REPORT TO

HEALTH INFRASTRUCTURE

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED NEW INTEGRATED SERVICES BUILDING

AT

MAIN CAMPUS,
LIVERPOOL HEALTH + ACADEMIC PRECINCT,
ELIZABETH STREET, LIVERPOOL, NSW

Date: 17 February 2020
Ref: 32837Arpt

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1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed new integrated services building (ISB) located within the main campus of 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 Shamma Hasan of Johnstaff Projects Pty Ltd, on behalf of Health Infrastructure (HI), in an email dated 15 November 2019. The commission was on the basis of our fee proposal, Ref. 'P50653A' dated 5 November 2019.

We have been provided with the following information:

- Draft 'Main Works SSDA Design Statement' report prepared by Fitzpatrick + Partners (Revision 01, dated 24 January 2020);
- 'Main Works SSDA' drawings prepared by Fitzpatrick + Partners (Project No. 21807, Drawing Nos. A-SSDA-MW-01^{Rev5} to A-SSDA-MW-43^{Rev5}, dated 23 January 2020);
- Survey plan 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 Cancer Building, Pathology Building, Alex Grimson Building, enclosed pedestrian linkways, and the Thomas and Rachael Moore Education Centre.
- Retention of the Oncology Bunkers.
- Construction of a new three to six storey ISB, with plant and equipment at roof level (Level 6). A partial basement level is proposed below the central portion of the new building. The basement floor level will be constructed at RL7.9m, and will require excavation to depths between 1.5m and 3.5m below existing grade. The ground floor level will be constructed at RL12.2m, and will require cut and fill earthworks around the basement level to a maximum depth/height of about 1.5m. Two separate lift cores are proposed. We have assumed that the lift pits will be 1.5m deep below basement level. The proposed ground floor level will partially extend over the existing Old Clinical Services Building (single) basement level. Structural loads typical of this type of development have been assumed.
- Construction of a new pedestrian bridge over Campbell Street connecting the new ISB to the Health Services Building to the north.

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 three accessible (pre-demolition) borehole locations. Based on the information obtained, we present our comments and recommendations on site preparation, excavation, drainage, retention systems, piled footings, soil aggression, earthquake design parameters, and the basement floor slab, and additional investigations.

This report supersedes our previous 'due diligence' geotechnical assessment report, Ref. '30993ZArpt' dated 16 November 2017.

Our environmental consulting division, JK Environments (JKE), have completed a 'Stage 1 & Preliminary Stage 2 Environmental Site Assessment' for the proposed development. Reference should be made to JKE report Ref. 'E32837BDrpt' dated 13 February 2020.

2 BACKGROUND INFORMATION

As discussed in Section 1, we have completed numerous geotechnical investigations at LHAP, including for the original hospital buildings (main campus) in 1991, and for the major redevelopments (eastern and main campuses) between 2003 and 2010. The information relevant to the proposed ISB is summarised below:

Year	Report Title	Report Ref.	Date	Relevant Information	Appendix
1991	Geotechnical Investigations for Proposed Redevelopment	8471W/vm	4/11/91	Borehole Logs 3, and 6 to 16	A
2003	Stage 1 Geotechnical Investigation for Proposed New Mental Health Facility	M17359WArpt	21/01/03	Borehole Log 101	B
2006	Geotechnical Investigation for Proposed Liverpool Hospital Redevelopment Project	M20303ZArpt	13/07/06	Borehole Logs 1008	C
2007	Geotechnical Investigation for Proposed Extension to Cancer Therapy Building	M20852ZArpt	17/5/07	Borehole Logs CT1 & CT3 Laboratory Test Results	D
2010	Geotechnical Investigation for Proposed Research Bunkers and Clinical Skills Training Centre	24403SBrpt	29/11/2010	Borehole Logs 2009 to 2011	E
2009	Geotechnical Investigation for Proposed New Building at 1 Campbell Street, Liverpool	M23302ZArpt	23/11/09	Borehole Log RB1	F

The locations of the previous boreholes have been plotted onto the attached Figure 2. The relevant borehole logs and laboratory test results are presented in Appendices A to F for ease of reference.

Furthermore in 2009, we completed a geotechnical investigation for the proposed new internal roads at LHAP. This investigation included nineteen boreholes over the main and eastern campuses, as well as nine soaked CBR tests. Based on the results of our 2009 investigation, we recommended that the design of new pavements be based on a CBR value of 2% for compacted clay subgrade.

3 CURRENT INVESTIGATION PROCEDURE

The fieldwork for the investigation was carried out on 26, 27 and 28 November 2019 and comprised the drilling and testing of three boreholes (MW1 to MW3), at the locations shown on Figure 2, to depths of 11.57m, 18.89m and 14.59m below existing surface levels, respectively. The boreholes were completed using our track mounted JK305 drill rig which is equipped for site investigation purposes.

Prior to the commencement of the fieldwork, a specialist sub-consultant reviewed available 'Dial Before You Dig' information and the buried service information shown on the supplied survey plans, and electro-magnetically scanned the borehole locations for buried services.

The borehole locations were set out by tape measurements from existing surface features. The surface RL's indicated on the attached 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 aerial image forms the basis of Figure 2.

The soil and upper weathered bedrock profiles were spiral auger drilled. The relative compaction/strength of the soil profile was assessed from the Standard Penetration Test (SPT) 'N' values, together with hand penetrometer readings on clay soils recovered in the SPT split-spoon sampler and off the auger (ie. on remoulded samples), and by tactile examination. 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 cuttings and correlations with subsequent laboratory moisture content test results.

In MW1, MW2 and MW3, at depths of 5.85m, 12.89m and 8.80m, respectively, 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. For the JKE investigation, 50mm diameter Class 18 PVC groundwater monitoring wells were installed into MW1, MW2 and MW3 to depths of 11.57m, 12.1m and 6.34m, respectively. A cast-iron 'Gatic' cover was concreted flush with the ground surface to protect the top of each groundwater monitoring well. The installation details are presented on the attached borehole log. Long-term groundwater level monitoring in each well was outside the scope of the geotechnical investigation.

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

Our geotechnical engineer (Joanne Lagan) was present full-time during the fieldwork to set out the borehole locations, direct the electro-magnetic scanning, nominate testing and sampling, and to prepare the attached borehole logs. The Report Explanation Notes define the logging terms and symbols used.

Selected soil and rock cutting 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 another 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 232600'.

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 CURRENT INVESTIGATION

4.1 Site Description

The site is located in relatively flat topography, at the western end of the LHAP main campus, with a gentle slope down to the south-east. Campbell Street, Goulburn Street and Elizabeth Street bound the site to the north, west and south, respectively. Campbell and Elizabeth Streets are relatively level. Goulburn Street generally grades gently down to the south at less than 1°.

Previous development within this portion of the western campus required cut and fill earthworks to a maximum depth/height of about 3m. At the time of the fieldwork, the site was occupied by the following structures and pavements:

- Two storey Cancer Building, including the Oncology Bunkers, which were contained within a partial basement level.

- Three storey Pathology Building.

- Three storey Alex Grimson Building, which was underlain by a basement level. A fourth level plant room was located above the central portion of this building.

- A two level suspended linkway (oriented north-south) extending between the Alex Grimson Building and the Pathology Building.

- A single level, partially suspended linkway (oriented east-west) extending between the Alex Grimson Building and the Mental Health Centre.

- On-grade pavements at the northern end of the site, along the northern and eastern sides. The pavements, all surfaced with asphaltic concrete (AC), included a cul-de-sac along the eastern side of the site, an on-grade car park adjacent to the eastern end of the Alex Grimson Building, a loading dock on the eastern side of the Pathology Building, and a car park and driveway on the northern side of the Pathology Building. The AC was generally in fair to poor condition with subsidence, cracking and evidence of patchwork repairs.

- Loading dock (Entrance ‘S’ Goulburn Street) comprising a concrete driveway and hardstand. This loading dock was located on the southern side of the Alex Grimson Building. The driveway descended from Goulburn Street and the hardstand was roughly at the same level as the Alex Grimson Building basement level. The concrete pavements were generally in good to fair condition with some spalling at joints.

- Two storey Thomas and Rachael Moore Education Centre, which was underlain by a basement level.

- Surrounding the above mentioned structures were concrete and brick paved footpaths, small lawn areas, garden beds, and scattered small to large size trees.

- Surrounding the existing buildings were some permanent batter slopes which graded between 12° (1V on 4.7H) and 28° (1V on 1.9H). Supporting the landscaping between the Alex Grimson Building and the Cancer Building/Pathology Building, were brick retaining walls and one segmental block retaining wall, which were up to 1.5m high and appeared to be in good condition.

- Based on our knowledge of the hospital grounds, an east-west services tunnel extends from the eastern side of the site (in the vicinity of the eastern end of the Alex Grimson building) to the Central Energy building in the eastern campus. The details of the services tunnel (ie. width, invert level, etc.) and the location of the western end of the tunnel are unknown.

- Surface indicators of numerous buried services, particularly sewer, stormwater and communications, were observed across the site.

Abutting the site on its eastern side (from north to south) were other hospital buildings and structures, including a multi-storey car park, the Don Everett Building, the Mental Health Centre, the Caroline Chisholm Building, and the Old Clinical Services Building, which is underlain by a basement car parking level. This basement level is accessed via a ramp off Goulburn Street.

The existing hospital buildings located within the site and along its eastern side appeared to be in good external condition based on cursory inspection.

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 Bringelly Shale of the Wianamatta Group.

Generally, the current boreholes encountered AC pavements and/or fill, overlying alluvial and/or residual soils, then siltstone bedrock at variable depths. Reference should be made to the attached borehole logs for specific details at each location. A graphical borehole summary is presented as Figure 4. A summary of the subsurface conditions encountered in the current boreholes is provided below:

Pavements

A 50mm thick AC surfacing was encountered in MW1 and MW2. Only the AC surfacing in MW1 was underlain by an unbound granular roadbase layer, which was 150mm thick.

Fill

Fill, predominantly comprising clayey soils and to a lesser extent, sandy soils (MW1 only), was encountered below the pavements in MW1 and MW2, and from the surface in MW3 to depths of either 1.1m or 2.1m. The fill in MW3 was grass covered. Inclusions of igneous and sandstone gravel, and brick and concrete fragments were found in the fill. Based on the SPT results, and limited hand penetrometer readings, the fill was generally assessed to be moderately to well compacted.

Alluvial Soils

Alluvial soils were encountered below the fill in MW2 and MW3 to depths of 12.1m and 3.3m, respectively. The alluvial soils predominantly comprised silty clays of medium to high plasticity and of stiff to hard strength. In MW2, a medium dense alluvial sand and silty sand layer was encountered between depths of 3.6m (RL7.0m) and 6.2m (RL4.4m).

Residual Soils

Residual silty clays of high plasticity and of very stiff to hard strength were encountered below the fill in MW1 and below the alluvial soils in MW3 at 3.3m depth. No residual soils were encountered in MW2.

Siltstone Bedrock

Siltstone bedrock (formerly referred to as shale) was encountered in our previous relevant boreholes, and in our current MW1 to MW3, at the depths and RL's tabulated below:

Borehole	Approximate Surface RL (mAHD)	Depth to Weathered Bedrock Surface below Surface Level (m)	Approximately Weathered Bedrock Surface RL (mAHD)
MW1	11.7	4.0	7.7
MW2	10.6	12.1	-1.5
MW3	11.9	6.5	5.4
BH3	11.5	2.6	8.9
BH6	10.8	8.8	2.0
BH7	11.0	6.1	4.9
BH8	10.4	9.0	1.4
BH9	10.5	11.0	-0.5

Borehole	Approximate Surface RL (mAHD)	Depth to Weathered Bedrock Surface below Surface Level (m)	Approximately Weathered Bedrock Surface RL (mAHD)
BH10	10.8	11.1	-0.3
BH11	10.5	13.0	-2.5
BH12	10.1	11.4	-1.3
BH13	10.3	9.4	0.9
BH14	11.3	3.9	7.4
BH15	12.0	1.8	10.2
BH16	11.1	1.6	9.5
BH101	10.1	12.7	-2.6
BH1008	11.7*	4.0	7.7
CT1	10.8	12.0	-1.2
CT3	11.0	4.0	7.0
BH2009	11.8	3.5	8.3
BH2010	11.5	5.5	6.0
BH2011	12.1	2.4	9.7
RB1	12.7	3.3	9.4

* Surface RL was 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 3. This contour plan is based on the above and other borehole information and should be used as a guide only for assessing weathered bedrock surface levels.

In the current boreholes, the siltstone bedrock on first contact was generally highly to moderately weathered and of low and medium strength. In MW1, MW2 and MW3 below depths of 7.5m, 12.9m and 8.8m, respectively, the siltstone was fresh and of medium to high strength.

From the cored lengths of the current boreholes, the upper siltstone profile in MW1 contained numerous rock defects (ie. clay seams, crushed seams, extremely weathered seams and joints). Below 7.5m depth in MW1 and the entire cored lengths of MW2 and MW3, the bedrock contained very few defects. In MW1 and MW3, 150mm and 440mm thick ‘no core’ (core loss) zones were encountered at depths of 6.37m and 11.48m, respectively; presumably ‘weaker’ bands 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
MW1	11.7	4.0-7.5 [7.7]	-	-	7.5-11.6 [4.2]
MW2	10.6	-	12.1-12.9 [-1.5]	-	12.9-18.9 [-2.3]
MW3	11.9	-	6.5-11.9 [5.4]	-	11.9-14.6 [RL0]
BH3[2]	11.5	3.3-4.1 [8.2]	4.1-5.4 [7.4]	5.4-6.5 [6.1]	-
BH6[2]	10.8	8.8-9.3 [2.0]	9.3-10.2 [1.5]	-	10.2-12.0 [0.6]
BH7[2]	11.0	-	7.0-9.4 [4.0]	-	9.4-11.0 [1.6]
BH8[2]	10.4	9.0-9.9 [1.4]	-	9.9-12.0 [0.5]	-
BH9[2]	10.5	-	11.0-11.7 [-0.5]	11.7-14.0 [-1.2]	-
BH10[2]	10.8	-	11.1-11.8 [-0.3]	-	11.8-13.8 [-1.0]
BH11[2]	10.5	13.0-13.7 [-2.5]	-	-	13.7-16.6 [-3.2]
BH12[2]	10.1	-	11.4-12.2 [-1.3]	-	12.2-14.6 [-2.1]
BH13[2]	10.3	-	9.4-10.5 [0.9]	-	10.5-12.3 [-0.2]
BH14[2]	11.3	3.9-4.6 [7.4]	4.6-6.6 [6.7]	-	6.6-8.2 [4.7]
BH15[2]	12.0	1.8-3.5 [10.2]	3.5-4.8 [8.5]	4.8-5.7 [7.2]	5.7-6.5 [6.3]
BH16[2]	11.1	1.6-4.8 [9.5]	4.8-6.2 [6.3]	-	6.2-6.9 [4.9]
BH101	10.1	-	12.7-14.9 [-2.6]	14.9-15.8 [-4.8]	15.8-17.3 [-5.7]
BH1008	11.7[1]	4.0-7.0 [7.7]	-	-	-
CT1	10.8	12.0-13.0 [-1.2]	-	13.0-13.8 [-2.2]	13.8-16.1 [-3.0]
CT3	11.0	4.4-5.1 [6.6]	5.1-8.0 [5.9]	-	8.0-10.0 [3.0]
BH2009	11.8	3.5-7.5 [8.3]	-	-	7.5-10.7 [4.3]
BH2010[3]	11.5	6.4-7.0 [5.1]	7.0-8.6 (4.5)	8.6-9.0 [2.9]	-
BH2011[3]	12.1	2.4-3.6 [9.7]	3.6-4.6 [8.5]	4.6-7.5 [7.5]	-
RB1	12.7	3.3-6.7 [9.4]	-	-	6.7-7.2 [6.0]

NOTES:

1. Surface RL was approximated based on our knowledge of the hospital grounds and the current survey information.
2. We have updated our previous engineering classification completed in 1991, however, these should be considered as tentative based on the limited rock proving completed.
3. Engineering classification of bedrock estimated from augered boreholes only.

Groundwater

The current boreholes were 'dry' during and on completion of augering. Due to the introduced drill flush water associated with rock coring, no meaningful groundwater level measurements were obtained. During a return site visit by JKE on 11 December 2019, groundwater was measured in the MW1, MW2 and MW3 monitoring wells at depths of 5.3m (RL6.4m), 7.3m (RL3.3m) and 4.0m (RL7.9m), respectively. No long-term groundwater level monitoring was carried out.

4.3 Laboratory Test Results

The moisture content and Atterberg Limits test results confirmed our field classification of the site soils. The Atterberg Limits and linear shrinkage test results indicated the sampled residual clay of high plasticity from MW1, and the sampled alluvial clay of high plasticity from MW2, to have a high potential for shrink-swell reactivity with changes in moisture content. These test results indicated the sampled clayey fill of low plasticity from MW3 to have a slight potential for shrink-swell reactivity.

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)
MW1	3.0-3.45	Residual Clay	5.6	130	76	58
MW2	0.5-0.95	Clayey Fill	8.3	450	250	25
	1.5-1.95	Alluvial Clay	5.3	490	480	16
	3.8-4.2	Alluvial Sand	5.3	190	36	54
	5.4-5.8	Alluvial Sand	8.3	77	43	82
	9.8-10.2	Alluvial Clay	8.6	450	100	20
MW3	4.5-4.95	Residual Clay	8.2	690	150	16

The results of the moisture content tests carried out on recovered rock cuttings correlated well with our field assessment of bedrock strength. The results of the Point Load Strength Index tests carried out on the recovered rock cores from MW1 to MW3 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 12MPa to 44MPa, however, a value as high as 56MPa was indicated in MW3 at 13.3m depth.

5 COMMENTS AND RECOMMENDATIONS

5.1 Geotechnical Issue

Based on the results of our current and previous investigations, the primary geotechnical issues for the proposed ISB include:

- Variability in bedrock surface levels across the site between approximately RL11.0m and RL-2.0m, as shown on Figure 3.
- Potential for shrink-swell movements with changes in moisture content.
- Potential for differential shrink-swell movements following removal of existing trees.
- Low design CBR value for the clay subgrade.

The effects of the above geotechnical issues on design and construction are detailed in the sections which follow.

5.2 Site Preparation

5.2.1 Dilapidation Surveys

Prior to commencement of any site works, including demolition of the existing structures and pavements, consideration should be given to completing detailed internal and external dilapidation reports on the Oncology Bunkers, and on the adjacent portions of the retained hospital buildings to the east.

Dilapidation reports provide a record of existing conditions prior to commencement of any site works. The dilapidation reports would therefore be used as a benchmark against which to set vibration limits during excavation and earthworks, and for assessing possible future claims for damage arising from the works. We forewarn that Council may require dilapidation surveys on the abutting roadways and footpaths.

As dilapidation reports are relied upon for the assessment of potential damage claims, they must be carried out thoroughly by reputable companies with all defects rigorously described (ie. defect type, defect location, crack width, crack length etc.) and photographed.

The dilapidation reports should be reviewed by JKG and the structural engineer [Taylor Thomson Whitting (NSW) Pty Ltd (TTW)] prior to commencement of the works.

5.2.2 Vibration Monitoring

We recommend that full-time, continuous quantitative vibration monitoring be carried out on the Oncology Bunkers, and on the adjacent portions of the retained hospital buildings to the east, including:

- Don Everett Building;
- Mental Health Centre;
- Caroline Chisholm Building;
- Old Clinical Services Building.

The vibration monitoring should extend from the commencement of demolition up until the end of excavation and filling, as a precaution against possible vibration induced damage.

The vibration monitoring should include geophones affixed onto the adjacent buildings and a warning system (eg. flashing lights, audible alarm, etc.) which is set to trigger when the permissible vibration limit has been recorded. The locations of the geophones should be assessed following review of the dilapidation survey reports, and should be jointly nominated by JKG and the acoustic consultant.

The vibrations on the Oncology Bunkers should be tentatively limited to a peak particle velocity of 5mm/s, subject to review of the dilapidation survey report. The vibrations on the adjacent portions of the retained hospital buildings should be tentatively limited to a peak particle velocity of 8mm/s, subject to review of the dilapidation survey reports. HI should however, confirm the acceptability of the vibration limits taking equipment sensitivity and patient comfort into account.

If higher vibrations are recorded, then they should be measured against the attached Vibration Emission Design Goals as higher vibrations may be acceptable depending on the associated vibration frequency.

5.2.3 Demolition and Stripping

The proposed development will require demolition of the existing Cancer Building, Pathology Building, Alex Grimson Building, Thomas and Rachael Moore Education Centre, two linkways, vehicular pavements, and 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. Reference should be made to the JKE report for guidance on the offsite disposal of excavated soil and rock.

Care should be taken during site stripping and bulk excavation works not to undermine or remove support from the Campbell Street, Goulburn Street and Elizabeth Street boundaries, and the retained hospital buildings adjacent to the proposed ISB.

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 ISB.

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. For all trees located at or below proposed cut levels, we recommend that all soils located within their primary root structures be boxed out and replaced with engineered fill, as discussed in Section 5.3.5 below.

5.3 Earthworks

All earthworks recommendations provided below for the proposed ISB should be complemented by reference to AS3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'.

5.3.1 Subgrade Drainage

The clay subgrade at the site is expected to undergo substantial loss in strength when wet, as evident by the design CBR value of 2%. Furthermore, the clay subgrade is expected to have some shrink-swell reactive potential. Therefore, it is important to provide good and effective site drainage both during construction and for long-term site maintenance. The principle aim of the drainage is to promote run-off and reduce ponding. A poorly drained clay subgrade may become untrafficable when wet. The earthworks should be carefully planned and scheduled to maintain good cross-falls during construction.

5.3.2 Excavation Conditions

Prior to any excavation commencing, we recommend that reference be made to the Safe Work Australia 'Excavation Work Code of Practice' dated July 2015.

The proposed basement and ground floor levels will require excavation to maximum depths of 3.5m and 1.5m below existing grade, respectively. Based on the results of our previous and current investigation, the proposed excavations appear to extend only through the soil profile. Excavation of the soil profile can be carried out using hydraulic excavators and/or by using a dozer.

