JC GEOTECHNICS

April 29, 2020

Proposed Greenwich Seniors Living

GEOTECHNICAL INVESTIGATION REPORT

2 Greenwich Road, Greenwich, NSW

JC GEOTECHNICS PTY LTD
Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137

Document Control Record

Document Prepared by:

JC Geotechnical Pty Ltd

Shop 2, 143 – 147 Parramatta Road,
Concord, NSW 2137
T 02 8066 0665
E admin@jcgeotechnics.com.au
W www.jcgeotechnics.com.au

Document Control					**JC Geotechnics Pty Ltd**
Report Title		Geotechnical Report			
Document ID		GR1102.1J			
Client		**Alceon Group Pty Ltd**	**Client Contact**		Louise Campling
Rev	**Date**	**Revision Details/Status**	**Prepared by**	**Author**	**Approver**
	21 April 2020	**Draft Issue**	**RT**	**RT**	
00	29 April 2020	**Final Issue**	**RT**	**RT**	**JC**
Current Revision		**00**			

Approval			
Author Signature		**Approver Signature**	
Name	**Robert Tu**	**Name**	**Joseph Chaghouri**
Title	**Geotechnical Engineer**	**Title**	**Principal Geotechnical Engineer**

TABLE OF CONTENTS

APPENDICES

1. INTRODUCTION

JC Geotechnics Pty Ltd (JCG) has been commissioned by **Alceon Group Pty Ltd** to carry out a geotechnical investigation at 2 Greenwich Road, Greenwich, NSW. The site investigation was carried out over a period of five (5) working days between 19th March 2020 and 1st April 2020 and was completed in accordance with our Proposal Ref. GP2020-147 Rev.3 Greenwich, dated 13th March 2020.

The purpose of the investigation was to assess the subsurface conditions at four (4) borehole locations, to assist with the planning and design of the proposed development.

This report presents the results of the geotechnical investigation, interpretation, and assessment of the site's existing geotechnical conditions, as a basis to provide the following recommendations:

- Detailed logs of the boreholes and groundwater observations;
- Interpretation of subsurface profile;
- Dilapidation
- Basement Excavation
- Hydrogeological Consideration
- Basement Excavation Support
- Foundation Design

To assist in reading the report, reference should be made to "About Your Report" attached in Appendix A.

2. AVAILABLE INFORMATION

Prior to preparation of this report, the following information was made available to JC Geotechnics:

- Survey Plan Titled 'Survey,' prepared by Veris Australia Pty Ltd, Ref No. 202046, Issue 1, dated 18 February 2020.
- Architectural Drawings Titled 'Basement 3,' prepared by Marchese Partners International Pty Ltd, Job No. 19118, Drawing No. DA2.01, Revision B, dated 20 April 2020.
- Architectural Drawings Titled 'Basement 2,' prepared by Marchese Partners International Pty Ltd, Job No. 19118, Drawing No. DA2.02, Revision B, dated 20 April 2020.
- Architectural Drawings Titled 'Basement 1,' prepared by Marchese Partners International Pty Ltd, Job No. 19118, Drawing No. DA2.03, Revision B, dated 20 April 2020.
- Architectural Drawings Titled 'Section 1,' prepared by Marchese Partners International Pty Ltd, Job No. 19118, Drawing No. DA4.01, Revision B, dated 20 April 2020.

- Architectural Drawings Titled 'Section 2,' prepared by Marchese Partners International Pty Ltd, Job No. 19118, Drawing No. DA4.02, Revision B, dated 20 April 2020.
- Architectural Drawings Titled 'Access Ramp Sections,' prepared by Marchese Partners International Pty Ltd, Job No. 19118, Drawing No. DA4.03, Revision B, dated 20 April 2020.

Based on the information provided, we understand that the proposed development comprises demolition of the existing buildings and construction of an eight-storey building over three levels of basement car parking. The ground floor will be used for commercial purposes while the seven remaining levels will be used for residential purposes. The lowest basement is proposed to be constructed at RL73.20m. In order to achieve the proposed bulk excavation level, excavation to depth of at least 13.5m is expected as part of the works.

3. SCOPE OF WORK

The fieldwork for the geotechnical site investigation was carried out by an experienced Geotechnical Engineer from JCG broadly following the guidelines provided in Australian Standard AS 1726-2017 (Reference 1).

A site walk-over inspection was carried out by a Geotechnical Engineer in order to determine the overall surface conditions and to identify relevant site features.
Prior to commencement of the fieldwork, the proposed borehole locations were electromagnetically scanned by a specialist subcontractor with reference to Dial Before You Dig (DBYD) plans.

Safe work measures and procedures were implemented during the course of the fieldwork.

Auger drilling of four (4) boreholes to a depth of 6.3m (or RL of about 79.7mAHD) in BH1, 9.02m (or RL of about 72.78mAHD) in BH2, 6.0m (or RL of about 77.2mAHD) in BH3, and 0.51m (or RL of about 76.19mAHD) in BH4, below existing ground surface levels using a Tungsten Carbide 'TC' bit attached to the augers.

Standard Penetration Test (SPT) were carried out, where possible, in the augered section of the boreholes to assess the fill compaction and strength/relative density of the soils. Hand Penetrometer tests were also carried out, where possible, on the recovered SPT samples.

The four (4) boreholes were continued to depths of 17.4m (or RL of about 68.64m) in BH1, 14.2m (or RL of about 67.62m) in BH2, 16.7m (or RL of about 66.55m) in BH3 and 7.92m (or RL of about 68.87m) in BH4.

Groundwater levels were measured in the boreholes during and soon after completion of auger drilling. The use of water for coring precluded further measurements of groundwater levels.

