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
JKG105	17.12 - 17.15	1.4	28
	17.90 - 17.93	0.7	14
	18.12 - 18.15	1.5	30
	18.84 - 18.87	0.3	6
	19.14 - 19.17	0.9	18
	19.79 - 19.82	0.6	12
	20.10 - 20.14	1.0	20
	20.83 - 20.86	0.5	10
	21.14 - 21.17	0.9	18
	21.73 - 21.75	0.7	14
	22.12 - 22.15	0.8	16
	22.81 - 22.84	1.0	20
	23.39 - 23.42	1.6	32
	23.83 - 23.86	1.4	28
	24.15 - 24.18	1.6	32
	24.50 - 24.54	1.5	30
JKG106	15.61 - 15.64	0.2	4
	15.96 - 16.00	0.5	10
	16.34 - 16.37	0.6	12
	16.63 - 16.66	1.3	26
	17.00 - 17.04	2.1	42
	17.39 - 17.42	1.7	34
	17.84 - 17.87	1.9	38
	18.21 - 18.24	3.3	66
	18.76 - 18.79	2.1	42

NOTES: See Page 6 of 6

115 Wicks Road
Macquarie Park NSW 2113
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client: JK Geotechnics
Project: Proposed New Multi-Storey Carpark and Roadways
Location: Western Campus, Liverpool Hospital, NSW

Ref No: 32160A2
Report: B
Report Date: 2/10/2019
Page 5 of 6

BOREHOLE NUMBER	DEPTH m	$I_{S\ (50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
JKG106	19.40 - 19.44	1.8	36
	19.90 - 19.94	2.0	40
	20.25 - 20.28	1.8	36
	20.76 - 20.80	1.3	26
	21.15 - 21.19	1.6	32
	21.75 - 21.78	1.6	32
	22.23 - 22.27	3.0	60
	22.83 - 22.87	2.0	40
	23.29 - 23.33	1.6	32
	23.83 - 23.87	1.3	26
	24.26 - 24.30	1.7	34
JKG107	15.82 - 15.84	0.4	8
	16.00 - 16.03	0.3	6
	16.43 - 16.46	0.6	12
	16.74 - 16.77	0.8	16
	17.09 - 17.12	0.3	6
	17.75 - 17.79	0.6	12
	18.10 - 18.13	1.2	24
	18.86 - 18.89	1.5	30
	19.15 - 19.18	1.0	20
	19.69 - 19.73	0.8	16
	20.19 - 20.22	0.6	12
	20.80 - 20.83	1.3	26
	21.12 - 21.15	1.9	38
	21.68 - 21.71	1.8	36

NOTES: See Page 6 of 6

115 Wicks Road
Macquarie Park NSW 2113
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client: JK Geotechnics
Project: Proposed New Multi-Storey Carpark and Roadways
Location: Western Campus, Liverpool Hospital, NSW

Ref No: 32160A2
Report: B
Report Date: 2/10/2019
Page 6 of 6

BOREHOLE NUMBER	DEPTH m	$I_{S\,(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
JKG107	22.13 - 22.16	3.0	60
	22.81 - 22.84	1.9	38
	23.13 - 23.16	3.2	64
	23.79 - 23.82	1.9	38
	24.26 - 24.28	1.1	22
	24.74 - 24.77	1.2	24

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 $I_{S\,(50)}$

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

CERTIFICATE OF ANALYSIS 227147

Client Details

Client	JK Geotechnics
Attention	A Jackaman, Can Wang
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**32160A2, Liverpool Hospital**
Number of Samples	9 Soil
Date samples received	27/09/2019
Date completed instructions received	27/09/2019

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	04/10/2019
Date of Issue	04/10/2019

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

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

Results Approved By
Nick Sarlamis, Inorganics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

ACCREDITED FOR TECHNICAL COMPETENCE

Misc Inorg - Soil						
Our Reference		227147-1	227147-2	227147-3	227147-4	227147-5
Your Reference	UNITS	JKG102	JKG102	JKG102	JKG102	JKG102
Depth		0.8-1.0	2.8-3.0	5.4-5.6	6.0-6.2	8.5-8.7
Date Sampled		27/09/2019	27/09/2019	27/09/2019	27/09/2019	27/09/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	02/10/2019	02/10/2019	02/10/2019	02/10/2019	02/10/2019
Date analysed	-	02/10/2019	02/10/2019	02/10/2019	02/10/2019	02/10/2019
pH 1:5 soil:water	pH Units	7.5	5.6	6.4	8.2	8.4
Chloride, Cl 1:5 soil:water	mg/kg	38	210	170	710	590
Sulphate, SO4 1:5 soil:water	mg/kg	210	220	280	100	80
Resistivity in soil*	ohm m	54	32	39	21	23

Misc Inorg - Soil					
Our Reference		227147-6	227147-7	227147-8	227147-9
Your Reference	UNITS	JKG106	JKG106	JKG106	JKG106
Depth		0.8-1.0	2.8-3.0	5.5-6.0	8.5-3.0
Date Sampled		27/09/2019	27/09/2019	27/09/2019	27/09/2019
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	02/10/2019	02/10/2019	02/10/2019	02/10/2019
Date analysed	-	02/10/2019	02/10/2019	02/10/2019	02/10/2019
pH 1:5 soil:water	pH Units	8.3	7.7	7.0	8.2
Chloride, Cl 1:5 soil:water	mg/kg	92	290	210	650
Sulphate, SO4 1:5 soil:water	mg/kg	530	300	59	88
Resistivity in soil*	ohm m	24	27	49	19

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.

Client Reference: 32160A2, Liverpool Hospital

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	227147-2
Date prepared	-			02/10/2019	1	02/10/2019	02/10/2019		02/10/2019	02/10/2019
Date analysed	-			02/10/2019	1	02/10/2019	02/10/2019		02/10/2019	02/10/2019
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	7.5	7.5	0	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	38	33	14	101	116
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	210	230	9	108	124
Resistivity in soil*	ohm m	1	Inorg-002	<1	1	54	54	0	[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.

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; 60-140% for organics (+/-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.

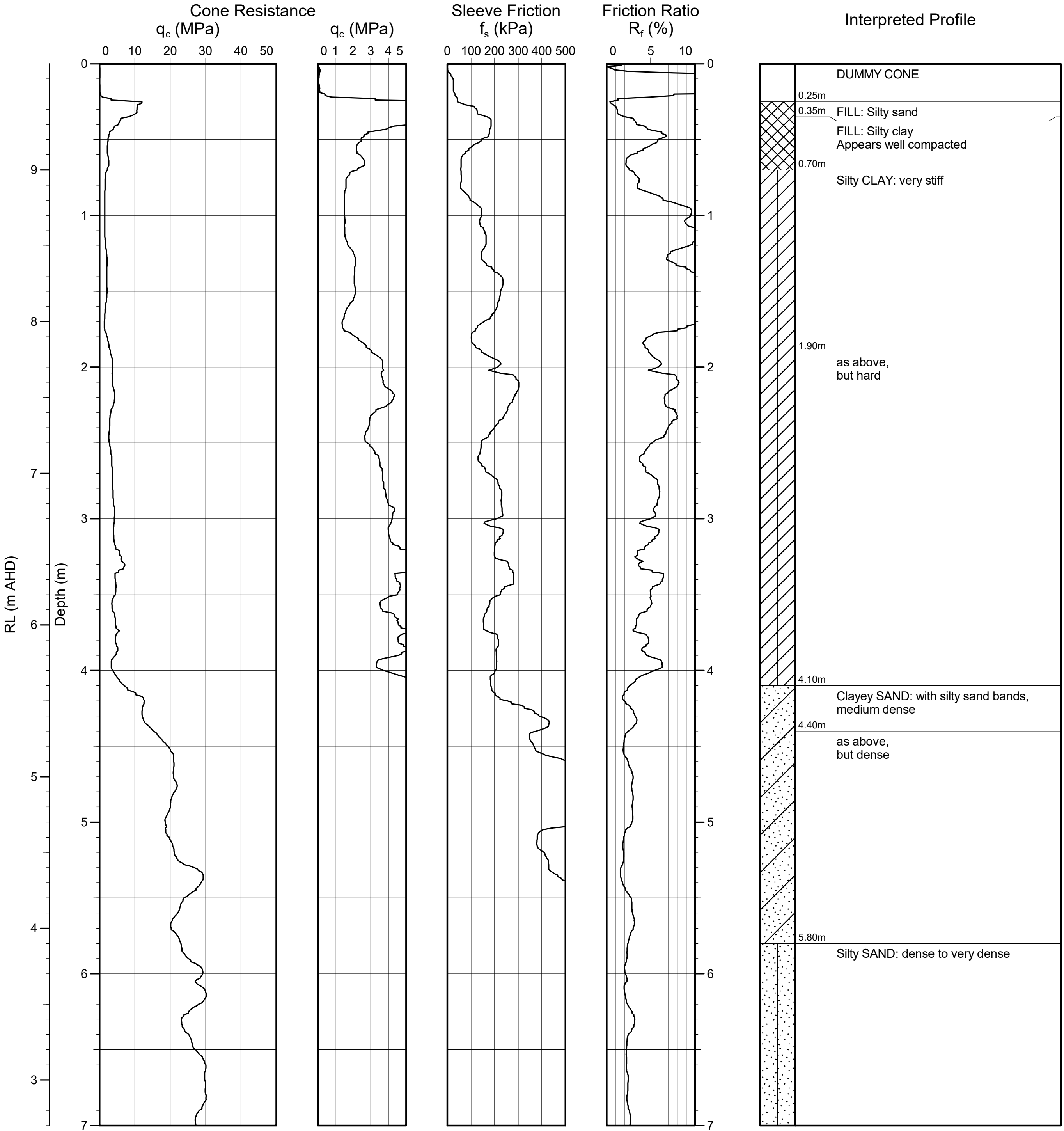
JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No.
JKG101A
1 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**R.L. Surface:** ~9.7 m	**Data File:** 32160A2_CPT101A
Date: 16/9/19	**Datum:** AHD	**Operator:** K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

JK 9.02.4 LIB.GLB Log JK CPT MATERIAL - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:32 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

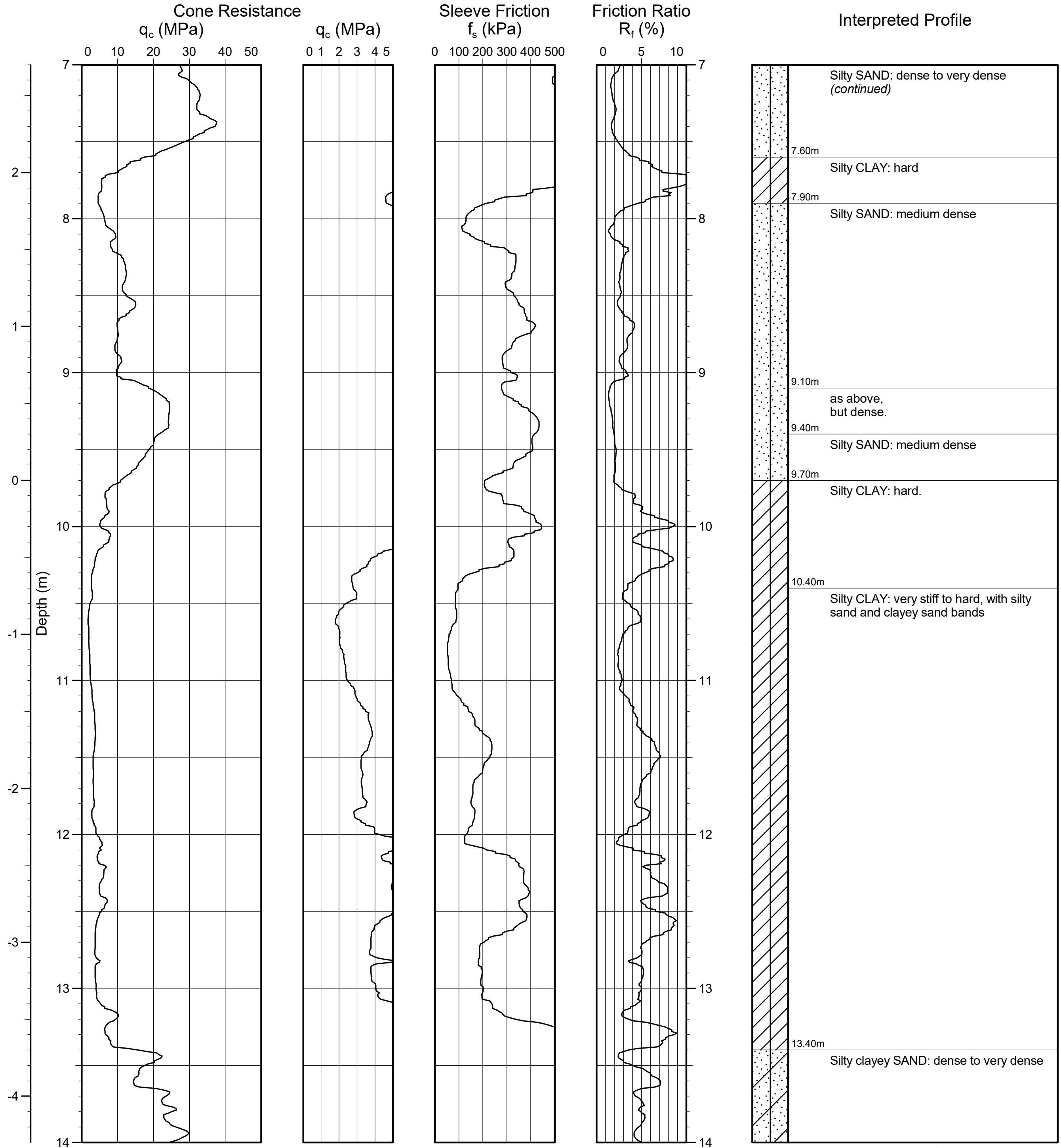
JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No.
JKG101A
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**R.L. Surface:** ~9.7 m	**Data File:** 32160A2_CPT101A
Date: 16/9/19	**Datum:** AHD	**Operator:** K.K.S.



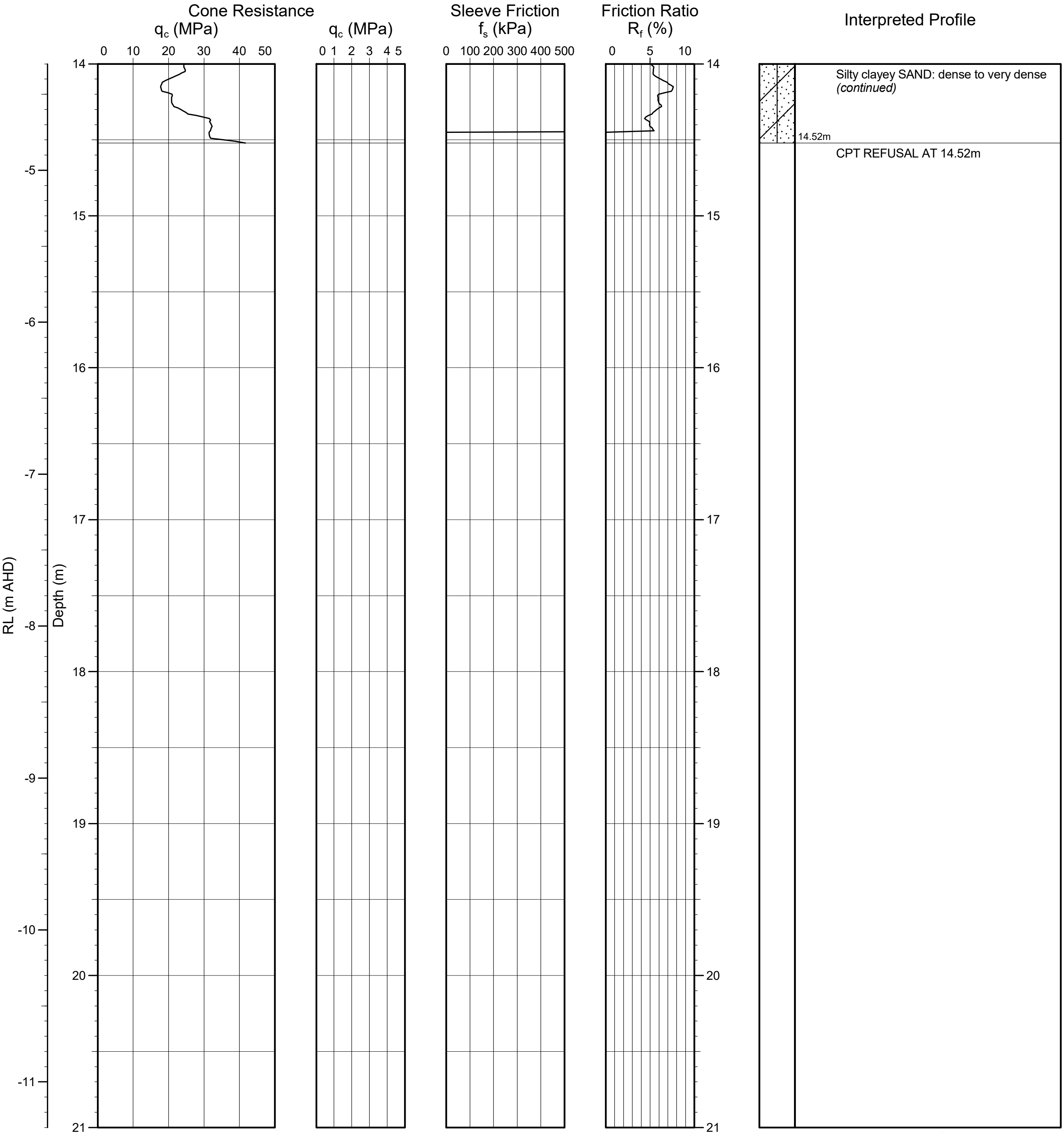
Interpreted by: K.K.S.
Checked by: A.J.

CONE PENETROMETER TEST RESULTS

CPT No.
JKG101A
3 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~9.7 m
Data File: 32160A2_CPT101A
Date: 16/9/19
Datum: AHD
Operator: K.K.S.



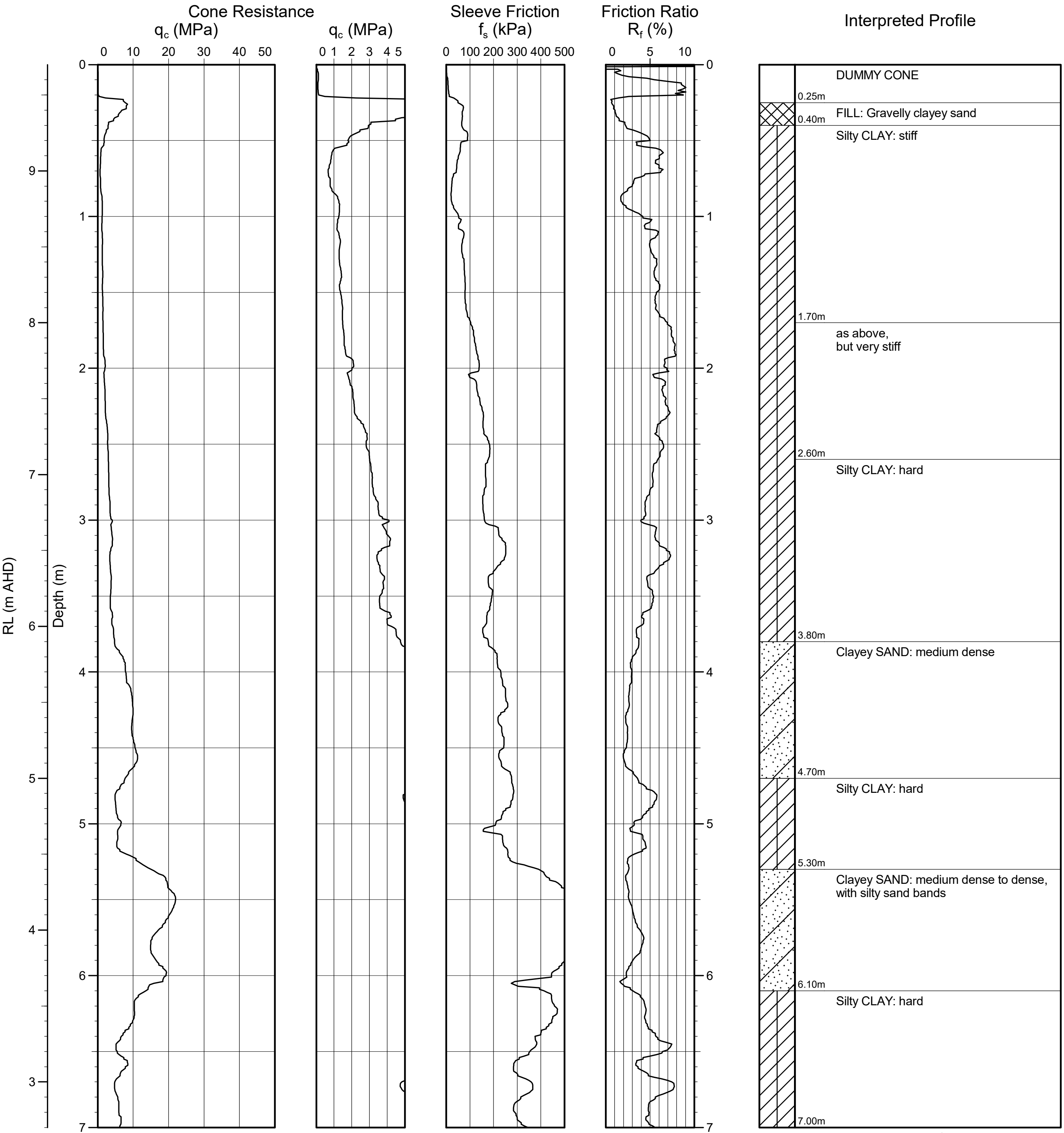
Interpreted by: K.K.S.
Checked by: A.J.

CONE PENETROMETER TEST RESULTS

CPT No.
JKG102A
1 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~9.7 m
Data File: 32160A2_CPT102A
Date: 16/9/19
Datum: AHD
Operator: K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

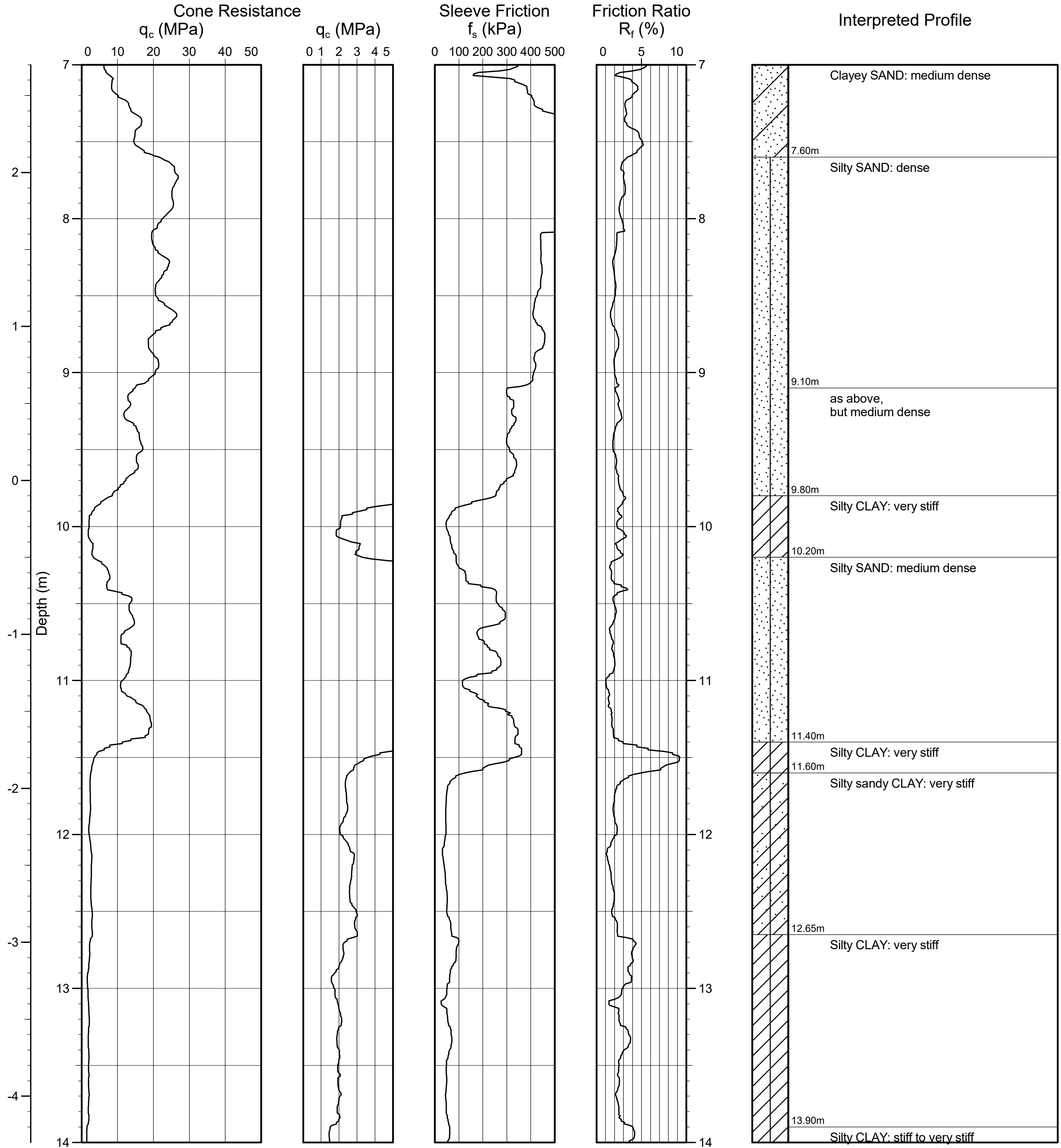
JK 9.02.4 LIB.GLB Log JK CPT MATERIAL - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:32 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CONE PENETROMETER TEST RESULTS

CPT No.
JKG102A
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~9.7 m
Data File: 32160A2_CPT102A
Date: 16/9/19
Datum: AHD
Operator: K.K.S.