If bedrock is encountered along the western side of the proposed basement level excavation and/or at the north-western corner of the proposed ground floor level excavation, then an attempt should be made to remove the bedrock using a 'digging bucket' and/or ripping tyne fitted to a large hydraulic excavator (say, at least 30 tonnes). Notwithstanding, JKG should be contacted for an inspection, so that advice can be provided on appropriate excavation methods and potential vibration risks.

All cuts should be temporarily battered back at no steeper than 1V on 1H for stability considerations and to facilitate compaction of engineered fill up against the cut faces. Surcharge loads (including plant and stockpiles) must be set well back from the crests of the temporary batter slopes. All temporary batter slopes should be inspected by a geotechnical engineer to confirm that no untoward conditions exist. If temporary batter slopes cannot be accommodated or are not preferred, then further advice in relation to cast-insitu retention systems (eg. soldier pile walls with concrete infill panels, etc.) should be obtained from JKG.

5.3.3 Excavation Drainage

Groundwater inflows into the basement and ground floor level excavations are expected to occur as local seepage flows at the base of the fill, through gravel bands or relic joints/fissures within the alluvial and residual clays, and at the soil/rock interface (if encountered), particularly after heavy rain. Seepage volumes into the excavations are expected to be localised, of limited volume and controllable by conventional sump and pump discharge systems. Discharge from the drainage system should be piped to the stormwater system. The excavation will need to be monitored as it progresses by the contractor and JKG to confirm the drainage requirements.

5.3.4 Subgrade Preparation

Following stripping and bulk excavation, the soil subgrade should be proof rolled with at least six passes of a static (non-vibratory) smooth drum roller of at least 10 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 exists. 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 soil subgrade should be over-excavated to below the depth of moisture softening and replaced with engineered fill. If clayey 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 used to raise site levels.

5.3.5 Engineered Fill

General

From a geotechnical perspective, the excavated clayey soils are considered suitable for reuse as engineered fill on condition that they are free of asbestos and organic matter, and contain a maximum particle size not exceeding 75mm. Notwithstanding, reuse of excavated site soils must be completed in accordance with any Remediation Action Plan prepared for the proposed development.

For the engineered fill specification provided below, we have assumed that the proposed ground floor slab will be fully suspended on the footings, and that the proposed basement floor slab will be constructed on-grade; that is, as a 'floating' slab.

Below the proposed basement level, engineered fill comprising site won clayey soils should be compacted in maximum 250mm thick loose layers using a large static (non-vibratory) pad-foot roller (say, at least 12 tonnes deadweight) to a density ratio strictly between 98% and 102% of Standard Maximum Dry Density (SMDD) and at a moisture content within 2% of Standard Optimum Moisture Content (SOMC). Below the proposed ground floor level and external landscaping areas, the compaction specification can be relaxed to a density ratio between 95% and 102% of SMDD and at a moisture content within 2% of SOMC. All compaction must be carried out using the static mode of the roller due to the potential for vibration induced damage and nuisance to the surrounding hospital buildings. Moisture conditioning of the site won clayey soils should be expected in order to comply with the above moisture content specification.

Edge Compaction

The 'tying in' of engineered fill to temporary cut batter slopes can be achieved by locally benching the cut slopes in no greater than 0.3m to 0.4m high steps. This can be carried out progressively as the height of engineered fill increases.

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, Basement Wall and Lift Pit Backfill

As for services trenches, retaining wall, basement wall and lift pit backfilling must also be carried out using engineered fill in order to reduce post-construction settlements. Compaction of the engineered backfill should be carried out using a hand operated vertical rammer compactor for the lower layers and immediately behind the wall in the upper layers. Elsewhere a small static roller can be used. 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.

Compaction of engineered fill behind retaining walls, basement walls and lift pits is very difficult. 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 is often preferred if good performance is a priority; 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. A non-woven geotextile filter fabric such as Bidim A34 should be placed as a separation layer immediately above the cut batter slope (prior to backfilling) to control subsoil erosion. Provided the aggregate backfill is placed 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.

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 1000m^2, or one test per 200m^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, basement wall and lift pit backfill (for material other than single sized aggregate) 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.

Level 2 testing of fill compaction is the minimum permissible in AS3798-2007. Due to a potential conflict of interest, the geotechnical testing authority (GTA) should be directly engaged by HI or their representative, and not by the contractor.

5.3.6 Warning

In order to achieve satisfactory completion of the earthworks, 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.

5.4 Retaining Walls, Basement 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 ISB, should be designed using a triangular lateral earth pressure distribution, with 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 and basement walls supporting areas where movements are undesirable (eg. if movement sensitive buried services are present behind the walls, etc.) and/or are incorporated into the proposed ISB, should be designed using a triangular lateral earth pressure distribution, with an 'at-rest' earth pressure coefficient (K_0) of 0.5 for the soil profile, 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/slab 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 basement 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 pits, we expect that no external drainage will be provided. As such, the lift pit walls should be designed to withstand (external) lateral and uplift hydrostatic pressures to a design head of water at RL7.9m (ie. basement floor slab level).

Free-standing cantilevered retaining walls independent of the proposed ISB and founded in alluvial clay or residual clay of at least stiff strength may be designed for an allowable bearing pressure of 100kPa. Movement joints should be provided at about 3m centres to accommodate likely shrink-swell movements.

The passive lateral toe resistance for free-standing cantilevered retaining walls independent of the proposed ISB and founded in alluvial clay or residual clay 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.

If the retaining wall footings are founded in existing fill and/or new engineered fill (to Level 2 control), then further geotechnical advice should be sought. For this scenario, an alternative footing design based on an allowable bearing pressure of 50kPa and a K_p value of 2.5 (assuming horizontal ground in front of the wall) should be provided.

The retaining wall footing excavations should be cleaned out, inspected and Dynamic Cone Penetrometer (DCP) tested (as appropriate) 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.

5.5 Piled Footings

5.5.1 Geotechnical Design

For uniformity of support, we recommend that the proposed ISB, and proposed pedestrian bridge over Campbell Street, be uniformly supported on piled footings socketed into the underlying siltstone bedrock. The primary geotechnical issues for the design and construction of the piles are the variability in bedrock surface levels across the site between approximately RL11.0m and RL-2.0m (as shown on Figure 3), and the presence of alluvial sands across the eastern side of the site (as encountered in MW2 & BH101).

In order to obtain better site coverage for piling and to confirm the depth to Class II/I siltstone where not proven by our previous boreholes, we recommend that six additional cored boreholes be completed immediately following demolition, at the locations shown on the attached Figure 5. More cored boreholes may be required if long rock sockets are nominated in the structural design. 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 across the eastern side of the site (in the vicinity of MW2), we recommend that the proposed ISB be supported in this area 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. Elsewhere, particularly where near-surface residual soils were encountered, conventional bored piles can be adopted.

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 no higher than 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.

Due to the presence of medium and high strength siltstone, the prospective piling contractors should be provided with a full copy of this report to ensure that appropriate drill rigs and equipment are brought to site. We also note that a 0.6m thick capping layer of very high strength bedrock was encountered at 3.3m depth in our previous borehole (RB1) located in the vicinity of the northern side of the proposed pedestrian bridge. Penetration of the very high strength shale band will be difficult using conventional bored piling rigs.

Due to the shrink-swell nature of the clay soils, we recommend that any ground beams between pile heads and the suspended ground floor slab be poured over void formers. The void formers must be able to accommodate heave movements of 50mm in order to protect the structural elements. A minimum 75mm thick cardboard void former should be used.

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.

All bored piles should be cleaned out, inspected and tremie poured on the same day as drilling. The roughness of the rock socket must be inspected by a geotechnical engineer 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.

Where the proposed ISB is to be connected into retained hospital buildings, we recommend that construction joints be provided to permit independent movement.

5.5.2 Earthquake Design Parameters

The following parameters should be adopted for earthquake design in accordance with AS1170.4-2007 ‘Structural Design Actions, Part 4: Earthquake Actions in Australia’ (including Amendment Nos. 1 & 2):

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

5.5.3 Soil Aggression

The soil pH test results have indicated moderately 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’.

5.6 Basement Floor Slab

The proposed basement floor slab should be constructed independent of the building footings and walls (ie. designed as a ‘floating’ slab) to permit relative movement. Based on the previous laboratory test results, and on condition that the subgrade preparation works detailed in Section 5.3.4 have been completed, we recommend that the basement floor slab be designed for a CBR value of 2% or a short-term Young’s modulus of 16MPa for the compacted clay subgrade.

Slab joints should be designed to resist shear forces but not bending moments by providing dowelled or keyed joints.

The basement floor slab should be provided with at least a 100mm thick sub-base of good quality, durable, single size, crushed rock (free of fines) such as such as ‘Blue Metal’ gravel or crushed concrete aggregate (free of fines), which will also act as underfloor drainage.

The underfloor drainage should include a sump and pump system. The basement wall drains should be connected into the underfloor drainage system. Groundwater seepage monitoring should be carried out during basement excavation prior to finalising the design of the pump out facility. In order to avoid flooding of proposed basement level, appropriately sized sumps each with an automatic level control pump will be required to intermittently discharge the seepage water to the stormwater system. Outlets into the stormwater system will require approval from the relevant authorities.

5.7 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:

1. Additional investigation post-demolition comprising at least six cored boreholes.
2. Pre-construction meeting to discuss the earthworks.
3. Dilapidation survey reports.
4. Vibration monitoring.
5. Inspection of all temporary batter slopes.
6. Groundwater seepage monitoring.
7. Proof rolling inspections.
8. Insitu density testing of all engineered fill by at GTA to at least Level 2 control.
9. Witnessing of CFA pile installations, and bored pile inspections.

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 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.

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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 Integrated Services Building
Location: Main Campus, Liverpool Hospital, Liverpool, NSW

Ref No: 32837A
Report: A
Report Date: 18/12/2019
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 %**
MW1	1.50 - 1.95	24.3	71	21	50	18.0
MW1	4.00 - 4.50	6.8	-	-	-	-
MW1	4.80 - 5.20	6.9	-	-	-	-
MW2	1.20 - 1.50	17.9	53	14	39	15.0
MW2	7.50 - 7.95	25.4	-	-	-	-
MW2	9.00 - 9.45	22.8	-	-	-	-
MW2	10.50 - 10.95	19.6	-	-	-	-
MW3	0.50 - 0.95	19.8	34	13	21	5.5
MW3	8.00 - 8.50	7.6	-	-	-	-

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: 09/12/2019
- Sampled and supplied by client. Samples tested as received.

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18/12/2019

Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	32837A
Project:	Proposed New Integrated Services	**Report:**	B
Location:	Main Campus, Liverpool Hospital, Liverpool, NSW	**Report Date:**	2/12/2019
		Page 1 of 2	

BOREHOLE NUMBER	DEPTH m	$I_{S\ (50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
MW1	5.88 - 5.92	0.6	12
	6.68 - 6.72	0.7	14
	7.32 - 7.37	0.8	16
	7.78 - 7.82	1.0	20
	8.18 - 8.22	1.9	38
	8.74 - 8.78	1.5	30
	9.23 - 9.26	1.3	26
	9.80 - 9.84	2.2	44
	10.14 - 10.18	1.6	32
	10.66 - 10.69	1.1	22
	11.33 - 11.37	1.1	22
MW2	12.89 - 12.92	0.8	16
	13.38 - 13.42	1.6	32
	13.88 - 13.92	1.3	26
	14.29 - 14.32	0.8	16
	14.77 - 14.80	1.2	24
	15.23 - 15.27	2.0	40
	15.79 - 15.83	1.8	36
	16.22 - 16.26	1.6	32
	16.83 - 16.87	1.8	36
	17.34 - 17.39	1.7	34
	17.78 - 17.83	1.6	32
	18.14 - 18.18	1.0	20
	18.18 - 18.22	0.9	18
	18.80 - 18.84	1.2	24

NOTES: See Page 2 of 2

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SOIL TEST SERVICES

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client: JK Geotechnics
Project: Proposed New Integrated Services
Location: Main Campus, Liverpool Hospital, Liverpool, NSW
Ref No: 32837A
Report: B
Report Date: 2/12/2019
Page 2 of 2

BOREHOLE NUMBER	DEPTH m	$I_{S\ (50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
MW3	8.80 - 8.84	0.9	18
	9.18 - 9.22	1.4	28
	9.65 - 9.69	1.1	22
	10.16 - 10.21	0.9	18
	10.78 - 10.82	1.1	22
	11.92 - 11.96	1.0	20
	12.37 - 12.42	1.1	22
	12.84 - 12.88	1.1	22
	13.27 - 13.31	2.8	56
	13.83 - 13.87	1.7	34
	14.40 - 14.43	2.1	42

NOTES:

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

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CERTIFICATE OF ANALYSIS 232600

Client Details

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

Sample Details

Your Reference	**32837A, Liverpool**
Number of Samples	7 Soil
Date samples received	06/12/2019
Date completed instructions received	06/12/2019

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	13/12/2019
Date of Issue	11/12/2019

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Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

ACCREDITED FOR TECHNICAL COMPETENCE

Misc Inorg - Soil						
Our Reference		232600-1	232600-2	232600-3	232600-4	232600-5
Your Reference	UNITS	MW1	MW2	MW2	MW2	MW2
Depth		3.0-3.45	0.5-0.95	1.5-1.95	3.8-4.2	5.4-5.8
Date Sampled		26/11/2019	28/11/2019	28/11/2019	28/11/2019	28/11/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	09/12/2019	09/12/2019	09/12/2019	09/12/2019	09/12/2019
Date analysed	-	09/12/2019	09/12/2019	09/12/2019	09/12/2019	09/12/2019
pH 1:5 soil:water	pH Units	5.6	8.3	5.3	5.3	8.3
Chloride, Cl 1:5 soil:water	mg/kg	130	450	490	190	77
Sulphate, SO4 1:5 soil:water	mg/kg	76	250	480	36	43
Resistivity in soil*	ohm m	58	25	16	54	82

Misc Inorg - Soil			
Our Reference		232600-6	232600-7
Your Reference	UNITS	MW2	MW3
Depth		9.8-10.2	4.5-4.95
Date Sampled		28/11/2019	27/11/2019
Type of sample		Soil	Soil
Date prepared	-	09/12/2019	09/12/2019
Date analysed	-	09/12/2019	09/12/2019
pH 1:5 soil:water	pH Units	8.6	8.2
Chloride, Cl 1:5 soil:water	mg/kg	450	690
Sulphate, SO4 1:5 soil:water	mg/kg	100	150
Resistivity in soil*	ohm m	20	16

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			09/12/2019	1	09/12/2019	09/12/2019		09/12/2019	[NT]
Date analysed	-			09/12/2019	1	09/12/2019	09/12/2019		09/12/2019	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	5.6	5.6	0	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	130	170	27	84	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	76	98	25	92	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	1	58	54	7	[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 (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

BOREHOLE LOG

Borehole No.
MW1
1 / 2

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW INTEGRATED SERVICES BUILDING
Location: MAIN CAMPUS, LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No.: 32837A **Method:** SPIRAL AUGER **R.L. Surface:** ~11.7 m
Date: 26/11/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./A.J.

Groundwater Record	Field Tests	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING		-	ASPHALTIC CONCRETE: 50mm.t	M			
			FILL: Gravelly silty sand, fine to medium grained, dark grey, fine to coarse grained igneous gravel.				NO FCF AT 0.1 NOT ENOUGH SAMPLE FOR BUCKET 3.9kg BUCKET
	N=SPT 8/ 60mm REFUSAL		FILL: Silty sand, fine to medium grained, light brown, trace of fine to coarse grained igneous and sandstone gravel.	w~PL			NO FCF 2.8kg BUCKET NO FCF
			FILL: Silty clay, medium plasticity, brown and red brown, trace of fine to medium grained sand and fine to coarse grained igneous and sandstone gravel.				7.6kg BUCKET NO FCF APPEARS WELL COMPACTED
		CH	FILL: Silty sandy clay, low plasticity, dark grey, fine to medium grained sand, with fine to medium grained igneous gravel.	w>PL	VSt		RESIDUAL
	N = 10 5,5,5		Silty CLAY: high plasticity, brown orange mottled red brown, trace of fine grained ironstone gravel.			360 360 350	
			as above, but red brown.				
	N = 28 9,13,15		as above, but light grey, with extremely weathered siltstone bands.	w~PL	Hd	560 >600 470	
		-	SILTSTONE: grey and brown, with clay bands.	HW	L		BRINGELLY SHALE LOW TO LOW 'TC' BIT RESISTANCE WITH VERY LOW BANDS
ON 11/12/19			SILTSTONE: grey and brown.	MW			LOW RESISTANCE
			REFER TO CORED BOREHOLE LOG				

RL (m AHD): 11, 10, 9, 8, 7, 6, 5
Depth (m): 1, 2, 3, 4, 5, 6

SAMPLES: ES U50 DB DS

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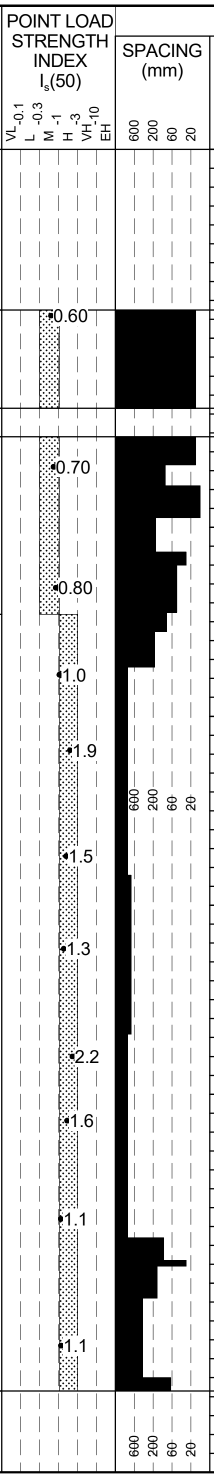
CORED BOREHOLE LOG

Borehole No.
MW1
2 / 2

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW INTEGRATED SERVICES BUILDING
Location: MAIN CAMPUS, LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No.: 32837A	**Core Size:** NMLC	**R.L. Surface:** ~11.7 m
Date: 26/11/19	**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	Formation
		6			START CORING AT 5.85m			
95% RETURN			6		SILTSTONE: grey and brown, bedded at 0-5°.	MW	M	Bringelly Shale
					NO CORE 0.15m			
		5			SILTSTONE: grey and brown, bedded at 0-5°.	MW	M	
			7		SILTSTONE: grey, with light grey and brown laminae, bedded at 0-5°.	SW		
		4			as above, but grey, with light grey laminae.	FR	H	
		3, 2, 1	8, 9, 10, 11					
		0			END OF BOREHOLE AT 11.57 m			



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

GROUNDWATER MONITORING WELL INSTALLED TO 11.57m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 4.57m TO 11.57m. CASING 0.05m TO 4.57m. 2mm SAND FILTER PACK 4.3m TO 11.57m. BENTONITE SEAL 1.0m TO 4.3m. COMPLETED WITH A CONCRETED GATIC COVER.

(5.88m) Be, 10°, Ir, Cn
(5.90m) Be, 0°, Ir, R, Fe Sn
(5.94m) Be, 0°, Ir, R, Fe Sn
(5.97m) J, 30°, P, R, Fe Sn
(6.01m) Be, 10°, Ir, R, Fe Sn
(6.03m) Be, 10°, Ir, R, Fe Sn
(6.04m) Cr, 0°, 150 mm.t
(6.22m) Cr, 0°, 25 mm.t
(6.26m) Be, 0°, Ir, R, Fe Sn
(6.29m) J, 50°, Ir, R, Fe Sn
(6.34m) XWS, 0°, 25 mm.t
(6.53m) Be, 0°, Ir, R, Fe Sn
(6.59m) Cr, 40°, 80 mm.t
(6.67m) Be, 0°, Ir, R, Fe Sn
(6.78m) XWS, 0°, 10 mm.t
(6.80-6.95m) Be x 8, 0 - 5°, Ir, R, Fe Sn
(7.13m) CS, 0°, 5 mm.t
(7.16m) J, 25°, Ir, R, Clay FILLED, 1 mm.t
(7.20m) Cr, 0°, 50 mm.t
(7.28m) XWS, 0°, 30 mm.t
(7.36m) Be, 0°, P, R, Fe Sn
(7.39m) CS, 0°, 3 mm.t
(7.45m) Be, 0°, P, R, Cn
(7.55m) Be, 0°, P, R, Cn
(7.74m) Be, 0°, P, R, Cn
(8.75m) J, St, R, Cn
(8.84m) CS, 0°, 8 mm.t
(9.68m) XWS, 0°, 10 mm.t
(10.76m) J, 40°, Ir, R, Cn
(10.88m) J, 65°, P, R, Cn
(10.91m) J, 20°, P, S, Cn
(11.08m) Cr, 0°, 60 mm.t
(11.50m) J, 70 - 90°, Ir, R, Cn

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32837A LIVERPOOL.GPJ <<DrawingFile>> 11/02/2020 15:14 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

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JOB NO 32837A MW1 START CORING AT 5.85m
6
NO CORE 150mm
7
8
9
10
11
END OF MW1 AT 11.57m

BOREHOLE LOG

Borehole No.
MW2
1 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW INTEGRATED SERVICES BUILDING
Location: MAIN CAMPUS, LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No.: 32837A **Method:** SPIRAL AUGER **R.L. Surface:** ~10.6 m
Date: 28/11/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./A.J.