On completion of coring, three (3) Class 18 PVC standpipes GW1, GW2 and GW3 were installed in BH1, BH2 and BH3 respectively to allow for further measurements of the groundwater levels. Each borehole was capped with a gatic cover at the surface.

Groundwater monitoring was undertaken using data loggers installed in GW1, GW2 and GW3. The data loggers were installed to record the groundwater readings for the three following months. The data obtained from the data loggers were downloaded by JCG once every month.

Laboratory testing of selected soil samples for one (1) Atterberg Limits/Linear Shrinkage tests, four (4) Moisture Content tests, four (4) Aggressivity Suits and thirty-six (36) point load strength index testing on selected rock core samples recovered from the boreholes.

The approximate locations of the four boreholes are shown on "Figure 1 – Borehole Location Plan" attached in Appendix B. The levels on the borehole logs were interpolated between spot levels shown on the survey plans referenced above.

A geotechnical engineer from JC Geotechnics was present full-time on site to set out the test locations, log the encountered subsurface profile and nominate in-situ testing and sampling, measure the groundwater levels and install the monitoring wells and data loggers. The borehole logs, together with explanatory notes used are attached in Appendix C and Appendix F, respectively.

4. SITE DESCRIPTION

The site is located mid-slope of a south facing hillslope. The subject site slopes down from North to South and West to East at an angle of about 5° to 6°.

At the time of our investigation, the site has been constructed into the hillslope and consisted of two properties, No. 2 Greenwich Road and No. 3 Anglo Road, Greenwich.

The site is approximately rectangular in shape with a total area of approximately 2140m^2. The site is bounded by Greenwich Road to the West, a multi-storey commercial building with at least one level of basement to the North, residential buildings to the South and East.

The site at 2 Greenwich Road was occupied by the existing Northside Clinic. The multi-storey concrete clinic overlaid two levels of basement carpark. An existing stairway provided access to the reception and café area of the clinic located at the front of the property. Another stairway provided access to the ground floor outdoor area of the clinic on the southern boundary of the site. The building appeared to be in good external condition with minor cracking observed. However, during our time onsite, we were advised by the facility manager 'Mr. Greg Nilsson' of the clinic, that the building is in a poor condition with cracking and leakage in the clinic interior.

An existing concrete driveway was located along the northern boundary and was shared between the subject site and the property to the North. A steep slope of about 14° was measured as the driveway descended into the basement. A concrete retaining wall of approximately 2.5m high was located north of the driveway. Trees and plants were observed above the retaining wall. The retaining wall was observed to be in good condition. The paved driveway and the retaining wall appeared to be in a good condition towards the entrance, however, as the driveway sloped towards the basement car park, moderate cracking on the surface was observed. Another concrete retaining wall was observed south of the Clinic Café of approximately 6.2m high. An overgrown garden was situated on top of the retaining wall. The retaining wall was observed to be in good condition.

Two levels of basement car park spaces were present below Northside Clinic. Each floor had a relatively low clearance of 2.1m with concrete pavement and cemented pillars for support. A slope was present on the first basement floor to allow cars to travel to the lower basement. A range of different pipelines were observed on the roof of each basement floor to allow for sewage circulation. The basement does not appear to extend all the way to the site boundary. The concrete pavement and cemented pillars inside the basement appear to be in good condition with little to no cracking observed.

Access to the rear of Northside Clinic (Eastern boundary) was gained through a concrete driveway at the residential property located at 3 Anglo Street, Greenwich. The concrete paved driveway appeared to in poor condition with multiple cracks. An existing two-storey timber residential dwelling was observed siting at an elevated level at the property. The property appeared to be in an extremely poor condition with cracked tiles and broken timber rails throughout. The driveway led to the backyard of the residential property which connected the Eastern end of Northside Clinic. No barriers or fencing separated the residential property from Northside Clinic. A small stairway led to a brick tiled area for the Northside Clinic. The brick tiled area appeared to be in good condition with little to no cracking. Staircases with aluminium guard rails was observed descending from the brick tiled area into the ground floor of Northside Clinic. Another retaining wall of approximately 6.2m high was observed north of the descending staircase. The retaining wall appeared to be in good condition and connected with the previous retaining wall located adjacent to the Clinic driveway.

5. INVESTIGATION RESULTS

5.1 Geology

Reference to the Sydney 1:100,000 Geological Series Sheet 9130 Edition 1, dated 1983, by the Geological Survey of New South Wales, Department of Mineral Resources, indicates the site is located within the geological boundary known as Ashfield Shale (Rwa) of the Wianamatta Group of Middle Triassic age. Ashfield Shale is described as “Black to dark-grey shale and laminite.”

It should be noted that the published geological profile does not take into account the residual soils derived from in-situ weathering of the bedrock or the presence of fill that may have been generated from previous earthworks.

5.2 Subsurface Conditions

The subsurface conditions encountered within the boreholes are summarised below:

Pavement

Asphaltic concrete was observed in BH1, BH2 and BH4 with thickness measured ranging to be from 210mm to 450mm. Brick pavement was observed in BH3 with 40mm thickness.

Fill

Fill material was encountered in the boreholes, BH1, BH2, and BH3 with depths ranging from 0.3m (or RL of about 82.9mAHD) in BH3 to 5.5m (or RL of about 80.5mAHD) in BH1. The fill material was comprised of Silty Clay of low to medium plasticity with various organic contents such as roots and root fibres. The deep fill material from BH1 may be associated with the construction of the Clinic driveway. No fill material was encountered in BH4.