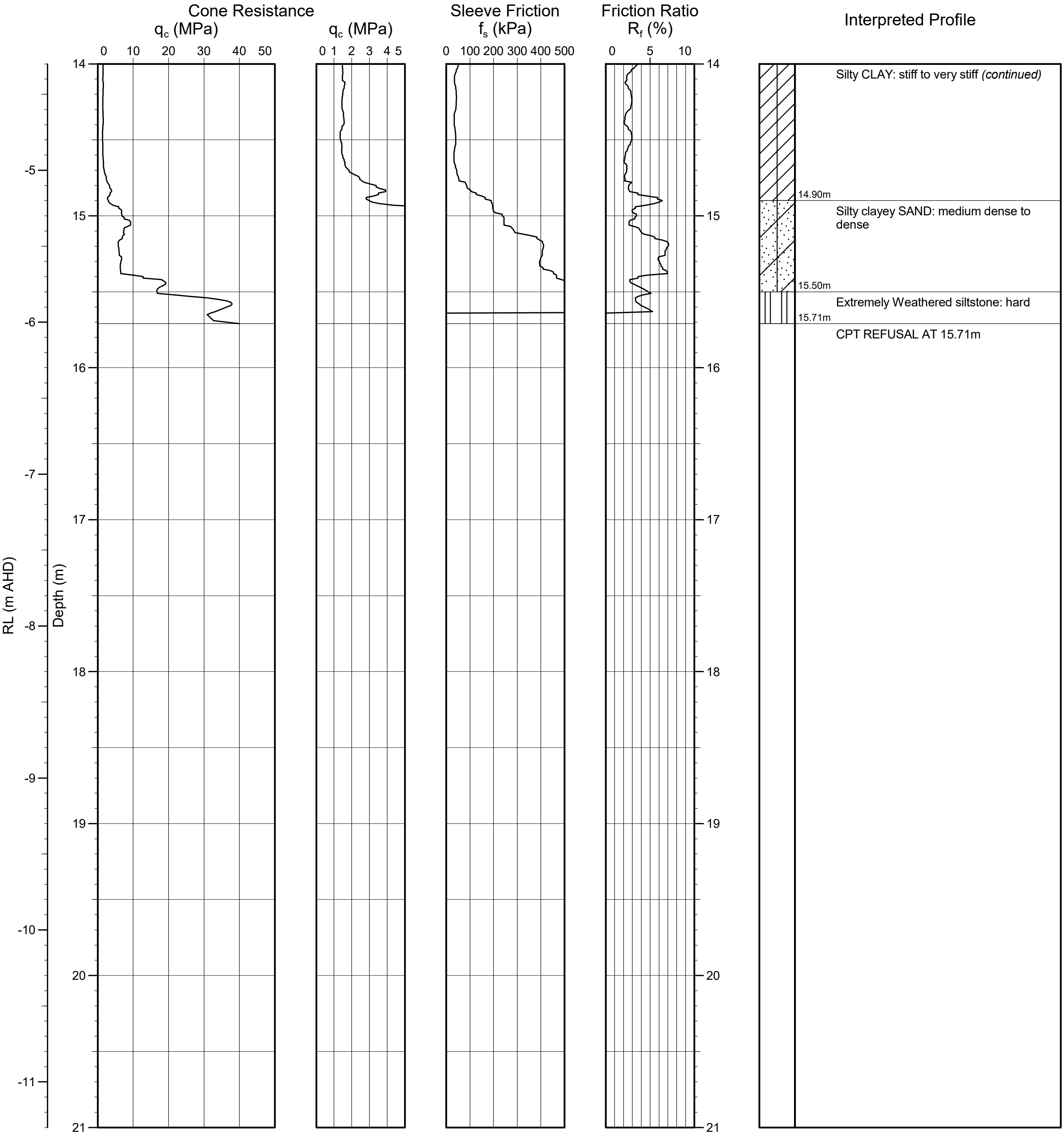
Interpreted by: K.K.S.
Checked by: A.J.

CONE PENETROMETER TEST RESULTS

CPT No.
JKG102A
3 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~9.7 m
Data File: 32160A2_CPT102A
Date: 16/9/19
Datum: AHD
Operator: K.K.S.



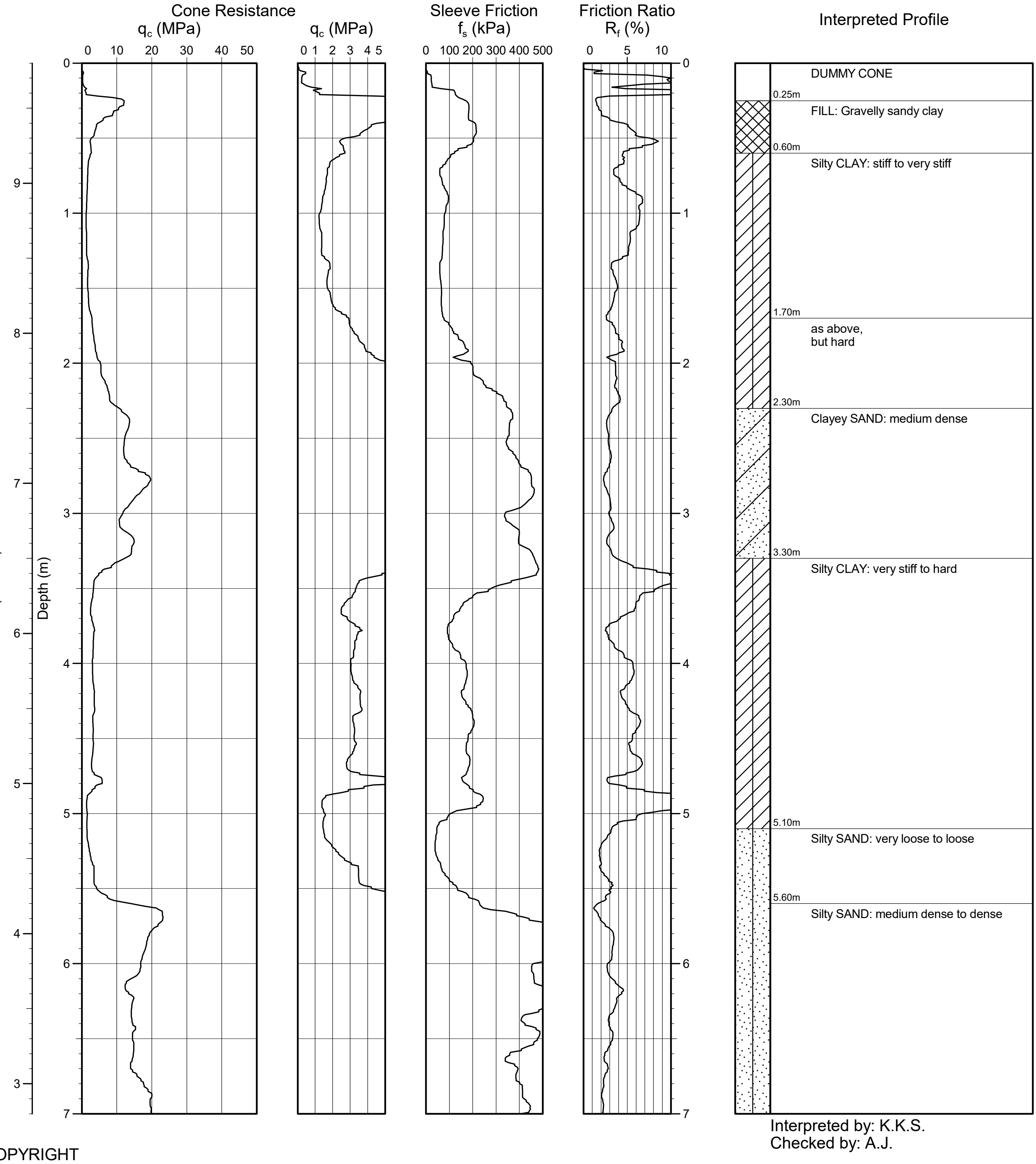
Interpreted by: K.K.S.
Checked by: A.J.

CONE PENETROMETER TEST RESULTS

CPT No.
JKG103A
1 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**R.L. Surface:** ~9.8 m	**Data File:** 32160A2_CPT103A
Date: 16/9/19	**Datum:** AHD	**Operator:** K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

JK 9.02.4 LIB.GLB Log JK CPT MATERIAL - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:33 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

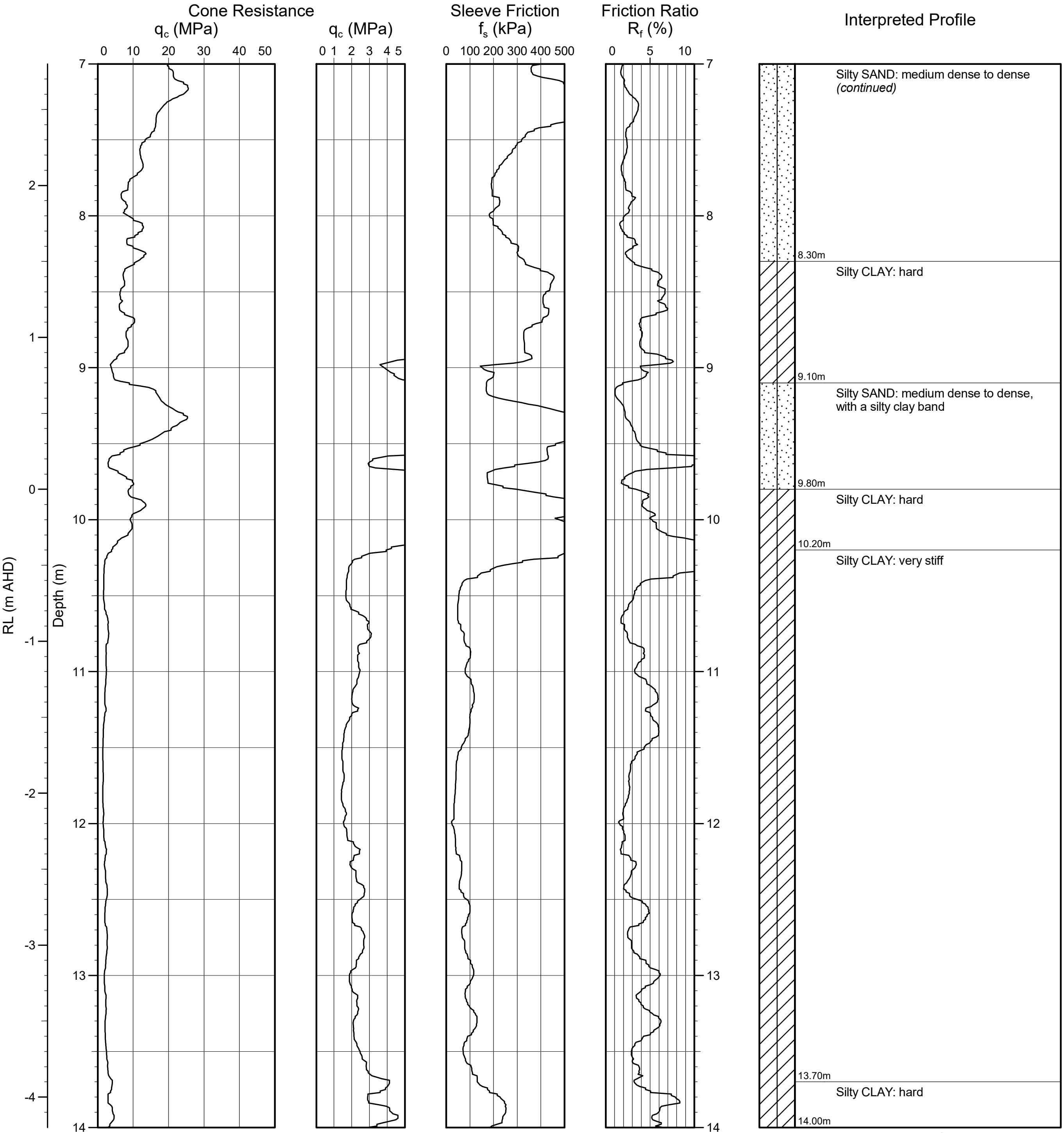
JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No.
JKG103A
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~9.8 m
Data File: 32160A2_CPT103A
Date: 16/9/19
Datum: AHD
Operator: K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

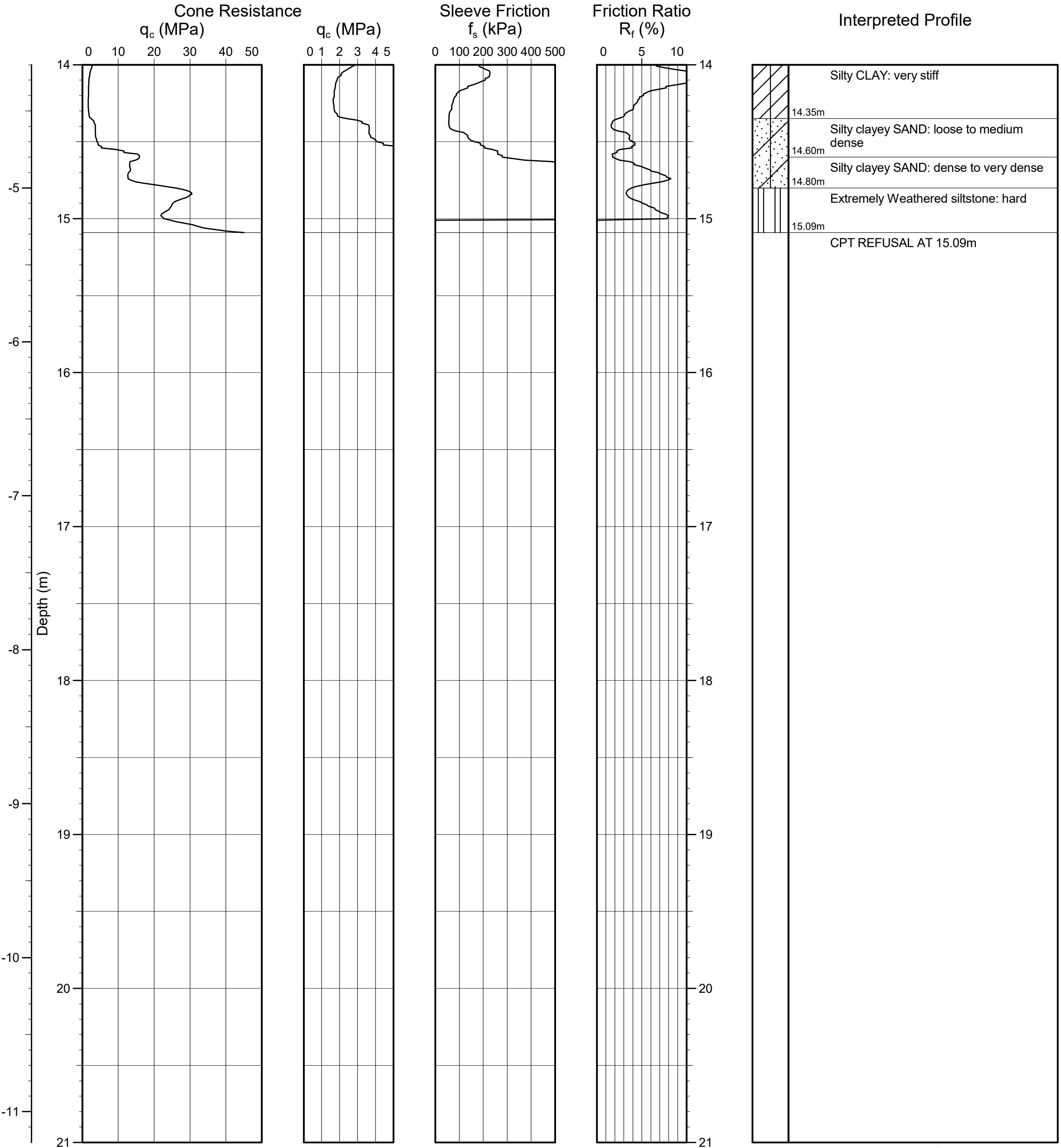
JK 9.02.4 LIB.GLB Log JK CPT MATERIAL - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:33 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CONE PENETROMETER TEST RESULTS

CPT No.
JKG103A
3 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~9.8 m
Data File: 32160A2_CPT103A
Date: 16/9/19
Datum: AHD
Operator: K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

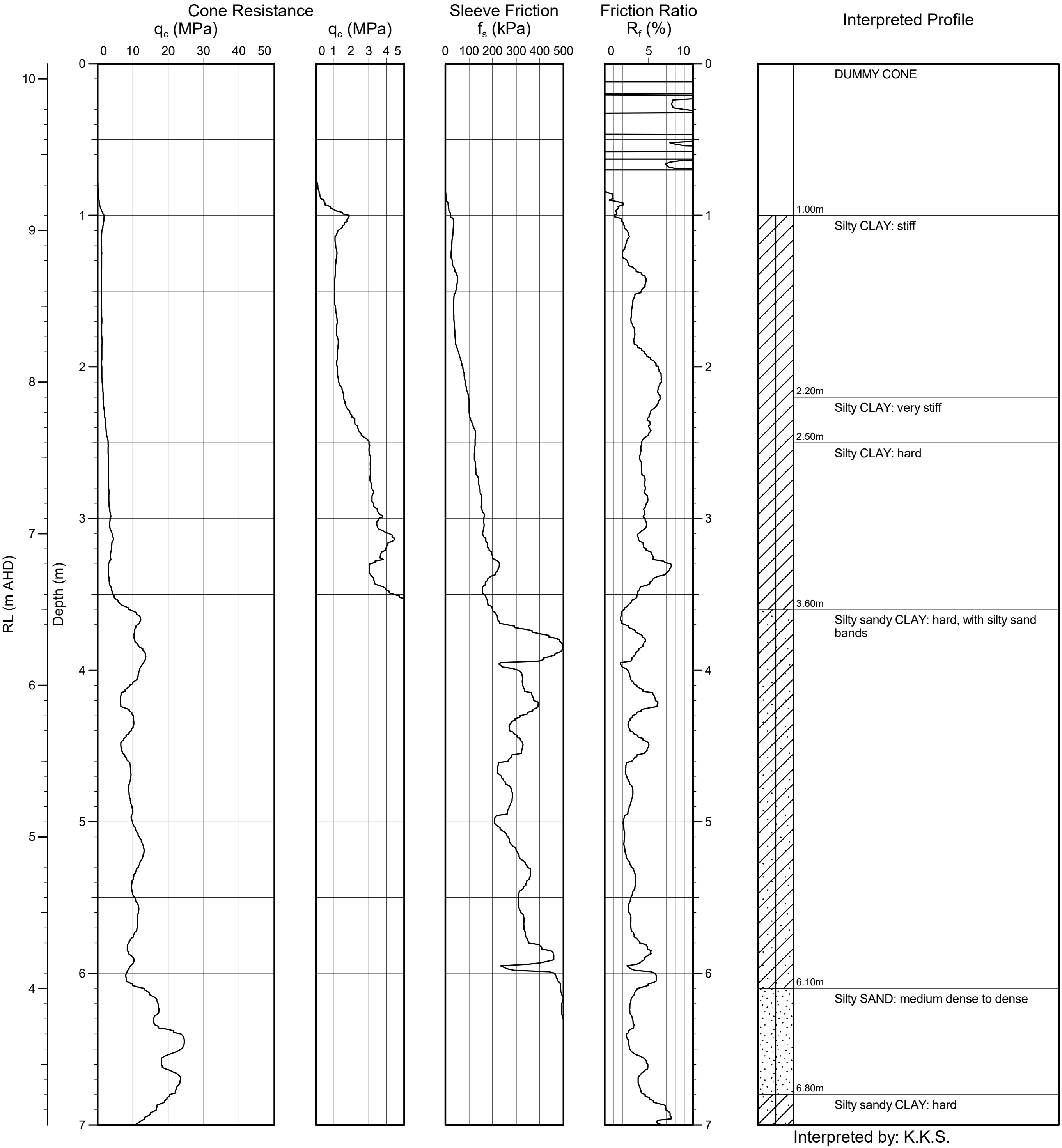
JK 9.02.4 LIB.GLB Log JK CPT MATERIAL - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:33 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CONE PENETROMETER TEST RESULTS

CPT No.
JKG104A
1 / 2

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~10.1 m
Data File: 32160A2_CPT104A
Date: 16/9/19
Datum: AHD
Operator: K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

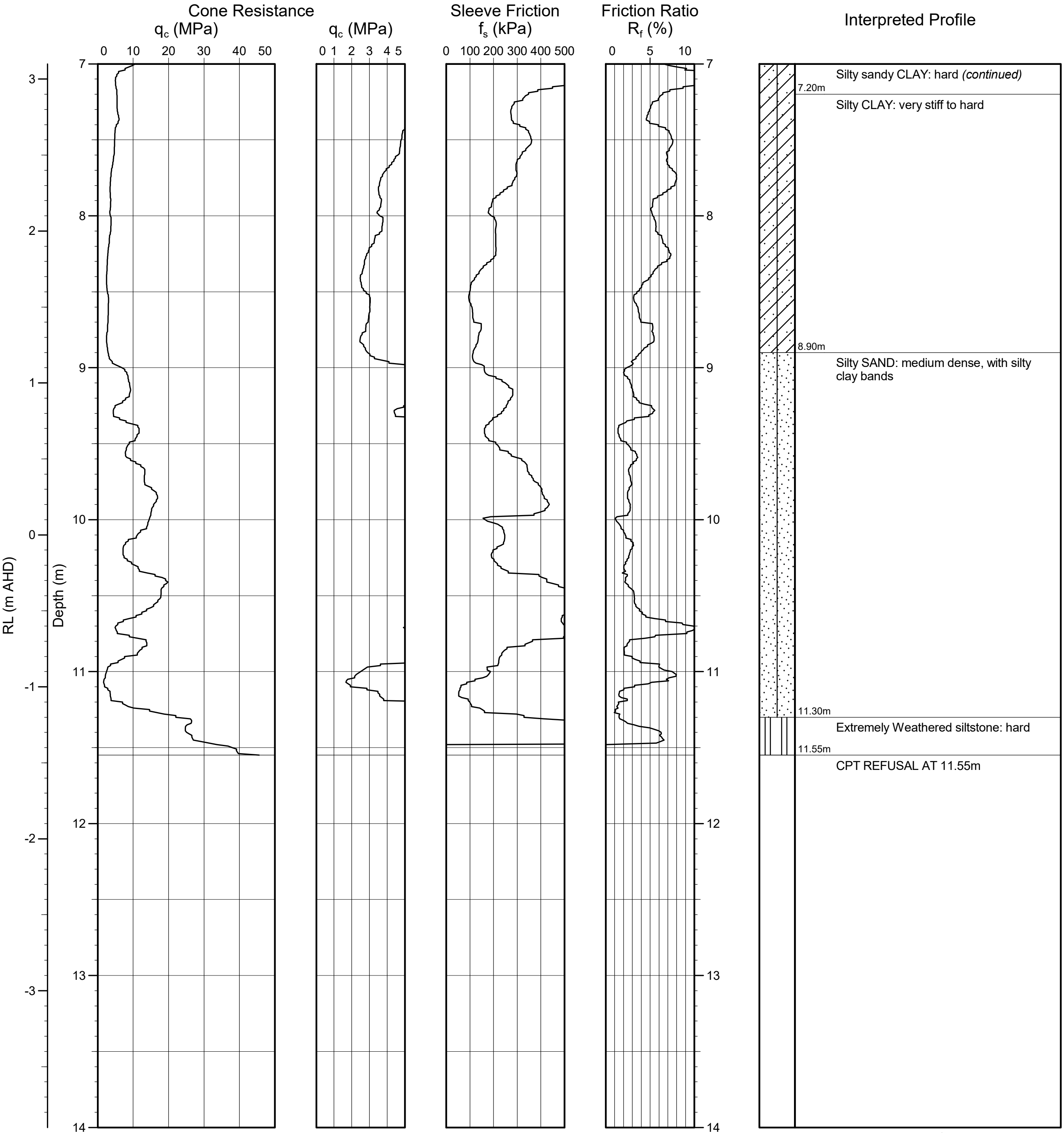
JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No.
JKG104A
2 / 2

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**R.L. Surface:** ~10.1 m	**Data File:** 32160A2_CPT104A
Date: 16/9/19	**Datum:** AHD	**Operator:** K.K.S.



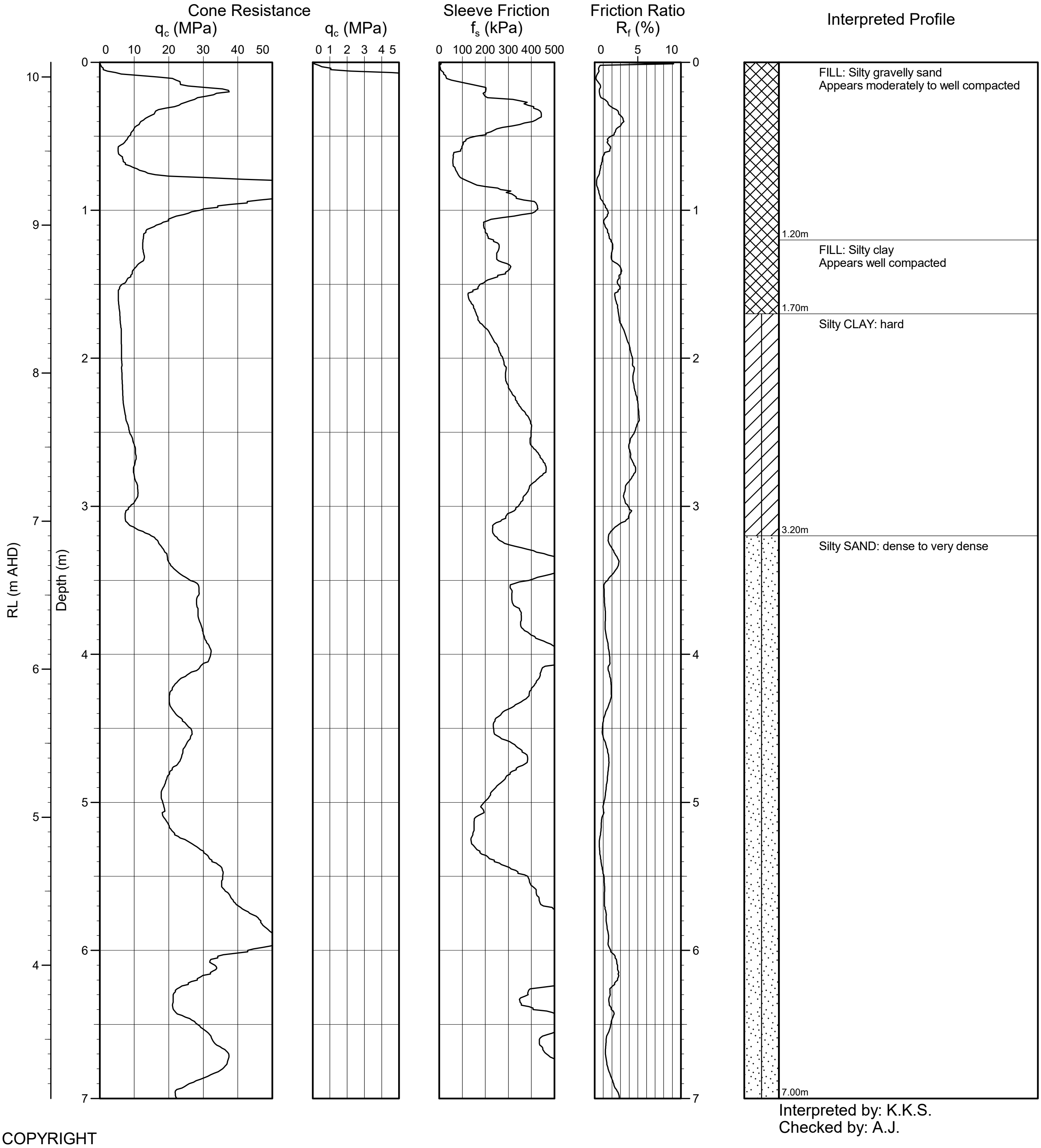
Interpreted by: K.K.S.
Checked by: A.J.