Groundwater Record	Field Tests	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING			ASPHALTIC CONCRETE: 50mm.t				
	N = 10 5,6,4	-	FILL: Silty clay, low to medium plasticity, brown, trace of fine grained igneous gravel, fine to medium grained sand, brick fragments and root fibres.	w<PL			NO FCF AT 0.1m 10.8kg BUCKET NO FCF APPEARS MODERATELY COMPACTED
	N = 15 5,6,9	CH	Silty CLAY: high plasticity, light grey and red brown, trace of fine grained ironstone gravel.	w>PL	VSt - Hd	400 380 350	ALLUVIAL HAND PENETROMETER TESTING CARRIED OUT ON REMOULDED SAMPLE
					Hd	510 510 520	
	N = 22 5,8,14					>600 450 530	
		CL-CI	Sandy CLAY: low to medium plasticity, light grey, fine to medium grained sand.	w~PL			
	N = 30 6,14,16	SP	SAND: fine to medium grained, yellow brown and orange brown.	M	MD		
		SM	Silty SAND: fine to medium grained, light grey mottled light orange brown, trace of clay fines.				
	N = 12 5,6,6		as above, but red brown, with iron cemented sand nodules.				
		CL	Silty CLAY: low plasticity, light grey, trace of fine grained sand.	w>PL	VSt	250 320 280	
		CH	Silty CLAY: as below		St - VSt		

SAMPLES: ES U50 DB DS

RL (m AHD): 10, 9, 8, 7, 6, 5, 4

Depth (m): 1, 2, 3, 4, 5, 6

Graphic Log

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32837A LIVERPOOL.GPJ <<DrawingFile>> 11/02/2020 15:14 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

BOREHOLE LOG

Borehole No.
MW2
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW INTEGRATED SERVICES BUILDING
Location: MAIN CAMPUS, LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No.: 32837A **Method:** SPIRAL AUGER **R.L. Surface:** ~10.6 m
Date: 28/11/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./A.J.

Groundwater Record	Field Tests	RL (m AHD)	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
▽ ON 11/12/19				CH	Silty CLAY: high plasticity, light grey and light orange brown.	w>PL	St - VSt		
	N = 9 3,4,5	3						50 210 150	
			8						
		2			as above, but grey and red brown.		St		
	N = 7 1,3,4		9					140 120 140	
		1		CI-CH	as above, but medium to high plasticity, dark grey.				
			10						
	N = 16 4,5,11	0						160 100 140	
			11						
		-1							
	N=SPT 10/ 100mm REFUSAL		12				VSt - Hd	440 330 300	
				-	SILTSTONE: grey and brown.	MW	L - M		BRINGELLY SHALE LOW TO MODERATE 'TC' BIT RESISTANCE
		-2							
			13		REFER TO CORED BOREHOLE LOG				
		-3							

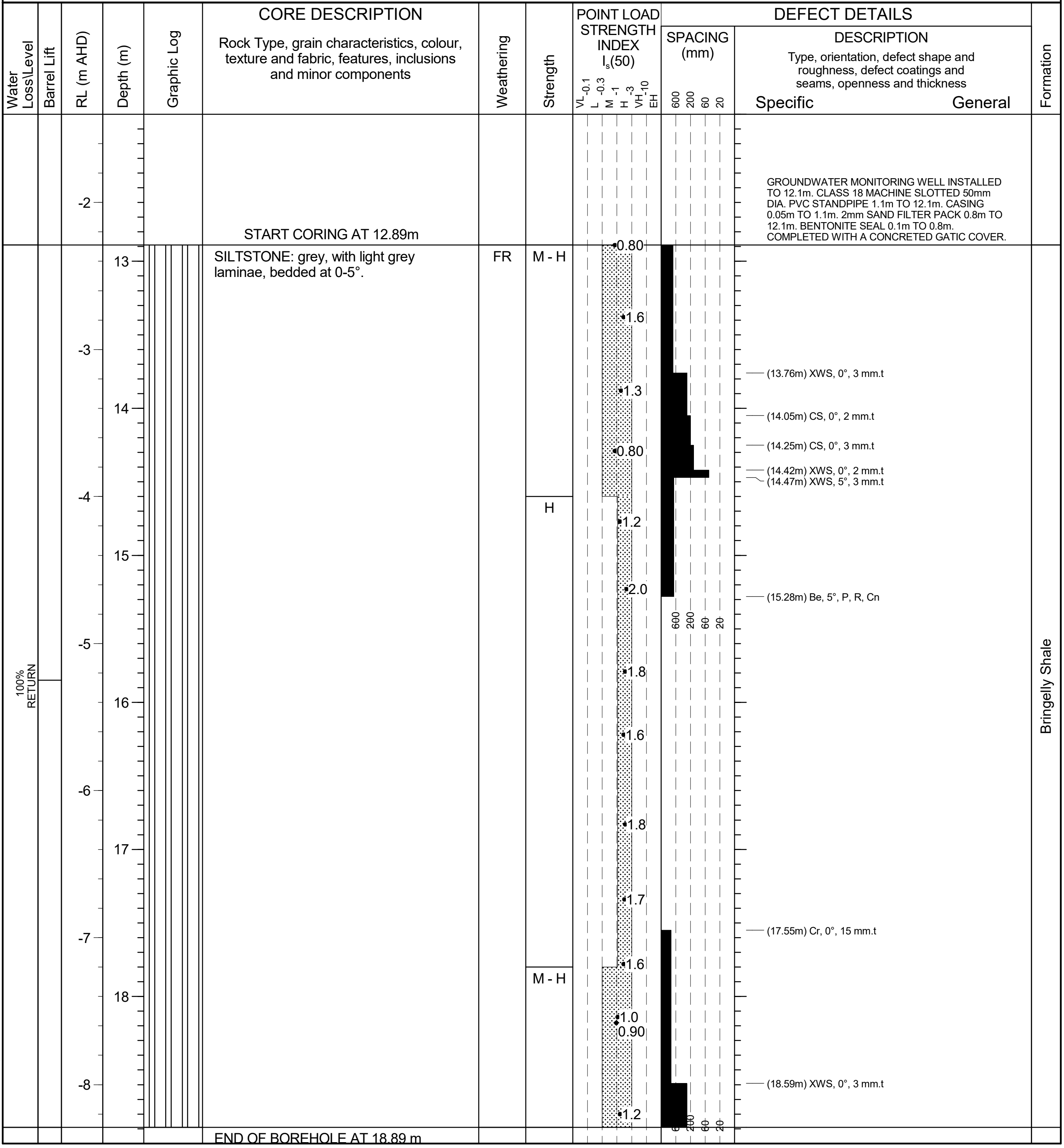
JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32837A LIVERPOOL.GPJ <<DrawingFile>> 11/02/2020 15:14 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CORED BOREHOLE LOG

Borehole No.
MW2
3 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW INTEGRATED SERVICES BUILDING
Location: MAIN CAMPUS, LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No.: 32837A
Core Size: NMLC
R.L. Surface: ~10.6 m
Date: 28/11/19
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 $I_s(50)$	DEFECT DETAILS SPACING (mm)	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific / General	Formation
					START CORING AT 12.89m					GROUNDWATER MONITORING WELL INSTALLED TO 12.1m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 1.1m TO 12.1m. CASING 0.05m TO 1.1m. 2mm SAND FILTER PACK 0.8m TO 12.1m. BENTONITE SEAL 0.1m TO 0.8m. COMPLETED WITH A CONCRETED GATIC COVER.	
100% RETURN					SILTSTONE: grey, with light grey laminae, bedded at 0-5°.	FR	M - H H M - H	0.80 1.6 1.3 0.80 1.2 2.0 1.8 1.6 1.8 1.7 1.6 1.0 0.90 1.2		(13.76m) XWS, 0°, 3 mm.t (14.05m) CS, 0°, 2 mm.t (14.25m) CS, 0°, 3 mm.t (14.42m) XWS, 0°, 2 mm.t (14.47m) XWS, 5°, 3 mm.t (15.28m) Be, 5°, P, R, Cn (17.55m) Cr, 0°, 15 mm.t (18.59m) XWS, 0°, 3 mm.t	Bringelly Shale

END OF BOREHOLE AT 18.89 m

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS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JOB NO 32837A MW2 START CORING AT 12.89m
13
14
15
16
17
18
END OF MW2 AT 18.89m

BOREHOLE LOG

Borehole No.
MW3
1 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW INTEGRATED SERVICES BUILDING
Location: MAIN CAMPUS, LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No.: 32837A **Method:** SPIRAL AUGER **R.L. Surface:** ~11.9 m
Date: 27/11/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./A.J.

Groundwater Record	Field Tests	RL (m AHD)	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING					FILL: Silty clay, low plasticity, brown, with fine to coarse grained igneous and ironstone gravel, trace of fine to medium grained sand, concrete fragments, roots and root fibres.	w<PL			GRASS COVER NO FCF AT 0.1 7.3kg BUCKET NO FCF
						w>PL			
	N = 14 7,7,7	11	1						6.4kg BUCKET NO FCF APPEARS WELL COMPACTED
	N = 10 5,5,5	10	2					>600 >600 >600	
				CH	Silty CLAY: high plasticity, light grey and orange brown mottled red brown, trace of fine grained ironstone gravel.	w>PL	VSt	200 250 350	ALLUVIAL HAND PENETROMETER TESTING CARRIED OUT ON REMOULDED SAMPLE 3.2kg BUCKET NO FCF
	N = 8 1,2,6	9	3				Hd	500 460 480	
					as above, but light grey mottled red brown and orange brown.				RESIDUAL
ON 11/12/19		8	4		as above, but with occasional red brown bands.		VSt - Hd		
	N = 21 11,10,11	7	5					290 340 440	
	N = 27 4,12,15	6	6		as above, but with extremely weathered siltstone bands.		Hd	>600 >600 >600	
		5		-	SILTSTONE: grey and brown.	MW	L		BRINGELLY SHALE LOW 'TC' BIT RESISTANCE

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BOREHOLE LOG

Borehole No.
MW3
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW INTEGRATED SERVICES BUILDING
Location: MAIN CAMPUS, LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No.: 32837A **Method:** SPIRAL AUGER **R.L. Surface:** ~11.9 m
Date: 27/11/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./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										
	■			■ ■		4	8	▥	-	SILTSTONE: grey and brown. *(continued)*	MW - SW	L - M		BRINGELLY SHALE LOW 'TC' BIT RESISTANCE
						3 2 1 0 -1 -2	9 10 11 12 13			REFER TO CORED BOREHOLE LOG				

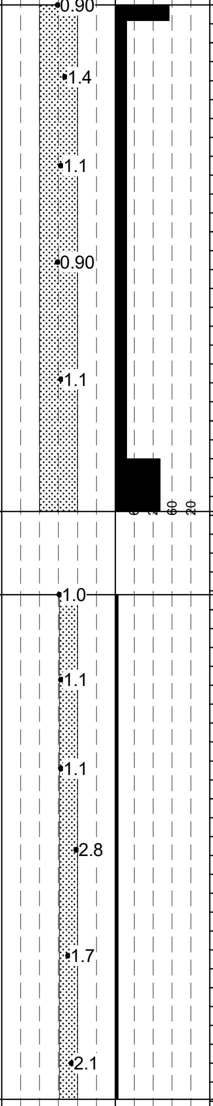
JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32837A LIVERPOOL.GPJ <<DrawingFile>> 11/02/2020 15:14 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CORED BOREHOLE LOG

Borehole No.
MW3
3 / 3

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEW INTEGRATED SERVICES BUILDING
Location: MAIN CAMPUS, LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No.: 32837A
Core Size: NMLC
R.L. Surface: ~11.9 m
Date: 27/11/19
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 $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific General	Formation
					START CORING AT 8.80m					GROUNDWATER MONITORING WELL INSTALLED TO 6.34m. CLASS 18 MACHINE SLOTTED 50 mm DIA. PVC STANDPIPE 2.04M TO 6.34m. CASING 0.05m TO 2.04m. 2mm SAND FILTER PACK 1.9m TO 6.34m. BENTONITE SEAL 0.05m TO 1.9m. COMPLETED WITH A CONCRETED GATIC COVER.	
100% RETURN		3 2 1	9 10 11		SILTSTONE: grey, with light grey lamination, bedded at 0-10°.	FR	M - H	0.90 1.4 1.1 0.90 1.1		(8.88m) Be, 10°, P, R, Fe Sn (10.05m) J, 75°, P, R, Cn (11.20m) J, 80°, P, R, Cn (11.35m) J, 75°, P, R, Cn	Bringelly Shale
					NO CORE 0.44m						
		0 -1 -2	12 13 14		SILTSTONE: grey, with light grey laminae, bedded at 0-10°.	FR	H	1.0 1.1 1.1 2.8 1.7 2.1			Bringelly Shale
		-3			END OF BOREHOLE AT 14.59 m						

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
JOB NO 32837A MW3 START CORING AT 8.80m
9
10
11
NO CORE 440mm
12
13
14
END OF MW3 AT 14.59m

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

IMAGE SOURCE: http://maps.au.nearmap.com.22.Oct. 2019

0 20 40 60 80 100
SCALE 1:2000 @A4 m

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

Title:

SITE LOCATION PLAN

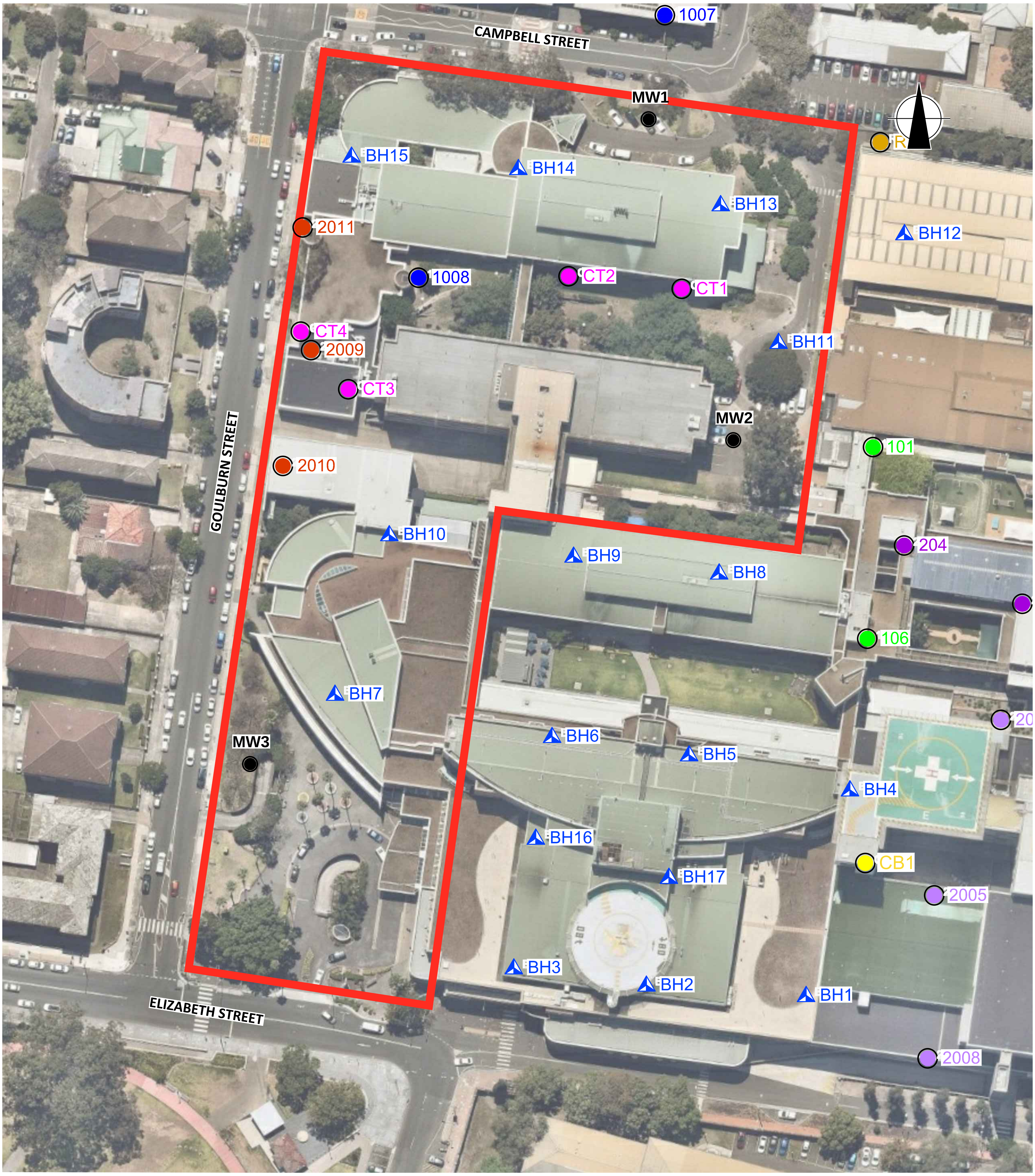
Location: MAIN CAMPUS
LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Report No: 32837A

Figure: 1

JKGeotechnics

PLOT DATE: 17/02/2020 3:18:04 PM DWG FILE: X:\32837A LIVERPOOL HOSPITAL\CAD\32837A.DWG



LEGEND

▲ JKG 1991 BOREHOLE

🟢 JKG 2003 BOREHOLE

🟣 JKG 2004 BOREHOLE

🔵 JKG 2006 BOREHOLE

● JKG 2007A BOREHOLE

🟡 JKG 2007B BOREHOLE

● JKG 2008 BOREHOLE

🟠 JKG 2009A BOREHOLE

🔴 JKG 2010 BOREHOLE

⚫ CURRENT BOREHOLE

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

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

Title:
BOREHOLE LOCATION PLAN

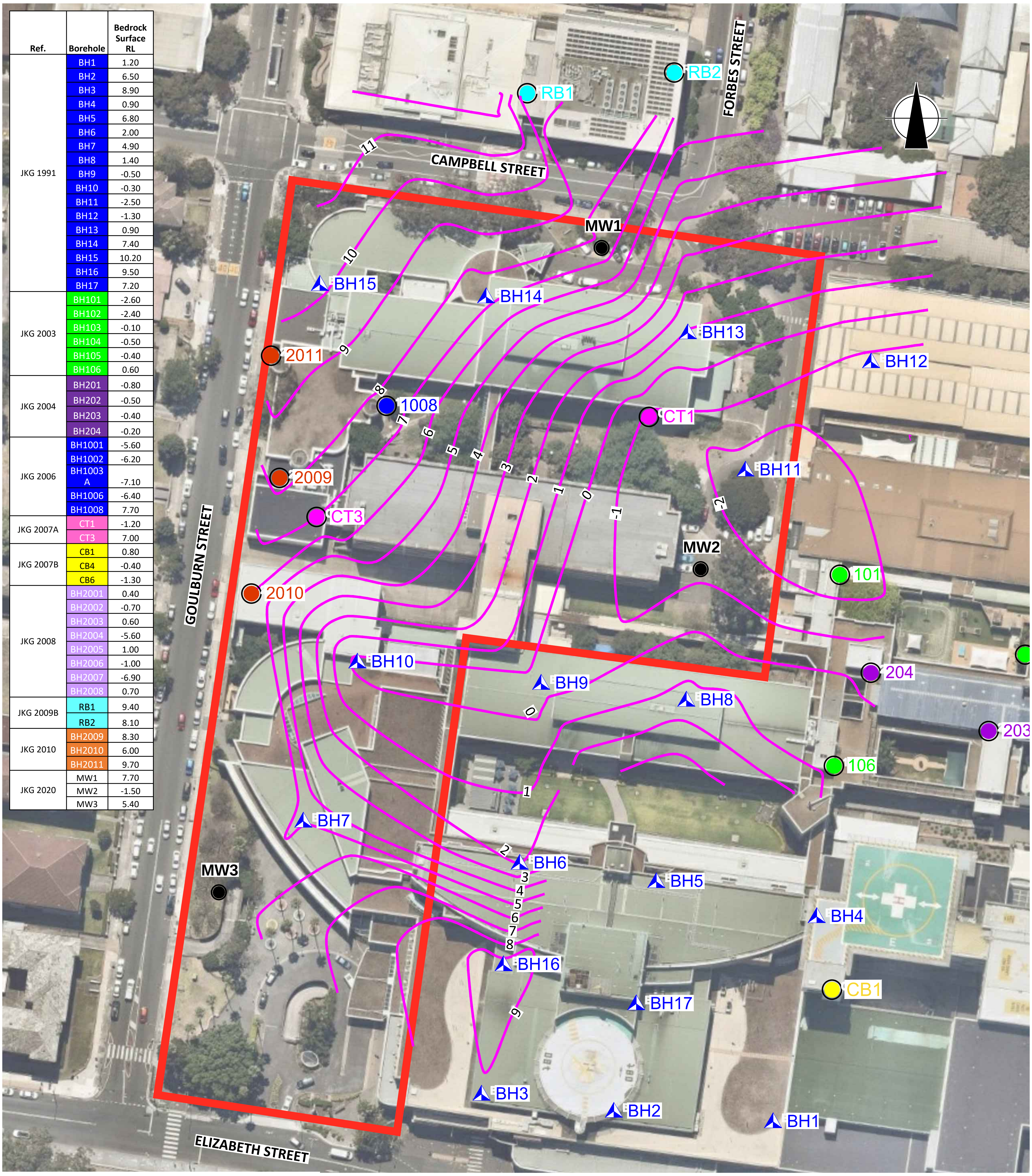
Location: MAIN CAMPUS
LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Report No: 32837A

Figure: 2

JKGeotechnics

PLOT DATE: 17/02/2020 3:18:21 PM DWG FILE: X:\32837A LIVERPOOL HOSPITAL\CAD\32837A.DWG



Ref.	Borehole	Bedrock Surface RL
JKG 1991	BH1	1.20
	BH2	6.50
	BH3	8.90
	BH4	0.90
	BH5	6.80
	BH6	2.00
	BH7	4.90
	BH8	1.40
	BH9	-0.50
	BH10	-0.30
	BH11	-2.50
	BH12	-1.30
	BH13	0.90
	BH14	7.40
	BH15	10.20
	BH16	9.50
	BH17	7.20
JKG 2003	BH101	-2.60
	BH102	-2.40
	BH103	-0.10
	BH104	-0.50
	BH105	-0.40
	BH106	0.60
JKG 2004	BH201	-0.80
	BH202	-0.50
	BH203	-0.40
	BH204	-0.20
JKG 2006	BH1001	-5.60
	BH1002	-6.20
	BH1003 A	-7.10
	BH1006	-6.40
	BH1008	7.70
JKG 2007A	CT1	-1.20
	CT3	7.00
JKG 2007B	CB1	0.80
	CB4	-0.40
	CB6	-1.30
JKG 2008	BH2001	0.40
	BH2002	-0.70
	BH2003	0.60
	BH2004	-5.60
	BH2005	1.00
	BH2006	-1.00
	BH2007	-6.90
	BH2008	0.70
JKG 2009B	RB1	9.40
	RB2	8.10
JKG 2010	BH2009	8.30
	BH2010	6.00
	BH2011	9.70
JKG 2020	MW1	7.70
	MW2	-1.50
	MW3	5.40