Residual

Residual soil was encountered below the fill material in BH2, BH3 and below the concrete slab in BH4. The residual soil was comprised of Silty Clay and extended between 0.5m (or RL of about 76.2mAHD) in BH4 to 9.02m (or RL of about 72.78mAHD) in BH2. The silty clay was generally of low to medium plasticity and firm to stiff strength.

Bedrock

Weathered shale bedrock was encountered in all boreholes at depths ranging from 0.5m (or RL of about 76.2mAHD) in BH4 to 9.02m (or RL of about 72.78mAHD) in BH2. Generally, on first contact the shale was extremely weathered to distinctly weathered and of extremely low to very low strength. This upper band of extremely low to very low strength rock was then underlain by shale of low strength. The augered boreholes were terminated within these upper shale layers.

Within the cored boreholes (BH1 to BH4) slightly weathered and fresh shale of medium to high strength was encountered at depths ranging from 3.5m (or RL of about 73.2mAHD) in BH4 to 12.3m (or RL of about 73.7mAHD) in BH1. The cored shale initially contained significant defects including frequent poorly cemented laminae, extremely weathered sections, clay seams, bedding partings and a number of steeply inclined joints. The shale improved with depth encountering only a few minor defects within the slightly weathered and fresh rock.

5.3 Groundwater

Groundwater seepage was not encountered in any of the boreholes during and following the completion of auger drilling. Water flush during the coring process precluded any further measurement of groundwater levels.

Piezometers installed during the fieldwork were measured on the 26th, 31st March, 1st and 7th April 2020. In addition, groundwater monitoring was carried out within three of the groundwater wells (GW1, GW2 and GW3) using data loggers carried out over three weeks between 7th April 2020 and 29th April 2020.

Groundwater levels recorded during the five site visits are presented in Table 1 below.

Table 1: Groundwater Measurements and Design Groundwater Levels

GW Well No.	Date	Approximate Depth of GW Below Existing Surface Level (m)	Reduced Level (mAHD)
GW1	26/03/2020	7.20	78.80
	31/03/2020	7.20	78.80
	01/04/2020	7.30	78.70
	07/04/2020	6.10	79.90
	29/04/2020	7.00	79.00

GW2	26/03/2020	Not Yet Drilled	Not Yet Drilled
	31/03/2020	4.40	77.40
	01/04/2020	4.30	77.50
	07/04/2020	4.10	77.70
	29/04/2020	4.10	77.70
GW3	26/03/2020	7.30	75.90
	31/03/2020	7.40	75.80
	01/04/2020	7.10	76.10
	07/04/2020	6.70	76.50
	29/04/2020	6.70	76.50

Note that groundwater levels may be subject to seasonal and daily fluctuations influenced by factors such as rainfall and future development of the surrounding properties.

5.4 Laboratory Testing

The Atterberg Limits test result confirmed the sample tested was of high plasticity with an expected moderate potential for shrink-swell reactivity with changes in moisture content.

The results of the moisture content tests carried out on recovered rock cutting samples correlate well with our field assessment of bedrock strength.

The point load strength index test results on selected samples of the bedrock showed reasonably good correlation with our field assessment of rock strength. The estimated Uncoffined Compressive Strength (UCS) of the rock roe ranged from 1 MPa to 40 MPa.

The soil pH test results were 9.0 (BH1), 5.6 (BH3) and 5.5 (BH4). The sulfate contents were 380mg/kg (BH1), 280mg/kg (BH3) and 290mg/kg (BH4), the chloride contents were 150mg/kg (BH1), 60mg/kg (BH3) and <10mg/kg (BH4) and the electrical conductivity values were 463µS/cm (BH1), 119µS/cm (BH3) and 69µS/cm (BH4).

6. COMMENTS AND RECOMMENDATIONS

6.1 Dilapidation Reports

Prior to excavation and construction, we recommend that detailed dilapidation surveys be carried out on all structures, buried services and infrastructures surrounding the site that falls within the zone of influence of the excavation. The zone of influence of the excavation is defined by a distance back from the excavation perimeter of twice the total depth of the excavation. The report would provide a record of existing conditions prior to commencement of the work. A copy of each report should be provided to the adjoining property owner who should be asked to confirm that it represents a fair assessment of existing conditions. The reports should be carefully reviewed prior to demolition and construction.

6.2 Basement Excavation

Prior to any excavation commencing, we recommend that reference be made to the WorkCover Excavation Work Code of Practice – July 2015.

Based on the borehole log, the proposed basement excavations will therefore extend through fill, residual clay and for the most part shale bedrock. An engineered retention system must be installed for at least the soil and shale of less than low strength prior to excavation commencing.

The soil and shale of less than low strength could be excavated using buckets of conventional earthmoving Hydraulic Excavators, particularly if fitted with 'Tiger Teeth' with some ripping.

Ripping of low strength shale or better bedrock, is expected to be encountered towards the base of the excavation and will present hard ripping or "hard rock" excavation conditions and therefore excavation productivity will be slow and higher than normal 'wear and tear' of excavation attachments is to be expected. The presence of defects will help facilitate excavation, but only marginal. Therefore, ripping would require a high capacity and heavy bulldozer of at least D9 or similar. The use of a smaller size bulldozer will result in lower productivity, and this should be allowed for. Perimeter and Grid sawing techniques with ripping will also facilitate the excavation and assist in reducing vibration emissions.

Should rock hammers be used for this site, vibration monitoring must be used and further advice must be sought from the geotechnical engineer.

Groundwater seepage monitoring should be carried out during bulk excavation prior to finalising the design of a pump out facility. Outlets into the stormwater system will require Council approval.

Furthermore, any existing buried services which run below the site will require diversion prior to the commencement of excavation or alternatively be temporarily supported during excavation, subject to permission or other instructions from the relevant service authorities. Enquiries should also be made for further information and details, such as invert levels, on the buried services.