CONE PENETROMETER TEST RESULTS

CPT No.
JKG105A
1 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~10.1 m
Data File: 32160A2_CPT105A
Date: 17/9/19
Datum: AHD
Operator: K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

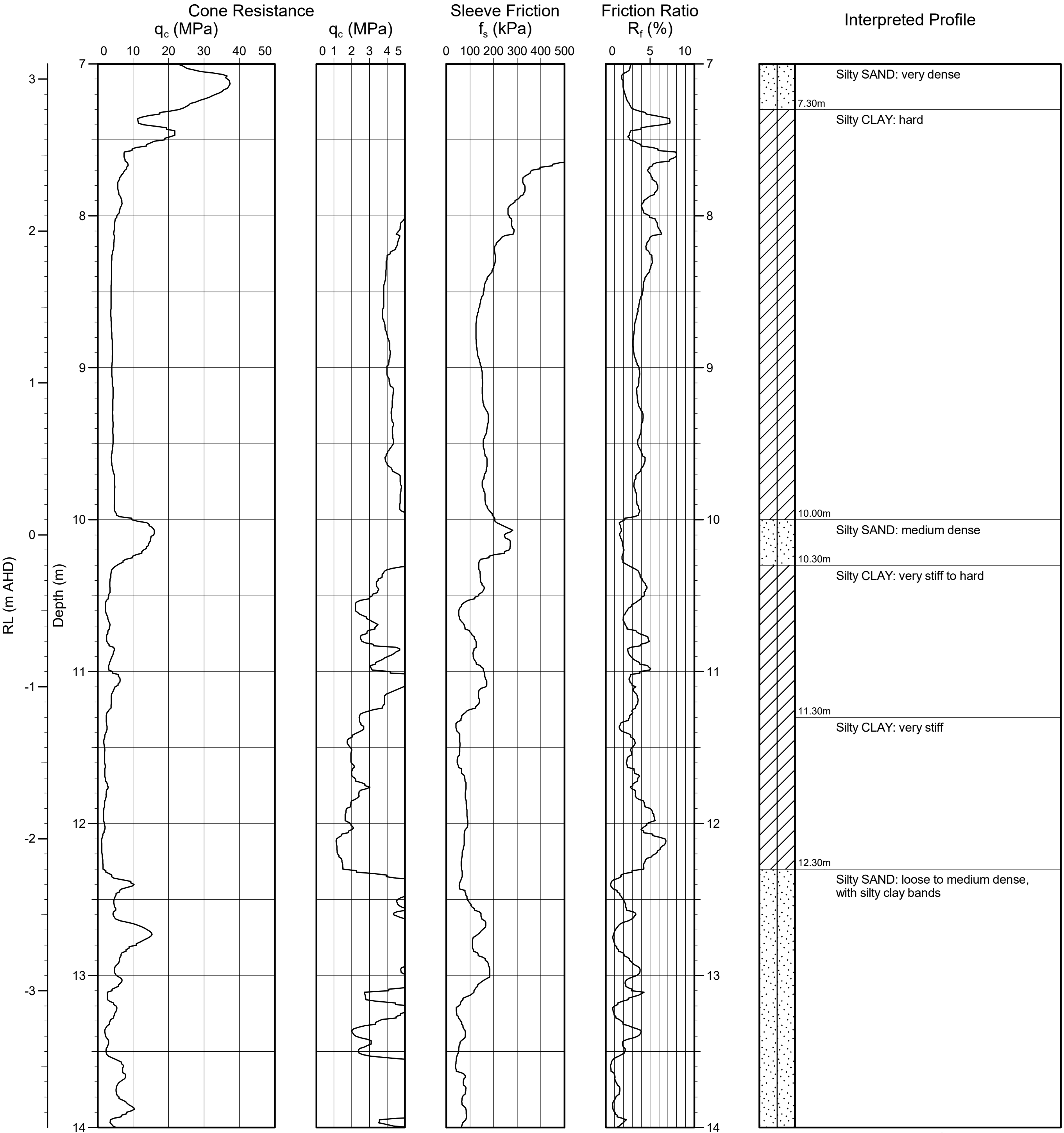
JK 9.02.4 LIB.GLB Log JK CPT MATERIAL - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:33 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CONE PENETROMETER TEST RESULTS

CPT No.
JKG105A
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~10.1 m
Data File: 32160A2_CPT105A
Date: 17/9/19
Datum: AHD
Operator: K.K.S.



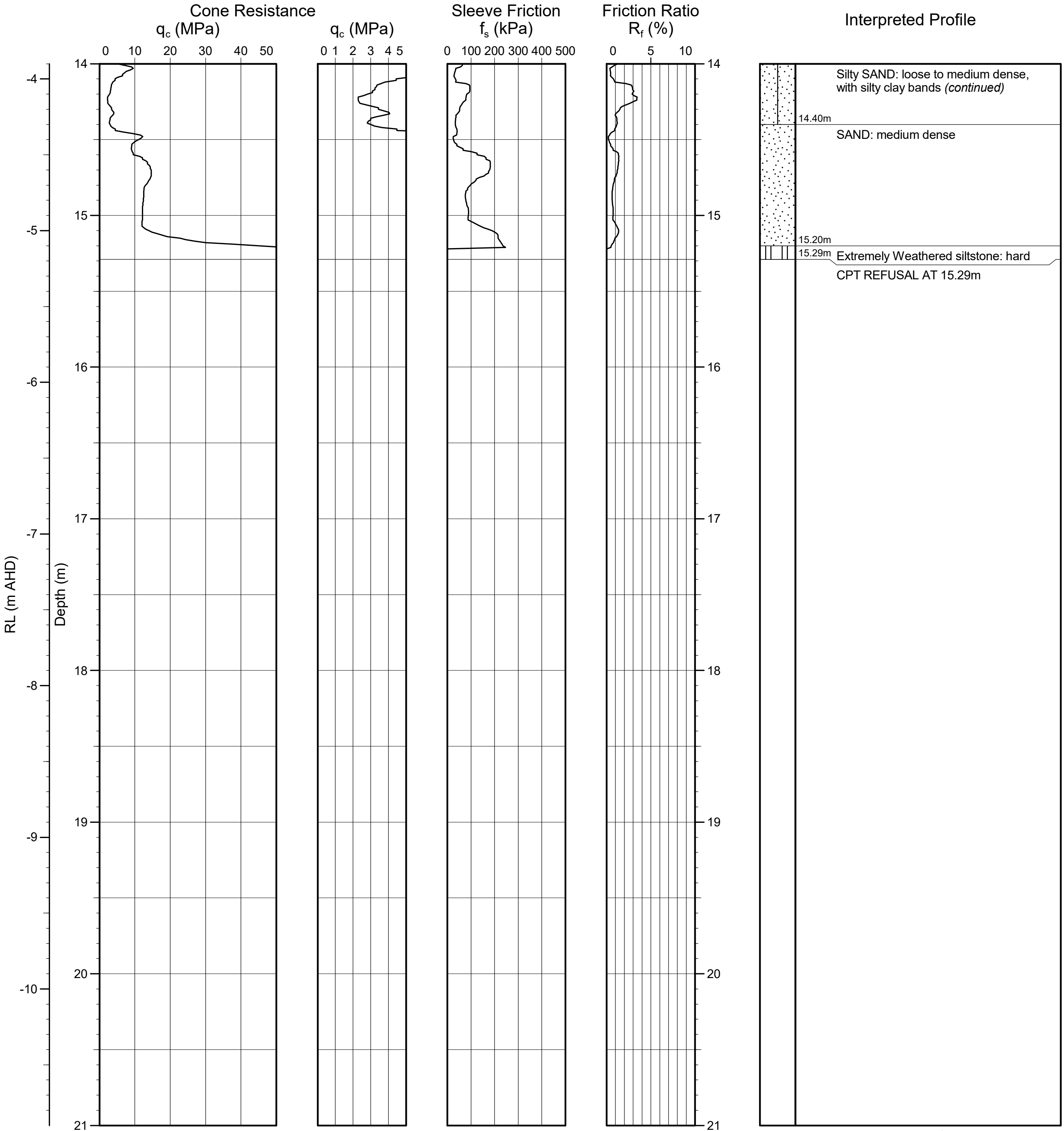
Interpreted by: K.K.S.
Checked by: A.J.

CONE PENETROMETER TEST RESULTS

CPT No.
JKG105A
3 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~10.1 m
Data File: 32160A2_CPT105A
Date: 17/9/19
Datum: AHD
Operator: K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

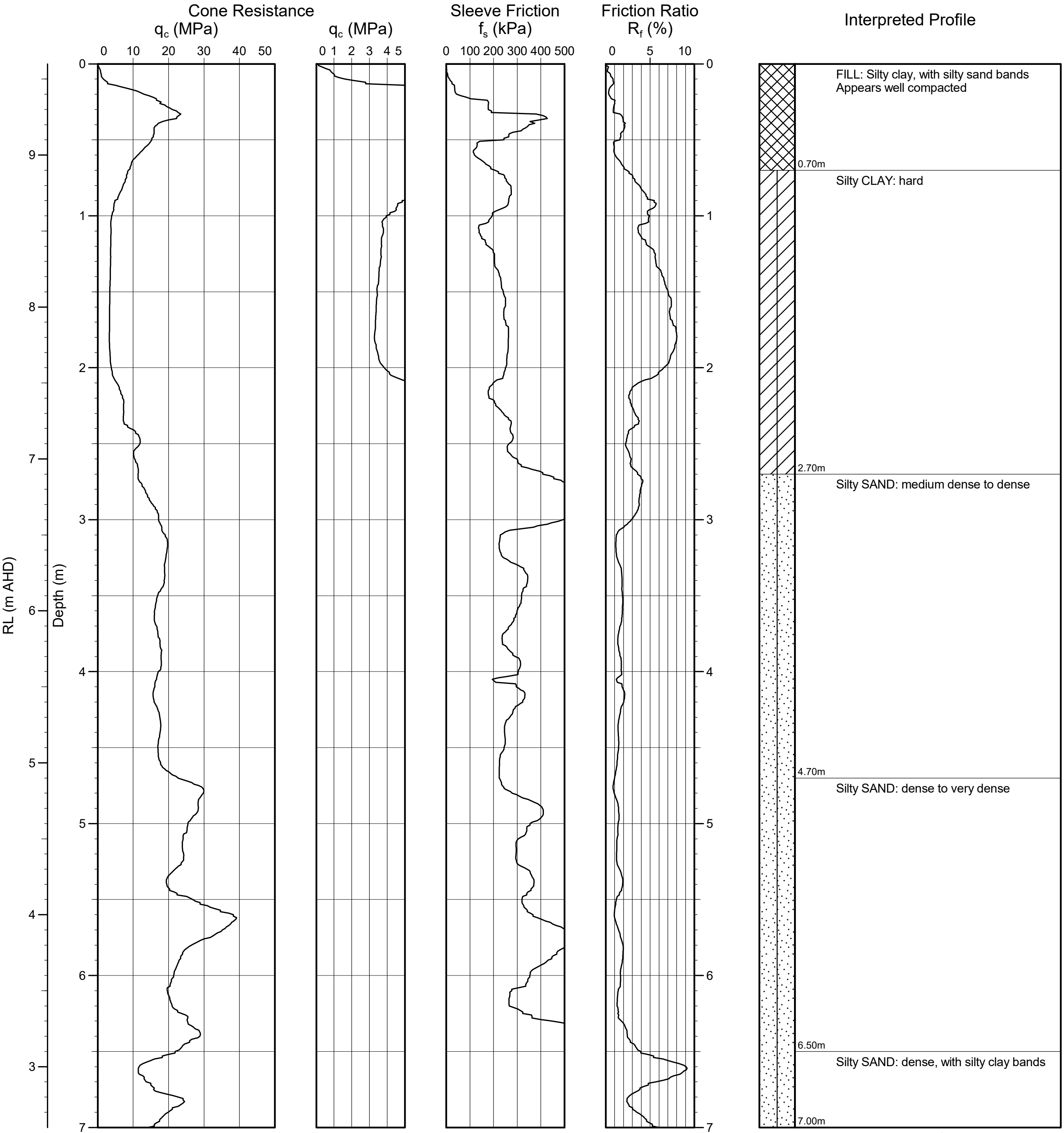
JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No.
JKG106A
1 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**R.L. Surface:** ~9.6 m	**Data File:** 32160A2_CPT106A
Date: 17/9/19	**Datum:** AHD	**Operator:** K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

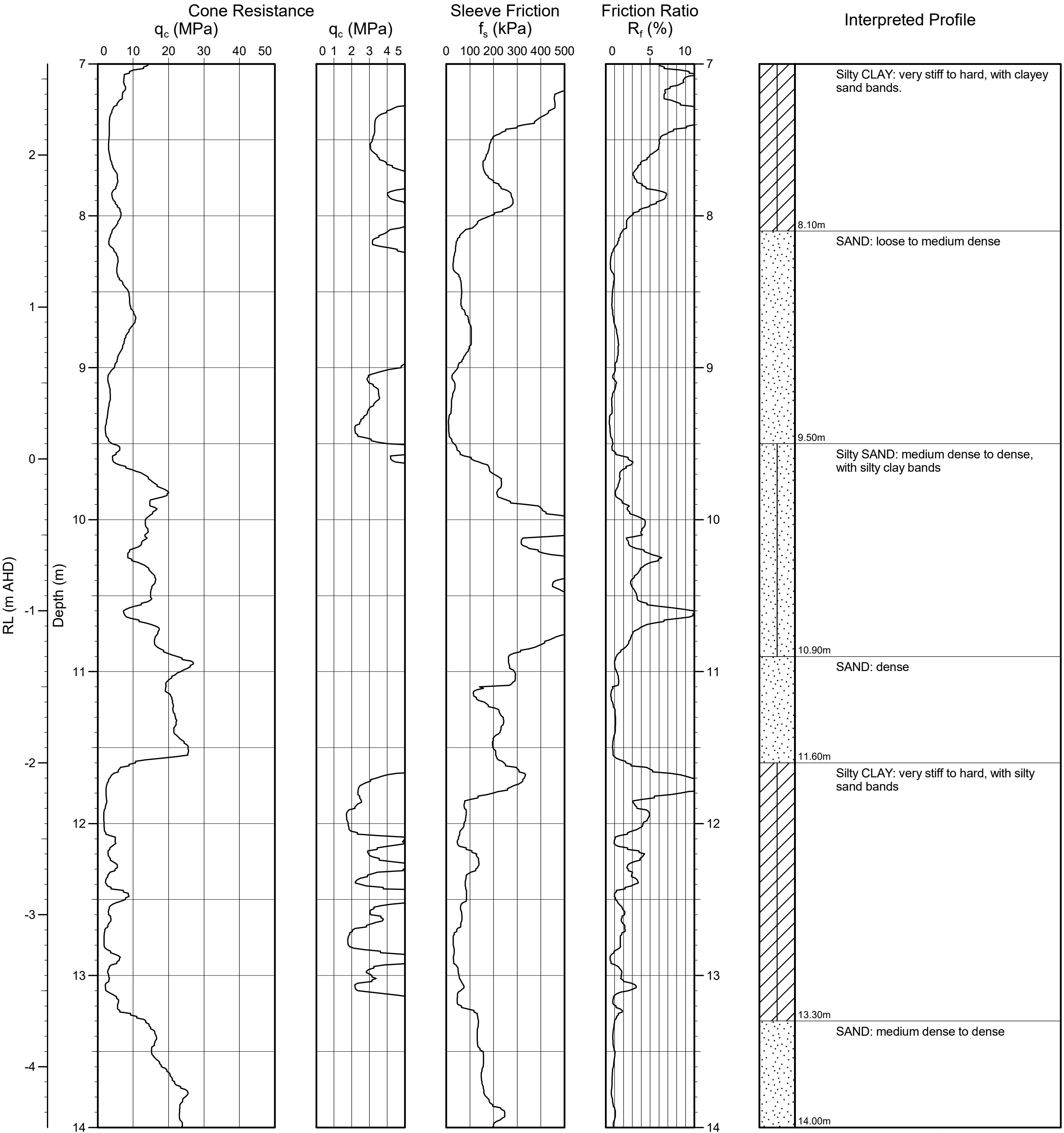
JK 9.02.4 LIB.GLB Log JK CPT MATERIAL - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:33 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CONE PENETROMETER TEST RESULTS

CPT No.
JKG106A
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**R.L. Surface:** ~9.6 m	**Data File:** 32160A2_CPT106A
Date: 17/9/19	**Datum:** AHD	**Operator:** K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

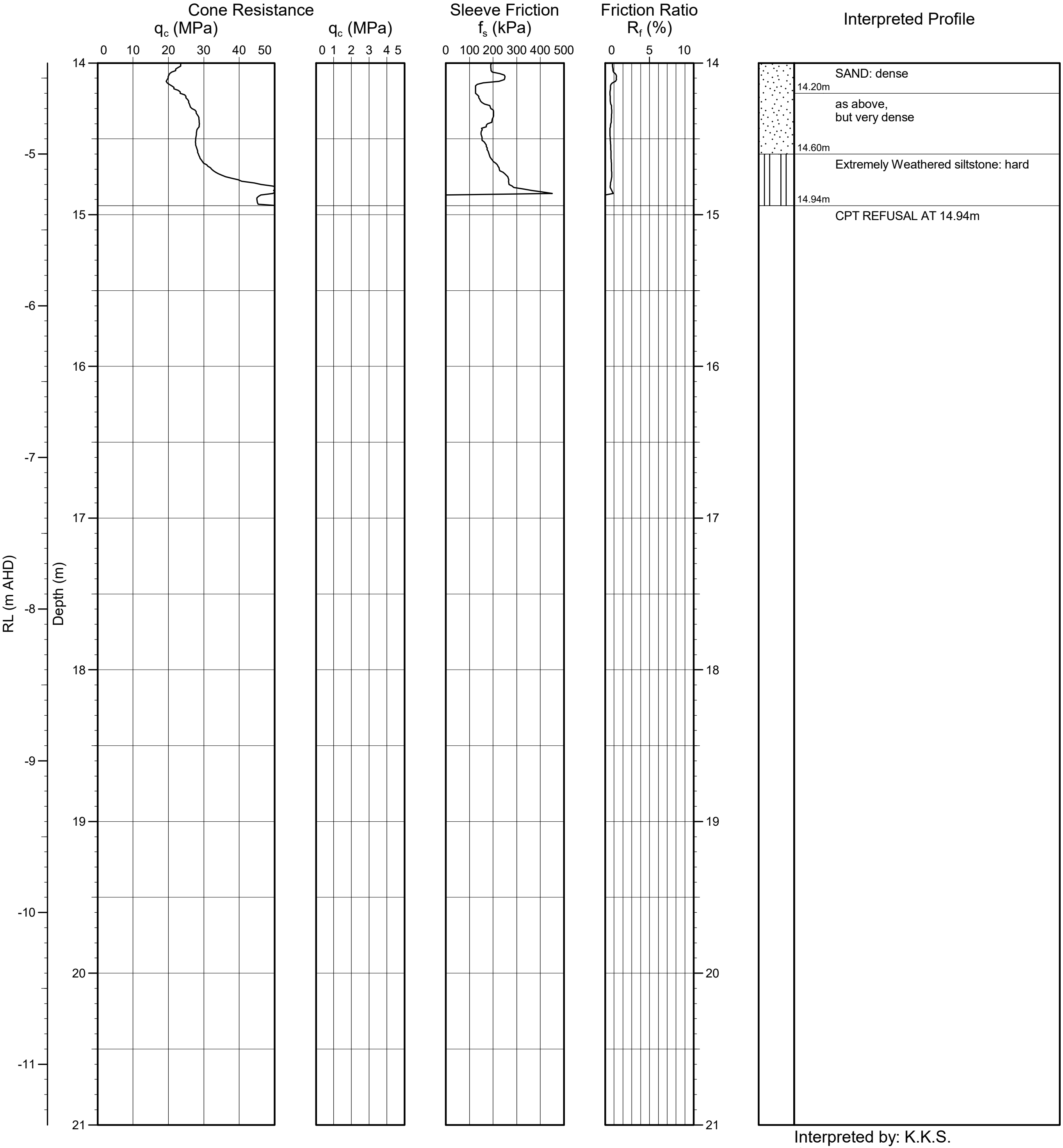
JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No.
JKG106A
3 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **R.L. Surface:** ~9.6 m **Data File:** 32160A2_CPT106A
Date: 17/9/19 **Datum:** AHD **Operator:** K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

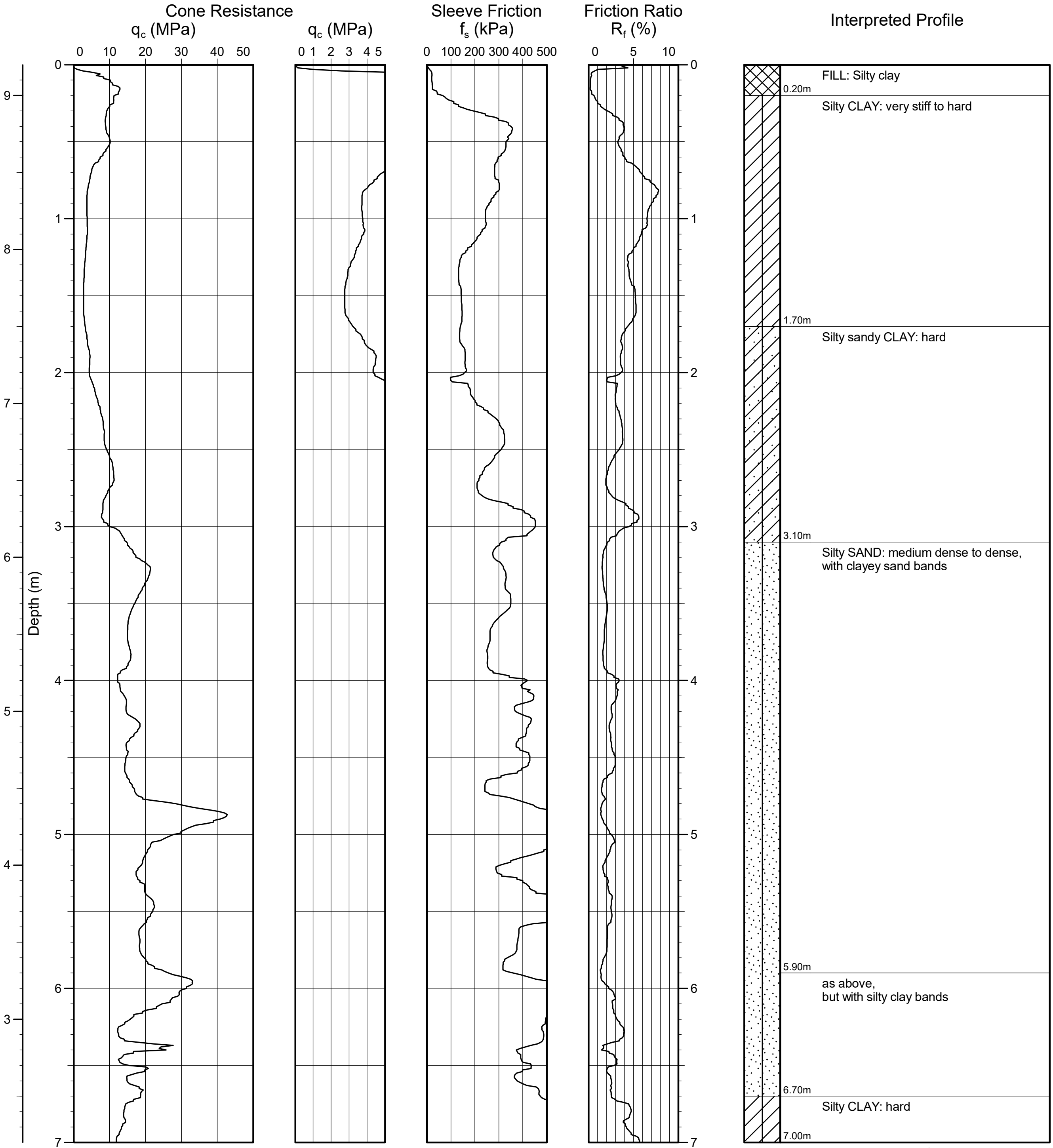
JKGeotechnics

CONE PENETROMETER TEST RESULTS

CPT No.
JKG107A
1 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~9.2 m
Data File: 32160A2_CPT107A
Date: 17/9/19
Datum: AHD
Operator: K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

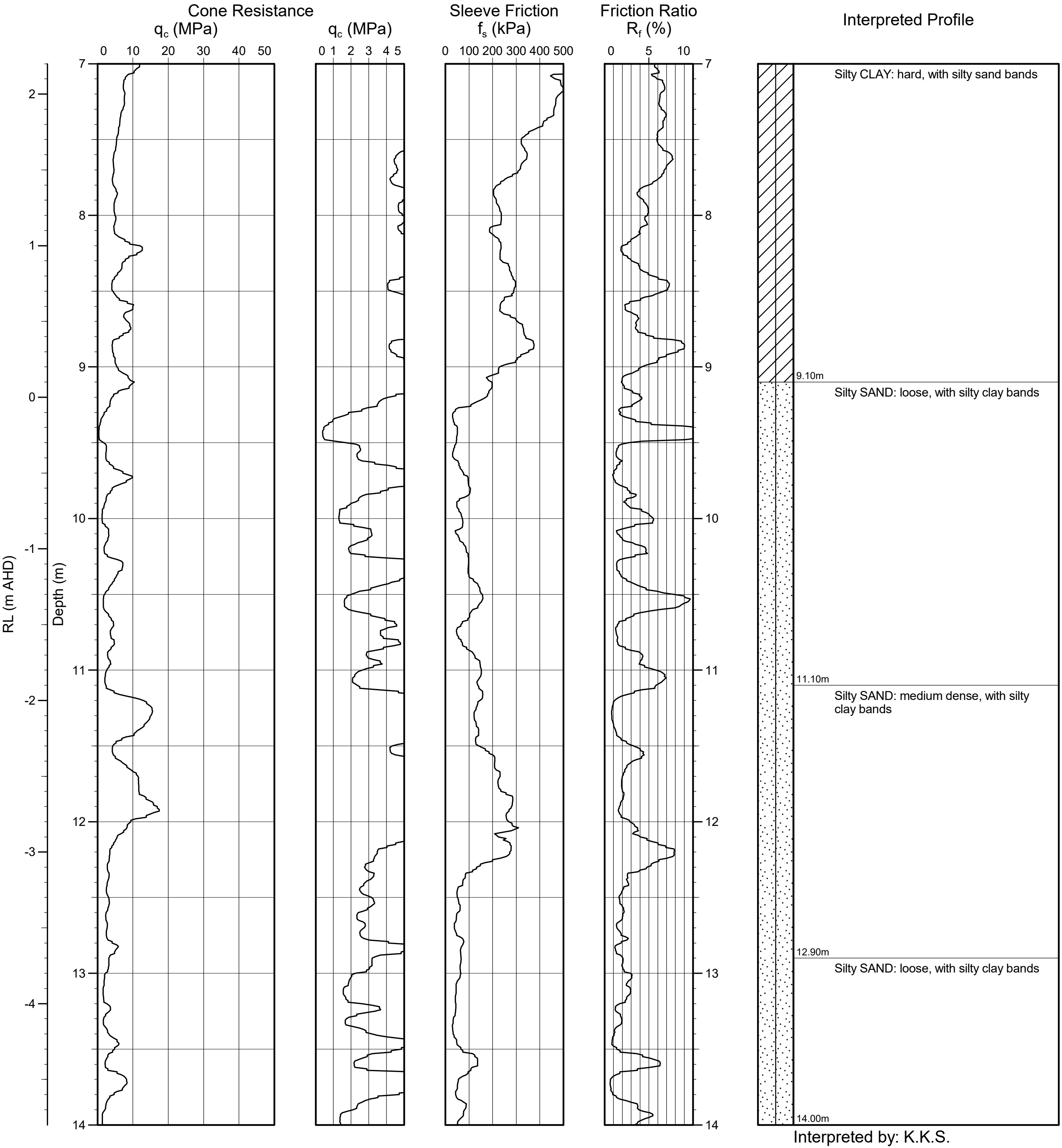
JK 9.02.4 LIB.GLB Log JK CPT MATERIAL - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:33 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CONE PENETROMETER TEST RESULTS

CPT No.
JKG107A
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**R.L. Surface:** ~9.2 m	**Data File:** 32160A2_CPT107A
Date: 17/9/19	**Datum:** AHD	**Operator:** K.K.S.