LEGEND

▲	JKG 1991 BOREHOLE
●	JKG 2003 BOREHOLE
●	JKG 2004 BOREHOLE
●	JKG 2006 BOREHOLE
●	JKG 2007A BOREHOLE
●	JKG 2007B BOREHOLE
●	JKG 2009B BOREHOLE
●	JKG 2010 BOREHOLE
●	CURRENT BOREHOLE
~10~	WEATHERED BEDROCK SURFACE CONTOUR (RL mAHD)

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

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

Title: **SURFACE OF WEATHERED BEDROCK CONTOUR PLAN**

Location: MAIN CAMPUS
LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Report No: 32837A
Figure: 3

JKGeotechnics

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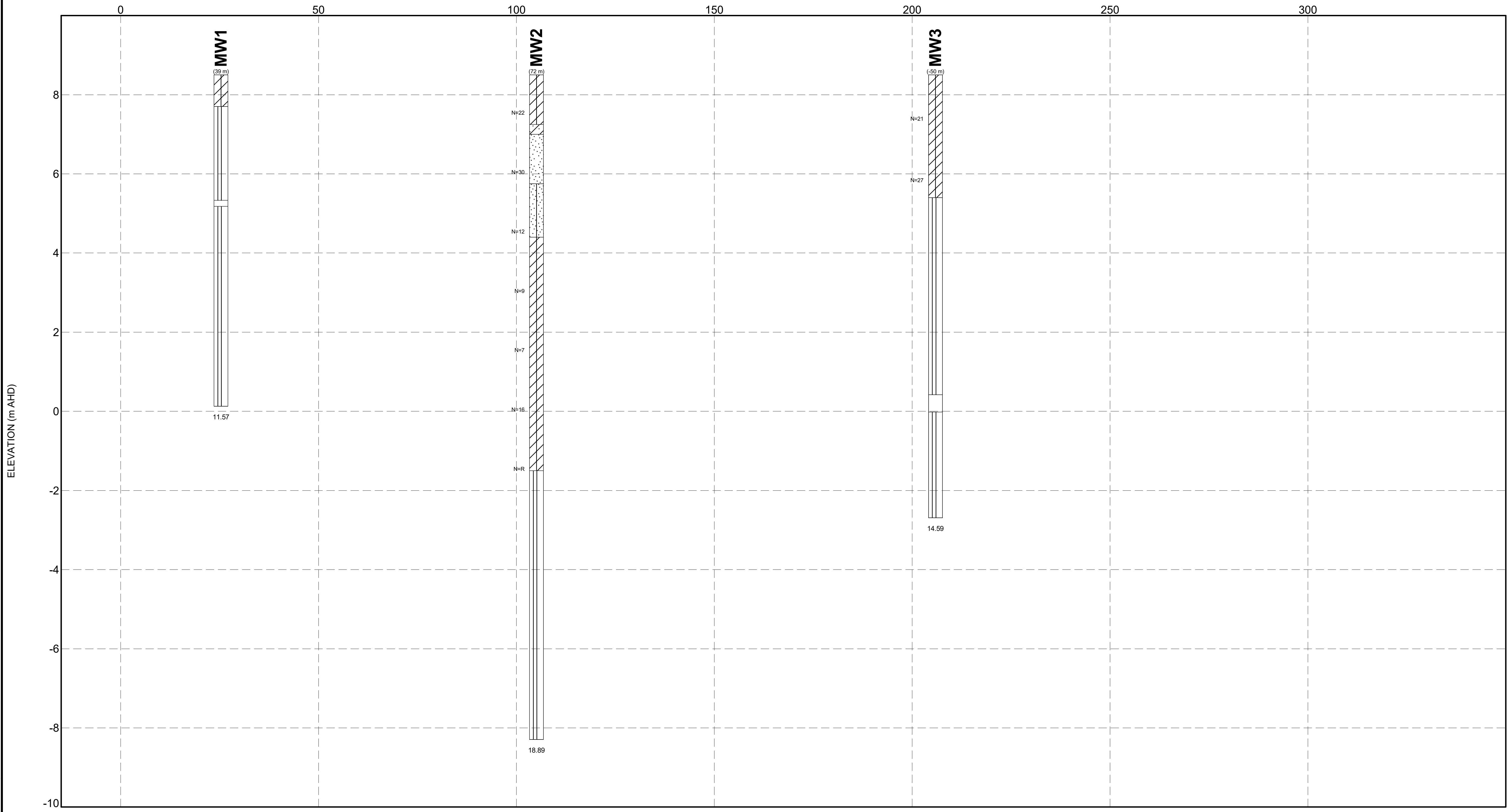


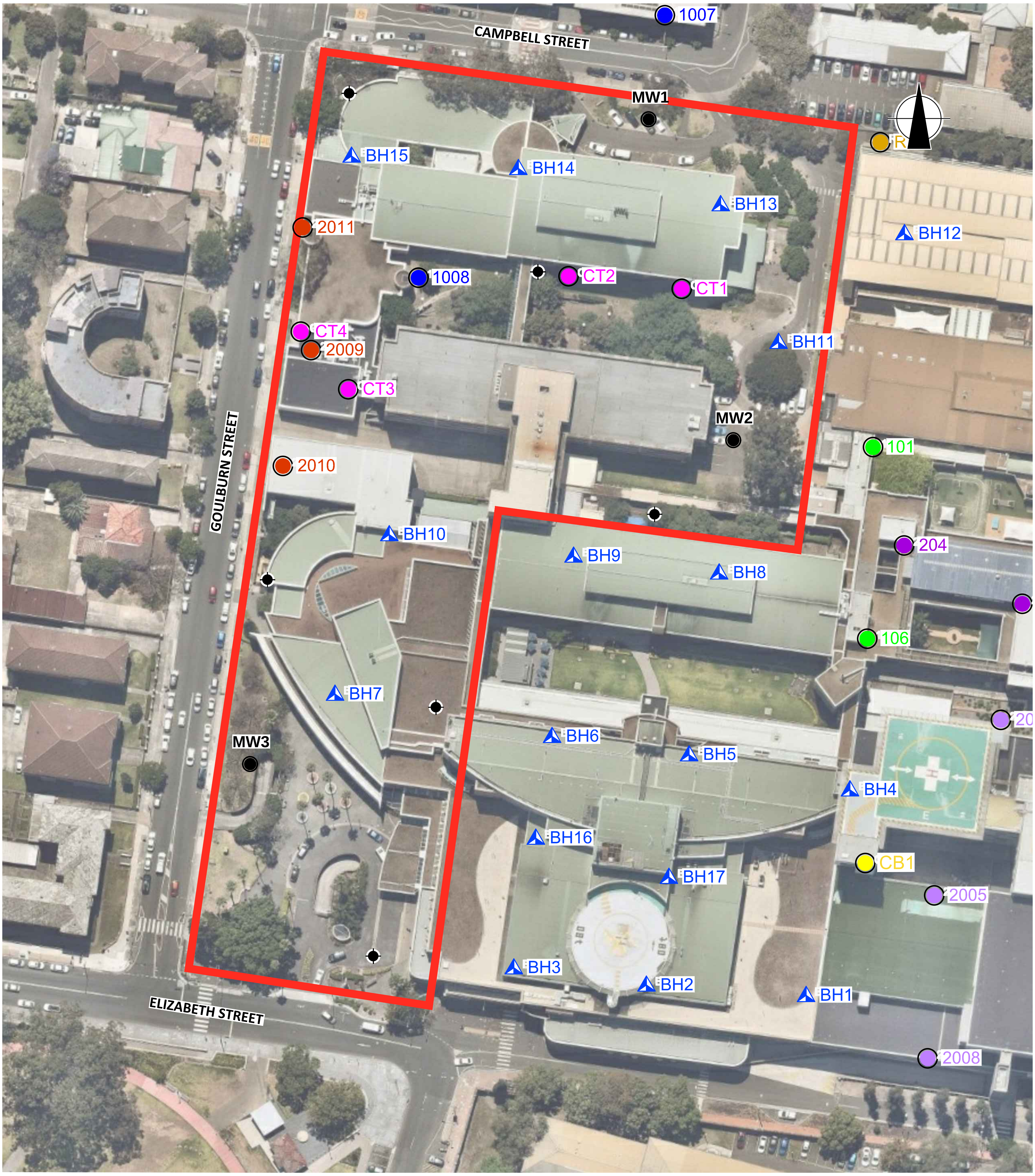
MATERIAL GRAPHIC

☐ NO CORE
⛆ SAND (SP, SW)
▨ SANDY CLAY (CL, CI, CH)
▨ SILTY CLAY (CL, CI, CH)
⛆ SILTY SAND (SM)
▥ SILTSTONE

GRAPHICAL BORHOLE SUMMARY
HEALTH INFRASTRUCTURE
MAIN CAMPUS, LIVERPOOL HOSPITAL,
LIVERPOOL, NSW
NEW INTEGRATED SERVICES BUILDING

DRAWN D.M.	DATE 11/02/2020
CHECKED A.J.	DATE 11/02/2020
SCALE H 1:1000 V 1:100	A3
PROJECT No 32837A	FIGURE No 4

JK 9.02.4 LIB.GLB Fence FENCE A3L 32837A LIVERPOOL.GPJ 32837A FIG 4.GDW 11/02/2020 14:34 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



LEGEND

▲ JKG 1991 BOREHOLE
● JKG 2003 BOREHOLE
● JKG 2004 BOREHOLE
● JKG 2006 BOREHOLE
● JKG 2007A BOREHOLE
● JKG 2007B BOREHOLE
● JKG 2008 BOREHOLE
● JKG 2009A BOREHOLE
● JKG 2010 BOREHOLE
● CURRENT BOREHOLE
⊕ PROPOSED BOREHOLE

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

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

Title:
PROPOSED BOREHOLE LOCATION PLAN

Location: MAIN CAMPUS
LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Report No: 32837A
Figure: 5

JKGeotechnics

PLOT DATE: 17/02/2020 9:22:39 AM DWG FILE: X:\32837A LIVERPOOL HOSPITAL\CAD\32837A.DWG

VIBRATION EMISSION DESIGN GOALS

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

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

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

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

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

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

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

REPORT EXPLANATION NOTES

INTRODUCTION

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

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

DESCRIPTION AND CLASSIFICATION METHODS

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

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

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

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

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

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

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

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

SAMPLING

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

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

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

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

INVESTIGATION METHODS

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

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

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

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

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

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

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

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

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

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

The test results are reported in the following form:

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

  N = 13
  4, 6, 7

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

  N > 30
  15, 30/40mm

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

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

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

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

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

The information provided on the charts comprise:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

LOGS

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

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

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

GROUNDWATER

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

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

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

FILL

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

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

LABORATORY TESTING

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

ENGINEERING REPORTS

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

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

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

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

SITE ANOMALIES

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

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

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

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

REVIEW OF DESIGN

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

SITE INSPECTION

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

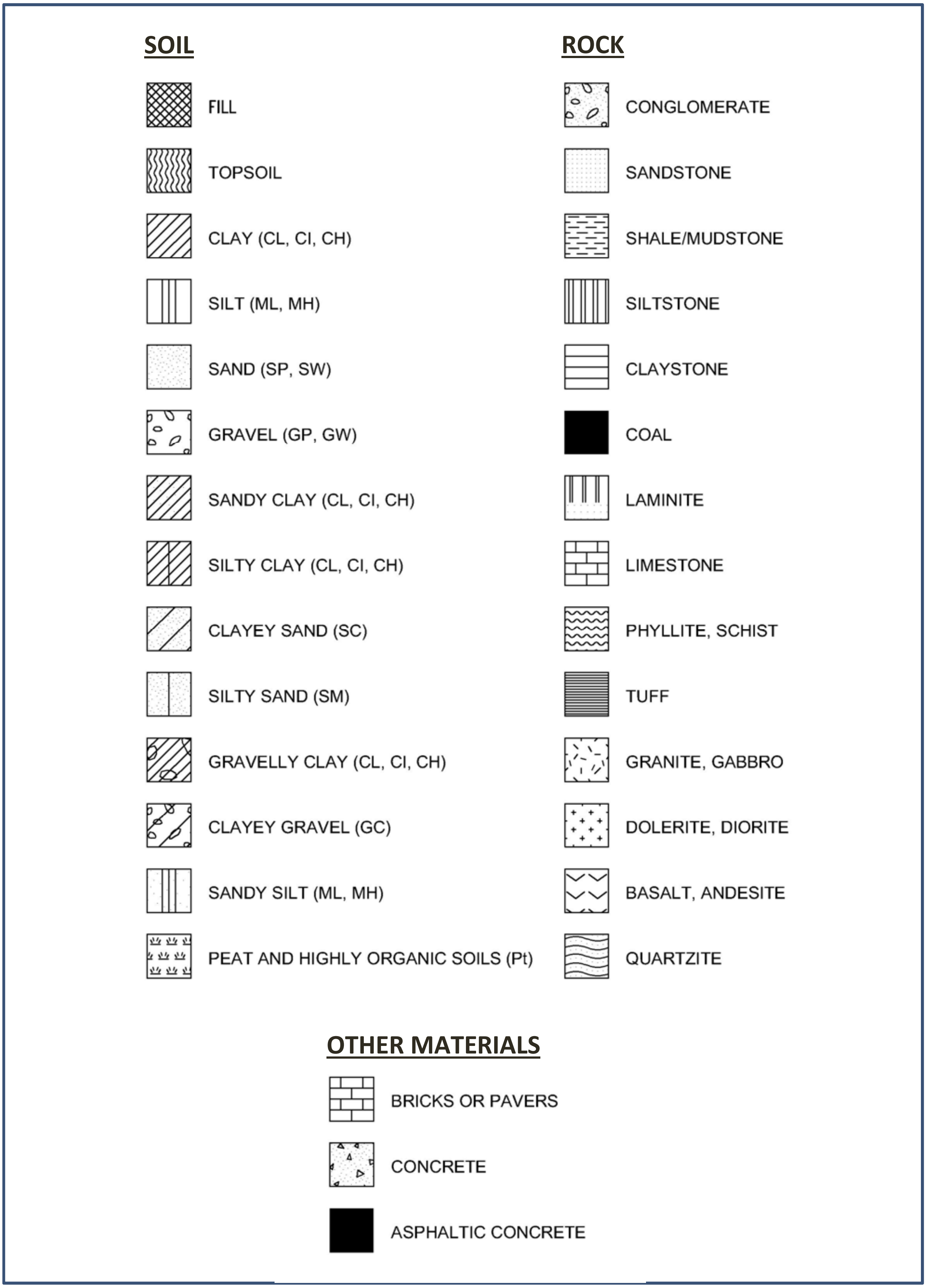
Requirements could range from:

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

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

iii) full time engineering presence on site.

SYMBOL LEGENDS



SOIL

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

ROCK

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

OTHER MATERIALS

- BRICKS OR PAVERS
- CONCRETE
- ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

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

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.

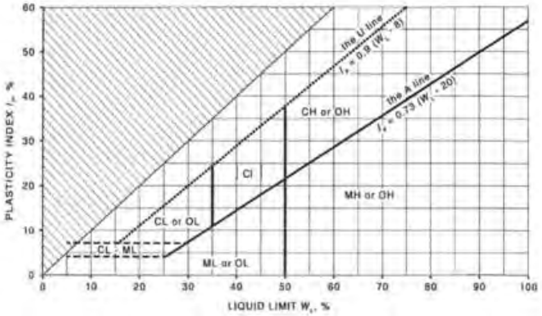
2 Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.

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.

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	–	–	–	–

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.		
	$w \approx PL$	Moisture content estimated to be approximately equal to plastic limit.		
	$w < PL$	Moisture content estimated to be less than plastic limit.		
	$w \approx LL$	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

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

Abbreviations Used in Defect Description

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

APPENDIX A

Borehole Logs 3, and 6 to 16 from

'Geotechnical Investigation for Proposed Redevelopment'

Report, Ref. 8471W/vm dated 4/11/91

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
3
1/2

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 16 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450
R.L. Surface: ≑ 11·5m
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPL-TION OF AUG-ERING						CONCRETE : 140mm thick (shrinkage reinforced)				
						FILL: Sand, coarse grained, brown.				APPEARS MODERATELY COMPACTED.
					CL-CH	FILL: Sandy Clay, shale pieces and pozzolan ash.	MC > PL	st to Vst.		RESIDUAL
	DS	N = 5 1, 2, 3	1			CLAY: medium to high plasticity, pale grey and red brown.			220 300 290	
			2		CL	SHALY CLAY: medium plasticity, pale grey and orange. Abundant ironstone seams. Some pale grey claystone seams.				(CLASS 5)
	DS	N >15 15, 15/110mm							>600 >600	ESTIMATED 'V' BIT REFUSAL.
			3			SHALE: grey, extremely weathered, extremely weak. Abundant ironstone seams.	(CLASS 5)			LOW 'TC' BIT RESISTANCE (CLASS 5)
	DS		4			as above but grey brown, highly weathered, very weak to weak, occasional ironstone seams.	(CLASS 4)			BANDED LOW & MODERATE RESISTANCE (CLASS 4)
	DS					as above but grey and brown, moderately weathered, medium strong.	(CLASS 3/4)			MODERATE RESISTANCE. (CLASS 3/4)
			5			REFER TO CORED BOREHOLE LOG.				
			6							
			7							

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Borehole No.
3 2/2

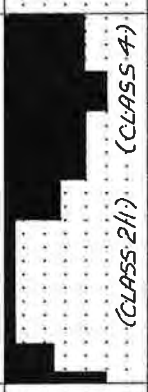
CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET LIVERPOOL.

Job No: 8471 W
Date Drilled: 16 - 10 - 91
Drill Type: INTERTECH BCD450

Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —

R. L. Surface: ≑ 11·5m.
Datum: A.H.D.



Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		4		START CORING AT 4·40m.						
				CORE LOSS 0·07m.						
FULL RETURN		5 6		SHALE: brown and grey, with pale grey fine grained sandstone laminae.	MW MW SW	MS MS S.	× ×		JOINT, 70°-80°, CURVED, SMOOTH. CLAY SEAM, 25-30mm. JOINT, 80-90°, CURVED, SMOOTH. EW SEAM, 10mm. JOINT 75°-80°, PLANAR, SMOOTH. EW SEAM, 5-10mm	NB. DEFECTS NOT LABELLED ARE BEDDING PARTINGS 0°-10°, PLANAR, SMOOTH.
		7 8 9		END OF BOREHOLE AT 6·5m.						

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JOB No. 8471W
BOREHOLE No. 3
START CORING AT 4.40m
4.40
41
LOSS
0.07m
5
6
END AT 6.50m

Jeffery and Katauskas Pty Ltd
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BOREHOLE LOG

Borehole No.
6
1/3

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 14 - 10 - 91
Method: SPIRAL AUGER
G.C.H. RIG
R.L. Surface: ≑ 10·8m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
				▩		Grass over FILL : fine crushed basalt.	D			APPEARS POORLY TO MODERATELY COMPACTED.
				▩		FILL : Silty Clay, low to medium plasticity, brown. Trace of gravel.	MC>PL			
	DS DS	N = 8 4, 4, 4	1	▨	CL-CH	CLAY : medium to high plasticity, grey brown becoming grey mottled brown.	MC > PL	Vst.	520 400	ALLUVIUM.
			2	▨						
	DS	N = 14 3, 6, 8		▨					340 370 550 330	
			3	▨						
				▨				H.		
	DS	N = 30 7, 15, 15	4	▨					450 430 >600	
			5	▨						
	DS	N >23 9, 13, 10/100mm		▨					320 440 480 500	
			6	▨						
			7	▨						

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Borehole No.
6
2/3

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 14-10-91
Method: SPIRAL AUGER
G.C.H. RIG.
R.L. Surface: ≑ 10.8m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
				▨	CL-CH.	CLAY: medium to high plasticity grey and yellow brown. Zones of silty clay.	MC>PL	Vst H.		
?			7	▨						
			8	▨						
			9	≡		SHALE: brown and grey, highly weathered and very weak to weak.	(CLASS 4)			LOW 'TC' BIT RESISTANCE WITH MODERATE BANDS.
						REFER TO CORED BOREHOLE LOG.				
			10							
			11							
			12							

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CORED BOREHOLE LOG

Borehole No. 6
3/3

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL.