6.3 Hydrogeological Considerations

Groundwater was not encountered in any of the boreholes during auger drilling. Groundwater levels were measured in five (5) separate occasions within the previously installed groundwater wells, the result of which are shown in **Table 1** above. In addition, data loggers were installed in GW1, GW2 and GW3 on the 7th April 2020 to measure and record the groundwater levels within the monitoring wells. JCG visited the above site on 29th April 2020 to download the recorded data. The highest recorded groundwater levels over the duration of three weeks were 7.1m (or RL of about 78.9mAHD) in GW1, 4.14m (or RL of about 77.66mAHD) in GW2 and 6.85m (or RL of about 76.35mAHD) in GW3. A detailed record of the groundwater monitoring plots from the data loggers can be found in Appendix D attached at the end of the report.

Experience shows that due to the expected low permeability of the soil and bedrock profile, groundwater inflows into the excavation should not have an adverse impact on the neighbouring sites. We expect groundwater inflows into the excavation along the soil/rock interface and through any defects within the bedrock (such as jointing, and bending planes, etc.) particularly following a period of heavy rain. The initial flows into the excavation may be locally high but would be expected to decrease with time as the bedding seams/joints are drained. We recommend that monitoring of seepage be implemented during the excavation works to confirm the capacity of the drainage system.

We expect that any seepage that does occur should be able to be controlled by a conventional sump and pump system. We recommend that a sump-and-pump system be used both during construction and for permanent groundwater control below the basement floor slab.

In the long term, drainage should be provided behind all basement retaining walls, around the perimeter of the basement and below the basement slab. The completed excavation should be inspected by the hydraulic engineer to confirm that adequate drainage has been allowed for. Drainage should be connected to the sump- and-pump system and discharging into the stormwater system. The permanent groundwater control system should take into account any possible soluble substances in the groundwater which may dictate whether or not groundwater can be pumped into the stormwater system.

We recommend that pump-out tests be undertaken together with seepage analysis to estimate the predicted groundwater seepage volumes into the excavation.

The design of drainage and pump systems should take the above issues into account along with careful ongoing inspections and maintenance programs.

6.4 Basement Excavation Support

6.4.1 Retention System

From a geotechnical perspective, it is critical to maintain the stability of the adjacent structures, infrastructures and buried services during demolition, excavation and construction works.

Based on the provided architectural plans, the basement is proposed to have setback of 1.0m, 3.0m, 5.0m and 0m to the Northern, Southern, Western and Eastern boundaries respectively.

Where space permits, temporary batters of no steeper than 1 Vertical (V) : 1 Horizontal (H) may be used provided that all surcharge loads are setback a distance H equal to height of the batter from the crest of the batter.

Unsupported vertical cuts of the soil and weathered rock profile are not recommended for this site as these carry the risk of potential slump failure especially after a period of wet weather. Slumping of the material may result in injury to personnel and/or damage to nearby structures/infrastructures and equipment.

A suitable retention system will be required for the support of the excavation. An anchored and/or propped soldier pile wall with concrete infill panels is recommended for this site. Anchors/props and shotcrete must be installed progressively as excavation proceeds. The use of a more rigid system (such as a contiguous or semi-contiguous pile wall) is recommended adjacent to neighbouring buildings/infrastructures, to reduce the lateral movements and the risk of potential damage. We assume that permanent support of the retention system will be provided by bracing from the proposed structure.

Bored piers may be used for this site. However, relatively large capacity piling rigs (e.g. Soilmec SR-40 or larger) with rock augers and coring buckets will be required for drilling through the shale bedrock. The proposed pile locations should take into account the presence of any buried walls, footings, neighbouring anchors and/or the presence of buried services. Further advice should be sought from prospective piling contractor who should be provided with a copy of this report. Working platforms may also be required.

6.4.2 Design Parameters

The following parameters may be used for static design of temporary and permanent retaining walls at the subject site:

For progressively anchored or propped walls where minor movements can be tolerated (provided there are no buried movement sensitive services), we recommend the use of a trapezoidal earth pressure distribution of 5HkPa for soil and shale of less than low strength, where H is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system, tapering to nil at top and bottom;

For progressively anchored or propped walls which support areas which are highly sensitive to movement (such as areas where movement sensitive structures or infrastructures or buried services are located in close proximity), we recommend the use of a trapezoidal earth pressure distribution of 8HkPa for soil and shale of less than low strength, where 'H' is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system, tapering to nil at top and bottom;

All surcharge loading affecting the walls (including from construction equipment, construction loads, adjacent high-level footings, etc.) should be adopted in the retaining wall design as an additional surcharge using an 'at rest' earth pressure coefficient, k_o, of 0.55;

The retaining walls should be designed as drained and measures are to be taken to provide complete and permanent drainage behind the walls. Strip drains protected with a non-woven geotextile fabric should be used behind the shotcrete infill panels for soldier pile walls or inserted between gaps in contiguous piles. Alternatively, for the contiguous pile walls, weepholes comprising 20mm diameter PVC pipes grouted into holes or gaps between adjacent piles at 1.2m centres (horizontal and vertical), may be used. The embedded end of the pipes must, however, be wrapped with a non-woven geotextile fabric (such as Bidim A34) to act as a filter against subsoil erosion;

For piles embedded into medium to high strength bedrock and below bulk excavation level, an allowable lateral toe resistance value of 350kPa may be adopted. This value assumes excavation is not carried out within the zone of influence of the wall toe and the rock does not contain adverse defects etc. The upper 0.3m depth of the socket should not be taken into account to allow for tolerance and disturbance effects during excavation.