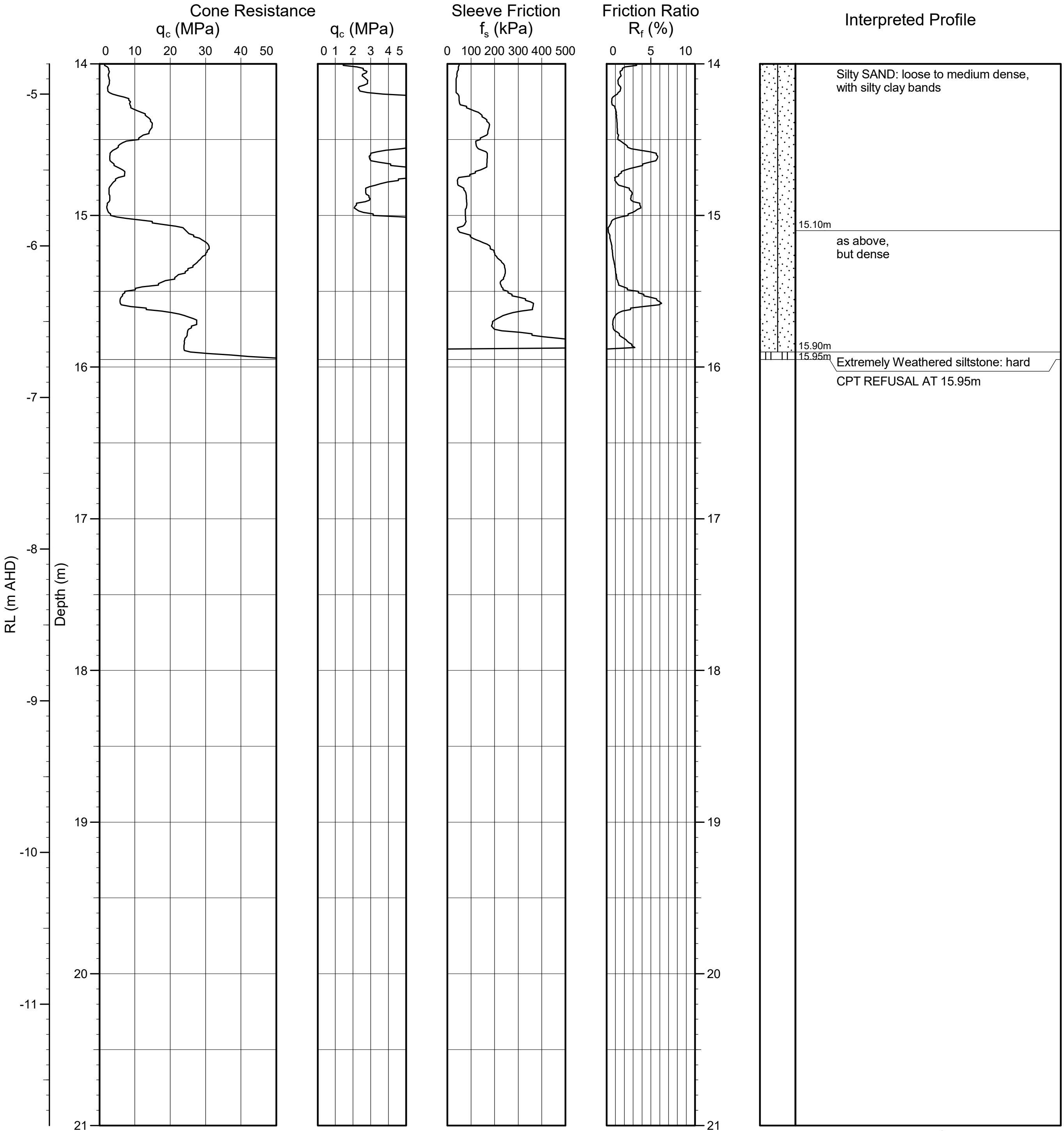
Interpreted by: K.K.S.
Checked by: A.J.

CONE PENETROMETER TEST RESULTS

CPT No.
JKG107A
3 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
R.L. Surface: ~9.2 m
Data File: 32160A2_CPT107A
Date: 17/9/19
Datum: AHD
Operator: K.K.S.



Interpreted by: K.K.S.
Checked by: A.J.

BOREHOLE LOG

Borehole No.
JKG101
1 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Method: SPIRAL AUGER
R.L. Surface: ~9.7 m
Date: 17/9/19 TO 18/9/19
Datum: AHD
Plant Type: JK500
Logged/Checked By: C.W./A.J.

Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ASPHALTIC CONCRETE: 50mm.t				
-	FILL: Silty clay, medium plasticity, dark grey and light brown, trace of fine grained sand, and fine to medium grained siltstone and sandstone gravel.	w>PL			
CI	Silty CLAY: medium plasticity, light brown mottled red brown and light grey.	w>PL			ALLUVIAL
	as above, but red brown mottled light grey.				
	as above, but red brown and light brown mottled light grey.				THE BOREHOLE LOGGING WAS BASED ON LIMITED SOIL SAMPLING. REFERENCE SHOULD BE MADE TO CPT JKG 101A FOR DETAILS OF THE ALLUVIAL SOIL LAYERING AND STRENGTHS.
	Silty CLAY: medium plasticity, yellow brown mottled light grey.				
SC	Clayey SAND: fine to medium grained, yellow brown.	M			
SM	Silty SAND: fine to medium grained, brown.				

RL (m AHD): 9, 8, 7, 6, 5, 4, 3
Depth (m): 1, 2, 3, 4, 5, 6

JKGeotechnics

BOREHOLE LOG

Borehole No.
JKG101
2 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~9.7 m
Date: 17/9/19 TO 18/9/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** C.W./A.J.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
▶ ON COMPLETION OF AUGERING				■		2 1	8 9		SM	Silty SAND: fine to medium grained, brown. *(continued)*	M W			ALLUVIAL
						0 -1 -2 -3 -4	10 11 12 13		-	REFER TO CPT JKG101A				NO BOREHOLE LOGGING BELOW 9.0m DEPTH AS NO SAMPLING WAS CARRIED OUT. PURPOSE OF DEEPER DRILLING WAS TO PROVE BEDROCK.

BOREHOLE LOG

Borehole No.
JKG101
3 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Method: SPIRAL AUGER
R.L. Surface: ~9.7 m
Date: 17/9/19 TO 18/9/19
Datum: AHD
Plant Type: JK500
Logged/Checked By: C.W./A.J.

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
	ES	U50	DB	DS										
									-	REFER TO CPT JKG101A *(continued)*				
						-5								
							15			REFER TO CORED BOREHOLE LOG				
						-6								
							16							
						-7								
							17							
						-8								
							18							
						-9								
							19							
						-10								
							20							
						-11								

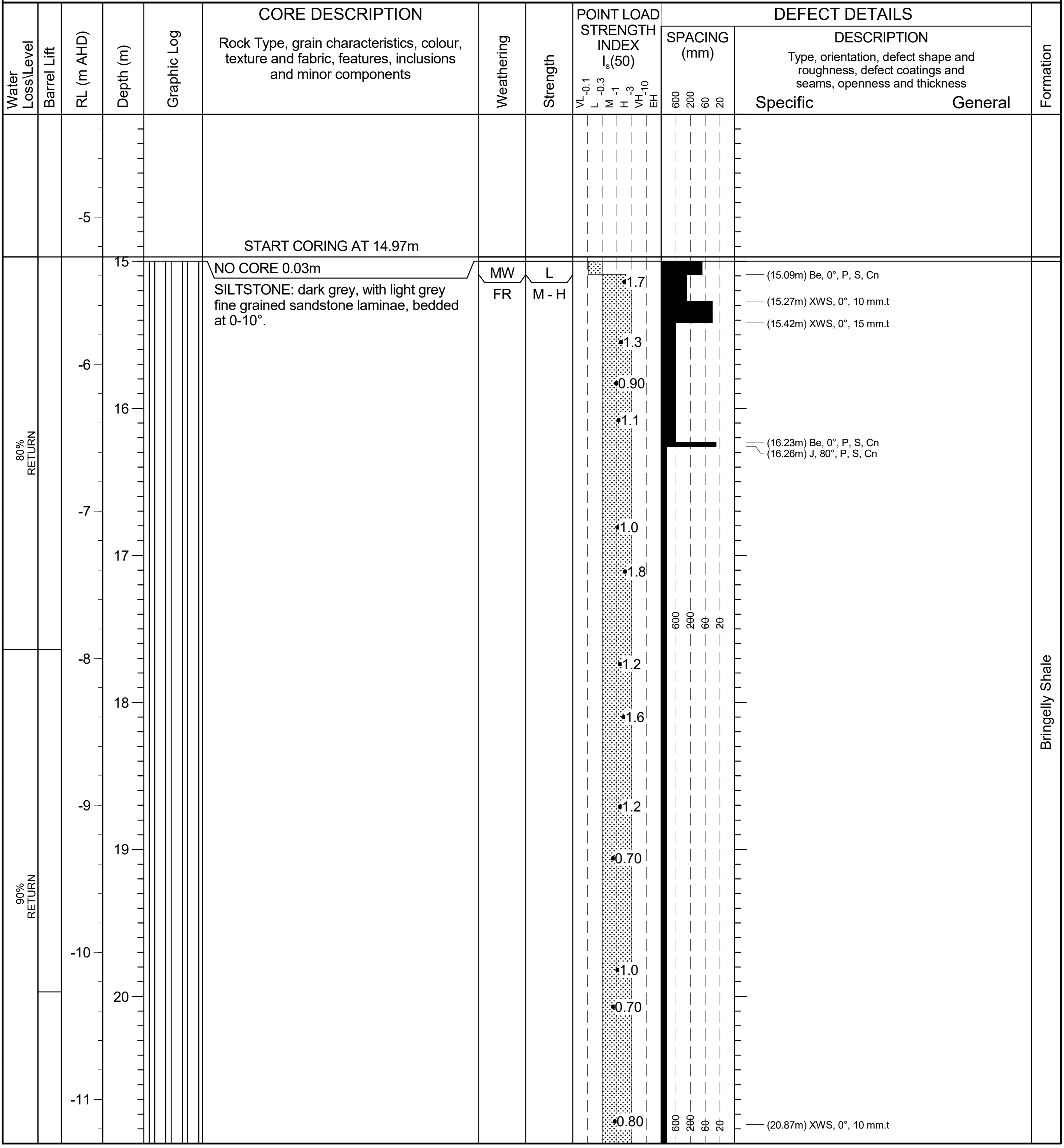
JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:54 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CORED BOREHOLE LOG

Borehole No.
JKG101
4 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**Core Size:** NMLC	**R.L. Surface:** ~9.7 m
Date: 17/9/19 TO 18/9/19	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** C.W./A.J.



START CORING AT 14.97m

NO CORE 0.03m

SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°.

MW / FR

L / M - H

(15.09m) Be, 0°, P, S, Cn
(15.27m) XWS, 0°, 10 mm.t
(15.42m) XWS, 0°, 15 mm.t
(16.23m) Be, 0°, P, S, Cn
(16.26m) J, 80°, P, S, Cn
(20.87m) XWS, 0°, 10 mm.t

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:54 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

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
JKG101
5 / 5

Client: HEALTH INFRASTRUCTURE

Project: PROPOSED NEW MULTI-STOREY CAR PARK

Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Core Size: NMLC
R.L. Surface: ~9.7 m

Date: 17/9/19 TO 18/9/19
Inclination: VERTICAL
Datum: AHD

Plant Type: JK500
Bearing: N/A
Logged/Checked By: C.W./A.J.

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	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific / General	Formation
90% RETURN		-12 -13 -14	22 23		SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°. *(continued)*	FR	M - H	1.0 1.6 2.0 1.1 0.70 0.60			Bringelly Shale
		-15 -16 -17 -18	24 25 26 27		END OF BOREHOLE AT 23.88 m				600 200 60 20		

COPYRIGHT

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
JOB NO. 32160A2 JKG101 CORING STARTS AT 14.97m
N/C 0.03 m
15
16
17
18
19
20
21
22
23
END OF JKG101 AT 23.88 m

BOREHOLE LOG

Borehole No.
JKG102
1 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~9.7 m
Date: 18/9/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** C.W./A.J.

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
DRY DURING AUGERING TO 8.7M										ASPHALTIC CONCRETE: 50mm.t				
									-	FILL: Gravelly clayey sand, fine to medium grained, light brown mottled dark grey, fine to medium grained sandstone and ironstone gravel, trace of concrete fragments.	M			
						9	1		CI-CH	Silty CLAY: medium to high plasticity, light brown.	w>PL			ALLUVIAL
						8				as above, but light brown and red brown.				THE BOREHOLE LOGGING WAS BASED ON LIMITED SOIL SAMPLING. REFERENCE SHOULD BE MADE TO CPT JKG102A FOR DETAILS OF THE ALLUVIAL SOIL LAYERING AND STRENGTHS.
						7 6	2 3			Silty CLAY: medium to high plasticity, light brown mottled light grey and red brown.				
							4		SC	Clayey SAND: fine to medium grained, light brown mottled light grey and red brown.	M			
						5	5		CL	Silty CLAY: low plasticity, light brown and light grey, with fine to medium grained sand.	w>PL			
						4	6		SM	Clayey silty SAND: fine to medium grained sand, red brown.	M			
						3			CL	Silty CLAY: low plasticity, red brown, with fine to medium grained sand.	w>PL			

BOREHOLE LOG

Borehole No.
JKG102
2 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Method: SPIRAL AUGER
R.L. Surface: ~9.7 m
Date: 18/9/19
Datum: AHD
Plant Type: JK500
Logged/Checked By: C.W./A.J.

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
								▨	SC	Clayey SAND: medium to coarse grained, red brown.	M			ALLUVIAL
				■		2 1	8	▨	SM	Silty SAND: medium to coarse grained, red brown.				
ON COMPLETION OF CORING						0 -1 -2 -3 -4	9 10 11 12 13		-	REFER TO CPT JKG102A				NO BOREHOLE LOGGING BELOW 8.7m DEPTH AS NO SAMPLING WAS CARRIED OUT. PURPOSE OF DEEPER DRILLING WAS TO PROVE BEDROCK.

BOREHOLE LOG

Borehole No.
JKG102
3 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Method: SPIRAL AUGER
R.L. Surface: ~9.7 m
Date: 18/9/19
Datum: AHD
Plant Type: JK500
Logged/Checked By: C.W./A.J.

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
						-5 -6	15		-	REFER TO CPT JKG102A *(continued)*				
						-7 -8 -9 -10 -11	16 17 18 19 20			REFER TO CORED BOREHOLE LOG				

JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
JKG102
4 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**Core Size:** NMLC	**R.L. Surface:** ~9.7 m
Date: 18/9/19	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** C.W./A.J.

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	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific General	Formation
		-6			START CORING AT 15.81m						
		-7 -8 -9 -10 -11 -12	16 17 18 19 20 21		SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-5°.	SW FR	L - M M - H H	1.0 1.0 0.70 1.5 1.3 0.90 1.5 1.6 0.30 1.9 1.5 3.1 2.8		(15.89m) XWS, 0°, 2 mm.t (16.42m) Be, 5°, P, S, Cn (20.64m) XWS, 0°, 10 mm.t	Bringelly Shale

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:54 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

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

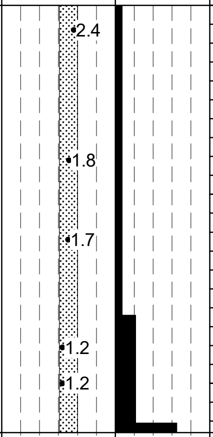
CORED BOREHOLE LOG

Borehole No.
JKG102
5 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Core Size: NMLC
R.L. Surface: ~9.7 m
Date: 18/9/19
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: C.W./A.J.

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	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific General	Formation
		-13 -14	23 24		SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-5°. *(continued)*	FR	H	2.4 1.8 1.7 1.2 1.2		(23.64m) XWS, 0°, 15 mm.t (24.21m) J, 60°, P, S, Cn	Bringelly Shale
		-15 -16 -17 -18 -19	25 26 27 28		END OF BOREHOLE AT 24.26 m				600 200 60 20		



FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
JOB NO 32160A2 JKG102 START CORING AT 15.81m
16
17
18
19
20
21
22
23
24
END OF JKG102 AT 24.26m

JKGeotechnics

BOREHOLE LOG

Borehole No.
JKG103
1 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Method: SPIRAL AUGER
R.L. Surface: ~9.8 m
Date: 19/9/19
Datum: AHD
Plant Type: JK500
Logged/Checked By: C.W./A.J.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
								■		ASPHALTIC CONCRETE: 50mm.t				
								▩	-	FILL: Gravelly sandy clay, low plasticity, dark grey, fine to medium grained gravel and fine to medium grained sand.	w>PL			
						9 8 7 6 5	1 2 3 4 5	▨	CI-CH	Silty CLAY: medium to high plasticity, light brown and red brown.	w>PL			ALLUVIAL THE BOREHOLE LOGGING WAS BASED ON LIMITED SOIL SAMPLING. REFERENCE SHOULD BE MADE TO CPT JKG103A FOR DETAILS OF THE ALLUVIAL SOIL LAYERING AND STRENGTHS.
						4	6	⠿	SM	Silty SAND: fine to coarse grained, light brown to dark brown.	M			
						3			-	REFER TO CPT JKG103A				NO BOREHOLE LOGGING BELOW 6.0m DEPTH AS NO SAMPLING WAS CARRIED OUT. PURPOSE OF DEEPER DRILLING WAS TO PROVE BEDROCK.

BOREHOLE LOG

Borehole No.
JKG103
2 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~9.8 m
Date: 19/9/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** C.W./A.J.

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
	ES	U50	DB	DS										
									-	REFER TO CPT JKG103A *(continued)*				
						2								
							8							
						1								
							9							
						0								
							10							
▽ ON COMPLETION OF CORING														
						-1								
							11							
						-2								
							12							
▶														
						-3								
							13							
						-4								

JKGeotechnics

BOREHOLE LOG

Borehole No.
JKG103
3 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~9.8 m
Date: 19/9/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** C.W./A.J.

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
	ES	U50	DB	DS										
									-	REFER TO CPT JKG103A *(continued)*				
						-5				REFER TO CORED BOREHOLE LOG				
							15							
						-6								
							16							
						-7								
							17							
						-8								
							18							
						-9								
							19							
						-10								
							20							
						-11								

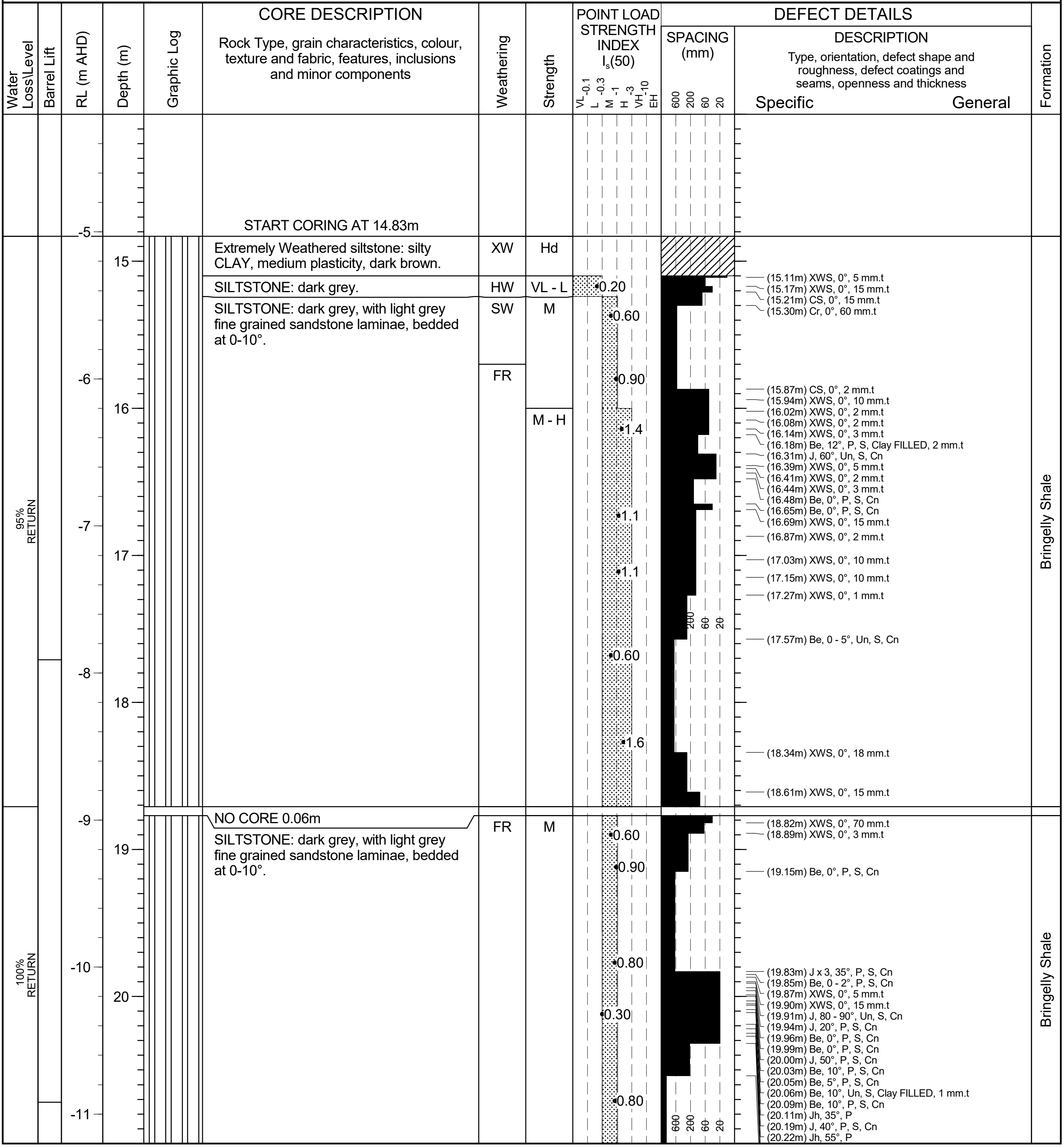
JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:54 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CORED BOREHOLE LOG

Borehole No.
JKG103
4 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**Core Size:** NMLC	**R.L. Surface:** ~9.8 m
Date: 19/9/19	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** C.W./A.J.



Water Loss\Level	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 General	Formation
	START CORING AT 14.83m					
95% RETURN	Extremely Weathered siltstone: silty CLAY, medium plasticity, dark brown.	XW	Hd			Bringelly Shale
	SILTSTONE: dark grey.	HW	VL - L	0.20	(15.11m) XWS, 0°, 5 mm.t (15.17m) XWS, 0°, 15 mm.t (15.21m) CS, 0°, 15 mm.t (15.30m) Cr, 0°, 60 mm.t	
	SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°.	SW FR	M M - H	0.60 0.90 1.4 1.1 1.1 0.60 1.6	(15.87m) CS, 0°, 2 mm.t (15.94m) XWS, 0°, 10 mm.t (16.02m) XWS, 0°, 2 mm.t (16.08m) XWS, 0°, 2 mm.t (16.14m) XWS, 0°, 3 mm.t (16.18m) Be, 12°, P, S, Clay FILLED, 2 mm.t (16.31m) J, 60°, Un, S, Cn (16.39m) XWS, 0°, 5 mm.t (16.41m) XWS, 0°, 2 mm.t (16.44m) XWS, 0°, 3 mm.t (16.48m) Be, 0°, P, S, Cn (16.65m) Be, 0°, P, S, Cn (16.69m) XWS, 0°, 15 mm.t (16.87m) XWS, 0°, 2 mm.t (17.03m) XWS, 0°, 10 mm.t (17.15m) XWS, 0°, 10 mm.t (17.27m) XWS, 0°, 1 mm.t (17.57m) Be, 0 - 5°, Un, S, Cn (18.34m) XWS, 0°, 18 mm.t (18.61m) XWS, 0°, 15 mm.t	
100% RETURN	NO CORE 0.06m					Bringelly Shale
	SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°.	FR	M	0.60 0.90 0.80 0.30 0.80	(18.82m) XWS, 0°, 70 mm.t (18.89m) XWS, 0°, 3 mm.t (19.15m) Be, 0°, P, S, Cn (19.83m) J x 3, 35°, P, S, Cn (19.85m) Be, 0 - 2°, P, S, Cn (19.87m) XWS, 0°, 5 mm.t (19.90m) XWS, 0°, 15 mm.t (19.91m) J, 80 - 90°, Un, S, Cn (19.94m) J, 20°, P, S, Cn (19.96m) Be, 0°, P, S, Cn (19.99m) Be, 0°, P, S, Cn (20.00m) J, 50°, P, S, Cn (20.03m) Be, 10°, P, S, Cn (20.05m) Be, 5°, P, S, Cn (20.06m) Be, 10°, Un, S, Clay FILLED, 1 mm.t (20.09m) Be, 10°, P, S, Cn (20.11m) Jh, 35°, P (20.19m) J, 40°, P, S, Cn (20.22m) Jh, 55°, P	

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

CORED BOREHOLE LOG

Borehole No.
JKG103
5 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Core Size: NMLC
R.L. Surface: ~9.8 m
Date: 19/9/19
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: C.W./A.J.

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	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific	General	Formation
100% RETURN		-12 -13	22 23		SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°. *(continued)*	FR	H	1.6 1.7 1.7 1.0 1.9		(20.25m) XWS, 0°, 15 mm.t (20.27m) Jh, 60°, C (20.32m) Jh, 60°, Ir (20.54m) J, 50°, P, S, Cn		Bringelly Shale
		-14 -15 -16 -17 -18	24 25 26 27		END OF BOREHOLE AT 23.32 m				600 200 60 20 600 200 60 20			

COPYRIGHT

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
JOB NO 32160A2 JKG103 START CORING AT 14.83m
15
16
17
18
N.C
60mm
+
19
20
21
22
23
END OF JKG 103 AT 23.32m

JKGeotechnics

BOREHOLE LOG

Borehole No.
JKG104
1 / 4

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~10.1 m
Date: 19/9/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** C.W./A.J.

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
DRY DURING AUGERING TO 6.5M						10			-	ASPHALTIC CONCRETE: 50mm.t FILL: Gravelly sandy clay, low plasticity, dark grey, fine to medium grained sand, fine to medium grained gravel.	w>PL			
									CI-CH	Silty CLAY: medium to high plasticity, light brown and red brown.	w>PL			ALLUVIAL THE BOREHOLE LOGGING WAS BASED ON LIMITED SOIL SAMPLING. REFERENCE SHOULD BE MADE TO CPT JKG104A FOR DETAILS OF THE ALLUVIAL SOIL LAYERING AND STRENGTHS.
						9	1							
						8	2							
						7	3							
						6	4							
						5	5							
						4	6							
									SM	Silty SAND: fine to coarse grained, light brown and dark brown.	M			
									-	REFER TO CPT JKG104A				

COPYRIGHT

JKGeotechnics

BOREHOLE LOG

Borehole No.
JKG104
2 / 4

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~10.1 m
Date: 19/9/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** C.W./A.J.