Job No: 8471 W
Date Drilled: 14 - 10 - 91
Drill Type: G.C.H. RIG.
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —
R. L. Surface: ≑ 10·8m.
Datum: A.H.D.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT DETAILS DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		9		START CORING AT 9·3m.						
FULL RETURN.				SHALE: brown and dark grey.	HW	W MS	×	 (CLASS 4)	JOINT 60-90° IRREGULAR FRAGMENTED. CLAY SEAM, 35mm. CLAY SEAM, 20mm. JOINT, 90°, PLANAR, SMOOTH.	NB: DEFECTS ARE BEDDING PARTINGS 0°-10°, PLANAR, SMOOTH, UNLESS LABELLED OTHERWISE.
		10		as above but dark grey with pale grey fine grained sandstone laminae.	MW SW	MS S	× ×	(CLASS 1)	JOINT, 75°, PLANAR, SMOOTH. JOINT, 75-90°, IRREGULAR, SMOOTH. HIGHLY FRAGMENTED SEAM, 5-10mm. JOINT, 85°-90°, CURVED SMOOTH.	
		11								
		12		END OF BOREHOLE AT 12·0m.						
		13								
		14								

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JOB No. 8471W
BH No. 6
START AT 9.30m
10
11
END OF BH6 AT 12.00m

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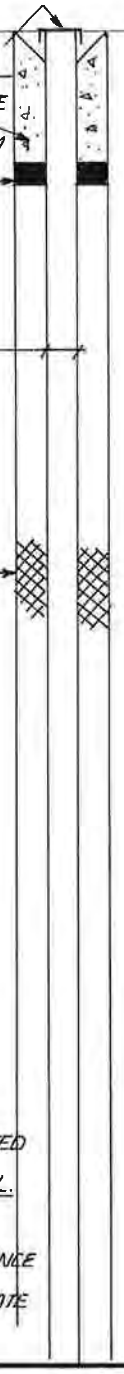
BOREHOLE LOG

Borehole No.
7
1/3

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 10 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450
R.L. Surface: ≑ 11·0m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
MOIST ON BASE BEFORE CORING						BITUMEN: 20mm t. over FINE CRUSHED ROCK: 40mm t. over				PVC CAP.
					CL	FILL: Clayey sand & ripped sandstone.	MC > PL	st.		CONCRETE
					CH.	SILTY CLAY: low to medium plasticity, brown. Grading to		Vst.		ALLUVIUM PLUG
	DS	N = 8 2, 4, 4	1			CLAY: high plasticity, grey brown, becoming pale grey mottled red brown.			270, 300 230, 290	
			2							50mm DIA PVC STAND-PIPE.
	DS	N = 21 7, 10, 11			CL-CH	CLAY: medium to high plasticity, grey. A trace of medium grained sand, ironstone gravel and fine roots.			400 270 250 300	BACKFILL
			3							
	DS	N = 22 6, 11, 11	4				MC < PL	H.	400 400 450 600	
			5			as above but with some ironstone gravel bands.				
ON COMPLETION OF SPT TEST.	DS	N = 24 7, 10, 14							>600 >600 >600 550	ESTIMATED 'V' BIT REFUSAL.
			6			INTERBEDDED SHALY CLAY: pale grey and SHALE: brown and grey, highly weathered, weak to medium strong.	(CLASS 4)			LOW 'TC' BIT RESISTANCE WITH MODERATE BANDS.
			7							



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BOREHOLE LOG

Borehole No. 7
2/3

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Method: SPIRAL AUGER
INTERTECH BCD 450
R.L. Surface: ≑ 11·0m
Date: 10 - 10 - 91
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
				▤		SHALE: grey, highly to moderately weathered, medium strong.		(CLASS 4)		LOW RESISTANCE WITH MODERATE BANDS.
▼ BEFORE CORING						REFER TO CORED BOREHOLE LOG.				BACKFILL
			8							
										SLOTTED ZONE 1·5m WRAPPED IN GEO-TEXTILE.
			9							
			10							
			11							
			12							
			13							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
7
3/3

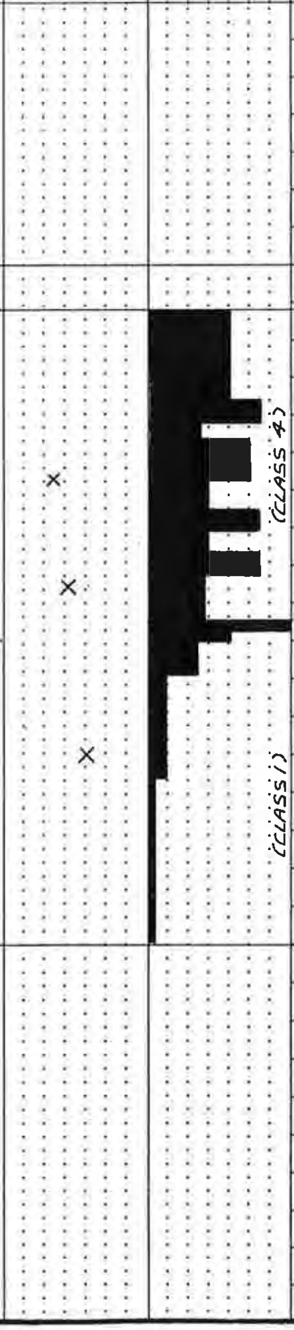
CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No: 8471W
Date Drilled: 10 - 10 - 91
Drill Type: INTERTECH BCD450
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —
R. L. Surface: ≑ 11·0m
Datum: A.H.D.

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
		7		START CORING AT 7·4m.				
FULL RETURN.				CORE LOSS 0·25m.				NB: DEFECTS ARE BEDDING PARTINGS 0°-10°, PLANAR SMOOTH UNLESS SHOWN OTHERWISE.
		8		SHALE: brown and grey.	HW — MW	W — MS.	CLAY SEAM, 10-15mm, 2 JOINTS, 25°, PLANAR, ROUGH. FRAGMENTED SEAM & CLAY SEAM, 0-12mm. CLAY SEAM, 5mm. JOINT, 70°, IRREGULAR, ROUGH, CLAYCOATED. HIGHLY FRAGMENTED, 120mm. 2 JOINTS, 60°, PLANAR, SMOOTH. EW/CLAY, SEAM, 15mm. HIGHLY FRAGMENTED, 40mm.	
		9						
		10		as above but dark grey with very thin fine grained sandstone laminae.	SW	MS - S		
		11		END OF BOREHOLE AT 11·0m.				
		12						

POINT LOAD INDEX STRENGTH $I_S(50)$ | DEFECT SPACING (mm)



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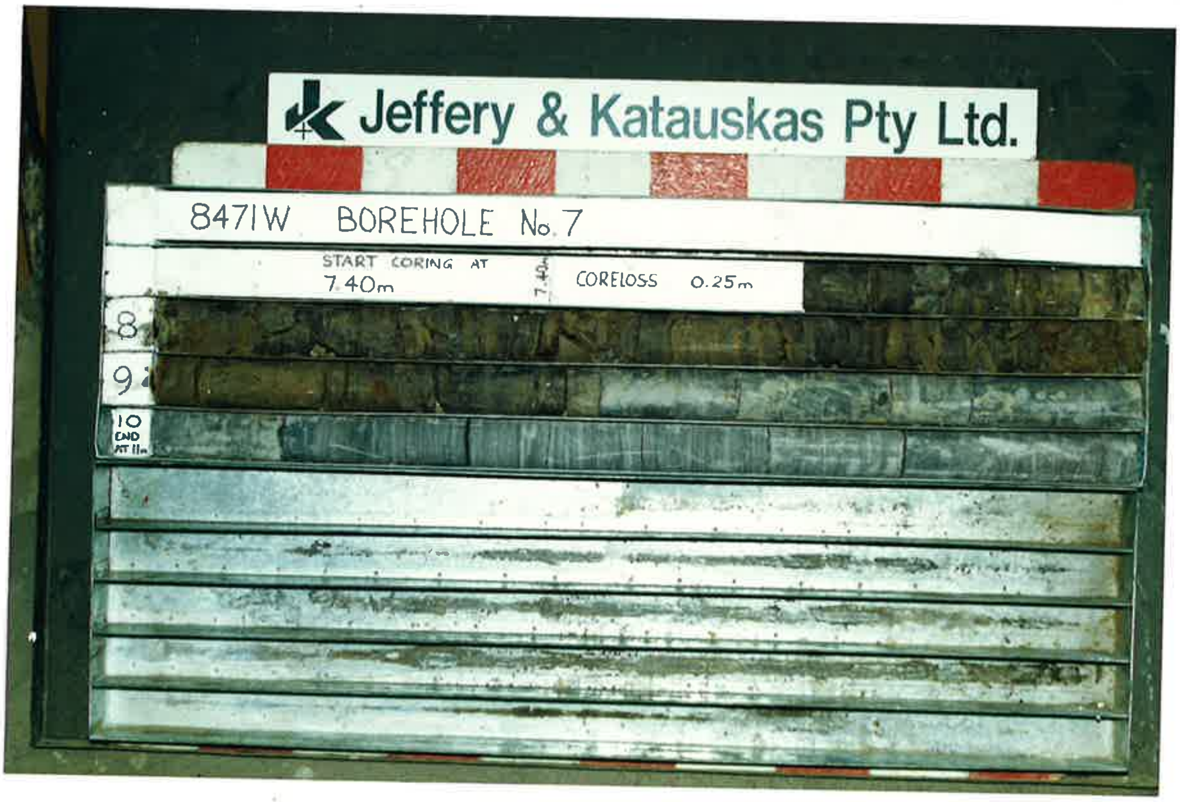
Jeffery & Katauskas Pty Ltd.
8471W BOREHOLE No. 7
START CORING AT 7.40m
7.40m
CORELOSS 0.25m
8
9
10 END AT 11m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

BOREHOLE LOG

Borehole No.
8
1/3

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 14 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450.
R.L. Surface: ≑ 10·4m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						Grass over FILL: Silty Clayey Sand and crushed basalt gravel.	MC>PL			PVC CAP. CONCRETE APPEARS MODERATELY COMPACTED
						SILTY CLAY: low to medium plasticity, light brown.				ALLUVIUM.
	DS	N = 9 4, 4, 5	1		CH.	CLAY: high plasticity, grey brown becoming grey mottled red brown.	MC>PL	Vst	>600	BACKFILL
			2							50mm DIA. PVC STANDPIPE.
	DS	N = 13 5, 6, 7							300 340 230 350	
			3							
					CL	SILTY CLAY: low to medium plasticity, pale grey mottled yellow brown. Some zones of silty sandy clay and a trace of ironstone gravel.	MC<PL	Vst H.		
	DS	N = 21 6, 10, 11	4						500 360 450	
			5							
	DS	N = 23 7, 10, 13							>600 300 450 280	
			6							
▼ ON COMPL-TION OF AUG-ERING			7		SM.	CLAYEY SANDY SILT: fine grained, pale and yellow brown. Zones of silty sand.	W	L		

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
8
2/3

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 14 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450
R.L. Surface: ≑ 10·4m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
	DS				SM	CLAYEY SANDY SILT: as above.	W	L		
						Grading to				
	DS		8			SILTY SANDY CLAY: fine to medium plasticity, pale grey and orange brown. Trace of ironstone gravel.	MC>PL	F-st.		BACKFILL. ESTIMATED 'V' BIT REFUSAL
			9			SHALE: grey, highly weathered, weak with very weak and medium strong bands.		(CLASS 4)		LOW 'TC' BIT RESISTANCE WITH SOME MODERATE BANDS.
						SHALE: grey, slightly weathered and strong.		(CLASS 1)		
			10			REFER TO CORED BOREHOLE LOG.				SLOTTED ZONE WRAPPED IN GEOTEXTILE
			11							
			12							
			13							

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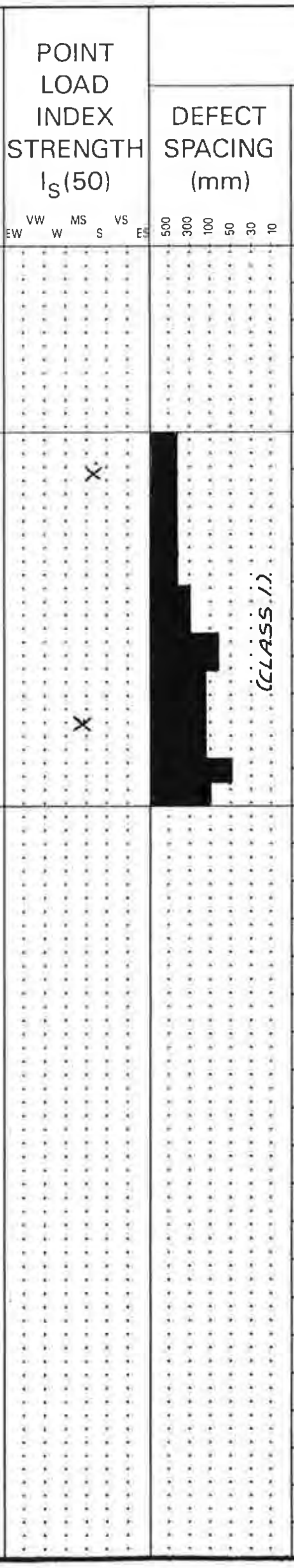
Borehole No.
8
3/3

CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL

Job No: 8471 W
Date Drilled: 14 - 10 - 91
Drill Type: INTERTECH BCD450
Core Size: N.M.L.C.
Inclination: VERTICAL
Bearing: —
R. L. Surface: ≑ 10·4m.
Datum: A.H.D.



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
				START CORING AT 10·0m.				
FULL RETURN.		10 11		SHALE: dark grey with very thin fine grained sandstone laminae.	SW	MS S	— BEDDING PARTING 0°-5° IRREGULAR, SMOOTH. — BEDDING PARTING, 3°, PLANAR, SMOOTH. JOINT, 70-80°, IRREGULAR, ROUGH. 4 BEDDING PARTINGS. JOINT, 75°, IRREGULAR, ROUGH.	
		12 13 14 15		END OF BOREHOLE AT 12·0m.				

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JOB No. 8471W BOREHOLE No. 8 START CORING AT 10.00m
10
11
END AT 12.00m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
9
1/3

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 14 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450.
R.L. Surface: ≑ 10.5m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						Grass over FILL: Sandy Silty Clay and crushed gravel.	MC<PL			APPEARS MODERATELY COMPACTED.
	DS					FILL: Clay, medium plasticity, brown and red brown.				
	DS									
	DS	N = 17 7, 9, 8	1		CL	CLAY: medium plasticity, pale grey and grey brown.	MC > PL	H.	500 510 450 510	ALLUVIUM.
						Grading to				
			2		CL-CH.	CLAY: medium to high plasticity, grey mottled red Brown.				
	DS	N = 18 6, 6, 12							500 510 490	
			3							
					CL	SILTY CLAY: medium plasticity, pale grey and yellow brown		Vst - H.		
	DS	N = 20 6, 8, 12	4						250 300 530	
			5			as above but with some ironstone gravel band. Occasional band of silty sand.				
	DS	N = 16 5, 7, 9			CL-CH.	CLAY: medium to high plasticity, pale grey and yellow brown. Trace of ironstone gravel.			400 300 290 430.	
			6							
			7							

BOREHOLE LOG

Borehole No.
9
2/3

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 14 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450
R.L. Surface: ≑ 10·5m
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
	DS		8 9		CL-CH.	CLAY: medium to high plasticity, grey, red brown and yellow brown. A trace of ironstone gravel.	MC<PL	Vst — H.		
BEFORE CORING			10		CL	SILTY CLAY: medium plasticity, pale grey and orange brown.				ESTIMATED 'V' BIT REFUSAL.
			11			SHALE: grey brown and grey, highly to moderately weathered, weak to medium strong.		(CLASS 4)		LOW 'TC' BIT RESISTANCE WITH SOME MODERATE BANDS.
						as above but moderately weathered, medium strong to strong.		(CLASS 2)		
			12 13			REFER TO CORED BOREHOLE LOG.				

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

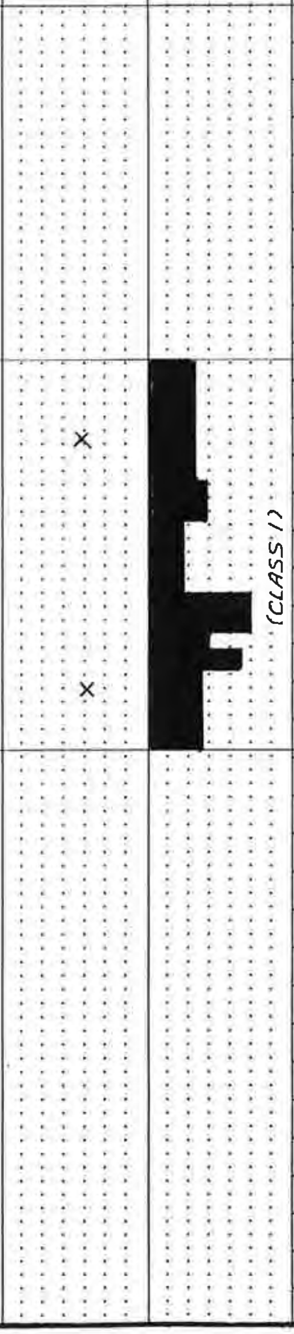
Borehole No.
9
3/3

CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL.

Job No: 8471 W
Date Drilled: 14 - 10 - 91
Drill Type: INTERTECH BCD450.
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: –
R. L. Surface: ≑ 10.5m.
Datum: A.H.D.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		11								
				START CORING AT 11.92m.						
FULL RETURN.		12		SHALE: dark grey with fine grained sandstone laminae.	SW	MS-S	×			NB. DEFECTS ARE BEDDING PARTINGS, 0°-10°, PLANAR, SMOOTH, UNLESS LABELLED OTHERWISE.
		13					×	(CLASS 1)	HIGHLY FRAGMENTED SEAM, 10-15mm.	
		14		END OF BH AT 13.99m						
		15								
		16								



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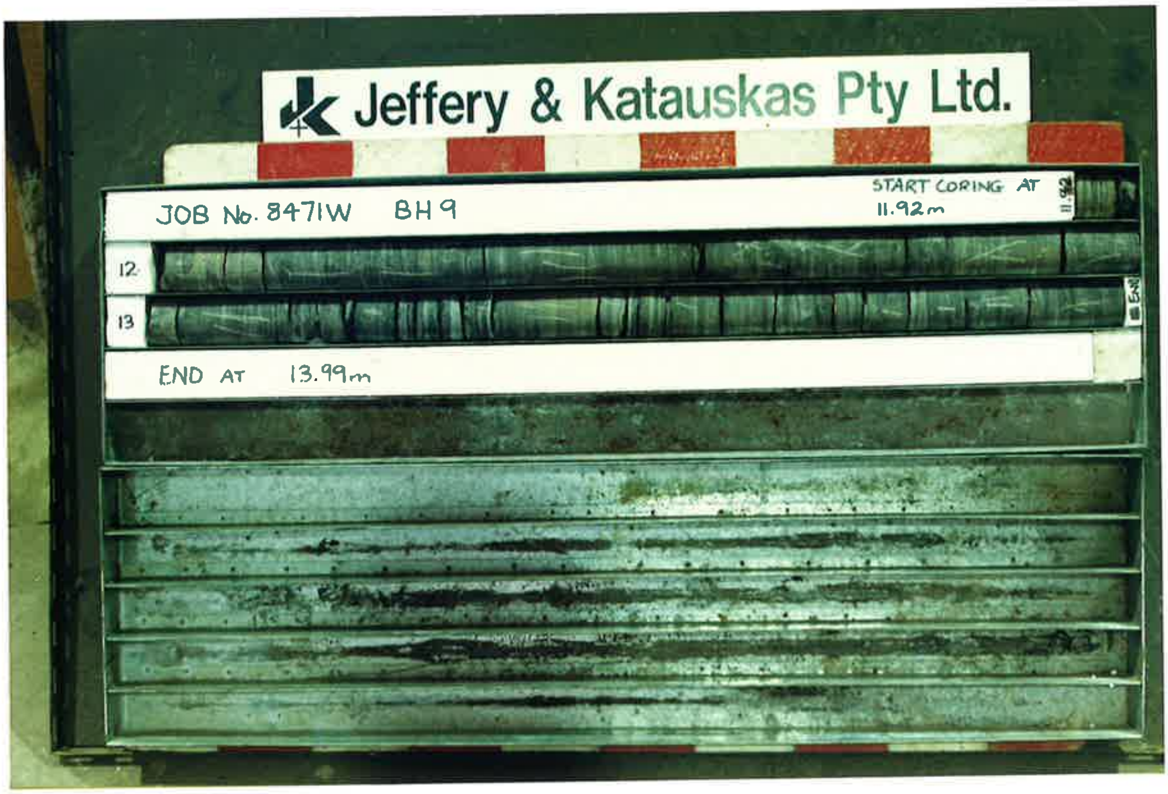
Jeffery & Katauskas Pty Ltd.
JOB No. 8471W BH9
START CORING AT 11.92m
12
13
END AT 13.99m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
10
1/3

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 14 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450
R.L. Surface: ≑ 10·8m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						Grass over FILL: Silty Clay, low to plasticity, brown. Some concrete pieces and basalt gravel.	MC<PL			APPEARS MODERATELY COMPACTED.
	DS	N = 5 1, 2, 3	1			FILL: Clay, high plasticity, grey brown and red brown. Trace of shale pieces.	MC>PL		170 160 70 100	APPEARS POORLY TO MODERATELY COMPACTED.
▶					CL	CLAY: medium plasticity, grey mottled red brown. A trace of fine grained sand and pinholes.	MC>PL	st		ALLUVIUM.
			2					Vst - H.		
	DS	N = 17 6, 7, 10	3						320 490 380 450	
ON SPT RODS AT 4·35m ▶ ▼ BEFORE CORING.					CL	SILTY SANDY CLAY: low to medium plasticity, pale grey and yellow brown. Occasional ironstone gravel bands.		st.		
	DS	N = 12 4, 5, 7	4						170 130 180.	
			5		CL-CH	CLAY: medium to high plasticity, grey and yellow brown.	MC<PL	Vst.		
	DS	N = 14 5, 6, 8	6						300 270 220 400	
						— — — as above but grey and orange brown. Some ironstone gravel.		st to Vst.		
	DS		7							

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Borehole No.
10
2/3

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 10 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450.
R.L. Surface: ≑ 10·8m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
					CL-CH.	CLAY: medium to high plasticity, grey and orange brown. Some ironstone gravel.	MC>PL	st – Vst.		
			8			— — — as above but with abundant ironstone gravel.				
	DS									
			9							
			10							
			11							ESTIMATED 'V' BIT REFUSAL.
						SHALE: grey, moderately weathered, weak to medium strong.		(CLASS 4)		BANDED LOW & MODERATE 'TC' BIT RESISTANCE.
										MODERATE RESISTANCE
						REFER TO CORED BOREHOLE LOG.				
			12							
			13							

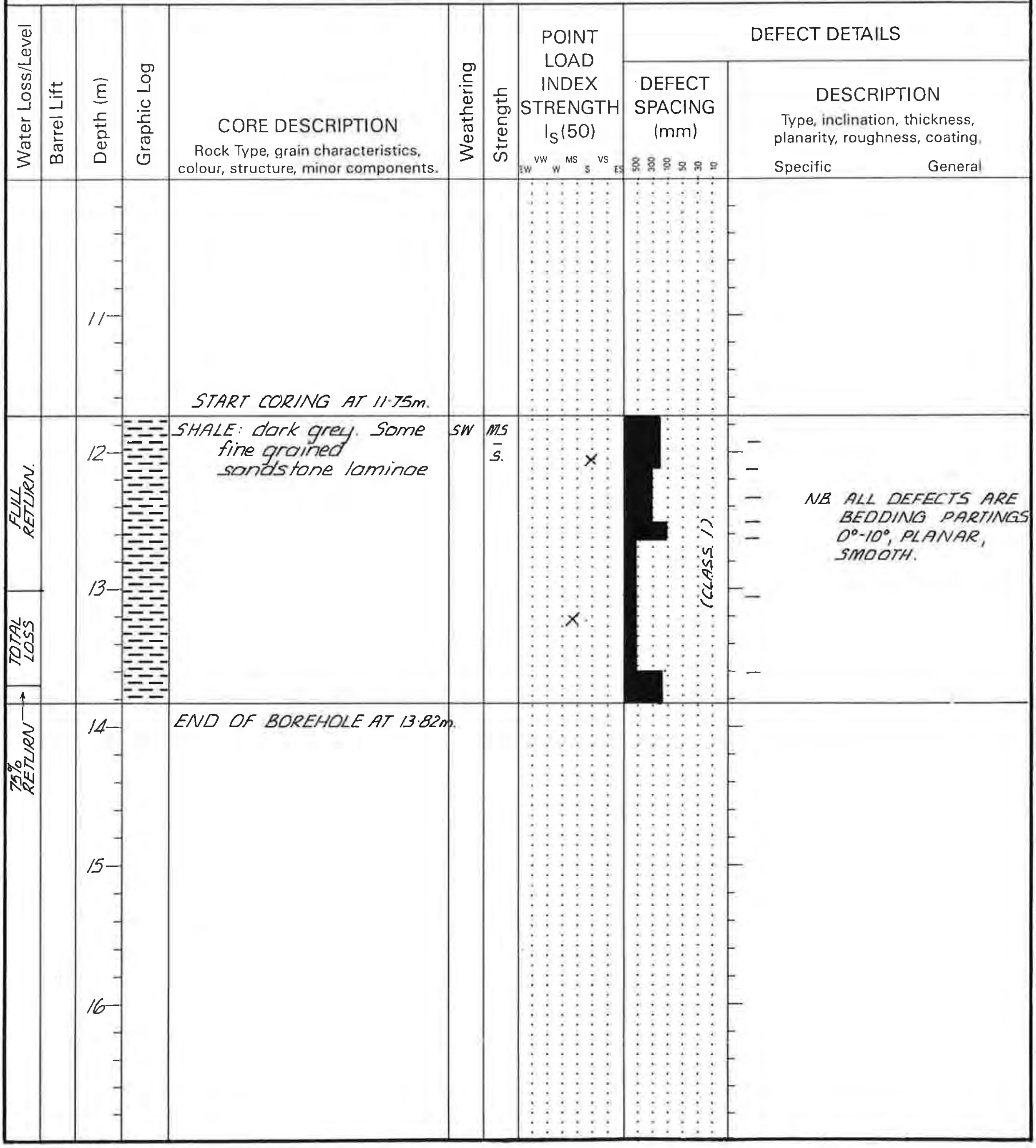
Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
10
3/3

CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL.