If temporary anchors extend beyond the site boundaries, then permission from the neighbouring properties would need to be obtained prior to installation. Also, the presence of neighbouring basements (if any) or services and their levels must be confirmed prior to finalising anchor design.

Anchors should have their bond length within low strength shale or better. For the design of anchors bonded into medium to high strength shale or better, an allowable bond stress value of 300kPa may be used, subject to the following conditions:

- Anchor bond lengths of at least 3m behind the ‘active’ zone of the excavation (taken as a 45-degree zone above the base of the excavation) is provided;
- Overall stability, including anchor group interaction, is satisfied;
- All anchors should be proof loaded to at least 1.33 times the design working load before locked off at working load. Such proof loading is to be witnessed by and engineer independent of the anchoring contractor. We recommend that only experienced contractors be considered for anchor installation with appropriate insurances;
- If permanent anchors are to be used, these must have appropriate corrosion provisions for longevity.

6.5 Foundation Design

It is expected that shale of at least medium to high strength to be exposed at bulk excavation level of RL73.20m. It is recommended that all footings for the building be founded within shale bedrock of similar strength to provide uniform support and reduce the potential for differential settlements.

Pad and strip footings founded within shale of at least medium to high strength may be designed for an allowable bearing capacity of 3500kPa, based on serviceability and subject to the completion on an additional cored borehole. In addition, an allowable shaft adhesion of 10% of the recommended bearing pressure may be used for rock sockets in medium to high strength shale or better provided the socket is satisfactory cleaned and roughened. All footings must be visually inspected by the geotechnical engineer.

A Higher Bearing Pressure of 6000kPa may be able to be adopted if excavation for deeper footings is allowed for, or piles are founded in high strength shale bedrock. If a higher bearing pressure of 6000kPa is to be adopted, then the completion of at least one additional cored borehole on the site particularly after demolition will be required together with spoon testing of at least 50% of all footings.

Should spoon testing be omitted, then the maximum allowable bearing pressure should be limited to 3500kPa. Perimeter piles founded in medium to high strength shale at the crest of a vertical cutting should be designed for a reduced allowable bearing pressure of 1500kPa provided the rock immediately below the pile toe is inspected by a geotechnical engineer to identify adverse defects and assess long term durability.

The allowable bearing pressures given above are based on serviceability criteria of settlements at the footing base of less than or equal to 1% of the minimum footing dimension.

Geotechnical inspections of foundations should be carried out by a geotechnical engineer to determine that the required socket and founding material has been achieved and determine any variations that may occur between the boreholes and inspected locations.

7. LIMITATIONS

The geotechnical assessment of the subsurface profile and geotechnical conditions within the proposed development area and the conclusions and recommendations presented in this report have been based on available information obtained during the work carried out by JC Geotechnics and in the provided documents listed in Section 2 of this report. Inferences about the nature and continuity of ground conditions away from and beyond the locations of field exploratory tests are made but cannot be guaranteed.

It is recommended that should ground conditions including subsurface and groundwater conditions, encountered during construction and excavation vary substantially from those presented within this report, JC Geotechnics Geosciences Pty Ltd be contacted immediately for further advice and any necessary review of recommendations. JC Geotechnics does not accept any liability for site conditions not observed or accessible during the time of the inspection.

This report and associated documentation and the information herein have been prepared solely for the use of **Alceon Group Pty Ltd** and any reliance assumed by third parties on this report shall be at such parties' own risk. Any ensuing liability resulting from use of the report by third parties cannot be transferred to JC Geotechnics Pty Ltd, directors or employees.

The conclusions and recommendations of this report should be read in conjunction with the entire report.

For and on behalf of

JC Geotechnics Pty Ltd

Robert Tu

Geotechnical Engineer

Reviewed By

Joseph Chaghouri

BSc (Civil), MEngSc (PM), MEngSc (Geotech), MIEAust

Principal Geotechnical Engineer

APPENDIX A

About Your Report

INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical- related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include the general nature of the structure involved, its size and configuration, the location of the structure on the site and its orientation, physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program.

To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should NOT be used:*

- when the nature of the proposed structure is changed: for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an un-refrigerated one,
- when the size or configuration of the proposed structure is altered.
- when the location or orientation of the proposed structure is modified.
- when there is a change of ownership, or for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

Geotechnical reports present the results of investigations carried out for a specific project and usually for a specific phase of the project. The report may not be relevant for other phases of the project, or where project details change.

The advice herein relates only to this project and the scope of works provided by the Client.

Soil and Rock Descriptions are based on AS1726- 1993, using visual and tactile assessment except at discrete locations where field and/or laboratory tests have been carried out. Refer to the attached terms and symbols sheets for definitions.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing is extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact. For this reason, most experienced owners retain their geotechnical consultants through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems that encountered on site.

SUB SURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions, and thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

Subsurface conditions can change with time and can vary between test locations. Construction activities at or adjacent to the site and natural events such as flood, earthquake or groundwater fluctuations can also affect the subsurface conditions.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems.

No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professional develop their plans based on mis-interpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

The interpretation of the discussion and recommendations contained in this report are based on extrapolation/ interpretation from data obtained at discrete locations. Actual conditions in areas not sampled or investigated may differ from those predicted.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, give contractors ready access in the complete geotechnical engineering report prepared or authorized for their use. Those who do not provide such access may proceed under mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are not exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publication's directory.