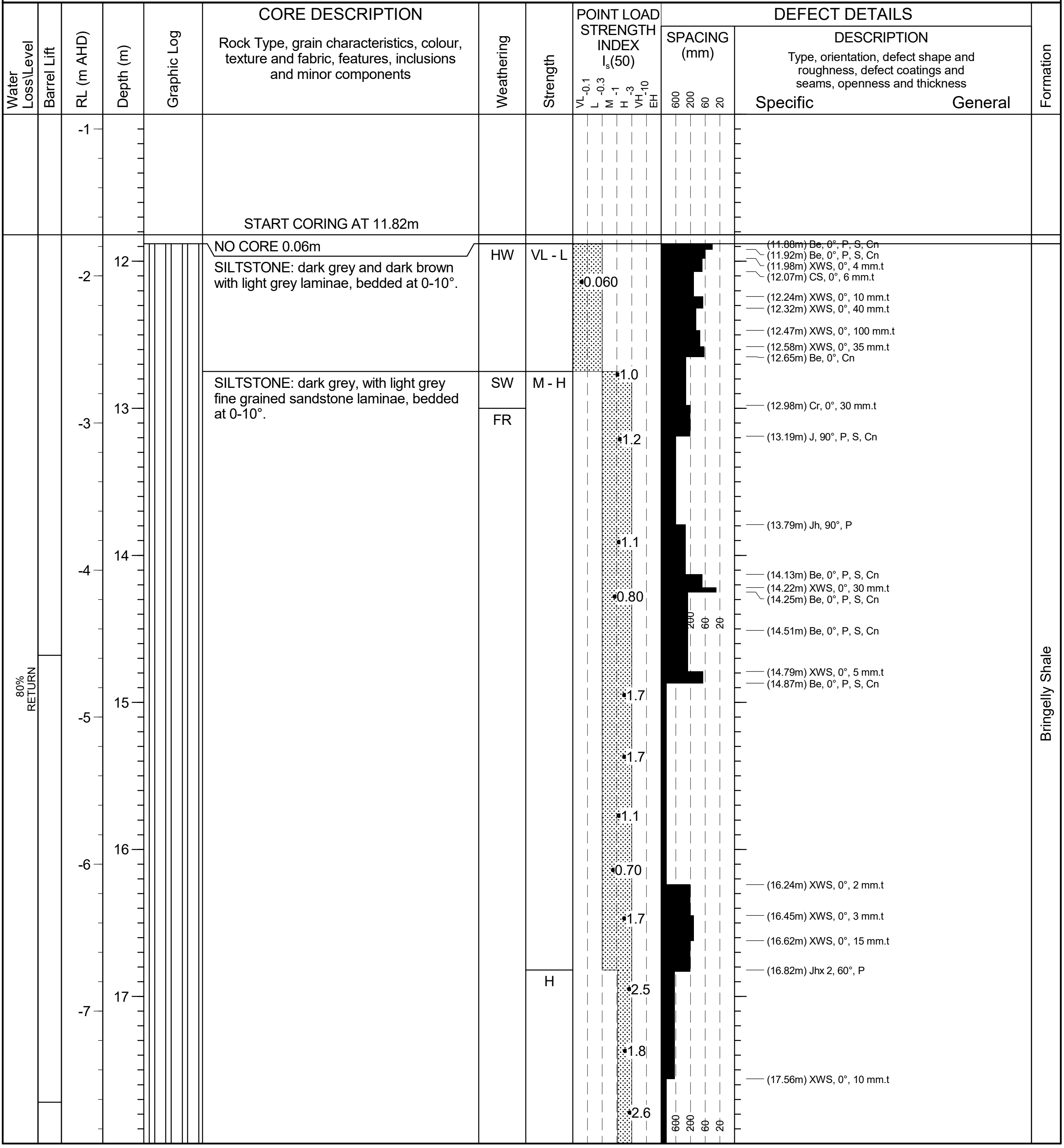
Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
						3			-	REFER TO CPT JKG104A *(continued)*				NO BOREHOLE LOGGING BELOW 6.5m DEPTH AS NO SAMPLING WAS CARRIED OUT. PURPOSE OF DEEPER DRILLING WAS TO PROVE BEDROCK.
							8							
						2								
							9							
						1								
							10							
						0								
							11							
						-1								
▽ ON COMPLETION OF CORING														
										REFER TO CORED BOREHOLE LOG				
							12							
						-2								
							13							
						-3								

CORED BOREHOLE LOG

Borehole No.
JKG104

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Core Size: NMLC
R.L. Surface: ~10.1 m
Date: 19/9/19
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: C.W./A.J.



START CORING AT 11.82m

NO CORE 0.06m

SILTSTONE: dark grey and dark brown with light grey laminae, bedded at 0-10°.

SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°.

(11.88m) Be, 0°, P, S, Cn
(11.92m) Be, 0°, P, S, Cn
(11.98m) XWS, 0°, 4 mm.t
(12.07m) CS, 0°, 6 mm.t
(12.24m) XWS, 0°, 10 mm.t
(12.32m) XWS, 0°, 40 mm.t
(12.47m) XWS, 0°, 100 mm.t
(12.58m) XWS, 0°, 35 mm.t
(12.65m) Be, 0°, Cn
(12.98m) Cr, 0°, 30 mm.t
(13.19m) J, 90°, P, S, Cn
(13.79m) Jh, 90°, P
(14.13m) Be, 0°, P, S, Cn
(14.22m) XWS, 0°, 30 mm.t
(14.25m) Be, 0°, P, S, Cn
(14.51m) Be, 0°, P, S, Cn
(14.79m) XWS, 0°, 5 mm.t
(14.87m) Be, 0°, P, S, Cn
(16.24m) XWS, 0°, 2 mm.t
(16.45m) XWS, 0°, 3 mm.t
(16.62m) XWS, 0°, 15 mm.t
(16.82m) Jhx 2, 60°, P
(17.56m) XWS, 0°, 10 mm.t

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:54 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

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

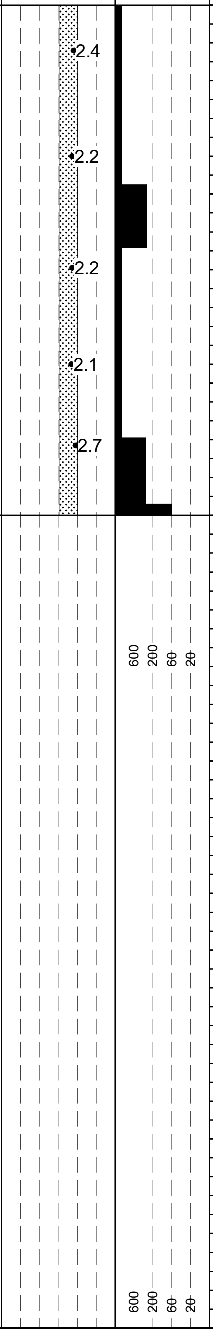
CORED BOREHOLE LOG

Borehole No.
JKG104
4 / 4

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Core Size: NMLC
R.L. Surface: ~10.1 m
Date: 19/9/19
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: C.W./A.J.

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 $I_s(50)$	DEFECT DETAILS SPACING (mm)	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific General	Formation
80% RETURN		-8 -9 -10	19 20		SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°. *(continued)*	FR	H	2.4 2.2 2.2 2.1 2.7		(18.95m) XWS, 0°, 20 mm.t (19.28m) XWS, 0°, 2 mm.t (20.29m) Be, 0°, P, S, Cn (20.64m) J, 60 - 70°, P, S, Cn	Bringelly Shale
		-11 -12 -13 -14	21 22 23 24		END OF BOREHOLE AT 20.70 m						



JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:54 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

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
JOB NO. 32160A2 JKG104 CORING STARTS AT 11.82m.
N.C 0.06m
12
13
14
15
16
17
18
19
20
END OF JKG104 AT 20.7m.

JKGeotechnics

BOREHOLE LOG

Borehole No.
JKG105
1 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~10.1 m
Date: 18/9/19 TO 19/9/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./A.J.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
						10			FILL: Silty sandy clay, low plasticity, dark brown, fine grained sand, trace of fine to medium grained igneous gravel and root fibres.	w<PL			GRASS COVER
									FILL: Silty gravelly sand, fine to medium grained, light grey, fine to coarse grained igneous gravel.	D			
						9	1		FILL: Silty clay, medium plasticity, brown and yellow brown, trace of fine grained sand, ash, slag and wood fragments.	w<PL			
						8	2	CH	Silty CLAY: high plasticity, red brown mottled light grey.	w<PL			ALLUVIAL THE BOREHOLE LOGGING WAS BASED ON LIMITED SOIL SAMPLING. REFERENCE SHOULD BE MADE TO CPT JKG105A FOR DETAILS OF THE ALLUVIAL SOIL LAYERING AND STRENGTHS.
								CI-CH	Silty CLAY: medium to high plasticity, brown and light grey.				
						7	3	CI	Silty CLAY: medium plasticity, light brown yellow and light grey, trace of fine grained sand.				
						6 5 4	4 5 6	SM	Silty SAND: fine to medium grained, light yellow brown.	M			

BOREHOLE LOG

Borehole No.
JKG105

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~10.1 m
Date: 18/9/19 TO 19/9/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./A.J.

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
						3		⁘	SM	Silty SAND: fine to medium grained, light yellow brown. *(continued)*	M			ALLUVIAL
				■		2	8	▨	CH	Silty CLAY: high plasticity, yellow brown and light grey, with red brown bands.	w>PL			
▶						1 0 -1 -2 -3	9 10 11 12 13		-	REFER TO CPT JKG105A				NO BOREHOLE LOGGING BELOW 9.0m DEPTH AS NO SAMPLING WAS CARRIED OUT. PURPOSE OF DEEPER DRILLING WAS TO PROVE BEDROCK.

BOREHOLE LOG

Borehole No.
JKG105
3 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Method: SPIRAL AUGER
R.L. Surface: ~10.1 m
Date: 18/9/19 TO 19/9/19
Datum: AHD
Plant Type: JK305
Logged/Checked By: J.L./A.J.

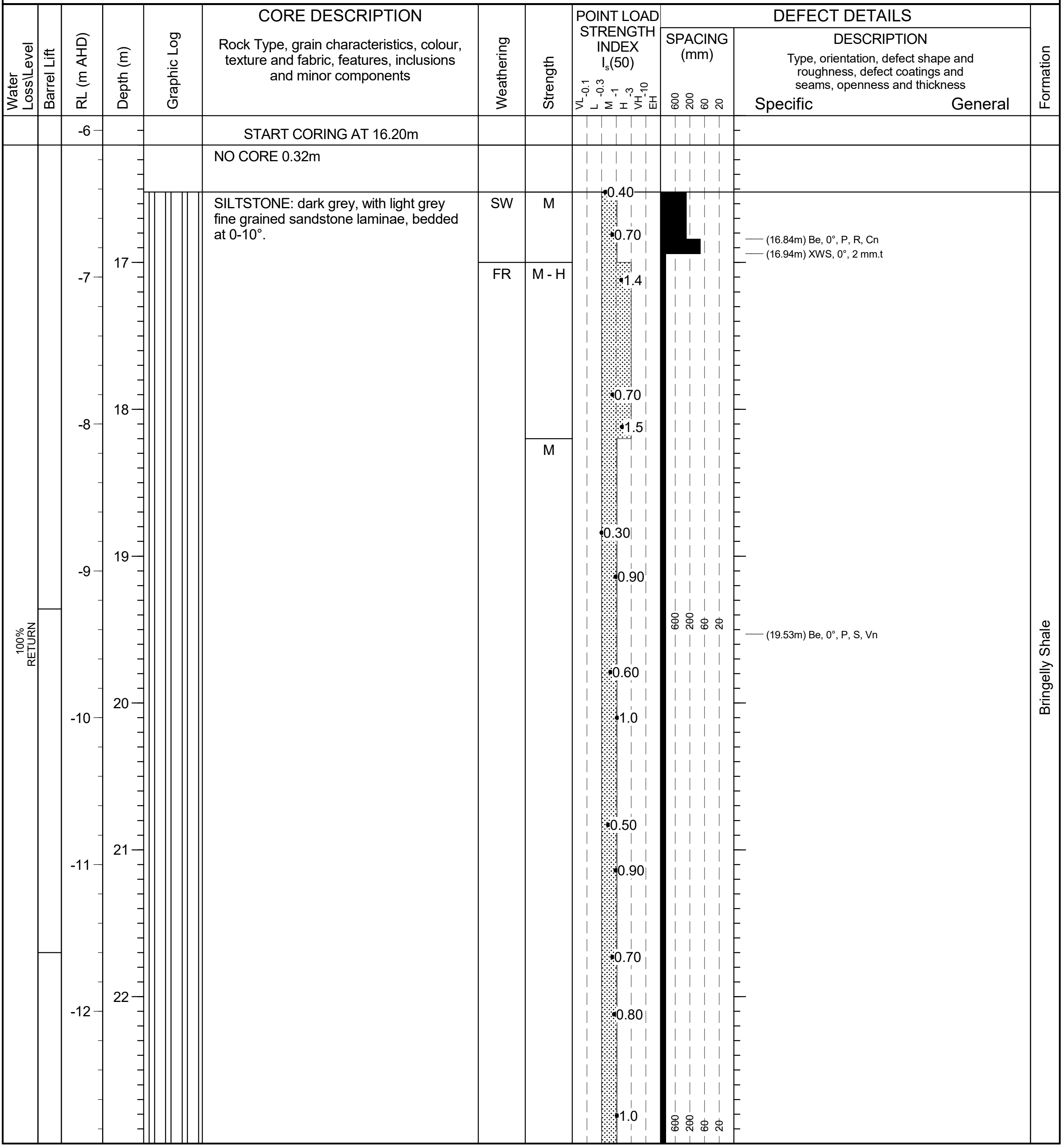
Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
						-4 -5	15		-	REFER TO CPT JKG105A *(continued)*				
								▥	-	Extremely Weathered siltstone: silty CLAY, medium plasticity, dark grey.	XW	Hd		BRINGELLY SHALE
						-6	16	▥		SILTSTONE: dark grey.	MW	L		LOW 'TC' BIT RESISTANCE
						-7 -8 -9 -10	17 18 19 20			REFER TO CORED BOREHOLE LOG				

CORED BOREHOLE LOG

Borehole No.
JKG105

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**Core Size:** NMLC	**R.L. Surface:** ~10.1 m
Date: 18/9/19 TO 19/9/19	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK305	**Bearing:** N/A	**Logged/Checked By:** J.L./A.J.



START CORING AT 16.20m

NO CORE 0.32m

SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°.

(16.84m) Be, 0°, P, R, Cn
(16.94m) XWS, 0°, 2 mm.t
(19.53m) Be, 0°, P, S, Vn

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

CORED BOREHOLE LOG

Borehole No.
JKG105
5 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Core Size: NMLC
R.L. Surface: ~10.1 m
Date: 18/9/19 TO 19/9/19
Inclination: VERTICAL
Datum: AHD
Plant Type: JK305
Bearing: N/A
Logged/Checked By: J.L./A.J.

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	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific General	Formation
100% RETURN		-13 -14	24		SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°. *(continued)*	FR	H	1.6 1.4 1.6 1.5		(23.12m) J, 80°, P, R, Cn (23.23m) J, SUB VERTICAL, Ir, R, Cn, 320mm LONG	Bringelly Shale
		-15 -16 -17 -18 -19	25 26 27 28 29		END OF BOREHOLE AT 24.67 m				600 200 60 20		

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
JOB NO 32160A2 JKG105 START CORING AT 16.20m
16
to NO CORE 0.32m
17
18
19
20
21
22
23
24
END OF JKG105 AT 24.67m

JKGeotechnics

BOREHOLE LOG

Borehole No.
JKG106
1 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Method: SPIRAL AUGER
R.L. Surface: ~9.6 m
Date: 19/9/19 TO 20/9/19
Datum: AHD
Plant Type: JK305
Logged/Checked By: J.L./A.J.

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 clay topsoil, low plasticity, dark brown, trace of root and root fibres.	w<PL			GRASS COVER
									-	CONCRETE: 150mm.t	w<PL			
						9				FILL: Silty clay, low to medium plasticity, dark brown and orange brown, trace of fine to medium grained sand, fine grained igneous gravel, slag and ash.				
							1		CI	Silty CLAY: medium plasticity, orange brown, trace of fine grained ironstone gravel.	w>PL			ALLUVIAL THE BOREHOLE LOGGING WAS BASED ON LIMITED SOIL SAMPLING. REFERENCE SHOULD BE MADE TO CPT JKG106A FOR DETAILS OF THE ALLUVIAL SOIL LAYERING AND STRENGTHS.
						8	2		CH	Silty CLAY: high plasticity, red brown and orange brown, trace of fine to medium grained ironstone gravel.				
						7			CI	Silty CLAY: medium plasticity, orange brown and light grey, trace of fine to medium grained sand.				
						6 5	3 4		SM	Silty SAND: fine to medium grained, orange brown, trace of clay fines.	M			
						4 3	5 6			Silty SAND: fine to medium grained, orange brown.				

COPYRIGHT

JKGeotechnics

BOREHOLE LOG

Borehole No.
JKG106
2 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~9.6 m
Date: 19/9/19 TO 20/9/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./A.J.

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
						2	8	▨	CL-CI	Silty CLAY: low to medium plasticity, orange brown, with fine to medium grained sand.	w>PL			ALLUVIAL
				■		1	9	░	SP	SAND: fine to medium grained, orange brown.	M			
▶						0 -1 -2 -3 -4	10 11 12 13		-	REFER TO CPT JKG106A				NO BOREHOLE LOGGING BELOW 9.0m DEPTH AS NO SAMPLING WAS CARRIED OUT. PURPOSE OF DEEPER DRILLING WAS TO PROVE BEDROCK.

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:55 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.
JKG106
3 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~9.6 m
Date: 19/9/19 TO 20/9/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./A.J.

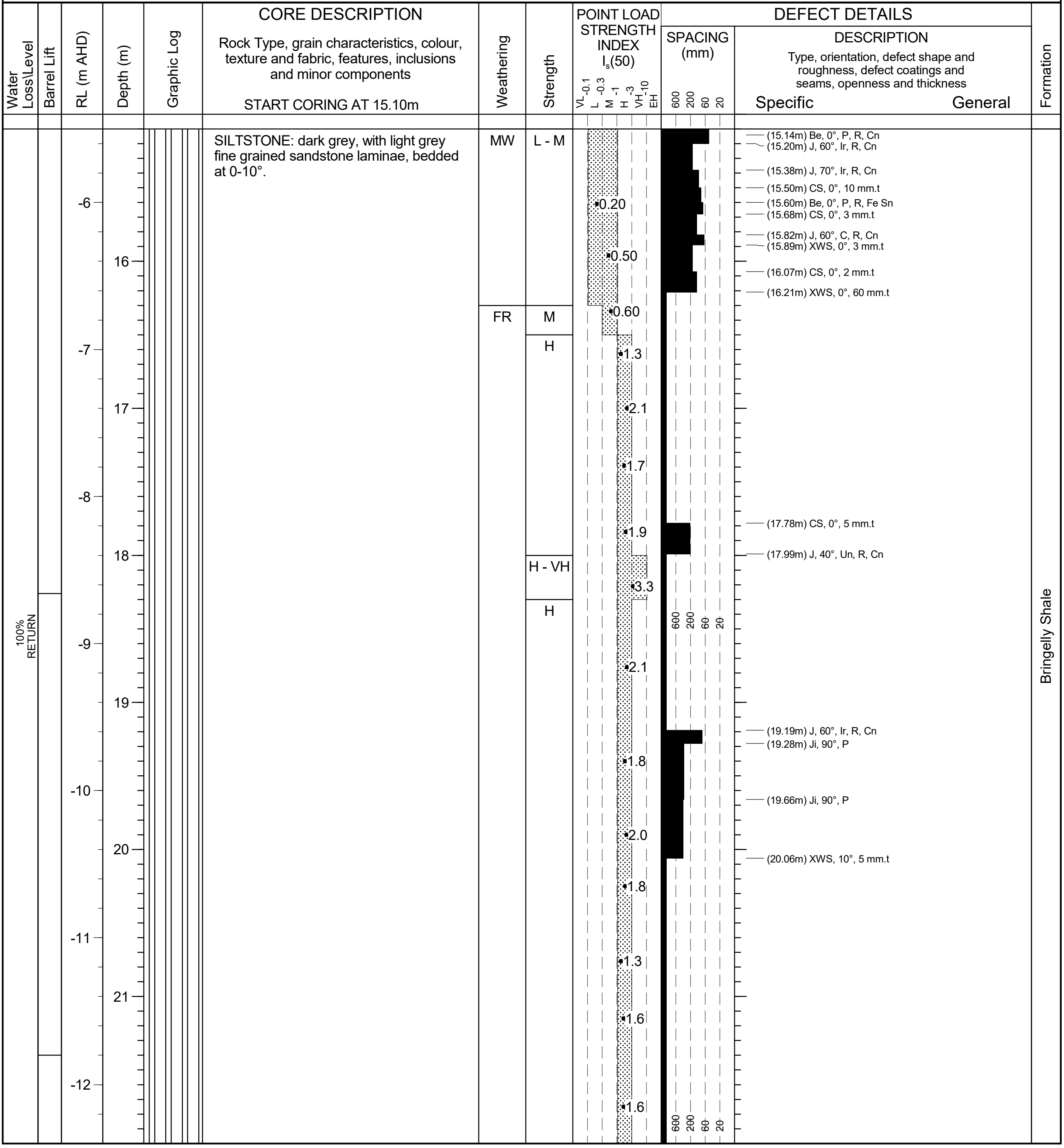
Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
									-	REFER TO CPT JKG106A *(continued)*				
						-5			-	Extremely Weathered siltstone: silty CLAY, medium plasticity, dark grey.	XW	Hd		BRINGELLY SHALE
							15			SILTSTONE: dark grey.	MW	L - M		LOW TO MODERATE 'TC' BIT RESISTANCE
										REFER TO CORED BOREHOLE LOG				
						-6								
							16							
						-7								
							17							
						-8								
							18							
						-9								
							19							
						-10								
							20							
						-11								

CORED BOREHOLE LOG

Borehole No.
JKG106
4 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**Core Size:** NMLC	**R.L. Surface:** ~9.6 m
Date: 19/9/19 TO 20/9/19	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK305	**Bearing:** N/A	**Logged/Checked By:** J.L./A.J.



CORE DESCRIPTION
Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components

START CORING AT 15.10m

SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°.

Water Loss\Level	Weathering	Strength	Point Load Strength Index $I_s(50)$	Formation
100% RETURN	MW	L - M	0.20 0.50	Bringelly Shale
	FR	M	0.60	
		H	1.3 2.1 1.7 1.9	
		H - VH	3.3	
		H	2.1 1.8 2.0 1.8 1.3 1.6 1.6	

DEFECT DETAILS
DESCRIPTION
Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness

Specific

(15.14m) Be, 0°, P, R, Cn
(15.20m) J, 60°, Ir, R, Cn
(15.38m) J, 70°, Ir, R, Cn
(15.50m) CS, 0°, 10 mm.t
(15.60m) Be, 0°, P, R, Fe Sn
(15.68m) CS, 0°, 3 mm.t
(15.82m) J, 60°, C, R, Cn
(15.89m) XWS, 0°, 3 mm.t
(16.07m) CS, 0°, 2 mm.t
(16.21m) XWS, 0°, 60 mm.t
(17.78m) CS, 0°, 5 mm.t
(17.99m) J, 40°, Un, R, Cn
(19.19m) J, 60°, Ir, R, Cn
(19.28m) Ji, 90°, P
(19.66m) Ji, 90°, P
(20.06m) XWS, 10°, 5 mm.t

General

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

CORED BOREHOLE LOG

Borehole No.
JKG106
5 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2
Core Size: NMLC
R.L. Surface: ~9.6 m
Date: 19/9/19 TO 20/9/19
Inclination: VERTICAL
Datum: AHD
Plant Type: JK305
Bearing: N/A
Logged/Checked By: J.L./A.J.

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	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific General	Formation
100% RETURN		-13 -14	23 24		SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°. *(continued)*	FR	H	3.0 2.0 1.6 1.3 1.7			Bringelly Shale
		-15 -16 -17 -18 -19	25 26 27 28		END OF BOREHOLE AT 24.43 m				600 200 60 20 600 200 60 20		

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

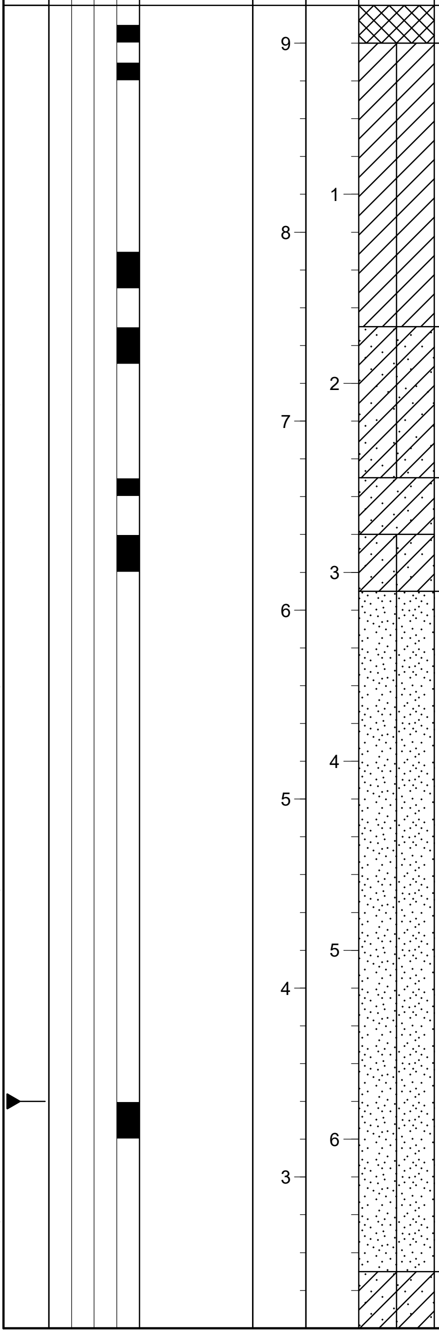

JK Geotechnics
JOB NO 32160A2 JKG106 START CORING AT 15.10m
15
16
17
18
19
20
21
22
23
24
END OF JKG106 AT 24.43m

BOREHOLE LOG

Borehole No.
JKG107
1 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~9.2 m
Date: 20/9/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** C.W./A.J.



Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	FILL: Silty clay, medium plasticity, dark grey and dark brown, trace of fine grained sand, ash, root fibres and fine grained siltstone gravel.	w>PL			GRASS COVER
CI	Silty CLAY: medium plasticity, light brown.	w>PL			ALLUVIAL THE BOREHOLE LOGGING WAS BASED ON LIMITED SOIL SAMPLING. REFERENCE SHOULD BE MADE TO CPT JKG107A FOR DETAILS OF THE ALLUVIAL SOIL LAYERING AND STRENGTHS.
	as above, but light brown mottled light grey.				
CL-CI	Silty sandy CLAY: low to medium plasticity, light grey and light brown, fine to medium grained sand.				
CL	Sandy CLAY: low plasticity, light grey and light brown, fine grained sand, trace of cemented sand nodules.				
	Silty sandy CLAY: low plasticity, light grey, fine to medium grained sand.				
SM	Silty SAND: fine to medium grained, light grey and light brown.	M			
		W			
CL	Silty sandy CLAY: as below	w>PL			

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:55 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.
JKG107
2 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~9.2 m
Date: 20/9/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** C.W./A.J.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
						2		▨	CL	Silty sandy CLAY: low plasticity, light brown and light grey, medium to coarse grained sand.	w>PL			ALLUVIAL
							8	▨						
						1		▨						
				■				▨						
							9		-	REFER TO CPT JKG107A				NO BOREHOLE LOGGING BELOW 8.8m DEPTH AS NO SAMPLING WAS CARRIED OUT. PURPOSE OF DEEPER DRILLING WAS TO PROVE BEDROCK.
						0								
							10							
						-1								
							11							
						-2								
▽ ON COMPLETION OF CORING							12							
						-3								
							13							
						-4								

COPYRIGHT

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2 **Method:** SPIRAL AUGER **R.L. Surface:** ~9.2 m
Date: 20/9/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** C.W./A.J.