Job No: 8471W
Date Drilled: 10 - 10 - 91
Drill Type: INTERTECH BCD450
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —
R. L. Surface: ≑ 10·8m.
Datum: A.H.D.



START CORING AT 11·75m.

SHALE: dark grey. Some fine grained sandstone laminae

SW

MS - S.

NB ALL DEFECTS ARE BEDDING PARTINGS 0°-10°, PLANAR, SMOOTH.

END OF BOREHOLE AT 13·82m.

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8471W
BOREHOLE No. 10
START CORING AT 11.75m
11.75
12
13
13.82
END AT 13.82m

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CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
11
1/3

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 14 - 10 - 91
Method: SPIRAL AUGER
GCH. RIG.
R.L. Surface: ≑ 10·5m
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
				▩		Grass over FILL: Clay and crushed shale, ironstone and basalt gravel.				
				▨	CL-CH	CLAY: medium to high plasticity, pale grey mottled orange brown.	MC>PL	Vst to H.		ALLUVIUM.
	DS	N=14 3, 6, 8	1	▨					570 540 540	
			2	▨						
	DS	N=27 6, 12, 15		▨					>600 >600	
			3	▨						
				▒	CL	SANDY SILTY CLAY: medium plasticity, pale grey with yellow brown and orange brown mottle zones of sandy clay and clay.		H.		
	DS	N ≥ 29 7, 19, 10/70mm	4	▒					>600 >600 >600	
			5	▒						
	DS	N=26 5, 11, 15		▒					590 >600 550	
			6	▒						
				▒				Vst with hard and stiff bands.		
			7							

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BOREHOLE LOG

Borehole No.
11
2/3

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 14 - 10 - 91
Method: SPIRAL AUGER
G.C.H. RIG.
R.L. Surface: ≑ 10·5m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
	DS	N =12 5, 6, 6			CL	SILTY SANDY CLAY: medium plasticity, grey and yellow brown. Abundant zones of clayey silty sand.	MC > PL	Vst with hard and stiff zones.	600 200 550.	
▼ BEFORE CORING										
			8							
			9							
			10							
			11							
			12							ESTIMATED 'V' BIT REFUSAL.
			13			SHALE : grey, highly weathered, very weak with extremely weak and weak bands.	(CLASS 4/5)			LOW 'TC' BIT RESISTANCE.
			14			as above but moderately weathered & medium strong.	(CLASS 3)			MODERATE RESISTANCE.

REFER TO CORED BOREHOLE LOG

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CONSULTING GEOTECHNICAL ENGINEERS

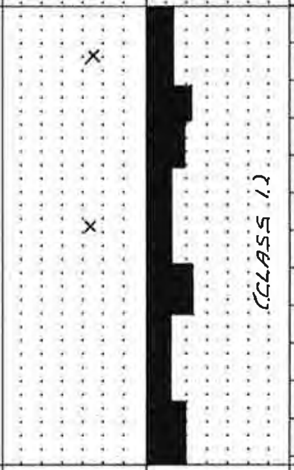
Borehole No.
11
3/3

CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL

Job No: 8471 W
Date Drilled: 14 - 10 - 91
Drill Type: G.C.H. RIG.
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —
R. L. Surface: ≑ 10·5m.
Datum: A.H.D.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS – DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) – Specific	General
		14		START CORING AT 14·20m.						
FULL RETURN.		15 16		SHALE: dark grey with fine grained sandstone laminae.	SW	S	× ×	(CLASS 1)	— — — — — —	NB DEFECTS ARE BEDDING PARTINGS 0°-10°, CURVED, SMOOTH.
		17 18 19		END OF BOREHOLE AT 16·61m						



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JOB No. 8471W
BOREHOLE No 11
START. CORING AT 14.20m
14.20
15
16
END OF BH 11 AT 16.61m

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL ENGINEERS

BOREHOLE LOG

Borehole No.
12
1/3

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 11 - 10 - 91
Method: SPIRAL AUGER
G.C.H. RIG.
R.L. Surface: ≑ 10·1m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						BITUMEN PAVEMENT 55mm thick FILL: Fine crushed rock 200mmt. FILL: Ripped sandstone & clayey sand mixtures, fine to coarse grained.				HAND AUGER APPEARS MODERATELY COMPACTED.
					CH.	CLAY: high plasticity, brown, grey mottled, trace of ironstone gravel.	MC≤PL	Vst to H.		ALLUVIUM.
	DS	N = 21 7, 10, 11	1						280 310 375 400 410	
						becomes red brown and grey mottled.				
			2							
						as above but some ironstone gravel bands.				
	DS	N = 25 5, 10, 15						H.	310 385 410 440	
			3							
					CL-CH.	SILTY SANDY CLAY: medium to high plasticity, yellow brown and grey. Grading to.				
	DS	N = 31 7, 13, 18	4		CL	SANDY CLAY: medium plasticity, grey with some ironstone gravel.			430 450 475 480	
			5				MC>PL			
	DS	N = 27 8, 12, 15								
			6			Grading to.				
					CL-CH.	SILTY SANDY CLAY: medium to high plasticity, yellow brown, some grey mottling.	MC>PL			
	DS		7							

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Borehole No.
12
2/3

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 11 - 10 - 91
Method: SPIRAL AUGER
G.C.H. RIG.
R.L. Surface: ≑10·1m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						SILTY SANDY CLAY: as above.	MC≥PL	H.		
					CL	SANDY CLAY: low plasticity yellow brown.	MC>PL			
	DS		8							
▶					SC	CLAYEY SAND: fine to medium grained, yellow brown.	W	(MD)		← HOLE COLLAPSE ON COMPLETION OF AUGERING.
	DS		9							
			10							
			11							⊤ 15mm.
	DS					SHALE: dark grey, highly to moderately weathered weak with occasional medium strong bands.		(CLASS 4)		LOW 'TC' BIT RESISTANCE WITH SOME MODERATE BANDS.
			12			as above but moderately weathered, medium strong, dark grey.		(CLASS 3)		MODERATE RESIST.
						REFER TO CORED BOREHOLE LOG.				
			13							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
12   3/3

CORED BOREHOLE LOG

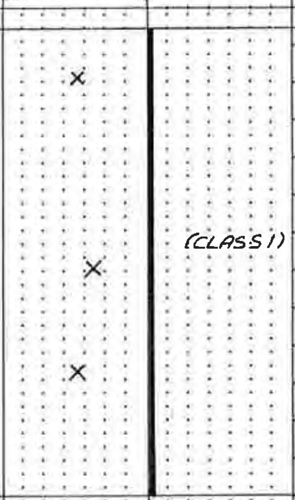
Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL.

Job No: 8471 W
Date Drilled: 11 - 10 - 91
Drill Type: G.C.H. RIG.

Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —

R. L. Surface: ≑ 10·1m.
Datum: A.H.D.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
				START CORING AT 12·15m.					
FULL RETURN.		13 14		SHALE : dark grey.	SW	MS to S	× × ×	(CLASS I)	— FRAGMENTED ZONE. 0°, 10mm. NB DEFECTS NOT LABELLED ARE BEDDING PARTINGS AND MECHANICAL BREAKS.
		15 16 17 18		END OF BH AT 14.60m					



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8471 W BH12 START AT 12.15m
12
12.15
13
14
END AT 14.6m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
13
1/3

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 11 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450
R.L. Surface: ≑ 10·3m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						BITUMEN PAVEMENT 50mm t. FILL: Fine crushed rock 150mm t. FILL: Ripped sandstone and clayey sand mixtures, fine to coarse grained.				APPEARS MODERATELY COMPACTED. HAND AUGER.
					CL-CH.	FILL: Sandy Clay, low plasticity, brown with some clay lumps and sandstone gravel.	MC≤PL	Vst to H.		ALLUVIUM.
	DS	N = 17 6, 6, 11	1						380 395 440 410.	
						CLAY: medium to high plasticity, brown, some grey mottling, trace of ironstone gravel.				
	DS									
			2			as above but red brown and grey mottled.				
	DS	N = 23 7, 10, 13						H.	380 410 440 390.	
			3							
						Grading to				
					CL-CH.	SILTY SANDY CLAY: medium to high plasticity, orange red brown, some ironstone gravel bands.				
	DS	N = 25 12, 11, 14	4			as above but some clay lenses of high plasticity, grey.			410 430 500 510	
					CL	SANDY CLAY: medium plasticity, yellow brown and grey with some ironstone gravel.				
	DS		5							
	DS	N = 28 11, 13, 15					MC>PL		410 425 400 430	
			6							
						becomes low to medium plasticity.				
	DS		7							

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BOREHOLE LOG

Borehole No.
13
2/3

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 11 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450
R.L. Surface: ≑ 10·3m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
▼ ON COMPLETION				▨	CL	SANDY CLAY: low plasticity, orange brown some iron cemented gravel.	MC>PL	(Vst to H)		
			8	▨						
	DS			▨						
			9	▨						
				☰		SHALE: dark grey, moderately weathered, medium strong.	(CLASS 3)			MODERATE 'TC' BIT RESISTANCE.
			10			REFER TO CORED BOREHOLE LOG.				
			11							
			12							
			13							

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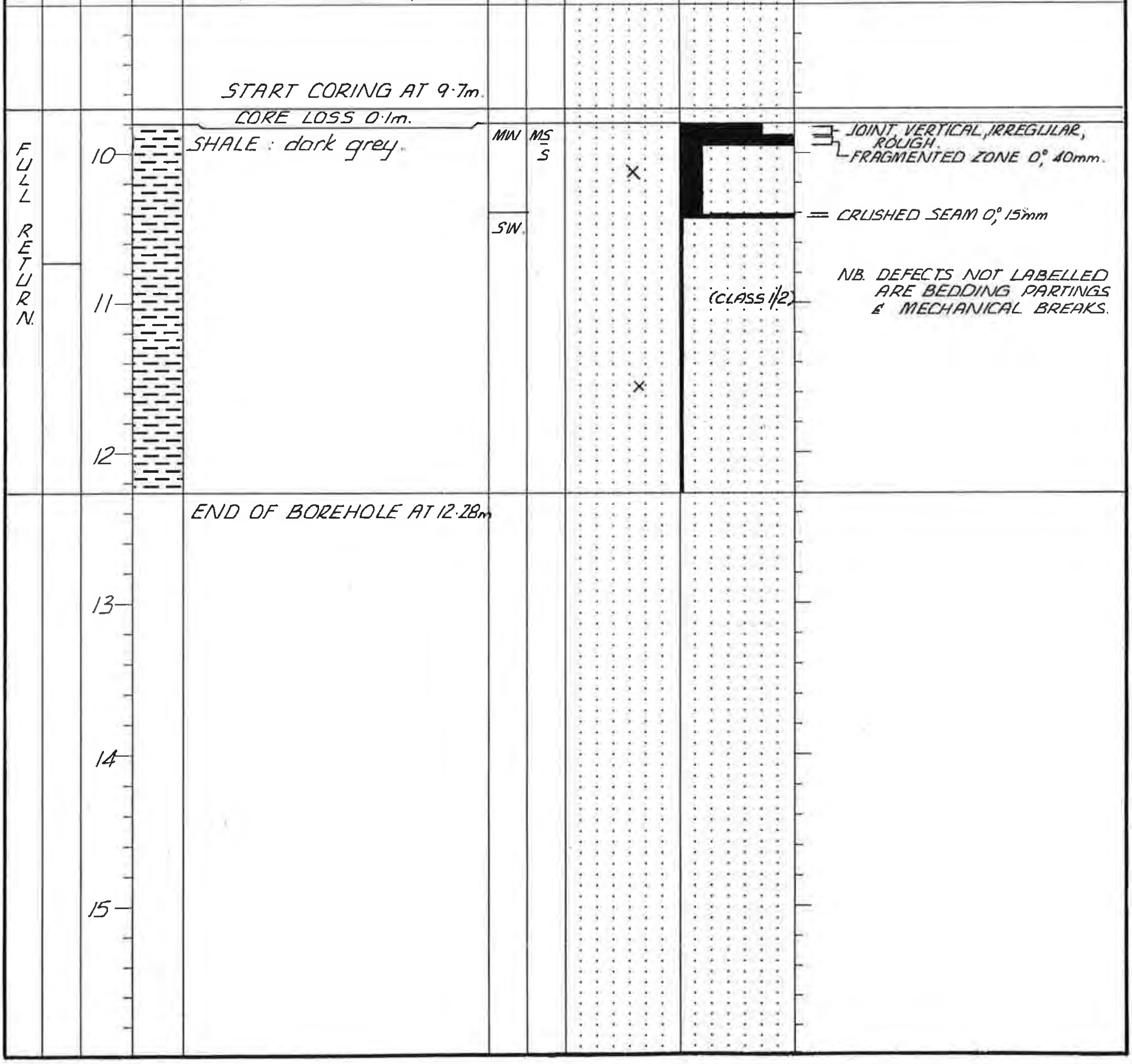
Borehole No.
13
3/3

CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL.

Job No: 8471 W
Date Drilled: 11 - 10 - 91
Drill Type: INTERTECH BCD450.
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —
R. L. Surface: ≑ 10·3m.
Datum: A.H.D.



Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific General
				START CORING AT 9·7m.					
				CORE LOSS 0·1m.					
FULL RETURN.		10 11 12		SHALE : dark grey.	MW SW	MS – S	× ×	(CLASS 1/2)	JOINT, VERTICAL, IRREGULAR, ROUGH. FRAGMENTED ZONE 0°, 40mm. CRUSHED SEAM 0°, 15mm NB. DEFECTS NOT LABELLED ARE BEDDING PARTINGS & MECHANICAL BREAKS.
		13 14 15		END OF BOREHOLE AT 12·28m					

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8471W BH13 START AT 9.7m
9.7
CORE LOSS 0.1m
10
11
12
END AT 12.28m

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CONSULTING GEOTECHNICAL ENGINEERS

Borehole No.
14
1/2

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 11 - 10 - 91
Method: SPIRAL AUGER INTERTECH BCD 450.
R.L. Surface: ≑ 11·3m
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION OF AUGERING.						Grass over FILL: Clayey Sand, fine to medium grained, brown, some roots.	D			APPEARS POORLY COMPACTED ALLUVIUM. PVC CAP.
					ML	CLAYEY SILT: low plasticity, greyish brown.	MC>PL	(st)		
	DB				CH	CLAY: high plasticity, red brown, some grey mottling, some ironstone gravel.	MC>PL	Vst.		CEMENT
	DS	N =7 3, 3, 4	1						210 280 275 260	CLAY BACKFILL
						becomes red brown and grey mottled.				STANDPIPE INSTALLED TO 8·0m.
			2							
	DS	N = 18 4, 7, 11							245 280 295 345	
			3			becomes grey, trace of sand.				
										BENTONITE
	DS	N >> 6 14, 6/30mm								
	DS	BOUNCING.	4			SHALE: grey & dark grey extremely to highly weathered, extremely to very weak, with occasional medium strong bands.		(CLASS 5)		LOW 'TC' BIT RESISTANCE WITH MODERATE BANDS.
						as above but highly weathered, weak.		(CLASS 4)		
	DS		5							
						as above but highly weathered, medium strong.		(CLASS 3/4)		SAND
	DS									
			6			REFER TO CORED BOREHOLE LOG.				2·0m SLOTTED ZONE WRAPPED WITH GEOTEXTILE
			7							

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Borehole No.
14
2/2

CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL.

Job No: 8471 W
Date Drilled: 11 - 10 - 91
Drill Type: INTERTECH. BCD 450.
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —
R. L. Surface: ≑ 11·3m.
Datum: A.H.D.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
				START CORING AT 5·9m.						
				CORE LOSS 0·08m.						
FULL RETURN.		6		SHALE: dark grey, partially ironstained down to 6·7m.	HW	MS			— CLAY SEAM, 0°, 3mm — CLAY SEAM, 0°, 3mm — EW BAND, 0°, 15mm — FRAGMENTED ZONE 0° 20mm.	
					MW		×	(CLASS4)		
					SW	MS to S			— JOINT, 0° PLANAR, ROUGH, FRAGMENTED ABOUT THE JOINT.	
		7								
							×	(CLASS 1)		
		8								
				END OF BOREHOLE AT 8 15m.						
		9								
		10								
		11								


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8471W BH14 START AT 5.9m
5.9
CORE LOSS 0.08m
6
7
8
END AT 8.15m

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BOREHOLE LOG

Borehole No. 15
1/2

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 11 - 10 - 91
Method: SPIRAL AUGER
G.C.H. RIG.
R.L. Surface: ≑ 12·0m
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION OF AUGERING.				▩		Grass over FILL: Clayey Sand, fine to medium grained, brown with some roots.	D			APPEARS POORLY COMPACTED.
	DS DS	N = 13 4, 6, 7	1	▨	CH.	CLAY: high plasticity, red brown, with some ironstone gravel.	MC > PL	Vst	300 320 345 360	RESIDUAL.
			2	░		SANDSTONE: fine grained, yellow brown, highly weathered very weak to weak.	(CLASS 5)			LOW 'TC' BIT RESISTANCE.
	DS DS	N ≫ 20 20/150mm BOUNCING	3	☰		SHALE: grey, extremely weathered, extremely weak with some sandstone bands interbedded, some shaly clay bands.				
						as above but highly weathered, medium strong.	(CLASS 4)			MODERATE RESISTANCE.
			4 5 6 7			REFER TO CORED BOREHOLE LOG.				

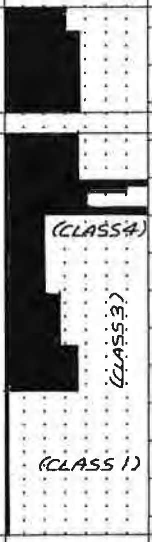
Borehole No.
15
2/2

CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL.

Job No: 8471 W
Date Drilled: 11 - 10 - 91
Drill Type: G.C.H. RIG.
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —
R. L. Surface: ≑ 12·0m
Datum: A.H.D.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT DETAILS: DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
				START CORING AT 3·7m.						
FULL RETURN.		4		SHALE: brownish grey, some Sandstone bands, up to 50mm thick interbedded.	HW	MS	×		— CLAY SEAM, 0°, 4mm — CLAY SEAM 0°, 4mm.	NB. DEFECTS NOT LABELLED ARE BEDDING PARTINGS OR MECHANICAL BREAKS.
				CORE LOSS 0·08m.						
				SHALE: as above.	HW	MS				
				— — Sandstone band, 90mm thick.		W to MS.			CLAY SEAM 0°, 10mm. CLAY SEAM, 0°, 3mm CLAY SEAM 0°, 20mm.	
		5		— — becomes dark grey, partially ironstained.		W				
					HW to MW	MS	×		— CLAY SEAM, 0°, 4mm — CLAY SEAM, 0°, 2mm. — EW BAND, 0°, 7mm. — CLAY SEAM, 0°, 3mm.	
		6			MW	MS S	×			
				END OF BOREHOLE AT 6·5m.						
		7								
		8								
		9								

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8471W BH15 START AT 3.7m
4
CORE LOSS 0.08m
5
6
END AT 6.5m

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Borehole No.
16
1/2

BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL.

Job No. 8471 W
Date: 15 - 10 - 91
Method: SPIRAL AUGER
INTERTECH BCD 450
R.L. Surface: ≑ 11·1m.
Datum: A.H.D.