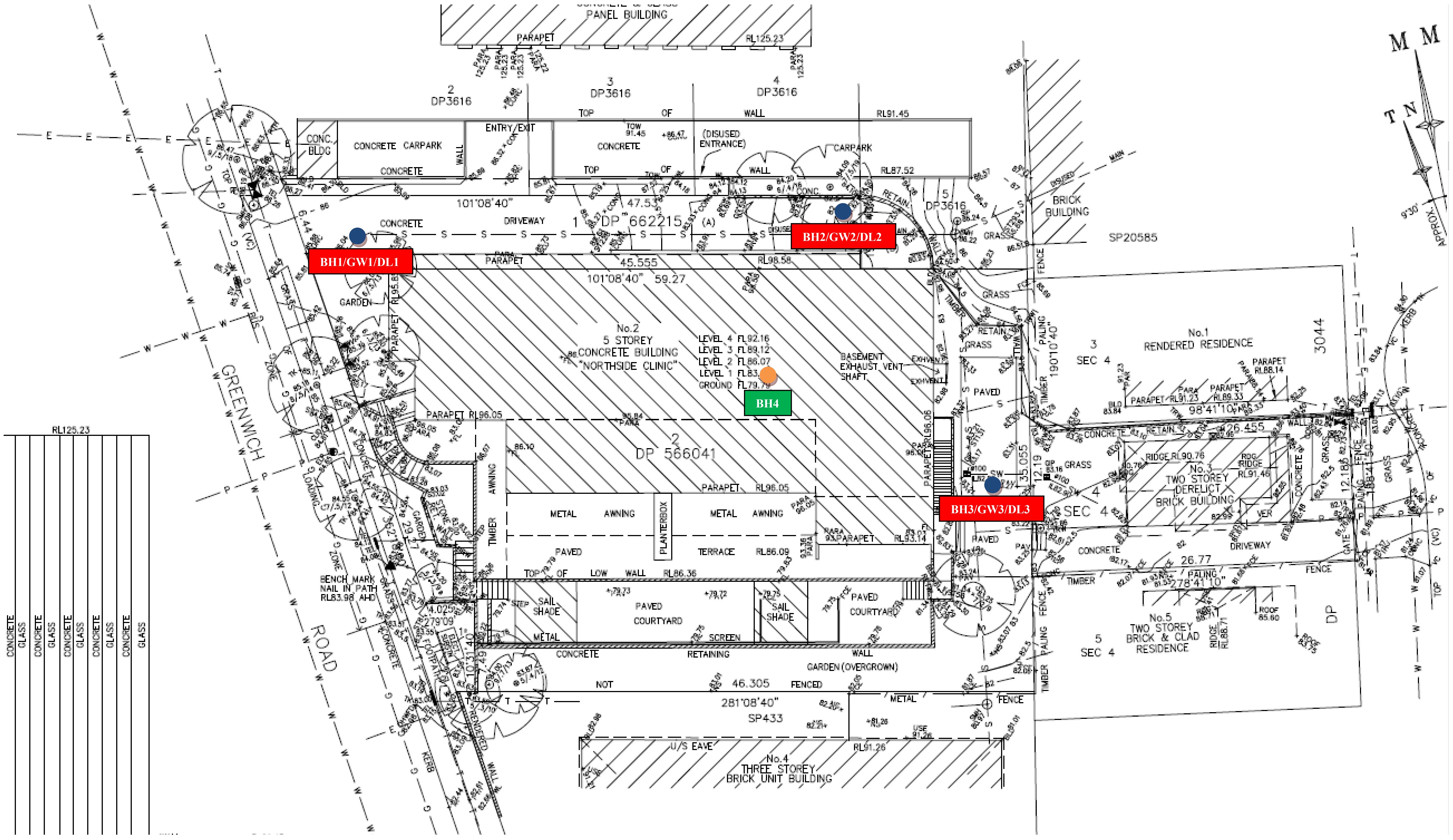
FURTHER GENERAL NOTES

Groundwater levels indicated on the logs are taken at the time of measurement and may not reflect the actual groundwater levels at those specific locations. It should be noted that groundwater levels can fluctuate due to seasonal and tidal activities.

This report is subject to copyright and shall not be reproduced either totally or in part without the express permission of the Company. Where information from this report is to be included in contract documents or engineering specifications for the project, the entire report should be included in order to minimize the likelihood of misinterpretation.

APPENDIX B

Borehole Location Plan



Drawn	RT	**Alceon Group Pty Ltd** **Proposed Residential Development** **2 Greenwich Road, Greenwich NSW**	Geotechnics	Figure	**1**
Checked	JC			Title	**Boreholes/Groundwater Wells/Data Loggers Location Plan**
Date	29/04/2020				
Scale	NTS			Job No.	**GR1102.1J**

APPENDIX C

Engineering Borehole Logs with Core Photographs

Client: **Alceon Group Pty Ltd**
Project: **Proposed Residential Development**

Borehole No: 1
Project No: GR1102.1J

Location: 2 Greenwich Road, Greenwich, NSW
Elevation: ~86.0m
Datum: AHD

Drilling Contractor: BG Drilling
Date Drilled: 19/03/2020
Logged By: RT

Drill Rig: Hanjin Rig 4
Depth To Water:
Date Completed: 19/03/2020
Checked By: JC