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
	ES	U50	DB	DS										
						-5 -6	15		-	REFER TO CPT JKG107A *(continued)*				
						-7 -8 -9 -10 -11	16 17 18 19 20			REFER TO CORED BOREHOLE LOG				

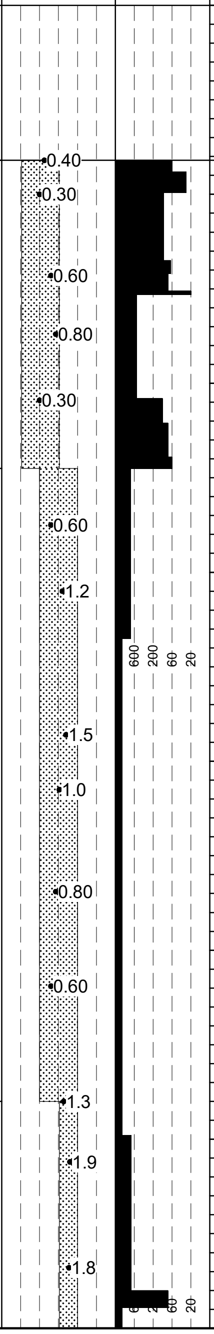
JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32160A2 LIVERPOOL.GPJ <<DrawingFile>> 20/11/2019 11:55 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CORED BOREHOLE LOG

Borehole No.
JKG107

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

Job No.: 32160A2	**Core Size:** NMLC	**R.L. Surface:** ~9.2 m
Date: 20/9/19	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** C.W./A.J.



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 $I_s(50)$	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific / General	Formation
		-6			START CORING AT 15.82m					
80% RETURN		-7	16		SILTSTONE: dark grey and dark brown, with light grey laminae, bedded at 0-10°.	MW	L - M	0.40 0.30 0.60	(15.88m) Be, 0°, P, S, Clay FILLED, 2 mm.t (15.91m) Be, 0°, P, S, Clay FILLED, 2 mm.t (15.94m) XWS, 0°, 2 mm.t (15.99m) XWS, 0°, 10 mm.t (16.11m) XWS, 0°, 40 mm.t (16.23m) XWS, 0°, 110 mm.t (16.35m) Be, 0°, P, S, Cn (16.42m) CS, 0°, 10 mm.t (16.51m) J, 90°, P, S, Cn (16.53m) Be, 0°, P, S, Cn	Bringelly Shale
		-8	17		SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°.	MW - SW		0.80 0.30	(17.08m) Be, 0°, P, S, Cn (17.21m) CS, 0°, 10 mm.t (17.30m) XWS, 0°, 5 mm.t (17.39m) Be, 0°, P, S, Cn (17.45m) Be, 0°, P, S, Cn	
		-9 -10 -11	18 19 20			FR	M - H	0.60 1.2 1.5 1.0 0.80 0.60 1.3	(18.33m) J, 40 - 50°, Un, S, Cn	
		-12	21				H	1.9 1.8	(20.98m) J, 60 - 70°, P, S, Cn (21.80m) J, 40°, P, S, Cn (21.89m) J, 90°, P, S, Cn	

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

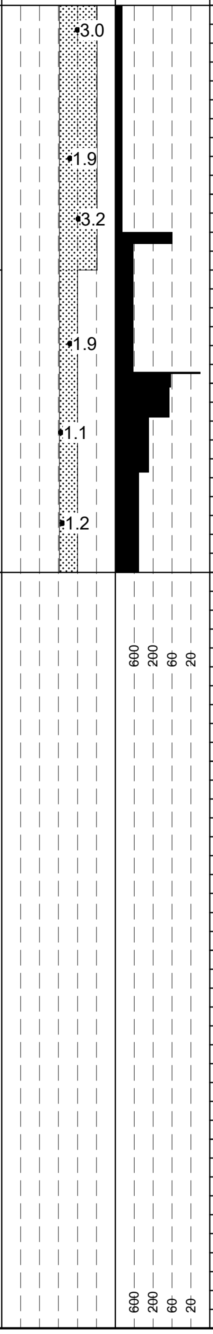
JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
JKG107
5 / 5

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW MULTI-STOREY CAR PARK
Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL, NSW

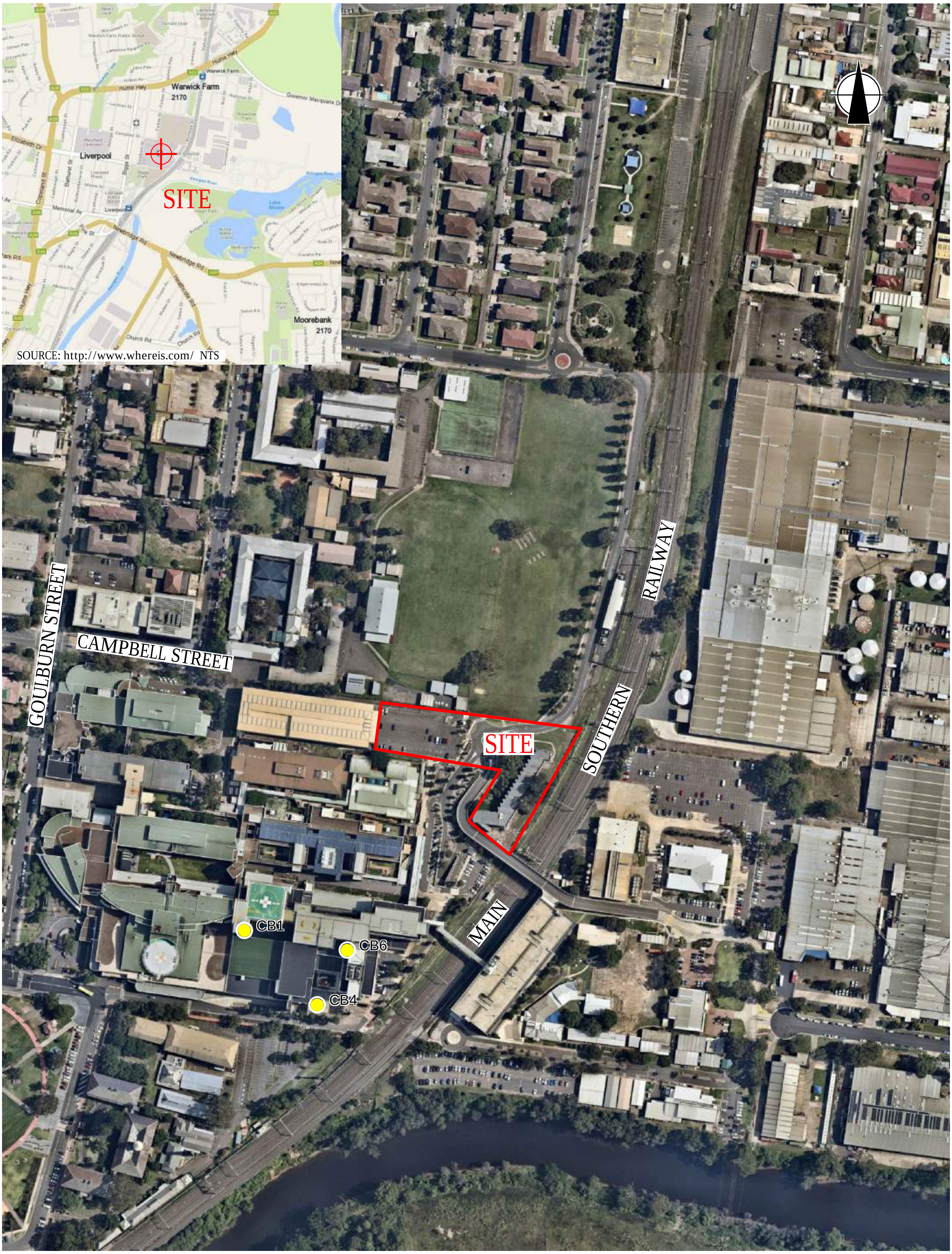
Job No.: 32160A2
Date: 20/9/19
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: ~9.2 m
Datum: AHD
Logged/Checked By: C.W./A.J.



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
80% RETURN		-13 -14 -15	23 24		SILTSTONE: dark grey, with light grey fine grained sandstone laminae, bedded at 0-10°. *(continued)*	FR	H - VH H	•3.0 •1.9 •3.2 •1.9 •1.1 •1.2		(23.20m) Be, 0°, P, S, Cn (23.26m) Be, 0°, Un, S, Cn (23.94m) Be, 0°, P, S, Cn (23.95m) J, 40°, P, S, Cn (24.02m) J, 40°, P, S, Cn (24.10m) J, 40°, P, S, Cn (24.18m) J, 60°, P, S, Cn (24.47m) J, 40°, P, S, Cn	Bringelly Shale
		-16 -17 -18 -19	25 26 27 28		END OF BOREHOLE AT 25.00 m				600 200 60 20		

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
JOB NO. 32160A2 JKG107 CORING STARTS AT 15.82m
16
17
18
19
20
21
22
23
24
END OF JKG107 AT 25.00m



SOURCE: http://www.whereis.com/ NTS

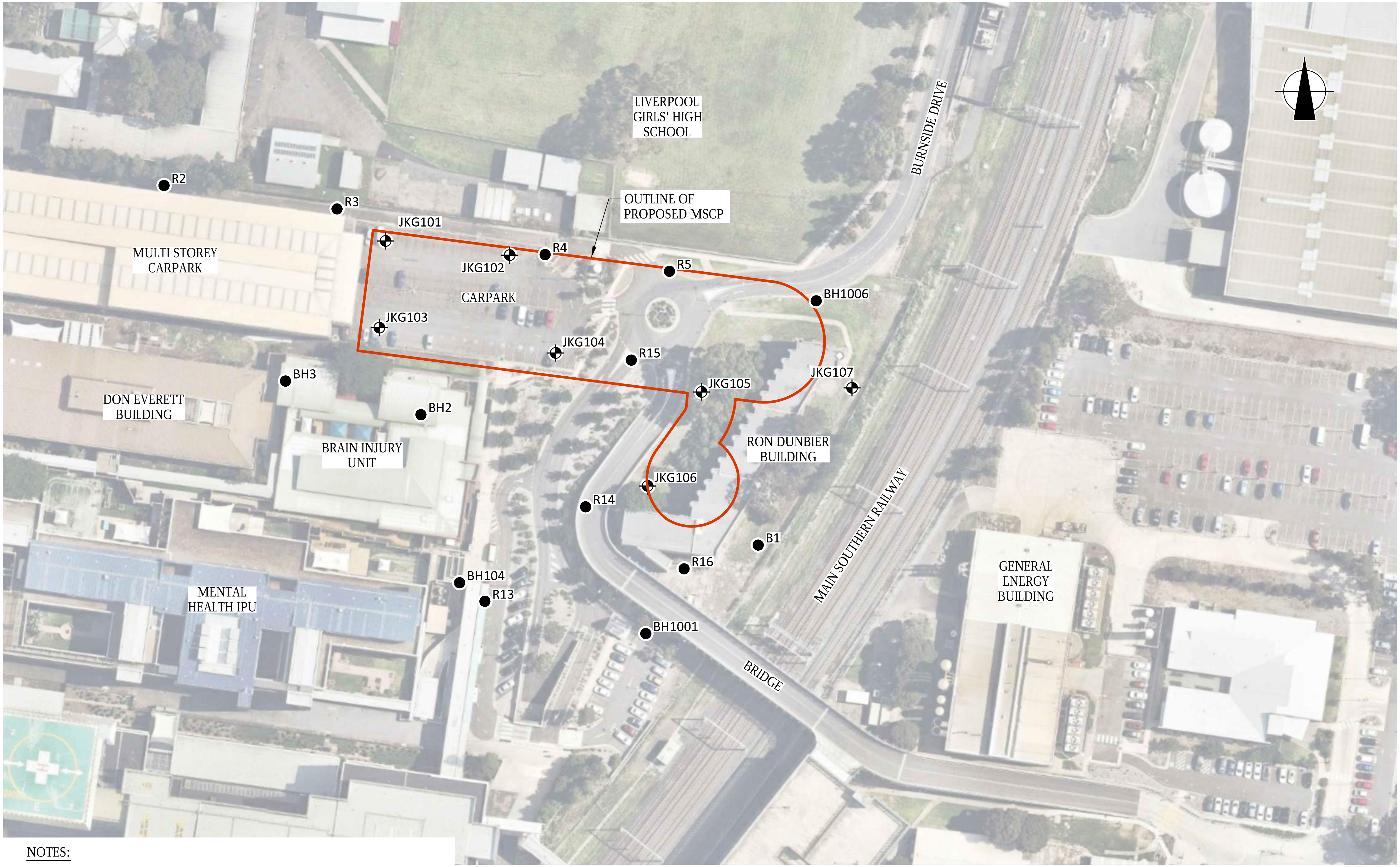
0 40 80 120 160 200 m

SCALE 1:4000 @A4

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

Title:	SITE LOCATION PLAN
Location:	LIVERPOOL HEALTH + ACADEMIC PRECINCT ELIZABETH STREET, LIVERPOOL, NSW
Report No: 32160A2	Figure: 1

JKGeotechnics



NOTES:

1. BH2 AND BH3 ARE FROM OUR 1992 INVESTIGATION.
2. BH104 IS FROM OUR 2003 INVESTIGATION.
3. BH1001 AND BH1006 ARE FROM OUR 2006 INVESTIGATION.
4. B1 IS FROM OUR 2007 INVESTIGATION.
5. R2 TO R5, AND R13 TO R16 ARE FROM OUR 2009 INVESTIGATION.
6. JKG101 TO JKG 107 ARE FROM THE CURRENT INVESTIGATION.

0 10 20 30 40 50
SCALE 1:1000 @A3 m

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

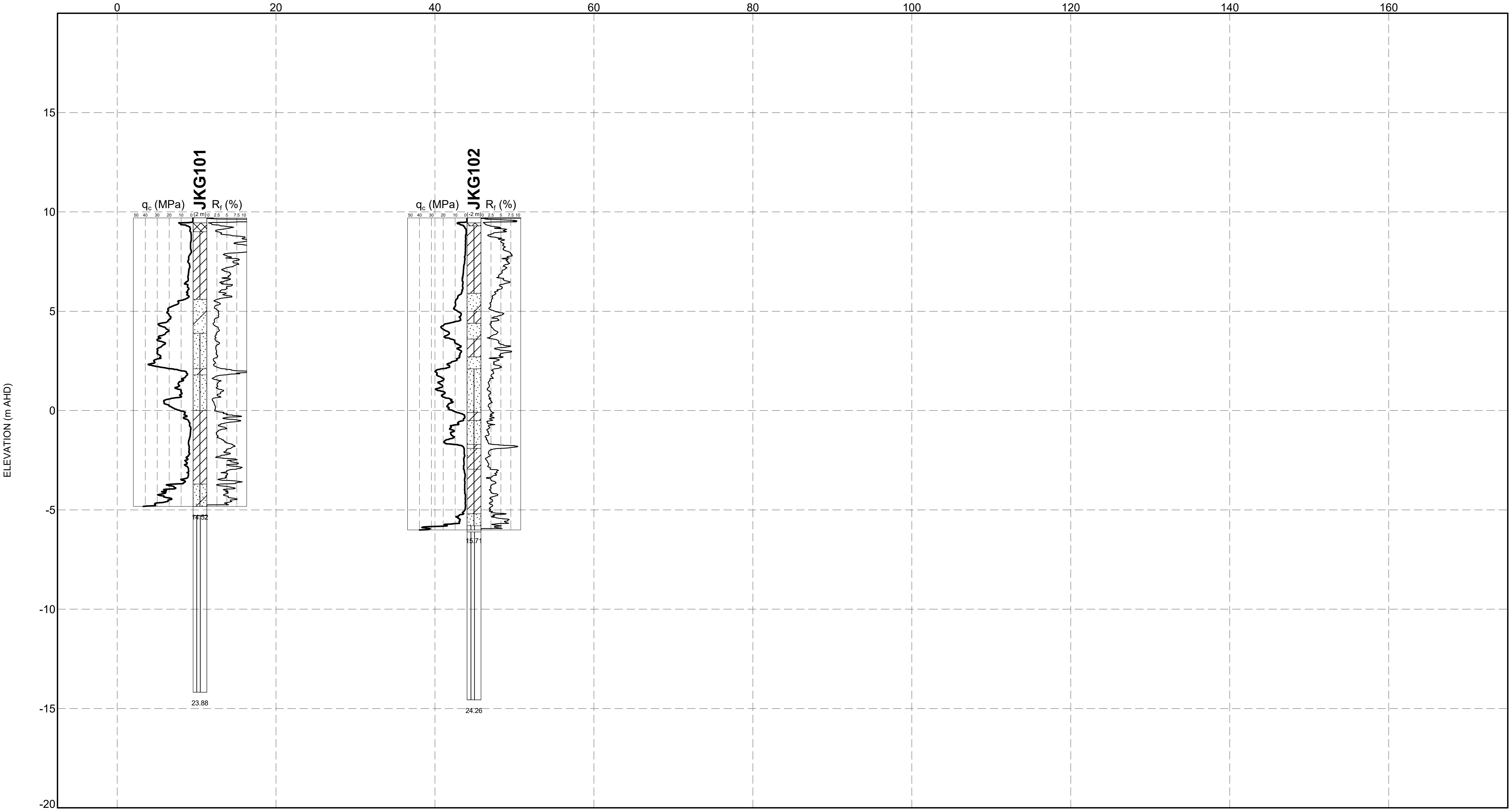
Title: INVESTIGATION LOCATION PLAN

Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT
ELIZABETH STREET, LIVERPOOL, NSW

Report No: 32160A2

Figure: 2

JKGeotechnics

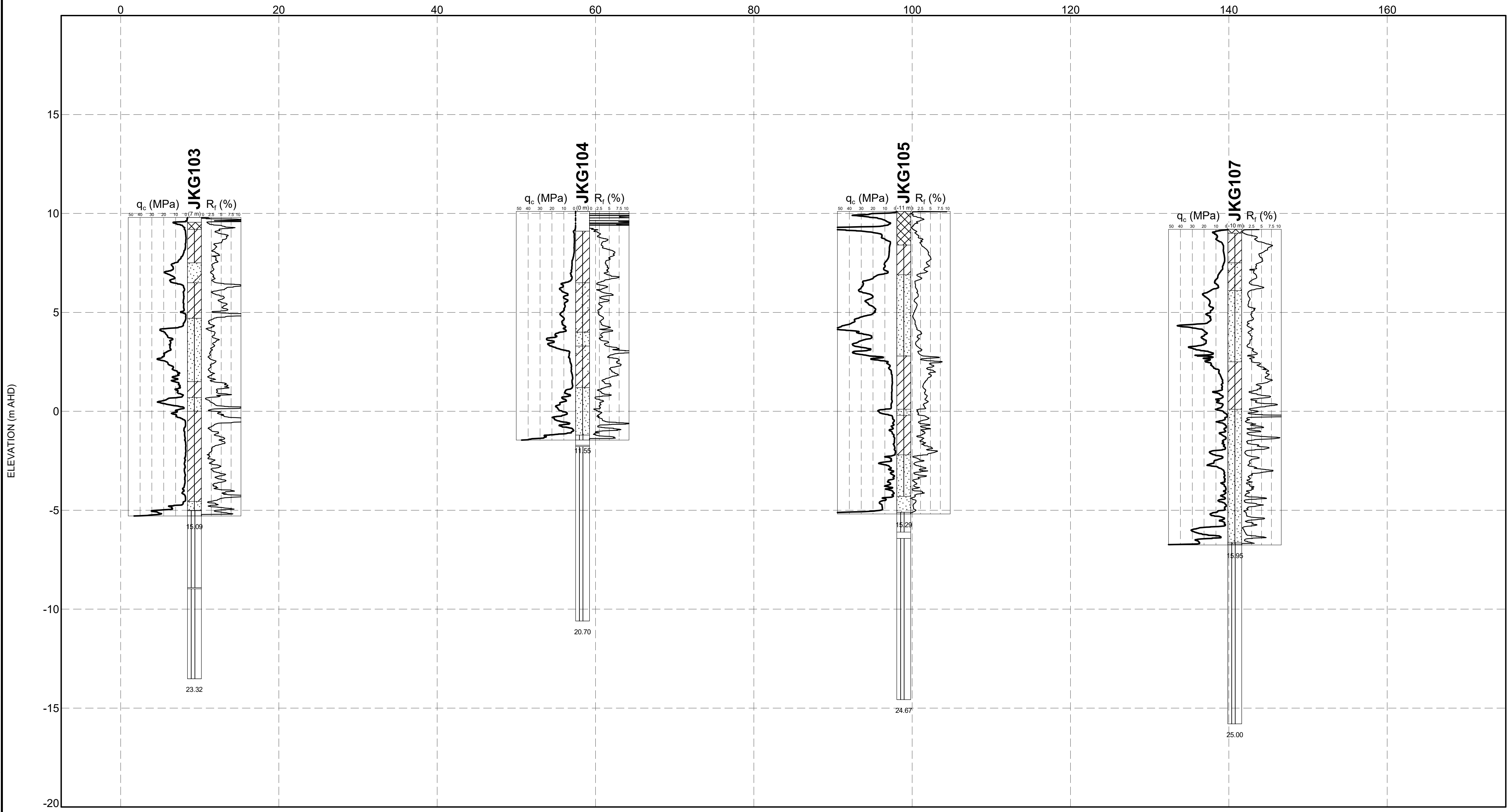


MATERIAL GRAPHIC

☐ BLANK	☐ NO CORE	▨ SILTY SANDY CLAY (CL, CI, CH)
░ CLAYEY SAND (SC)	▨ SILTY CLAY (CL, CI, CH)	☒ FILL
░ CLAYEY SILTY SAND (SM, SC)	░ SILTY SAND (SM)	▥ SILTSTONE

GRAPHICAL CPT & BOREHOLE SUMMARY LIVERPOOL HEALTH + ACADEMIC PRECINCT, ELIZABETH STREET, LIVERPOOL	DRAWN D.M.	DATE 21/11/2019	
	CHECKED A.J.	DATE 21/11/2019	
	SCALE H 1:500 V 1:200		A3
	PROJECT No 32160A2	FIGURE No 3	

JK 9.02.4 LIB.GLB Fence FENCE A3L 32160A2 LIVERPOOL.GPJ 32160A2 FIG 3.GDW 21/11/2019 11:58 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



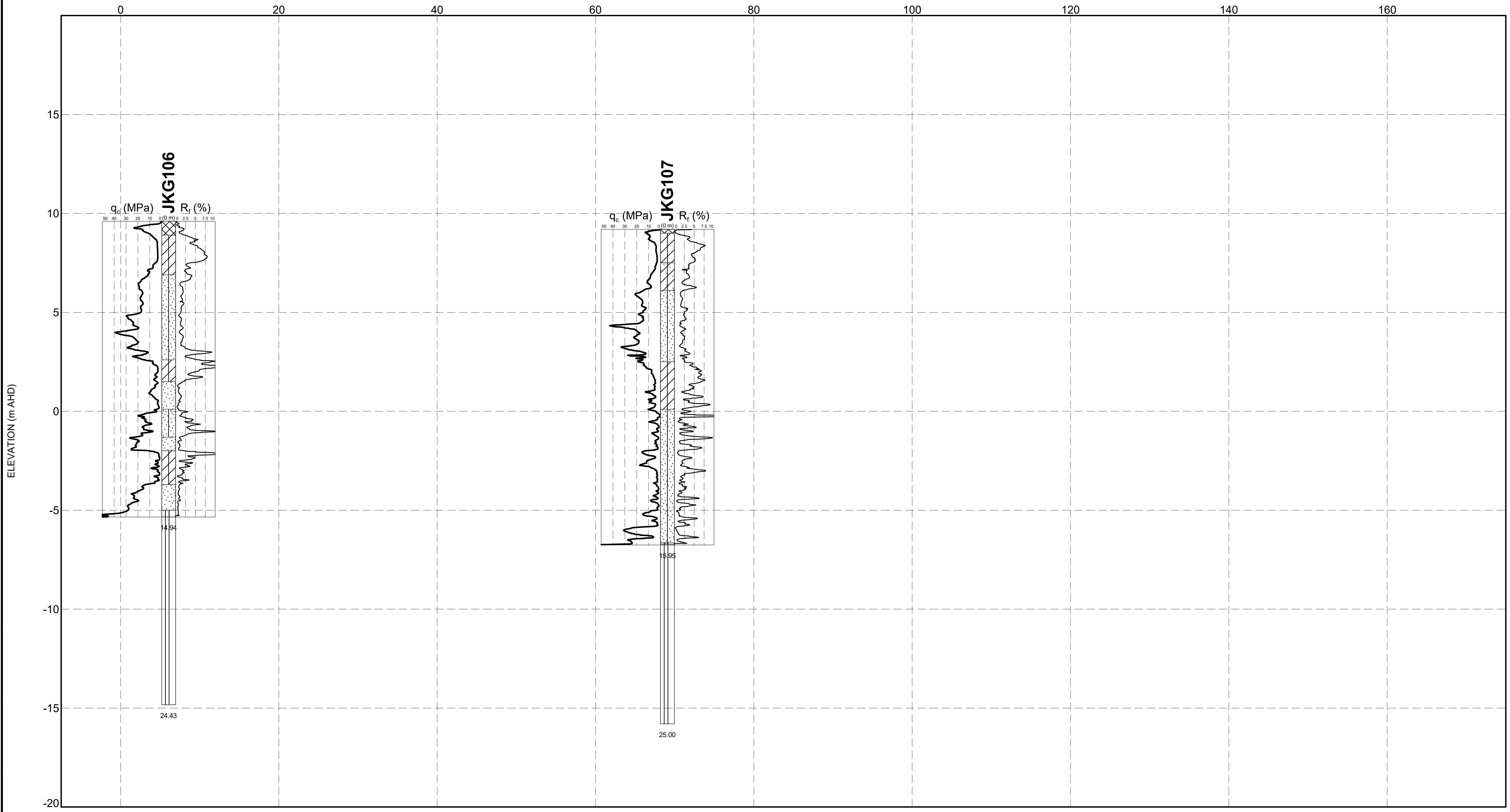
MATERIAL GRAPHIC

☐ BLANK
☐ NO CORE
▨ SILTY CLAY (CL, CI, CH)
▩ FILL
▨ CLAYEY SAND (SC)
░ SAND (SP, SW)
░ SILTY SAND (SM)
▥ SILTSTONE
▨ CLAYEY SILTY SAND (SM, SC)
▨ SANDY SILTY CLAY (CL, CI, CH)
▨ SILTY SANDY CLAY (CL, CI, CH)