Groundwater record	Samples	Field Tests	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION OF AUGERING.	BS					Grass over FILL: Sandy Silty Clay, low to medium plasticity, brown. Some brick and concrete fragments.	MC<PL			APPEARS MODERATELY COMPACTED.
	DS	N = 8 4, 3, 5	1		CL.	SILTY CLAY: low plasticity, brown.	MC>PL	VSt	390	RESIDUAL
					CL-CH.	CLAY: medium to high plasticity, orange brown.				ESTIMATED 'V' BIT REFUSAL.
	DS		2			SHALE / CLAYSTONE: pale grey, highly fractured, highly weathered, medium strong. Some extremely weak and ironstone seams.				BANDED LOW AND MODERATE 'TC' BIT RESISTANCE
	DS		3 4			SHALE: orange and pale grey, extremely weathered, extremely weak. Some clay, ironstone and weak shale bands.		(CLASS 5)		
AFTER 12 HRS BEFORE CORING.						SHALE: brown and grey, moderately weathered, medium strong. Some weak seams.		(CLASS 4/3)		MODERATE RESISTANCE.
			5 6 7			REFER TO CORED BOREHOLE LOG.				

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Borehole No.
16
2/2

CORED BOREHOLE LOG

Client: SOUTH WESTERN SYDNEY AREA HEALTH SERVICE
Project: PROPOSED REDEVELOPMENT
Location: LIVERPOOL HOSPITAL, GOULBURN STREET. LIVERPOOL.

Job No: 8471 W
Date Drilled: 16 - 10 - 91
Drill Type: INTERTECH BCD 450.
Core Size: N.M.L.C.
Inclination: VERTICAL.
Bearing: —
R. L. Surface: ≑ 11·1m.
Datum: A.H.D.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_S(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
				START CORING AT 4·95m.						
		5	═	SHALE: brown and dark grey.	MW	MS.	× ×	(CLASS 3)	— JOINT, 80°, CURVED, SMOOTH. — CLAY SEAM, 5-8mm. — HW SEAM, 5-10mm. — HIGHLY FRAGMENTED ZONE, 80mm 3 EW SEAMS, 10mm, 20mm, 10mm — HIGHLY FRAGMENTED ZONE, 40mm 2 EW SEAM, 10mm, 2mm	
		6	═	as above but dark grey with thin fine grained sandstone laminae.	MW SW	MS S	×	(CLASS 2)		
		7		END OF BOREHOLE AT 6·9m.						
		8								
		9								
		10								


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JOB No. 8471W
BOREHOLE No. 16
START CORING AT 4.95m
4.95
5
6
END AT 6.85m

APPENDIX B

Borehole Log 101 from
'Stage 1 Geotechnical Investigation for Proposed New Mental Health Facility' Report,
Ref. M17359WArpt dated 21/01/03

BOREHOLE LOG

Borehole No.
101
1/4

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

Job No. M17359SA
Date: 19-12-02
Method: SPIRAL AUGER
JK350
R.L. Surface: ≅ 10.1m
Datum: AHD
Logged/Checked by: A.J./AGH

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	▩		FILL: Silty sand, fine to medium grained, dark brown, with clay nodules, with a trace of fine to coarse grained sandstone and igneous gravel.	M			
	■		■		N = 9 3,4,5		▩		FILL: Silty clay, low plasticity, brown and various colours, with fine to medium grained sand, a trace of fine to medium grained igneous gravel, with occasional high plasticity seams.	MC>PL		290 330	APPEARS POORLY TO MODERATELY COMPACTED
			■			1	▩						
				■	N = 5 3,2,3		▩					150 100 140	POSSIBLY BACKFILL TO ADJACENT SERVICES TUNNEL
						2	▩						
							▨	CH	SILTY CLAY: high plasticity, brown, with a trace of ironstone gravel.	MC>PL	VSt- H	-	ALLUVIAL
	■				N = 28 6,12,16	3	▨					420 380 540	
				■			▨	CL	SILTY CLAY: low to medium plasticity, grey mottled orange brown, with fine grained sand.				
						4	░	SC	CLAYEY SAND: fine to medium grained, orange brown.	M	(MD)		
				■	N = 29 7,14,15		▨	CH	SILTY CLAY: high plasticity, orange brown mottled grey, with ironstone gravel.	MC≅PL	H	>600 590 >600	
						5	▨						
				■	N = 27 7,12,15	6	▨		as above, but mottled grey and orange brown, with fine grained sand.			>600 470 >600	
ON 20-12- 02 ▼						7	▨						

BOREHOLE LOG

Borehole No.
101 2/4

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

Job No. M17359SA
Date: 19-12-02
Method: SPIRAL AUGER JK350
Logged/Checked by: A.J./ AJH
R.L. Surface: ≅ 10.1m
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
▶				■	N = 9 3,3,6	8		CL	SILTY CLAY: medium plasticity, grey mottled orange brown, with occasional sand seams.	MC>PL	S-F St-VSt	30 30 70 190 220	
				■	N = 12 3,6,6	9		CL	SILTY SANDY CLAY: low plasticity, grey mottled orange brown, with dark brown clayey sand bands.		F-St	70 70 100 150	SPT SUNK FROM 9.0m TO 9.2m UNDER SELF WEIGHT
				■	N = 38 2,10,28	10		SC	SILTY CLAYEY SAND: fine to coarse grained, black.	W	MD		
						11 12		SP	SAND: fine to coarse grained, grey, with a trace of fine grained rounded quartz gravel.		D		
				■		13 14		-	SHALE: dark grey, with extremely weathered seams.	SW	H	-	LOW 'TC' BIT RESISTANCE

BOREHOLE LOG

Borehole No.
101 3/4

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

Job No. M17359SA
Date: 19-12-02
Method: SPIRAL AUGER JK350
Logged/Checked by: A.J./
R.L. Surface: ≅ 10.1m
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
							▤		SHALE: dark grey, with extremely weathered seams.	SW	H		
									REFER TO CORED BOREHOLE LOG				
						15							
						16							
						17							
						18							
						19							
						20							

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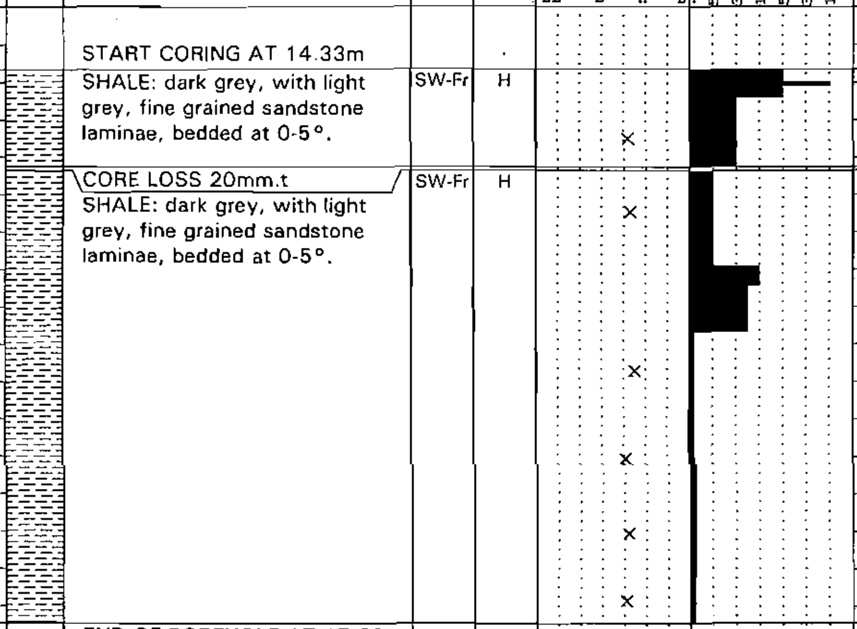
CORED BOREHOLE LOG

Borehole No.
101 4/4

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

Job No. M17359SA
Core Size: NMLC
R.L. Surface: ≅ 10.1m
Date: 19-12-02
Inclination: VERTICAL
Datum: AHD
Drill Type: JK350
Bearing: -
Logged/Checked by: A.J./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 $I_s(50)$ 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
		14		START CORING AT 14.33m						
				SHALE: dark grey, with light grey, fine grained sandstone laminae, bedded at 0-5°.	SW-Fr	H			- XWS, 7mm.t - XWS, 7mm.t - Cr, 5mm.t	
		15		CORE LOSS 20mm.t SHALE: dark grey, with light grey, fine grained sandstone laminae, bedded at 0-5°.	SW-Fr	H			CS, 10mm.t - XWS, 10mm.t - Cr, 5mm.t - CS, 1mm.t	
		16								
		17							50mm DIAMETER SLOTTED PVC STANDPIPE INSTALLED TO 12.0m DEPTH	
				END OF BOREHOLE AT 17.29m						
		18								
		19								
		20								



APPENDIX C

Borehole Log 1008 from ‘Geotechnical Investigation for Proposed Liverpool Hospital Redevelopment Project’ Report, Ref. M20303ZArpt dated 13/07/06

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
1008
1/2

Client:

Project: PROPOSED LIVERPOOL HOSPITAL REDEVELOPMENT PROJECT

Location: LIVERPOOL HOSPITAL, NSW

Job No. M20303ZA

Method: SPIRAL AUGER
JK250

R.L. Surface:

Date: 2-6-06

Datum:

Logged/Checked by: A.J./AJH

Groundwater Record	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 COMPLET-ION OF AUGER-ING	■			■	N = 10 3,5,5	0			FILL: Silty sand, fine to medium grained, dark brown, with fine to coarse grained sub angular sandstone gravel, with a trace of clay nodules, coarse grained angular slag gravel and brick fragments.	M MC<PL			GRASS COVER APPEARS MODERATELY COMPACTED
	■			■	N = 25 9,10,15	1			FILL: Silty clay, high plasticity, dark brown and various colours, with a trace of fine to medium grained sub angular sandstone and igneous gravel and fine to medium grained sand.				
	■					2		CH	SILTY CLAY: high plasticity, orange brown mottled light grey and red brown.	MC<PL	H	>600 >600	RESIDUAL
				■	N = 13 3,6,7	3		CL	SILTY CLAY: medium plasticity, light grey mottled orange brown and red brown, with a trace of fine to medium grained sub angular ironstone gravel.	MC>PL	St -VSt	320 140 270	
									as above, but with ironstone gravel bands.				
						4		-	SHALE: dark grey and dark brown.	DW	L	-	LOW 'TC' BIT RESISTANCE
						5 6 7			REFER TO CORED BOREHOLE LOG				

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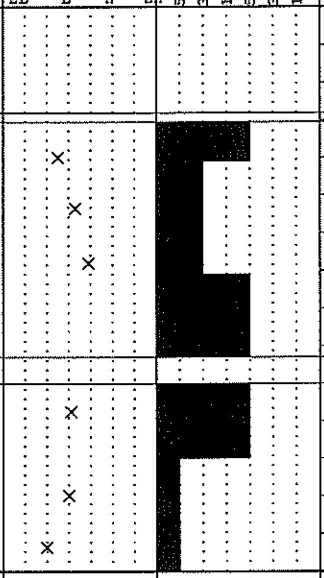
CORED BOREHOLE LOG

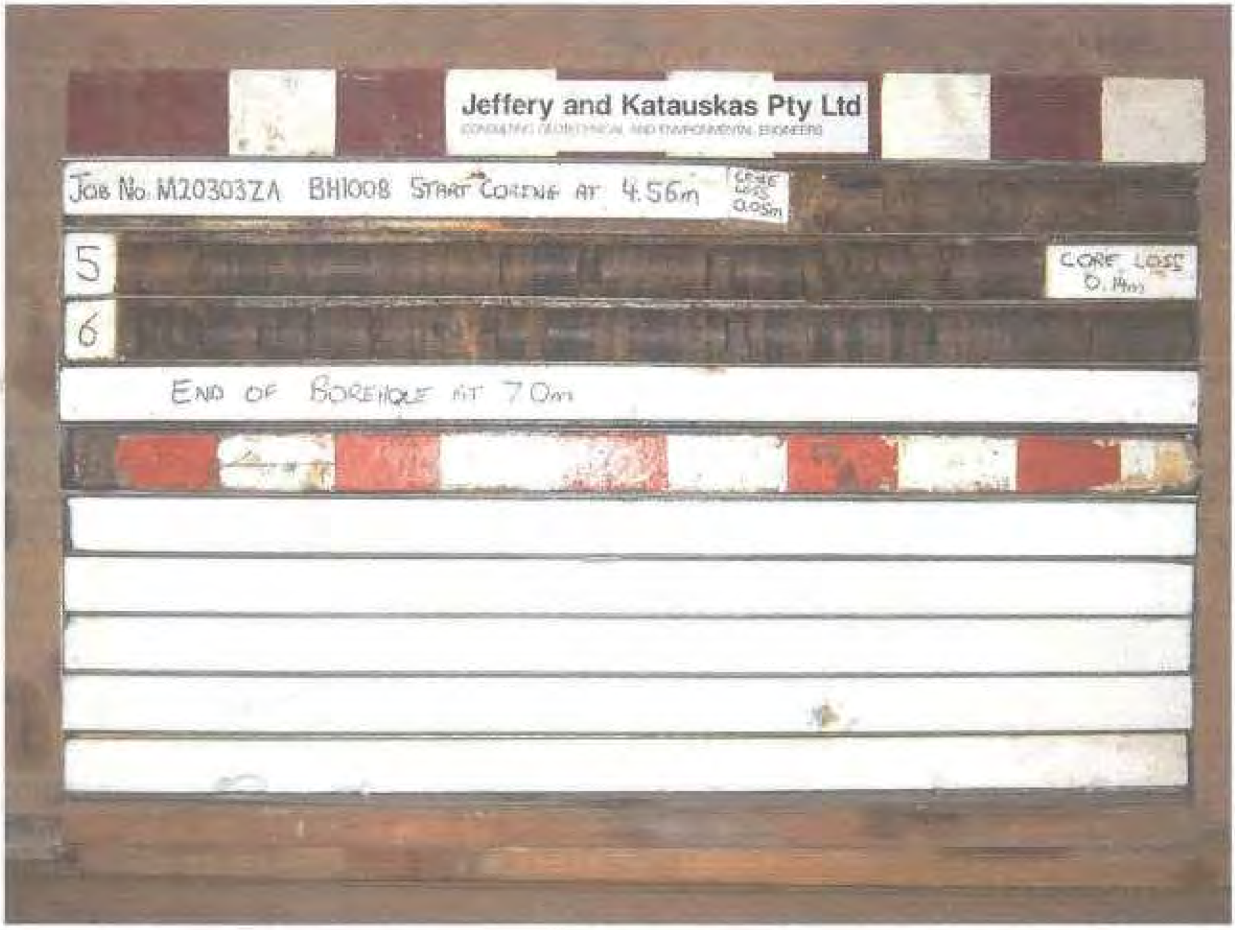
Borehole No.
1008
2/2

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

Job No. M20303ZA
Date: 2-6-06
Drill Type: JK350
Core Size: NMLC
Inclination: VERTICAL
Bearing: -
R.L. Surface:
Datum:
Logged/Checked by: A.J./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
		4		START CORING AT 4.56m						
FULL RET-URN		5		CORE LOSS 0.05m SHALE: dark brown with dark grey and grey seams, bedded at 0-5°.	DW	L-M			- CS, 40mm.t - XWS, 50mm.t - J, 80°, P, S - XWS/CS, 50mm.t - XWS, 10mm.t - Cr, 20mm.t - Be, 0°, P, R, CLAY COATED - Cr, 15mm.t - J, 30°, P, S - CS/XWS, 40mm.t	
				CORE LOSS 0.14m						
		6		SHALE: dark brown, with dark grey seams, bedded at 0-5°.	DW	L-M			- CS/Cr, 40mm.t - CS, 15mm.t - XWS, 20mm.t - Cr/XWS, 40mm.t - XWS/CS, 70mm.t - XWS, 20mm.t	
		7		END OF BOREHOLE AT 7.00m						
		8								
		9								
		10								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JOB No. M20303ZA BH1008 START CORING AT 4.56m
CORE LOSS 0.05m
5
CORE LOSS 0.14m
6
END OF BOREHOLE AT 7.0m

APPENDIX D

Borehole Logs CT1 & CT3 and Laboratory Test Results from ‘Geotechnical Investigation for Proposed Extension to Cancer Therapy Building’ Report, Ref. M20852ZArpt dated 17/05/07

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BOREHOLE LOG

Borehole No.
CT1
1/3

Client:
Project: PROPOSED EXTENSION TO CANCER THERAPY BUILDING
Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M20852ZA
Date: 8-1-07
Method: SPIRAL AUGER
JK300
R.L. Surface: ≈ 10.8m
Datum: AHD
Logged/Checked by: N.E.S./

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
						0			FILL: Silty clay, medium plasticity, grey brown, with sand and root fibres.	MC<PL			GRASS COVER
					N = 33 11,16,17				FILL: Silty clay, medium plasticity, grey brown, with shale and igneous gravel, and timber and brick fragments.				APPEARS WELL COMPACTED
						1							
					N = 17 7,8,9			CH	SILTY CLAY: high plasticity, grey and orange brown.	MC≈PL	H	>600 >600 >600	
						2							
					N = 15 6,7,8	3				MC>PL		490 >600 >600	
						4		CL	SILTY CLAY: medium plasticity, grey and orange brown, with ironstone gravel bands.		VSt- H		
					N = 15 5,6,9							300 300 520 590	
						5							
▼ ON COMPLETION OF CORING													
					N = 20 7,8,12	6					H	510 440 490	
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
CT1
2/3

Client:
Project: PROPOSED EXTENSION TO CANCER THERAPY BUILDING
Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M20852ZA
Date: 8-1-07
Method: SPIRAL AUGER JK300
Logged/Checked by: N.E.S./
R.L. Surface: ≈ 10.8m
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	SILTY CLAY: medium plasticity, grey and orange brown, with ironstone gravel bands.	MC>PL	H		
▶						8	▨						
▼ ON COMPLETION OF AUGERING					N = 12 3,4,8	9	▨						NO SAMPLE RECOVERED IN SPT SPLIT SPOON SAMPLER
						10	▨						
						11	▨						
						12	☰	-	SHALE: light grey and grey.	XW-DW	EL-VL	-	VERY LOW 'TC' BIT RESISTANCE
				■		13	☰		SHALE: grey.	DW	L-M		LOW RESISTANCE
									REFER TO CORED BOREHOLE LOG				
						14							

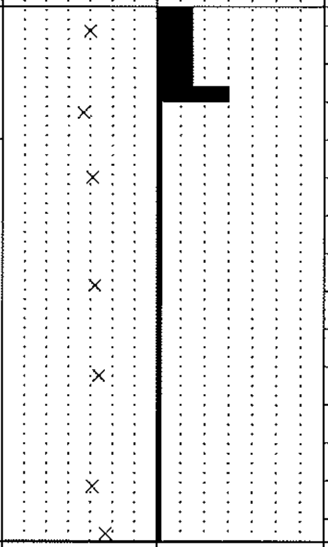
CORED BOREHOLE LOG

Borehole No.
CT1
3/3

Client:
Project: PROPOSED EXTENSION TO CANCER THERAPY BUILDING
Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M20852ZA
Core Size: NMLC
R.L. Surface: ≈ 10.8m
Date: 8-1-07
Inclination: VERTICAL
Datum: AHD
Drill Type: JK300
Bearing: -
Logged/Checked by: N.E.S./

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
		12								
		13								
				START CORING AT 13.30m						
			▒	SHALE: dark grey, with light grey laminae, bedded at 0-5°.	Fr	M-H				
			▒						- J, 45-90°, Un, R - J, 50°, Un, S	
		14	▒			H				
FULL RETURN			▒							
		15	▒						- Be, 0°, P, S	
		16	▒							
				END OF BOREHOLE AT 16.12m						
		17								
		18								

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JOB #M20852ZA BOREHOLE #CT1 START CORING AT 13.30m
13
13.30m
14
15
16
END AT 16.12m
10

BOREHOLE LOG

Borehole No.
CT3
1/3

Client:

Project: PROPOSED EXTENSION TO CANCER THERAPY BUILDING

Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M20852ZA

Date: 9-1-07

Method: SPIRAL AUGER
JK300

Logged/Checked by: N.E.S./

R.L. Surface: ≈ 11.0m

Datum: AHD

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 AUGER-ING			0			FILL: Silty clay, medium plasticity, grey brown, with root fibres.	MC≈PL			GRASS COVER
						FILL: Gravelly sand, fine to coarse grained, igneous gravel, orange grey brown, with a trace of clay fines.	M			APPEARS WELL COMPACTED
		N = 14 10,7,7				FILL: Gravelly clay, medium plasticity, grey brown and orange brown, fine to coarse grained igneous gravel, with sand.	MC≈PL			
			1		CH	SILTY CLAY: high plasticity, light grey and orange brown, with occasional ironstone gravel bands.	MC≈PL	VSt-H	-	
		N = 8 3,4,4							350 450 520	
			2				MC>PL	VSt		
		N = 14 3,6,8	3						270 290 360	
			4		-	SHALE: light grey and orange brown.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
		SPT 18/150mm REFUSAL				SHALE: grey and orange brown, with clay bands.	DW	VL		LOW RESISTANCE WITH VERY LOW BANDS
			5			SHALE: grey and grey brown.		L		VERY LOW TO LOW RESISTANCE
			6							
						SHALE: grey.	SW	L-M		LOW RESISTANCE
			7							

BOREHOLE LOG

Borehole No.
CT3
2/3

Client:
Project: PROPOSED EXTENSION TO CANCER THERAPY BUILDING
Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M20852ZA
Date: 9-1-07
Method: SPIRAL AUGER
JK300
R.L. Surface: ≈ 11.0m
Datum: AHD
Logged/Checked by: N.E.S./