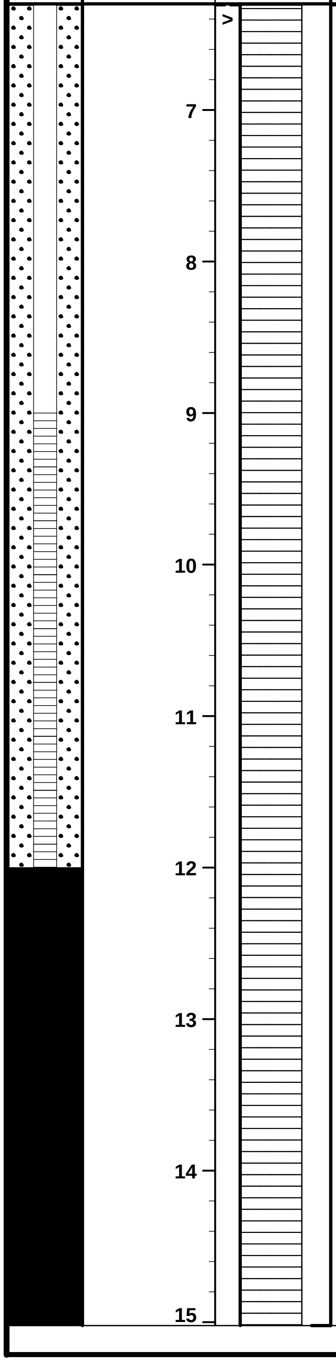
Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
		0			Asphaltic Concrete: 350mm thickness					Pavement
		1	▨		FILL: Silty Clay, low plasticity, dark brown mottled brown, trace fine to coarse grained gravel.	MC<PL				Appears to be poorly compacted
		2	▨		Fill: Silty Clay, low plasticity, red brown with fine to medium grained shale and ironstone gravel.	MC<PL		■	1,1,4 N=5	HP 50kPa
			▨							HP 10 kPa
			▨							HP 10kPa
		3 4	▨					■	2,9,15 N=24	Appears to be moderate to well compacted
		5	▨					■	5,8,8 N=16	
		6	☰		SHALE: red brown.	XW	VL			Bedrock
GWL Measured on 29.04.20 ▼		7 8 9 10			Refer to cored borehole log.					

This information pertains only to this boring and should not be interpreted as being indicative of the site.

CORING LOG OF BOREHOLE NO. 1

Client: Alceon Group Pty Ltd	**Project No.:** GR1102.1J
Project: Proposed Residential Development	**Logged By:** RT
Location: 2 Greenwich Road, Greenwich, NSW	**Checked By:** JC
Drilling Plant/Method: Hanjin Rig 4	**Elevation:** 86.0m AHD
Date Drilled: 19/03/2020 **Completed:** 19/03/2020	**Casing Depth:**
Depth To Water:	**TOTAL DEPTH:** 17.4 m

Well Description	Depth (m)	Graphic Log	Material Descrption	Weathering Condition	Strength	DEFECT DESCRIPTION	Defect Spacing mm	Point Load(a)



START CORING AT 6.31m
SHALE: Dark grey, sandstone laminated.

Weathering Condition:
- XW
- DW
- MW
- SR

Strength:
- EL
- VL-L
- M

Defect Description:

6.5,FR,50mm
6.61,JT,90°,50mm

6.76,FR,50mm
6.81,JT,80-90°,75mm
6.95,FR,50mm
7.00,FR,70mm
7.13,BP,0-5°,PL,SM,CN
7.91,Fractured seam,40mm

8.47,JT,20-30°,50mm
8.58,FR,120mm
8.78,FR,30mm
8.81,JT,20-30°,30mm
8.90,FR,60mm

9.28,Be,0-5°,PL.RO,VN

9.54,Be,0-10°,PL,RO,VN
9.61,Be,0-20°,PL,RO,VN
9.82,Be,0-10°,PL,SM,CN

10.05,Be,0-5°,PL,SM,CN
10.34,FR,30mm
10.55,Be,0-10°,PL,SM,CN

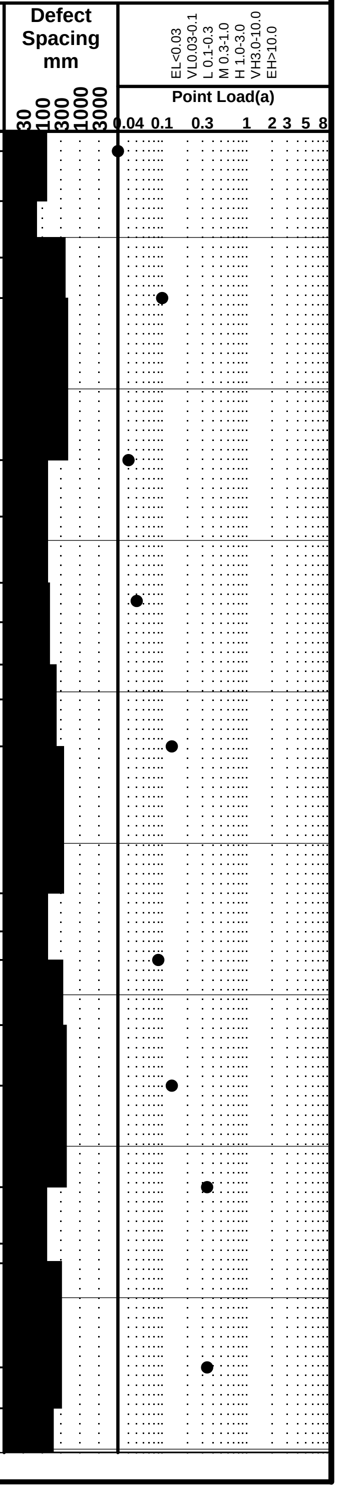
11.33,JT,80-90°,30mm
11.43,JT,60°,75mm
11.68,Be,0-10°,RO,VN
11.81,FR,20mm