GRAPHICAL CPT & BOREHOLE SUMMARY

LIVERPOOL HEALTH + ACADEMIC
PRECINCT, ELIZABETH STREET, LIVERPOOL

DRAWN D.M.	DATE 21/11/2019		
CHECKED A.J.	DATE 21/11/2019		
SCALE H 1:500 V 1:200		A3	
PROJECT No 32160A2	FIGURE No 4		



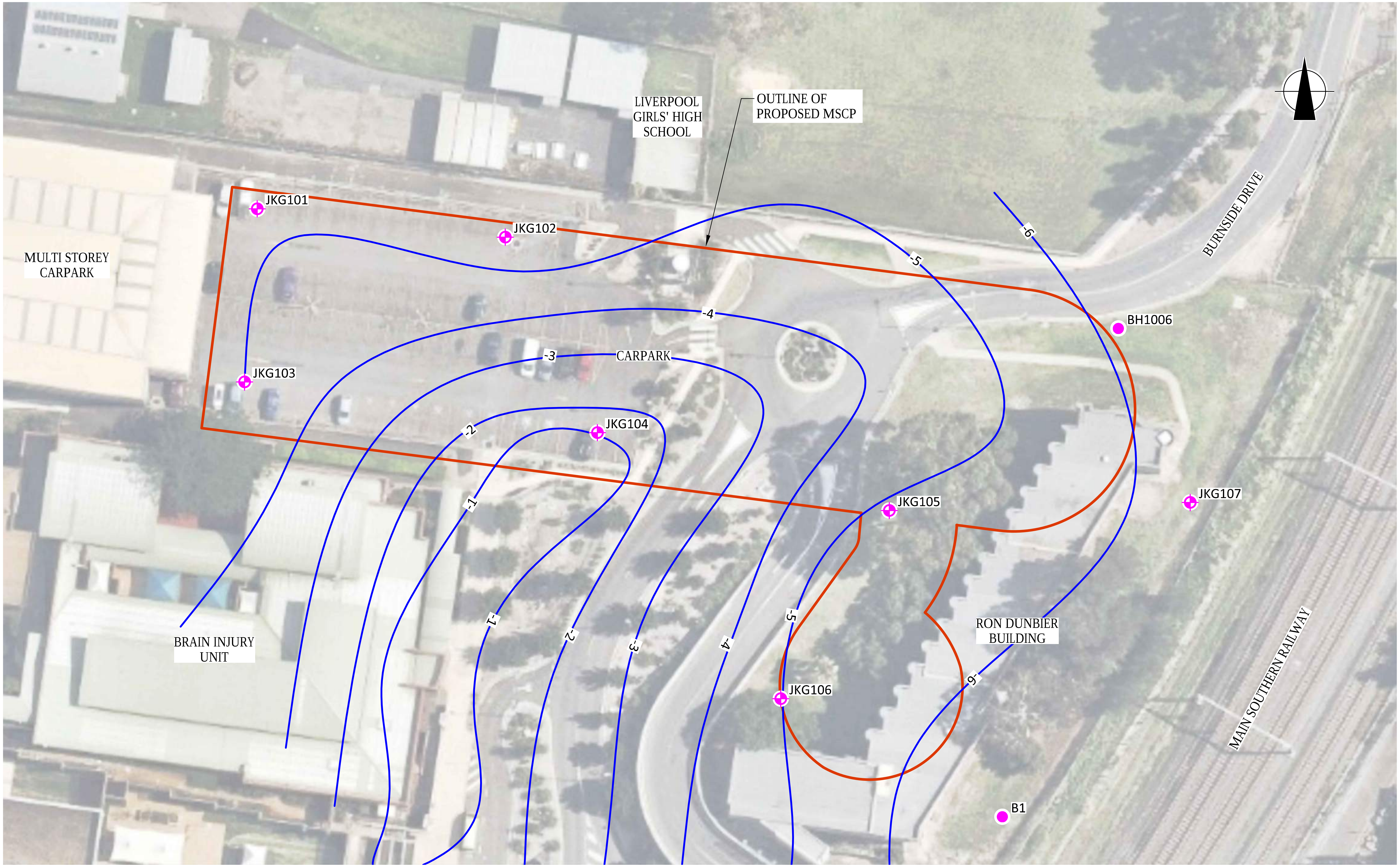
MATERIAL GRAPHIC

- ☐ BLANK
- ▨ SAND (SP, SW)
- ▨ SILTY CLAY (CL, CI, CH)
- ▨ SILTY SAND (SM)
- ▨ SILTY SANDY CLAY (CL, CI, CH)
- ▨ FILL
- ▥ SILTSTONE

GRAPHICAL CPT & BOREHOLE SUMMARY

LIVERPOOL HEALTH + ACADEMIC
PRECINCT, ELIZABETH STREET, LIVERPOOL

DRAWN D.M.	DATE 21/11/2019		
CHECKED A.J.	DATE 21/11/2019		
SCALE H 1:500 V 1:200		A3	
PROJECT No 32160A2	FIGURE No 5		



LEGEND:

-2 WEATHERED BEDROCK SURFACE CONTOUR (RL mAHD)

0 5 10 15 20 25

SCALE 1:500 @A3 m

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

Title: SURFACE OF WEATHERED BEDROCK CONTOUR PLAN

Location: LIVERPOOL HEALTH + ACADEMIC PRECINCT
ELIZABETH STREET, LIVERPOOL, NSW

Report No: 32160A2

Figure: 6

JKGeotechnics

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 <u>or</u> where only a limited investigation has been completed <u>or</u> 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.

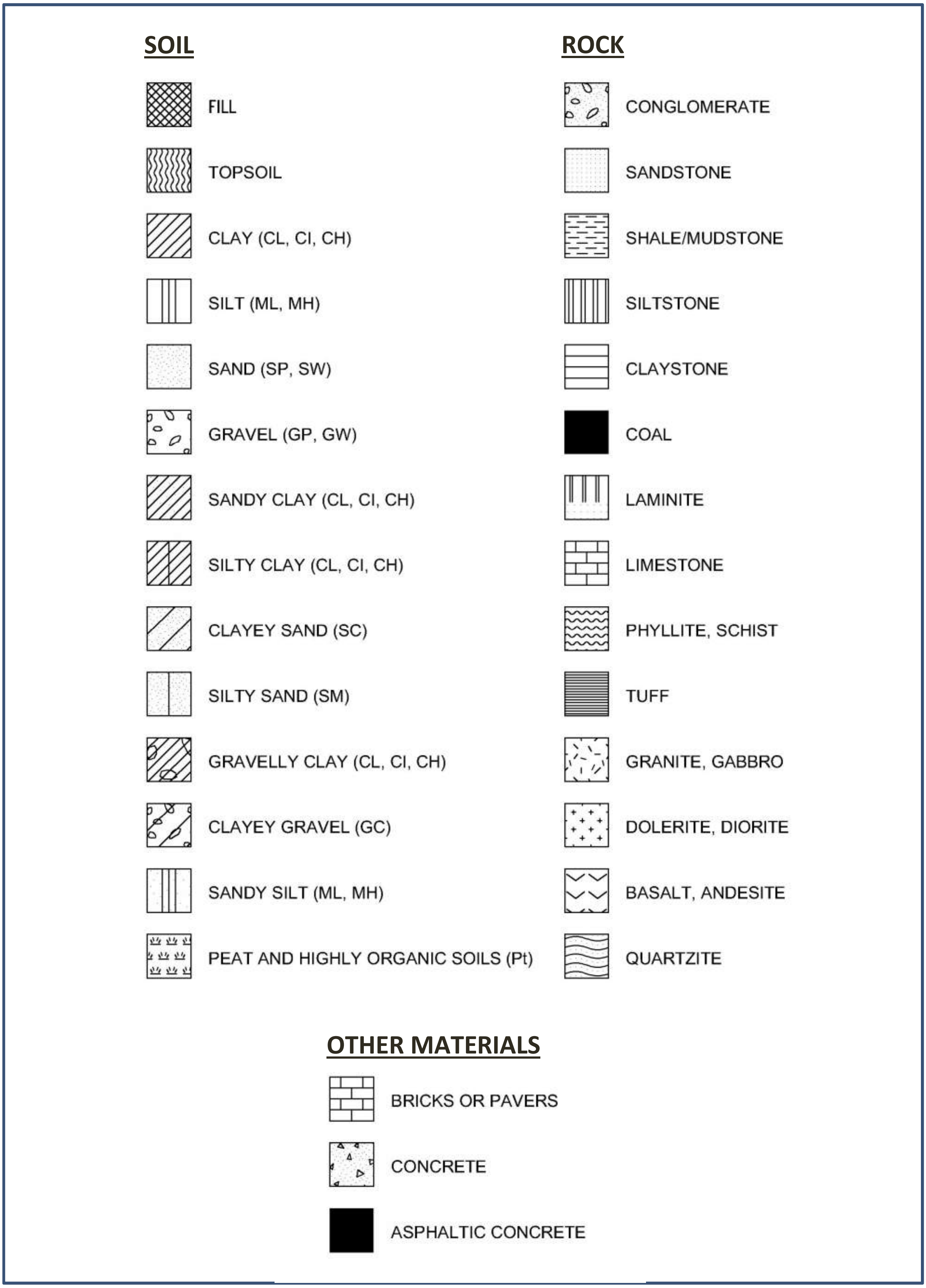
Requirements could range from:

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:

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

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:

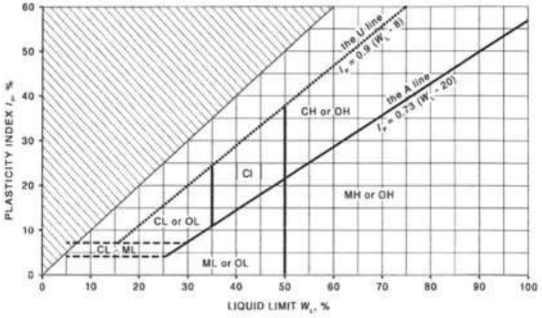
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

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	Sample taken over depth indicated, for environmental analysis.		
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.		
	DB	Bulk disturbed sample taken over depth indicated.		
	DS	Small disturbed bag sample taken over depth indicated.		
	ASB	Soil sample taken over depth indicated, for asbestos analysis.		
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.		
	SAL	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	Vane shear reading in kPa of undrained shear strength.		
	PID = 100	Photoionisation detector reading in ppm (soil sample headspace test).		
Moisture Condition (Fine Grained Soils)	*w* > PL	Moisture content estimated to be greater than plastic limit.		
	w ≈ PL	Moisture content estimated to be approximately equal to plastic limit.		
	w < PL	Moisture content estimated to be less than plastic limit.		
	w ≈ LL	Moisture content estimated to be near liquid limit.		
	w > LL	Moisture content estimated to be wet of liquid limit.		
(Coarse Grained Soils)	D	DRY – runs freely through fingers.		
	M	MOIST – does not run freely but no free water visible on soil surface.		
	W	WET – free water visible on soil surface.		
Strength (Consistency) Cohesive Soils	VS	VERY SOFT – unconfined compressive strength ≤ 25kPa.		
	S	SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.		
	F	FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.		
	St	STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.		
	VSt	VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.		
	Hd	HARD – unconfined compressive strength > 400kPa.		
	Fr	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

Term		Abbreviation		Definition
Residual Soil		RS		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely Weathered		XW		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
Highly Weathered	Distinctly Weathered (Note 1)	HW	DW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately Weathered		MW		The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

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

Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Guide to Strength	
			Point Load Strength Index $I_{s(50)}$ (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

Borehole Logs 2 & 3, and Laboratory Test Results from 'Geotechnical Investigations for Proposed Brain Injury Unit' Report, Ref. 9014W/vm dated 11/08/92

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
2

BOREHOLE LOG

Client:
Project: PROPOSED BRAIN INJURY UNIT.
Location: LIVERPOOL HOSPITAL, NEAR CAMPBELL STREET, LIVERPOOL.

Job No. 9014 W.
Method: SPIRAL AUGER BCD - 450 RIG.
Date: 30 - 7 - 92

roundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION						FILL: Sandy Clay, low plasticity, brown with traces of roadbase gravel & ash.	MC<PL			Grass cover Root zone to 100mm APPEARS WELL COMPACTED.
	DS	N = 16 6, 8, 8				FILL: Clay, medium to high plasticity, brown & dark grey with zones of ash gravel.			400 280	
			1		CH.	CLAY: high plasticity, pale grey & orange brown.	MC>PL	Vst to H.		
	U50					as above but pale grey & red brown mottled.			470 510.	ALLUVIAL ORIGIN.
	DS	N = 24 5, 10, 14	2		CL-CH	CLAY: medium to high plasticity, pale grey mottled orange & red brown with some sand. Trace of ironstone gravel.		H.	>600 >600.	
			3		CL	SANDY CLAY: low to medium plasticity, pale grey & yellow brown with zones of clayey sand.				
	DS	N = 32 6,13,19	4			as above but pale grey and red brown with bands of sand.				FRIABLE
					CL/SC	SANDY CLAY/CLAYEY SAND fine to medium grained, low plasticity, pale grey & red brown.	D to M.	MD		
	DS	N = 26 8, 12, 14	5							FRIABLE
			6			END OF BOREHOLE AT 5·45m.				

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

BOREHOLE LOG

Borehole No. 3

Client:
Project: PROPOSED BRAIN INJURY UNIT.
Location: LIVERPOOL HOSPITAL, NEAR CAMPBELL STREET, LIVERPOOL.

Job No. 9014 W.
Method: SPIRAL AUGER BCD - 450 RIG.
Date: 30 - 7 - 92

oundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION.				▦		FILL: Sandy clay, low plasticity, brown with clayey zones, trace of gravel.	MC < PL.			Grass cover Root zone to 50mm. APPEARS MODERATELY TO WELL COMPACTED.
	DS	N = 23 8, 11, 12	1	▦						
				▨	CL-CH.	SILTY CLAY: medium to high plasticity, pale grey mottled orange & red brown.		H.	> 600.	
			2	▨		— — — as above but with a trace of sand.				ALLUVIAL ORIGIN.
	DS	N = 24 5, 10, 14		▨					>600 >600 >600.	
			3	▨	CL.	SANDY CLAY: low to medium plasticity, pale grey with yellow brown mottled zones. Clayey Sand zones. Sand fine to medium grained.	MC ≤ PL			
	DS	N = 35 13, 18, 17	4	▨						FRIABLE
				▨		Grading to				
	DS			░	SC	CLAYEY SAND: fine to medium grained, pale grey & yellow brown with zones of sandy clay and sand.	D to M.	D		
			5	░						
	DS	N = 33 10, 13, 20		░						FRIABLE
			6			END OF BOREHOLE AT 5·75m.				

COPYRIGHT

Ref No : 9014W
Table A: Page 1 of 1

TABLE A
SUMMARY OF LABORATORY TEST RESULTS

AS 1289	TEST METHOD	B1.1	C1.2	C2.1	C3.1	C4.1	D3.1
BOREHOLE NUMBER	SAMPLE DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %	pH
BH 1	0.40 - 0.80	17.0					7.0
BH 1	0.90 - 1.25	20.2	59	16	43	17½	
BH 2	0.50 - 0.95	19.4	32	19	13	7½	
BH 2	1.50 - 1.72	21.2					
BH 2	2.00 - 2.45	15.3					
BH 3	0.60 - 1.10	12.4					7.2
BH 3	2.30 - 2.75	14.8	43	14	29	13½C	
BH 3	3.80 - 4.25	8.4					
BH 4	0.50 - 1.10	12.6					
BH 4	1.50 - 1.80	18.0					

11·8·92
Authorised Signature

Ref No : 9014W
Table B: Page 1 of 1

TABLE B

SUMMARY OF SHRINK - SWELL TEST RESULTS

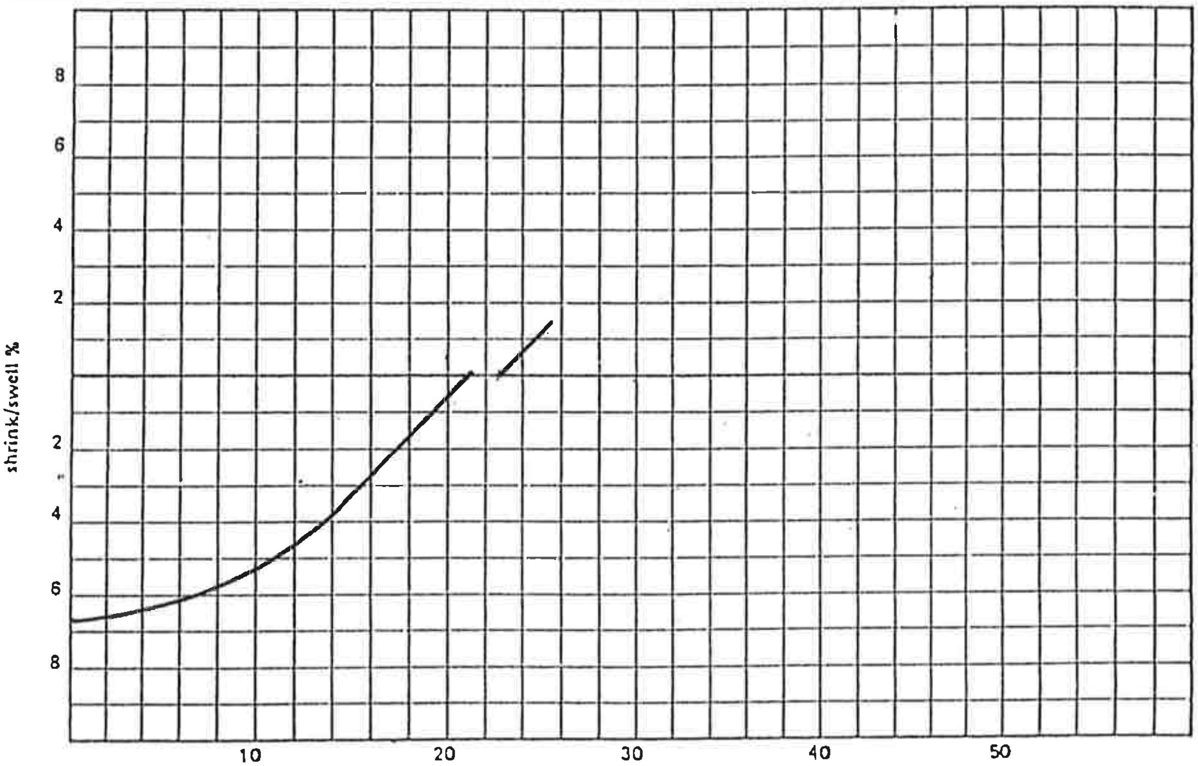
BOREHOLE: 2 ,DEPTH: 1.50 - 1.72 m

SWELL TEST: JEFFERY AND KATAUSKAS PROCEDURE NUMBER 6

Moisture Content Before test	Moisture Content After test	Estimated unconfined compressive strength Before test	Estimated unconfined compressive strength After test
22.6 %	25.7 %	350 kPa	230 kPa

Load	Settlement under load Before saturation	Swell on Saturation
25 kPa	0.3 %	1.3 %

SHRINK TEST: JEFFERY AND KATAUSKAS PROCEDURE NUMBER 6



Shrink Swell Index
4.1 %/pF

NOTES : (1) Suction Value used in calculation = 1.8 pF.
(2) Volume Change Coefficient (α) was assumed = 2.

11·8·92
Authorised Signature

Jeffery and Katauskas Pty Ltd 39 BUFFALO ROAD GLADESVILLE NSW 2111

This laboratory is registered by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with the terms of registration. This document shall not be reproduced except in full without the prior approval of the laboratory.

NATA

APPENDIX B

Borehole Log 104 from 'Geotechnical Investigation for Proposed New Mental Health Centre' Report, Ref. M17359WArpt2 dated 3/09/03

BOREHOLE LOG

Borehole No.
104 1/3

Client:
Project: PROPOSED NEW MENTAL HEALTH FACILITY
Location: LIVERPOOL HOSPITAL, NSW

Job No. M17359SA
Date: 20-12-02
Method: SPIRAL AUGER JK350
R.L. Surface: ≅ 10.0m
Datum: AHD
Logged/Checked by: A.H./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0	■		ASPHALTIC CONCRETE: 70mm.t				
	■						▩		FILL: Gravelly sand, fine to medium grained, grey, fine to coarse grained angular igneous gravel (roadbase).	M			
	■			■	N = 7 3,4,3		▩		FILL: Silty clay, medium to high plasticity, mottled brown grey and orange brown, with fine to coarse grained sub angular sandstone gravel.	MC>PL			APPEARS MODERATELY COMPACTED
						1	▨	CL-CH	SILTY CLAY: medium to high plasticity, grey mottled red and orange.	MC>PL	H	-	ALLUVIAL
	■			■	N = 11 4,4,7		▨					500 450 480	
						2	▨						
							▨		as above, but grey mottled red brown.				
				■	N = 33 10,16,17	3	▨					>600 >600 >600	
▼ ON COMPLETION OF CORING AND AFTER REMOVAL OF CASING						4	▨		SILTY CLAY: medium to high plasticity, grey mottled red and orange, with a trace of fine to coarse grained ironstone gravel, and occasional fine grained sand bands.				
				■	N = 16 8,7,9		▨					>600 550 400	
						5	▨						
				■	N = 19 7,11,8	6	▨					450 400 420	
						7							

BOREHOLE LOG

Borehole No.
104 2/3

Client:
Project: PROPOSED NEW MENTAL HEALTH FACILITY
Location: LIVERPOOL HOSPITAL, NSW

Job No. M17359SA
Date: 20-12-02
Method: SPIRAL AUGER JK350
Logged/Checked by: A.H./A.J.
R.L. Surface: ≅ 10.0m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■			▨	CL-CH	SILTY CLAY: medium to high plasticity, grey mottled red and orange, with a trace of fine to coarse grained ironstone gravel.	MC>PL	H		
				■	N = 13 6,6,7	8	░	SM	SILTY SAND: fine to medium grained, grey, with orange brown and red brown clay bands.	M	MD		
▶				■			░			W			
				■	N = 36 5,13,20	9 10	░		SILTY SAND: fine to medium grained, grey brown.		D		
				■	N > 40 27,40/ 50mm REFUSAL	11 12	☰	-	SHALE: dark grey.	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
						13	☰			SW-Fr	M-H		LOW RESISTANCE
						14			REFER TO CORED BOREHOLE LOG				

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

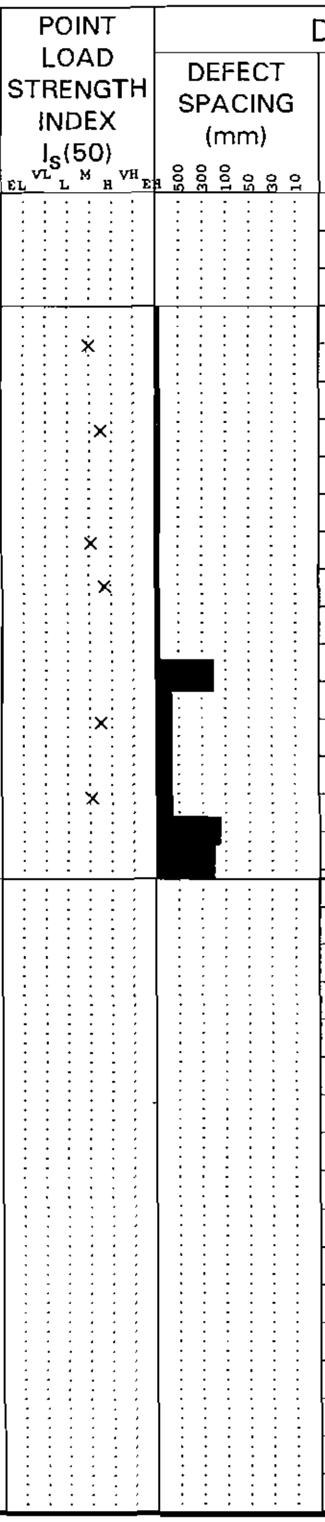
CORED BOREHOLE LOG

Borehole No.
104 3/3

Client:
Project: PROPOSED NEW MENTAL HEALTH FACILITY
Location: LIVERPOOL HOSPITAL, NSW

Job No. M17359SA
Core Size: NMLC
R.L. Surface: ≅ 10.0m
Date: 20-12-02
Inclination: VERTICAL
Datum: AHD
Drill Type: JK350
Bearing: -
Logged/Checked by: A.H./ A.J.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		13		START CORING AT 13.60m				
FULL RETURN		14		SHALE: dark grey, with light grey, fine grained sandstone laminae, bedded at 0-5°.	SW-Fr	M-H H		
		15					J, 65°, Un, R J, 65°, Un, R	
		16					J, 10°, Un, R J, 25°, Un, R	
				as above, but with a trace of fine grained angular quartz gravel.				
		17		END OF BOREHOLE AT 16.65m				
		18						
		19						



APPENDIX C

Borehole Logs 1001 & 1006, and Laboratory Test Results from ‘Geotechnical Investigation for Proposed Liverpool Hospital Redevelopment Project’ Report, Ref. M20303ZArpt dated 13/07/06

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
1001
1/4

Client:
Project: PROPOSED LIVERPOOL HOSPITAL REDEVELOPMENT PROJECT
Location: LIVERPOOL HOSPITAL, NSW

Job No. M20303ZA
Date: 30-5-06
Method: SPIRAL AUGER & WASHBORING
EDSON 3000
R.L. Surface:
Datum:
Logged/Checked by: M.T./ASH

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			CONCRETE: 120mm.t				7mm DIAMETER REINFORCEMENT, 45mm AND 55mm TOP COVER
	■						▨	-	FILL: Silty sand, fine to medium grained, dark grey, with concrete and brick fragments and igneous gravel.	M	-	-	APPEARS POORLY COMPACTED
				■	N = 8 7,3,5		▨						
	■					1	▨	CH	SILTY CLAY: high plasticity, brown, red and light grey, with root fibres and a trace of ironstone gravel.	MC>PL	VSt	-	ALLUVIAL
				■	N = 8 3,4,4		▨					310 320 310	
	■					2	▨						
				■	N = 19 5,8,11	3	▨		as above, but with no root fibres.	MC<PL	H	410 410 500	
						4	▨						
				■	N = 17 5,8,9		▨					410 450 460	
						5	▨						
				■	N = 18 6,7,11	6	▨			MC>PL	VSt	280 260 320	
				■			░	SC	CLAYEY SAND: fine to medium grained, light grey mottled orange brown.	M	(D)		
						7							

COPYRIGHT

BOREHOLE LOG

Borehole No.
1001
2/4

Client:
Project: PROPOSED LIVERPOOL HOSPITAL REDEVELOPMENT PROJECT
Location: LIVERPOOL HOSPITAL, NSW

Job No. M20303ZA
Date: 30-5-06
Method: SPIRAL AUGER & WASHBORING EDSON 3000
R.L. Surface:
Datum:
Logged/Checked by: M.T./ASH

Groundwater Record	SAMPLES ES U50 DB DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
					SP	SAND: fine to medium grained, orange brown and light grey.	M	(D)		
		N > 15 8,15/ 130mm REFUSAL				as above, but light grey.				
			8			SAND: fine to coarse grained, brown.				
▶							W			
		N > 3 15,3/ 10mm REFUSAL	9					-		CONTINUOUS SPIRAL AUGER AND WASHBORE DRILLING (ie NO INSITU TESTING) FROM 9.16m DOWN TO 15.55m IN ORDER TO PROVE BEDROCK
			10 11		SC	CLAYEY SAND: fine to medium grained, brown.				
			12 13		SM	SILTY SAND: fine to medium grained, light grey, with occasional clay bands.				COMMENCE ROTARY WASHBORE DRILLING
			14			as above, but brown and dark grey.				