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									
							▤		SHALE: grey.	SW	L-M		LOW RESISTANCE
									REFER TO CORED BOREHOLE LOG				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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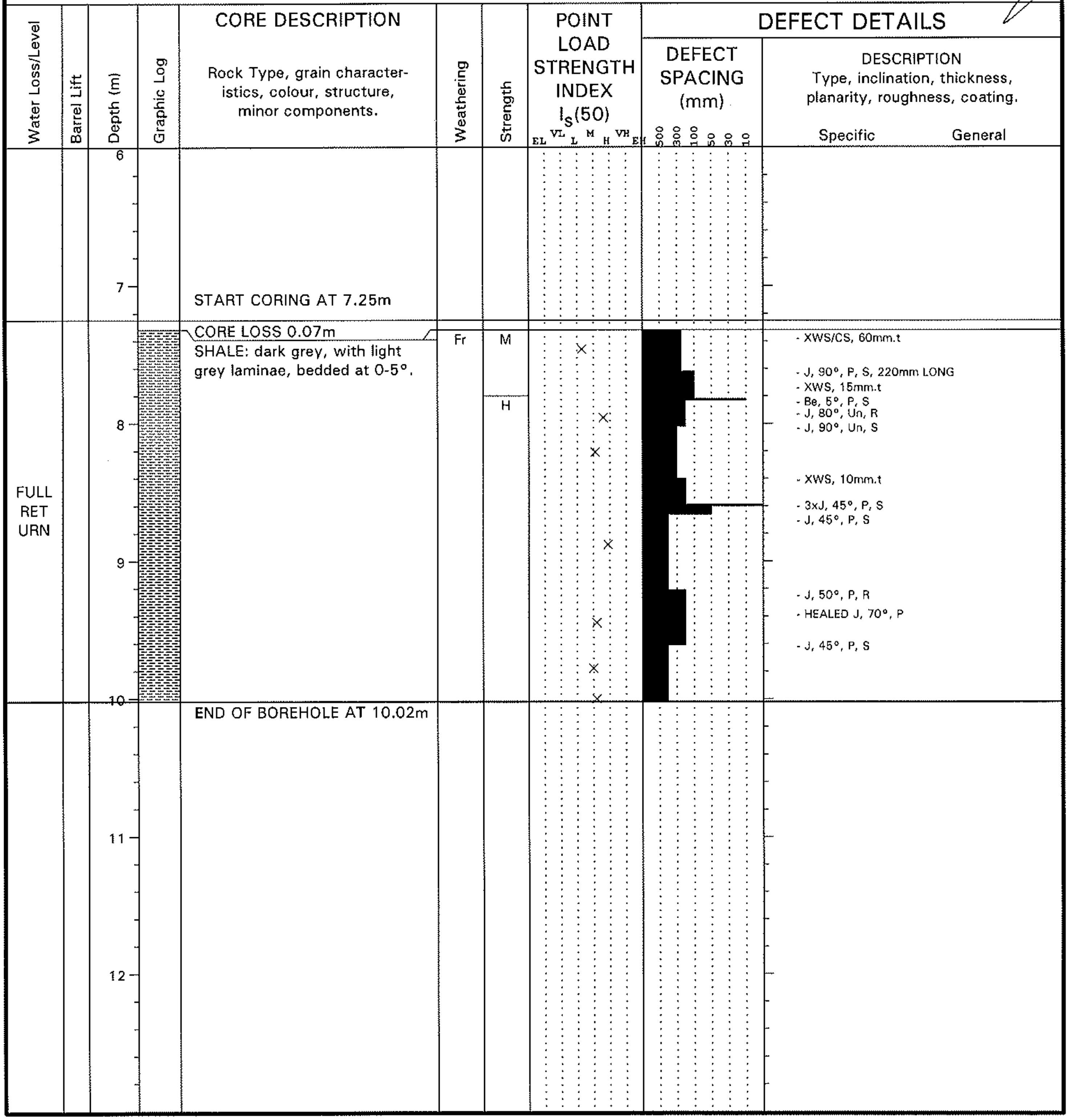
Borehole No.
CT3
3/3

CORED BOREHOLE LOG

Client:
Project: PROPOSED EXTENSION TO CANCER THERAPY BUILDING
Location: LIVERPOOL HOSPITAL, LIVERPOOL, NSW

Job No. M20852ZA
Core Size: NMLC
R.L. Surface: ≈ 11.0m
Date: 9-1-07
Inclination: VERTICAL
Datum: AHD
Drill Type: JK300
Bearing: -
Logged/Checked by: N.E.S./



CORE DESCRIPTION
Rock Type, grain characteristics, colour, structure, minor components.

DEFECT DETAILS
DESCRIPTION
Type, inclination, thickness, planarity, roughness, coating.
Specific
General

START CORING AT 7.25m

CORE LOSS 0.07m

SHALE: dark grey, with light grey laminae, bedded at 0-5°.

Fr

M

H

FULL RETURN

- XWS/CS, 60mm.t
- J, 90°, P, S, 220mm LONG
- XWS, 15mm.t
- Be, 5°, P, S
- J, 80°, Un, R
- J, 90°, Un, S
- XWS, 10mm.t
- 3xJ, 45°, P, S
- J, 45°, P, S
- J, 50°, P, R
- HEALED J, 70°, P
- J, 45°, P, S

END OF BOREHOLE AT 10.02m


Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
JOB #M20852ZA BOREHOLE #CT3 START CORING AT 7.25m
7
7.25m
C.L.
0.07m
8
9
10
END AT 10.10m
10

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 43 002 146 173

Ref No: M20852ZA
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)
CT1	13.43-13.47	1.0	20
	13.86-13.88	0.8	16
	14.20-14.22	1.2	24
	14.77-14.80	1.3	26
	15.25-15.29	1.7	34
	15.83-15.88	1.2	24
	16.08-16.12	2.5	50
CT3	7.46-7.49	0.5	10
	7.96-8.00	2.3	46
	8.21-8.25	1.2	24
	8.88-8.92	2.9	58
	9.45-9.49	1.3	26
	9.78-9.82	1.0	20
	10.00-10.02	1.3	26

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 2009 to 2011 from

‘Geotechnical Investigation for Proposed Research Bunkers and Clinical Skills Training Centre’ Report, Ref. 24403SBrpt dated 29/11/10

BOREHOLE LOG

Borehole No.
2009
1/2

Client:
Project: PROPOSED RADIOTHERAPY BUNKERS
Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA4
Date: 28-4-08
Method: SPIRAL AUGER
JK300
R.L. Surface: ≈ 11.8m
Datum: AHD
Logged/Checked by: A.C./AJ

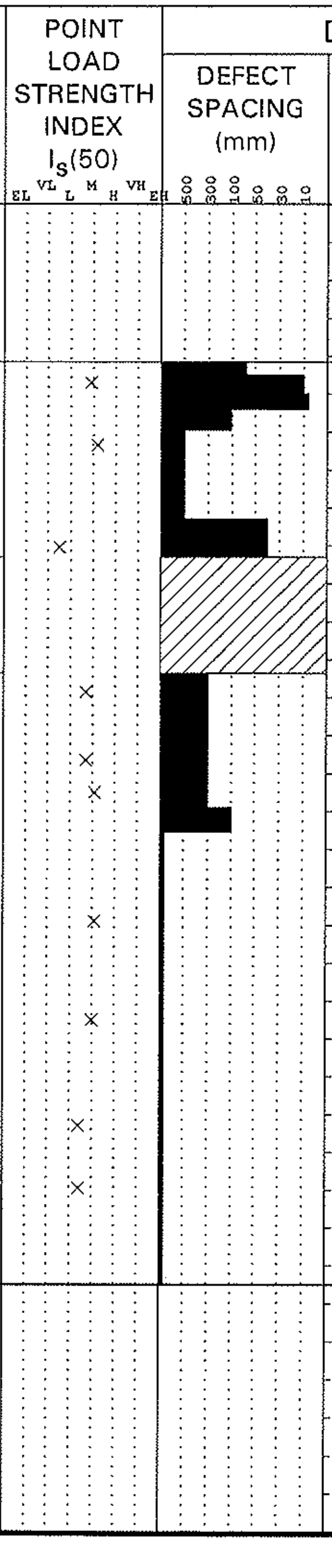
Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION OF AUGERING	■					0	▨		FILL: Silty clay, high plasticity, dark grey brown, with brick and concrete fragments, with a trace of root fibres.	MC≈PL			GRASS COVER
				■	N = 11 5,5,6		▨					540 >600 >600	APPEARS WELL COMPACTED
						1	▨						
				■	N = 12 3,6,6		▨		as above, but with a trace of ironstone gravel.			550 600 450	
						2	▨		FILL: Silty clayey sand, fine to medium grained, light grey brown, with a trace of concrete fragments.	M			
				■	SPT 9/100mm REFUSAL	3	▨						
				■		4		-	SHALE: dark grey and orange brown, with EL strength bands.	DW	L	-	LOW 'TC' BIT RESISTANCE WITH VERY LOW BAND
				■		5							
											M		LOW TO MODERATE RESISTANCE
						6			REFE TO CORED BOREHOLE LOG				
						7							

Borehole No.
2009
2/2

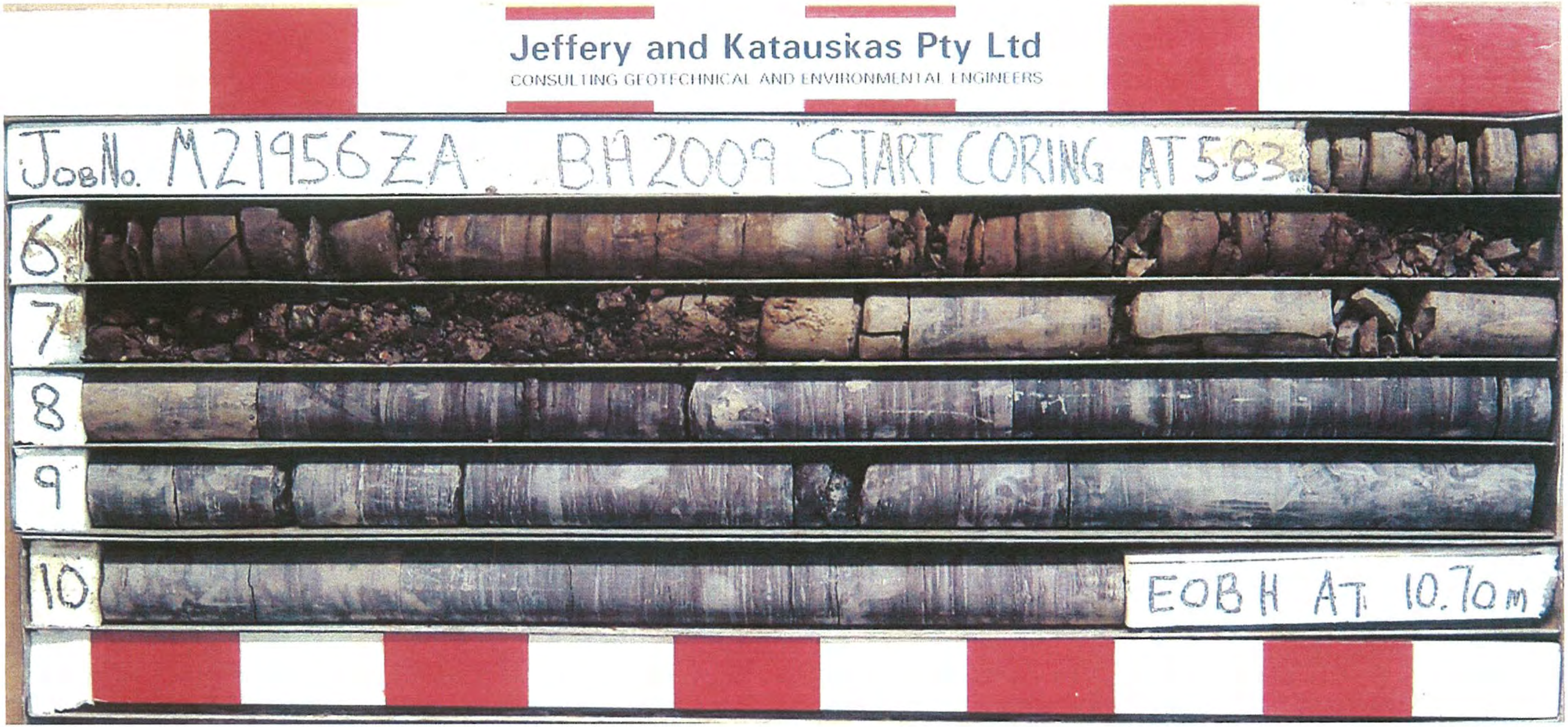
CORED BOREHOLE LOG

Client:
Project: PROPOSED RADIOTHERAPY BUNKERS
Location: LIVERPOOL HOSPITAL, NSW

Job No. M21956ZA4
Core Size: NMLC
R.L. Surface: ≈ 11.8m
Date: 28-4-08
Inclination: VERTICAL
Datum: AHD
Drill Type: JK300
Bearing: -
Logged/Checked by: A.C./AJ



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
		5		START CORING AT 5.83m				
		6		SHALE: orange brown, with light grey and dark grey bands, with H strength seams, bedded at 0-5°	DW	L-M	- XWS, 20mm.t - XWS, 10mm.t - J, 40°, P, HEALED - J, 70°, P, S - J, 30°, P, HEALED - J, 40°, P, S, IS - J, 30°, P, S	
		7			XW	EL	J, SUBVERTICAL, P, S	
				SHALE: dark grey, with light grey laminae, bedded at 0-5°.	SW	M-H	J, SUBVERTICAL, P, S	
FULL RET URN		8					- J, 55°, P, HEALED - XWS, 10mm.t	
					FR			
		9						
		10						
				END OF BOREHOLE AT 10.70m				
		11						


Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
JobNo. M21956ZA BH2009 START CORING AT 5.83
6
7
8
9
10
EOBH AT 10.70m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
2010
1/2

Client:

Project: PROPOSED RESEARCH BUNKER & CLINICAL SKILLS TRAINING CENTRE

Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL, NSW

Job No. 24403SB
Date: 5-11-10

Method: SPIRAL AUGER
JK300

Logged/Checked by: A.M./

R.L. Surface: ≅ 11.5m
Datum: AHD

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									
DRY ON COMPLETION						0			CONCRETE: 210mm.t				6mm DIAMETER REINFORCEMENT, 45mm TOP COVER
								-	FILL: Gravel, fine to coarse grained sub angular igneous, dark brown and dark grey.	-	-	-	
					N = 16 8,8,8	1			FILL: Silty sandy clay, low plasticity, brown, fine grained sand, with fine to medium grained sub angular igneous and sandstone gravel, and a trace of ash.	MC<PL		>400 >400 >400	APPEARS MODERATELY TO WELL COMPACTED
					N = 21 11,10,11	2		CL	SILTY CLAY: medium plasticity, light grey mottled orange brown.	MC<PL	H	- >400 >400 >400	POSSIBLY FILL
					N = 30 8,7,23	3			SILTY CLAY: medium plasticity, light grey mottled orange brown, with ironstone gravel bands.	MC≅PL		>400 >400 >400	RESIDUAL
					N = 23 8,11,12	4 5		CL-CH	SILTY CLAY: medium to high plasticity, orange brown mottled light grey, with ironstone bands.	MC>PL			
					SPT 34/150mm REFUSAL	6		-	SHALE: orange brown, with clay bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
						7				DW	VL		VERY LOW TO LOW RESISTANCE

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BOREHOLE LOG

Borehole No.
2010
2/2

Client:
Project: PROPOSED RESEARCH BUNKER & CLINICAL SKILLS TRAINING CENTRE
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL, NSW

Job No. 24403SB
Date: 5-11-10
Method: SPIRAL AUGER
JK300
R.L. Surface: ≅ 11.5m
Datum: AHD
Logged/Checked by: A.M./

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
				■					SHALE: brown and grey.	DW	L		LOW RESISTANCE
						8			SHALE: grey.		L-M		LOW TO MODERATE RESISTANCE
				■							M		MODERATE RESISTANCE
						9			END OF BOREHOLE AT 9.0m				
						10							
						11							
						12							
						13							
						14							

BOREHOLE LOG

Borehole No.
2011
1/2

Client:
Project: PROPOSED RESEARCH BUNKER & CLINICAL SKILLS TRAINING CENTRE
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL, NSW

Job No. 24403SB
Date: 5-11-10
Method: SPIRAL AUGER
JK300
Logged/Checked by: A.M./
R.L. Surface: ≅ 12.1m
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 sandy clay topsoil, dark brown, fine to medium grained sand, with fine to medium grained sub angular igneous gravel, brick fragments and a trace a root fibres.	MC≅PL			GRASS COVER
								CH	SILTY CLAY: high plasticity, orange brown, with ironstone gravel.	MC≅PL	H	-	RESIDUAL
				■	N = 6 1,2,4							350 380 400	
						1							
				■	N = 11 3,4,7				as above, but light grey mottled orange brown.			380 380 390	
						2							
				■				-	SHALE: orange brown, with ironstone bands and clay bands.	DW	VL	-	VERY LOW TO LOW 'TC' BIT RESISTANCE
						3							
									SHALE: brown and grey.		VL-L		
											L-M		LOW RESISTANCE
				■		4							
									SHALE: grey.				MODERATE RESISTANCE
						5							
				■		6							
													LOW TO MODERATE RESISTANCE
						7							

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
2011
2/2

Client:
Project: PROPOSED RESEARCH BUNKER & CLINICAL SKILLS TRAINING CENTRE
Location: LIVERPOOL HOSPITAL, GOULBURN STREET, LIVERPOOL, NSW

Job No. 24403SB
Date: 5-11-10
Method: SPIRAL AUGER
JK300
R.L. Surface: ≅ 12.1m
Datum: AHD
Logged/Checked by: A.M./

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
				■			▤		SHALE: grey.	DW	M-H		MODERATE TO HIGH RESISTANCE
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

APPENDIX F

Borehole Log RB1 from 'Geotechnical Investigation for Proposed New Building at 1 Campbell Street, Liverpool' Report, Ref. M23302ZArpt dated 23/11/09

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
RB1
1/2

Client:
Project: PROPOSED NEW BUILDING
Location: 1 CAMPBELL STREET, LIVERPOOL, NSW

Job No. M23302ZA
Date: 22-10-09
Method: SPIRAL AUGER
JK300
Logged/Checked by: G.F./
R.L. Surface: ≈ 12.7m
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 OF AUGERING						0		-	BRICK PAVERS: 50mm.t	-	-	-	
	■							-	FILL: Sand, fine to medium grained, yellow brown.	-	-	-	
								-	CONCRETE: 80mm.t	M	-	-	NO OBSERVED REINFORCEMENT
				■	N = 4 2,2,2				FILL: Gravelly sand, fine to coarse grained, light brown, fine to medium grained angular igneous gravel.	MC>PL			APPEARS POORLY COMPACTED
	■					1		CH	FILL: Silty clay, high plasticity, brown, with a trace of fine to medium grained angular and sub angular igneous and ironstone gravel.	MC>PL	St	150	RESIDUAL
▼ ON COMPLETION OF CORING				■	N > 15 10,15/ 50mm REFUSAL			CL	SILTY CLAY: high plasticity, light brown mottled red brown.		VSt -H	250 400	
						2			SILTY CLAY: medium plasticity, light grey, with XW shale bands and a trace of fine to medium grained sub angular ironstone gravel.				
				■	N > 20 11,20/ 100mm REFUSAL	3				MC<PL	H	>600 >600	
								-	SHALE: grey and light brown.	DW	VH	>600	HIGH 'TC' BIT RESISTANCE
									REFER TO CORED BOREHOLE LOG			-	
						4							
						5							
						6							
						7							

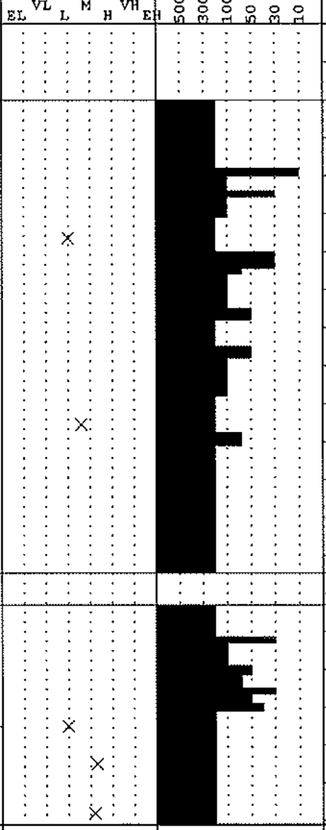
Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
RB1
2/2

CORED BOREHOLE LOG

Client:
Project: PROPOSED NEW BUILDING
Location: 1 CAMPBELL STREET, LIVERPOOL, NSW

Job No. M23302ZA
Core Size: NMLC
R.L. Surface: ≈ 12.7m
Date: 22-10-09
Inclination: VERTICAL
Datum: AHD
Drill Type: JK300
Bearing: -
Logged/Checked by: G.F./



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
		3		START CORING AT 3.40m				
80% RET-URN				SHALE: light grey and light brown, bedded at 0°.	DW	VH	- HEALED J, 30°, P	
		4 5		SHALE: orange brown and dark grey, with light grey laminae, bedded at 0-5°.		L-M	- J, 35°, P, R, IS - XWS/CS, 100mm.t - Cr, 10mm.t - Cr, 20mm.t - Cr/XWS, 30mm.t - J, 90°, P, R - CS, 30mm.t - J, 40-90°, Un, R - CS, 30mm.t - J, 90°, Un, S - Cr, 15mm.t - J, 45°, P, S - J, 40-90°, Un, R - 2xJ, 40°, P, S - Cr, 20mm.t - CS/XWS, 10mm.t - XWS/Cr, 15mm.t - XWS/CS, 5mm.t - J, 45°, P, S, CLAY INFILL 10mm.t - XWS, 150mm.t - J, 80-90°, Un, R	
		6		CORE LOSS 0.17m				
				SHALE: orange brown and dark grey, with light grey laminae, bedded at 0-5°.	DW	L-M	- XWS, 50mm.t - J, 80-90°, P, S - CS, 30mm.t - Cr, 50mm.t - CS/XWS, 20mm.t - CS, 5mm.t - Cr, 5mm.t	
		7		SHALE: dark grey, with light grey laminae, bedded at 0°.	SW	H	- Cr, 5mm.t - CS/XWS, 10mm.t - Cr, 5mm.t	
		8 9		END OF BOREHOLE AT 7.22m				


JEFFERY & KATAUSKAS PTY LTD
JOB NO: M23302ZA, RB1, START CORING AT 3.40m
3
4
5
CORE LOSS
6
0.47m
7
END AT 7.22m