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
1001
3/4

BOREHOLE LOG

Client:
Project: PROPOSED LIVERPOOL HOSPITAL REDEVELOPMENT PROJECT
Location: LIVERPOOL HOSPITAL, NSW

Job No. M20303ZA
Date: 30-5-06
Method: SPIRAL AUGER & WASHBORING
EDSON 3000
R.L. Surface:
Datum:
Logged/Checked by: M.T./ASH

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
						15		SM	SILTY SAND: fine to medium grained, brown and dark grey, with occasional clay bands.	W	-		
						16		-	SHALE: dark grey, with clay seams.	XW-DW	EL-VL	-	
						17 18 19 20			REFER TO CORED BOREHOLE LOG				

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

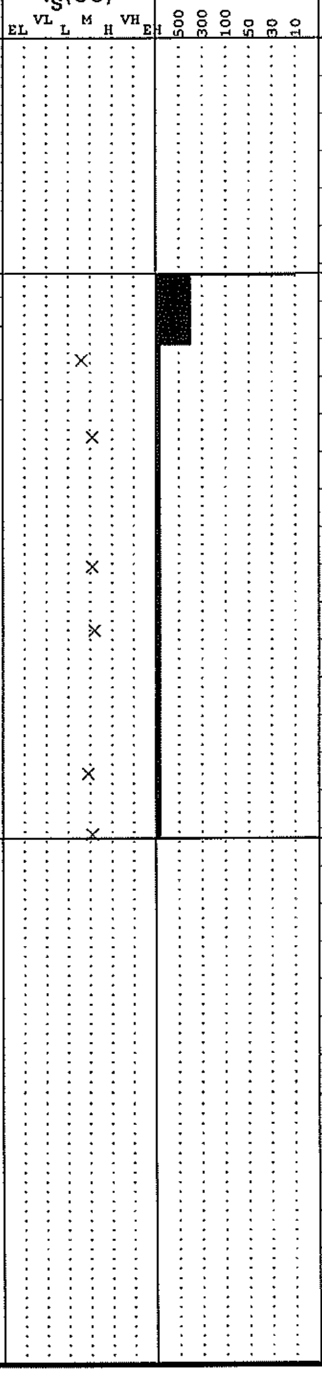
CORED BOREHOLE LOG

Borehole No.
1001
4/4

Client:
Project: PROPOSED LIVERPOOL HOSPITAL REDEVELOPMENT PROJECT
Location: LIVERPOOL HOSPITAL, NSW

Job No. M20303ZA
Date: 31-5-06
Drill Type: EDSON 3000
Core Size: NMLC
Inclination: VERTICAL
Bearing: -
R.L. Surface:
Datum:
Logged/Checked by: M.T./AJH

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT SPACING (mm)	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		15 16		START CORING AT 16.25m						
FULL RETURN		17 18 19		SHALE: dark grey, with fine grained, light grey sandstone laminae. bedded at 0-5°, spacing up to 5mm.	Fr	M-H L-M M M-H			CS, 20mm.t - CS, 10mm.t - Cr, 5mm.t	
		20 21		END OF BOREHOLE AT 19.25m						



Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
1006
1/4

Client:

Project: PROPOSED LIVERPOOL HOSPITAL REDEVELOPMENT PROJECT

Location: LIVERPOOL HOSPITAL, NSW

Job No. M20303ZA

Date: 31-5-06

Method: SPIRAL AUGER & WASHBORING
EDSON 3000

R.L. Surface:

Datum:

Logged/Checked by: M.T./

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION OF AUGERING					N = 25 11,11,14	0			FILL: Silty clay, medium plasticity, dark brown, with root fibres and concrete fragments and a trace of igneous gravel.	MC<PL			GRASS COVER APPEARS WELL COMPACTED
									as above, but light grey and brown, with no concrete fragments.				
						1		CH	SILTY CLAY: high plasticity, red and brown, with a trace of root fibres and ironstone gravel.	MC<PL	H	-	ALLUVIAL
					N > 28 9,17, 11/50mm END	2			as above, but light grey and yellow brown.			>600 >600 >600	
					N > 27 12,20, 7/40mm END	3		SC/CH	CLAYEY SAND/SANDY CLAY: fine to medium grained, high plasticity, light grey and brown.	MC<PL/ M	H/ D	>600 >600 >600	
					N > 24 8,18,6/ 20mm END	4 5		SP	SAND: fine to medium grained, yellow brown, with a trace of clay fines.	M	D		
						6 7		SC	CLAYEY SAND: fine to coarse grained, red brown, with ironstone gravel and clay bands.				

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
1006
2/4

Client: [redacted]
Project: PROPOSED LIVERPOOL HOSPITAL REDEVELOPMENT PROJECT
Location: LIVERPOOL HOSPITAL, NSW

Job No. M20303ZA
Date: 31-5-06
Method: SPIRAL AUGER & WASHBORING EDSON 3000
R.L. Surface:
Datum:
Logged/Checked by: M.T./KSH

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
							▨	CH	SILTY CLAY: high plasticity, light grey and orange brown, with a trace of fine to medium grained sand, ironstone gravel and root fibres.	MC<PL	H		
				■	N = 25 3,9,16		▨					>600 >600 >600	
						8	▨						
				■			▨						
				■	N > 32 9,16, 16/80mm END		▨					>600 >600 >600	
						9	▨						COMMENCE ROTARY WASHBORE DRILLING
						10	░	SP	SAND: fine to medium grained, brown.	W	-		CONTINUOUS WASHBORE DRILLING (ie NO INSITU TESTING) FROM 8.93m DOWN TO 15.75m DEPTH IN ORDER TO PROVE BEDROCK
						11	░						
						12	░						
							░		SAND: fine to coarse grained, grey and brown, with occasional ironstone gravel bands.				
						13	░						
						14	░						

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
1006
3/4

Client:
Project: PROPOSED LIVERPOOL HOSPITAL REDEVELOPMENT PROJECT
Location: LIVERPOOL HOSPITAL, NSW

Job No. M20303ZA
Date: 31-5-06
Method: SPIRAL AUGER & WASHBORING EDSON 3000
Logged/Checked by: M.T./AJH
R.L. Surface:
Datum:

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						15		SP	SAND: fine to coarse grained, grey and brown, with occasional ironstone gravel bands.	W	-		
						16		-	SHALE: dark grey, with occasional clay bands.	XW-DW SW-Fr	EL-VL L-M	-	
						17 18 19 20			REFER TO CORED BOREHOLE LOG				

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

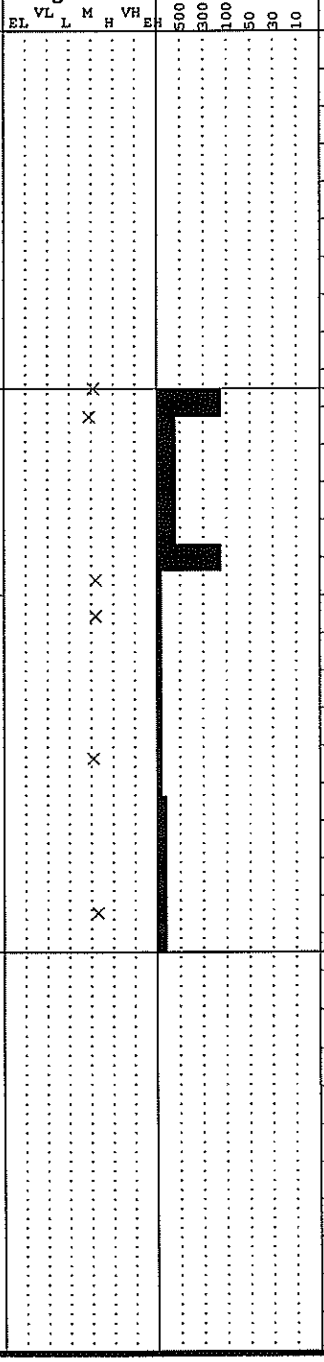
CORED BOREHOLE LOG

Borehole No.
1006
4/4

Client:
Project: PROPOSED LIVERPOOL HOSPITAL REDEVELOPMENT PROJECT
Location: LIVERPOOL HOSPITAL, NSW

Job No. M20303ZA
Date: 1-6-06
Drill Type: EDSON 3000
Core Size: NMLC
Inclination: VERTICAL
Bearing: -
R.L. Surface:
Datum:
Logged/Checked by: M.T./ASH

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT SPACING (mm)	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		15								
		16		START CORING AT 16.90m						
FULL RET-URN		17		SHALE: dark grey, with fine grained, light grey sandstone laminae, bedded at 0-5°, spacing up to 5mm.	Fr	M-H			- Cr, 5mm.t	
									- Cr, 15mm.t - Cr, 4mm.t	
		18				H				
		19							- Cr, 14mm.t	
		20		END OF BOREHOLE AT 19.90m						
		21								



Unit 3, 39 Buffalo Road
Gladesville, NSW 2111
Telephone: 02 9809 7322
Facsimile: 02 9809 7626
Email: dtreweek@jkgroup.net.au

SOIL TEST SERVICES
ABN 43 002 145 173

Ref No: M20303ZA
Table A: Page 1 of 1

TABLE A
SUMMARY OF MOISTURE CONTENT TEST RESULTS

AS 1289 **TEST METHOD** **2.1.1**

BOREHOLE NUMBER	DEPTH	MOISTURE CONTENT
	m	%
1001	1.30-1.75	23.6
1001	2.85-3.30	19.7
1001	4.35-4.80	16.7
1001	5.90-6.35	18.6
1007	2.50-2.90	5.2

Unit 3, 39 Buffalo Road
Gladesville, NSW 2111
Telephone: 02 9809 7322
Facsimile: 02 9809 7626
Email: dtreweek@jkgroup.net.au

STS
SOIL TEST SERVICES
ABN 43 002 145 173

Ref No: M20303ZA
Table B: Page 1 of 2

TABLE B
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
1001	16.71-16.74	0.7	14
	17.12-17.15	1.2	24
	17.81-17.83	1.1	22
	18.15-18.18	1.4	28
	18.91-18.93	0.9	18
	19.23-19.25	1.1	22
1002	16.35-16.37	0.8	16
	16.89-16.91	1.4	28
	17.13-17.15	0.6	12
	17.91-17.94	1.5	30
	18.21-18.23	0.8	16
	18.78-18.82	1.3	26
	19.25-19.28	1.7	34
1003A	17.14-17.16	0.7	14
	17.92-17.94	0.4	8
	18.10-18.13	0.9	18
	18.85-18.87	0.9	18
	19.10-19.13	0.8	16
	19.92-19.95	1.5	30
1004	18.88-18.90	1.1	22
	19.04-19.06	1.3	26
	19.89-19.92	0.9	18
	20.15-20.17	2.3	46
1005	21.70-21.73	2.4	48
	22.22-22.25	1.8	36
	22.90-22.92	1.0	20
	23.46-23.48	0.7	14

Notes: See page 2 of 2

Unit 3, 39 Buffalo Road
Gladesville, NSW 2111
Telephone: 02 9809 7322
Facsimile: 02 9809 7626
Email: dtreweek@jkgroup.net.au

SOIL TEST SERVICES
ABN 43 002 145 173

TABLE B
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
1006	16.90-16.92	1.2	24
	17.05-17.09	0.9	18
	17.92-17.95	1.3	26
	18.11-18.13	1.3	26
	18.87-18.89	1.2	24
	19.69-19.72	1.5	30
1007	3.42-3.44	0.6	12
	5.00-5.02	0.9	18
	5.43-5.45	0.8	16
	5.98-6.00	0.7	14
1008	4.80-4.82	0.2	4
	5.07-5.10	0.5	10
	5.36-5.38	0.9	18
	6.15-6.18	0.4	8
	6.60-6.63	0.3	6
	6.87-6.89	0.1	2

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: RTA T223.
4. 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 $I_{S(50)}$

APPENDIX D

Borehole Log B1, and Laboratory Test Results from ‘Geotechnical Investigation for Proposed Bridges and Multi-Storey Car Park’ Report, Ref. M21170ZArpt dated 9/08/07

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
B1
1/4

Client:

Project: PROPOSED BRIDGES AND MULTI-STOREY CARPARK

Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M21170ZA
Date: 24-5-07

Method: SPIRAL AUGER
JK550

R.L. Surface: ≈ 9.4m
Datum: AHD

Logged/Checked by: T.M./AJ

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
						0			FILL: Silty clay, medium plasticity, dark brown, with a trace of fine to coarse grained sub angular ironstone gravel, slag fragments and root fibres.	MC>PL			GRASS COVER
				■	N = 7 1,3,4			CH	SILTY CLAY: high plasticity, light brown and light grey, with a trace of fine grained rounded ironstone gravel and roots.	MC>PL	VSt	250 260 280	ALLUVIAL
						1							
									SILTY CLAY: high plasticity, red brown and light grey mottled light brown, with fine to coarse grained sub rounded ironstone gravel bands.	MC≈PL	H		
				■	N = 20 5,8,12							>600 >600 >600	
						2							
				■	N = 32 10,16,16	3		SC	CLAYEY SAND: fine grained, light grey, with orange brown bands, with silty clay seams.	M	D	>600 >600 >600	HP TESTING CARRIED OUT ON SILTY CLAY SEAMS
								SM	SILTY SAND: fine to medium grained, orange brown and light grey, with a trace of clay fines, with occasional sand and clayey sand bands.				
						4							
				■	N = 31 13,16,15								
						5							
									as above, but red brown.				
				■	N > 23 18,23/ 150mm END	6							
						7							

COPYRIGHT

BOREHOLE LOG

Borehole No.
B1
2/4

Client:
Project: PROPOSED BRIDGES AND MULTI-STOREY CARPARK
Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M21170ZA
Date: 24-5-07
Method: SPIRAL AUGER JK550
Logged/Checked by: T.M./
R.L. Surface: ≈ 9.4m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
								SC	CLAYEY SAND: fine to medium grained, light grey, orange brown and red brown, with occasional sandy clay bands.	M	L		
				■	N = 9 8,6,3								
						8							
ON COMPLETION OF AUGERING ▼								SW	GRAVELLY SAND: fine to coarse grained, red brown, fine to coarse grained sub angular to sub rounded ironstone gravel, with a trace of fines.		D		
►				■	N > 24 8,24/ 150mm END	9				W			
						10		SM	SILTY SAND: fine to coarse grained, red brown, with a trace of fine to coarse grained sub rounded ironstone gravel, with clayey sand bands.		MD		
				■	N = 16 8,9,7								
						11							
				■	N = 10 7,4,6	12							
						13			as above, but with grey bands.				
				■	N = 24 4,11,13								
						14							

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
B1
3/4

Client:

Project: PROPOSED BRIDGES AND MULTI-STOREY CARPARK

Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M21170ZA

Date: 24-5-07

Method: SPIRAL AUGER
JK550

Logged/Checked by: T.M./

R.L. Surface: ≈ 9.4m

Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
								SM	SILTY SAND: fine to coarse grained, red brown and grey, with a trace of fine to coarse grained sub rounded ironstone gravel, with clayey sand bands.	W	MD-D		
				■	N > 15 8,15/ 150mm REFUSAL	15							
						16							
									REFER TO CORED BOREHOLE LOG				
						17							
						18							
						19							
						20							

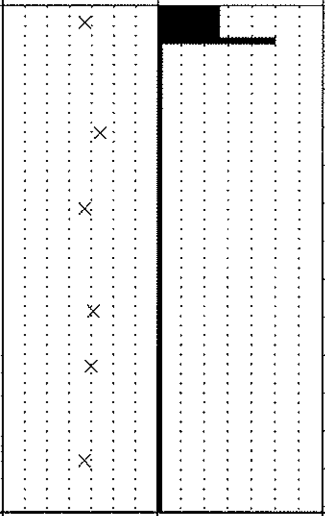
Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
B1
4/4

Client:
Project: PROPOSED BRIDGES AND MULTI-STOREY CARPARK
Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M21170ZA
Core Size: NMLC
R.L. Surface: ≈ 9.4m
Date: 24-5-07
Inclination: VERTICAL
Datum: AHD
Drill Type: JK550
Bearing: -
Logged/Checked by: T.M./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		15 16		START CORING AT 16.16m						
FULL RET-URN		17 18		SHALE: dark grey, with light grey laminae, bedded at 0-5°.	Fr	M-H			- Be, 0°, P, S - Be, 0°, P, S	
		19 20 21		END OF BOREHOLE AT 18.83m						

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

Ref No: M21170ZA
Table A: Page 1 of 1

TABLE A
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
B1	16.25-16.28	0.8	16
	16.83-16.87	1.8	36
	17.23-17.27	0.8	16
	17.77-17.81	1.1	22
	18.06-18.10	1.0	20
	18.56-18.61	0.8	16
B2	16.06-16.09	1.0	20
	16.86-16.90	1.0	20
	17.04-17.07	0.8	16
	17.64-17.68	0.6	12
	18.13-18.17	1.0	20

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: RTA T223.
4. 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 $I_{S(50)}$

APPENDIX E

Borehole Logs R2 to R5 & R13 to R16, Dynamic Cone Penetration Test Results, and Laboratory Test Results from 'Geotechnical Investigation for Proposed New Internal Roads' Report, Ref. M21956ZA2rpt dated 9/09/09

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
R2
1/1

Client:

Project: PROPOSED NEW INTERNAL ROADS

Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA2 **Method:** HAND AUGER **R.L. Surface:** ≈ 10.0m

Date: 24-4-08 **Datum:** AHD

Logged/Checked by: A.C./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION					REFER TO DCP TEST RESULTS	0	■		ASPHALTIC CONCRETE: 80mm.t				
				■			▨		FILL: Silty sand, fine to medium grained, yellow brown, with fine to coarse grained gravel.	M			
									END OF BOREHOLE AT 0.2m				HAND AUGER REFUSAL
						0.5							
						1							
						1.5							
						2							
						2.5							
						3							
						3.5							

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
R3
1/1

BOREHOLE LOG

Client:

Project: PROPOSED NEW INTERNAL ROADS

Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA2

Method: HAND AUGER

R.L. Surface: ≈ 9.8m

Date: 24-4-08

Datum: AHD

Logged/Checked by: A.C./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION					REFER TO DCP TEST RESULTS	0	■		ASPHALTIC CONCRETE: 100mm.t				
							▨		FILL: Silty sand, fine to medium grained, yellow brown.	M			HAND AUGER REFUSAL
									END OF BOREHOLE AT 0.12m				
						0.5							
						1							
						1.5							
						2							
						2.5							
						3							
						3.5							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
R4
1/1

Client:
Project: PROPOSED NEW INTERNAL ROADS
Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA2
Date: 23-4-08
Method: SPIRAL AUGER
JK300
R.L. Surface: ≈ 9.9m
Datum: AHD
Logged/Checked by: A.C./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0	▨		FILL: Silty sandy clay, medium to high plasticity, grey brown.	MC>PL			APPEARS POORLY COMPACTED
				■	N = 6 3,3,3	0.5	▨		FILL: Silty gravelly sand, fine to medium grained, dark grey brown, fine to medium grained gravel.	M			
						1	▨						
	■						▨						
						1.5			END OF BOREHOLE AT 1.5m				
						2							
						2.5							
						3							
						3.5							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
R5
1/1

Client:

Project: PROPOSED NEW INTERNAL ROADS

Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA2

Date: 23-4-08

Method: SPIRAL AUGER
JK300

Logged/Checked by: A.C./

R.L. Surface: ≈ 9.3m

Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0	▨		FILL/TOPSOIL: Silty clay, medium plasticity, dark brown, with root fibres.	MC>PL			GRASS COVER
	■						▨	CH	SILTY CLAY: high plasticity, orange and grey brown.	MC>PL	VSt	-	ALLUVIAL
	■		■	■	N = 6 1,3,3	0.5	▨					300 330 440	
			■			1	▨						
			■				▨		as above, but red and grey brown.				
				■	N = 14 4,7,7	1.5	▨					300 260 310	
						2			END OF BOREHOLE AT 1.95m				
						2.5							
						3							
						3.5							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
R13
1/1

Client: [redacted]
Project: PROPOSED NEW INTERNAL ROADS
Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA2
Date: 23-4-08
Method: SPIRAL AUGER
JK300
Logged/Checked by: A.C./
R.L. Surface: ≈ 9.4m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■ ■					0	▨	CH	SILTY CLAY: high plasticity, grey and orange brown.	MC>PL	St		ALLUVIAL
			■	■	N = 9 1,3,6	0.5	▨					160 160 150	
			■			1	▨		as above, but with a trace of ironstone gravel.				
				■	N = 11 1,4,7	1.5	▨				VSt -H	420 390 400	
						2			END OF BOREHOLE AT 1.95m				
						2.5							
						3							
						3.5							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
R14
1/1

Client:
Project: PROPOSED NEW INTERNAL ROADS
Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA2
Date: 23-4-08
Method: SPIRAL AUGER
JK300
Logged/Checked by: A.C./
R.L. Surface: ≈ 9.4m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	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 to high plasticity, dark grey and orange brown, with ash and brick fragments.	MC>PL			
	■		■				▨	CH	SILTY CLAY: high plasticity, grey and orange brown.	MC>PL	VSt	-	
	■		■	■	N = 7 1,2,5	0.5	▨					260 250 220	ALLUVIAL
			■			1	▨		as above, but red and grey brown.				
					N = 10 3,4,6	1.5	▨						
						2			END OF BOREHOLE AT 1.95m				
						2.5							
						3							
						3.5							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
R15
1/1

Client:

Project: PROPOSED NEW INTERNAL ROADS

Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA2

Date: 23-4-08

Method: SPIRAL AUGER
JK300

Logged/Checked by: A.C./

R.L. Surface: ≈ 9.4m

Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0	▩		FILL: Silty clayey sand, fine to medium grained, grey brown.	M			
	■		■	■	N = 13 6,6,7	0.5	▨	CL	SILTY CLAY: medium plasticity, grey, red brown and orange brown.	MC≈PL	H	- >600 >600 >600	ALLUVIAL
			■			1	▨						
				■	N = 39 9,16,23	1.5	▨		as above, but grey and orange brown.			>600 >600 >600	
						2			END OF BOREHOLE AT 1.95m				
						2.5							
						3							
						3.5							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
R16
1/1

Client:
Project: PROPOSED NEW INTERNAL ROADS
Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA2
Date: 23-4-08
Method: SPIRAL AUGER
JK300
Logged/Checked by: A.C./
R.L. Surface: ≈ 9.4m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■		■			0	▨	CH	SILTY CLAY: high plasticity, grey and orange brown.	MC>PL	VSt		ALLUVIAL
			■	■	N = 9 1,4,5	0.5	▨					260 220 230	
			■			1	▨						
				■	M = 24 4,9,15	1.5	▨		as above, but with a trace of ironstone gravel.		H	490 490 >600	
						2			END OF BOREHOLE AT 1.95m				
						2.5							
						3							
						3.5							

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

DYNAMIC CONE PENETRATION TEST RESULTS

Client:

Project: PROPOSED NEW INTERNAL ROADS

Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA2

Date: 24-4-08

Tested By: A.C.

Hammer Weight & Drop: 9kg/510mm

Rod Diameter: 16mm

Point Diameter: 20mm

	Number of Blows per 100mm Penetration						
Test Location							
Depth (mm)	**R1**	**R2**	**R3**				
0 - 100	EXCAVATED	EXCAVATED	EXCAVATED				
100 - 200	7/10mm	10	16/20mm				
200 - 300	REFUSAL	6/80mm	REFUSAL				
300 - 400		REFUSAL					
400 - 500							
500 - 600							
600 - 700							
700 - 800							
800 - 900							
900 - 1000							
1000 - 1100							
1100 - 1200							
1200 - 1300							
1300 - 1400							
1400 - 1500							
1500 - 1600							
1600 - 1700							
1700 - 1800							
1800 - 1900							
1900 - 2000							
2000 - 2100							
2100 - 2200							
2200 - 2300							
2300 - 2400							
2400 - 2500							
2500 - 2600							
2600 - 2700							
2700 - 2800							
2800 - 2900							
2900 - 3000							

Remarks:
1. The procedure used for this test is similar to that described in AS1289.6.3.2-1997, Method 6.3.2.
2. Usually 8 blows per 20mm is taken as refusal

Ref: Scala3.xls April 99

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

Ref No: M21956ZA2
Table A: Page 1 of 2

TABLE A
SUMMARY OF FOUR DAY SOAKED C.B.R.TEST RESULTS

BOREHOLE NUMBER	R5	R7	R10	R12	R15
DEPTH (m)	0.40 - 1.40	0.50 - 1.50	0.80 - 1.50	0.50 - 1.00	0.40 - 1.40
Surcharge (kg)	9.0	9.0	9.0	9.0	9.0
Maximum Dry Density (t/m^3)	1.740 STD	1.653 STD	1.555 STD	1.783 STD	1.695 STD
Optimum Moisture Content (%)	18.1	19.5	20.8	16.7	19.5
Moulded Dry Density (t/m^3)	1.69	1.52	1.40	1.74	1.67
Sample Density Ratio (%)	97	92	90	98	98
Sample Moisture Ratio (%)	124	154	160	109	100
Moisture Contents					
Insitu (%)	22.5	30.0	33.3	18.3	17.3
Moulded (%)	22.5	30.0	33.3	18.3	19.5
After soaking and After Test, Top 30mm(%)	27.6	33.3	34.5	20.1	30.5
Remaining Depth (%)	24.9	30.7	34.0	19.5	23.1
Material Retained on 19mm Sieve (%)	0	0	0	0	0
Swell (%)	0.0	0.0	0.0	0.4	3.2
C.B.R. value: @2.5mm penetration					
@5.0mm penetration	3.0	1.5	2.0	3.5	2.0

NOTES:

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods :
  - (a) Soaked C.B.R. : AS 1289 6.1.1
  - (b) Standard Compaction : AS 1289 5.1.1
  - (c) Moisture Content : AS 1289 2.1.1

Approved Signatory
(A.Tatikonda)

Date: 3/9/08

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

Ref No: M21956ZA2
Table A: Page 2 of 2

TABLE A
SUMMARY OF FOUR DAY SOAKED C.B.R.TEST RESULTS

BOREHOLE NUMBER	R16	R17	R18	R19
DEPTH (m)	0.40 - 1.40	0.50 - 1.50	0.00 - 1.00	0.40 - 1.00
Surcharge (kg)	9.0	9.0	9.0	9.0
Maximum Dry Density (t/m^3)	1.619 STD	1.567 STD	1.619 STD	1.561 STD
Optimum Moisture Content (%)	22.8	25.0	22.0	25.0
Moulded Dry Density (t/m^3)	1.59	1.54	1.53	1.46
Sample Density Ratio (%)	98	98	94	93
Sample Moisture Ratio (%)	100	102	120	120
Moisture Contents				
Insitu (%)	22.8	25.4	26.4	30.0
Moulded (%)	22.8	25.4	26.4	30.0
After soaking and				
After Test, Top 30mm(%)	28.6	28.8	28.7	32.8
Remaining Depth (%)	28.3	28.3	27.3	31.8
Material Retained on 19mm Sieve (%)	0	0	0	0
Swell (%)	1.5	1.6	0.0	0.0
C.B.R. value: @2.5mm penetration				
@5.0mm penetration	2.5	2.5	2.5	2.0

NOTES:

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods :
  - (a) Soaked C.B.R. : AS 1289 6.1.1
  - (b) Standard Compaction : AS 1289 5.1.1
  - (c) Moisture Content : AS 1289 2.1.1

Approved Signatory
(A.Tatikonda)

Date: 3/9/08