12.18,Be,0-5°,PL,SM,CN

12.76,Be,0-5°,PL,SM,CN

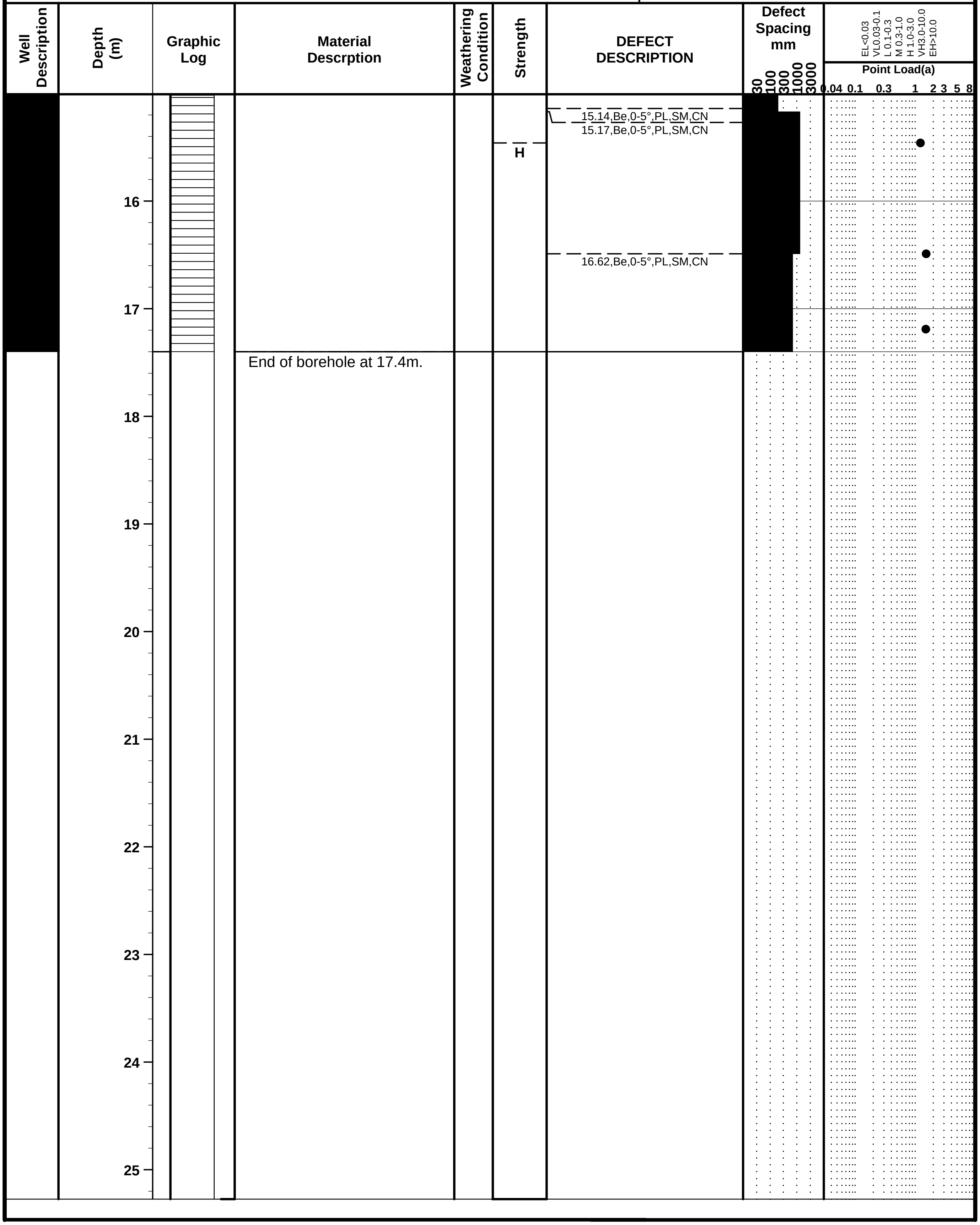
13.18,Be,0-5°,PL,SM,CN
13.34,JT,45°,30mm
13.47,Be,0-5°,PL,SM,CN
13.53,Be,0-5°,PL,SM,CN
13.76,Be,0-5°,PL,SM,CN

14.21,Be,0-5°,PL,SM,CN
14.26,Be,0-5°,PL,SM,CN
14.73,Be,0-5°,PL,SM,CN



Coring Log Of Borehole No. 1 (CONTINUED)

Project: Proposed Residential Development	**Project No.: GR1102.1J**
Location: 2 Greenwich Road, Greenwich, NSW	**Site Engineer: RT**



15.14,Be,0-5°,PL,SM,CN

15.17,Be,0-5°,PL,SM,CN

16.62,Be,0-5°,PL,SM,CN

End of borehole at 17.4m.

JC Geotechnics Pty Ltd

Sheet 3 of 3


GR1102.1J
BH1
CORING STARTS FROM 6.31 m
6
6.31m
7
8
NO CORE
9


10
11
12
13
14


15
16
17
18

Client: **Alceon Group Pty Ltd**

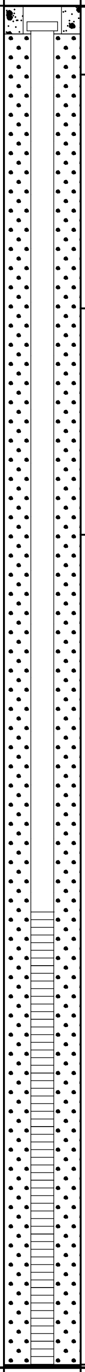
Project: **Proposed Residential Development**

Borehole No: 2

Project No: GR1102.1J

Location: 2 Greenwich Road, Greenwich, NSW	Elevation: ~81.8 m	Datum: AHD
Drilling Contractor: BG Drilling	Date Drilled: 26/03/2020	Logged By: RT
Drill Rig: Hanjin Rig 4 Depth To Water:	Date Completed: 19/03/2020	Checked By: JC

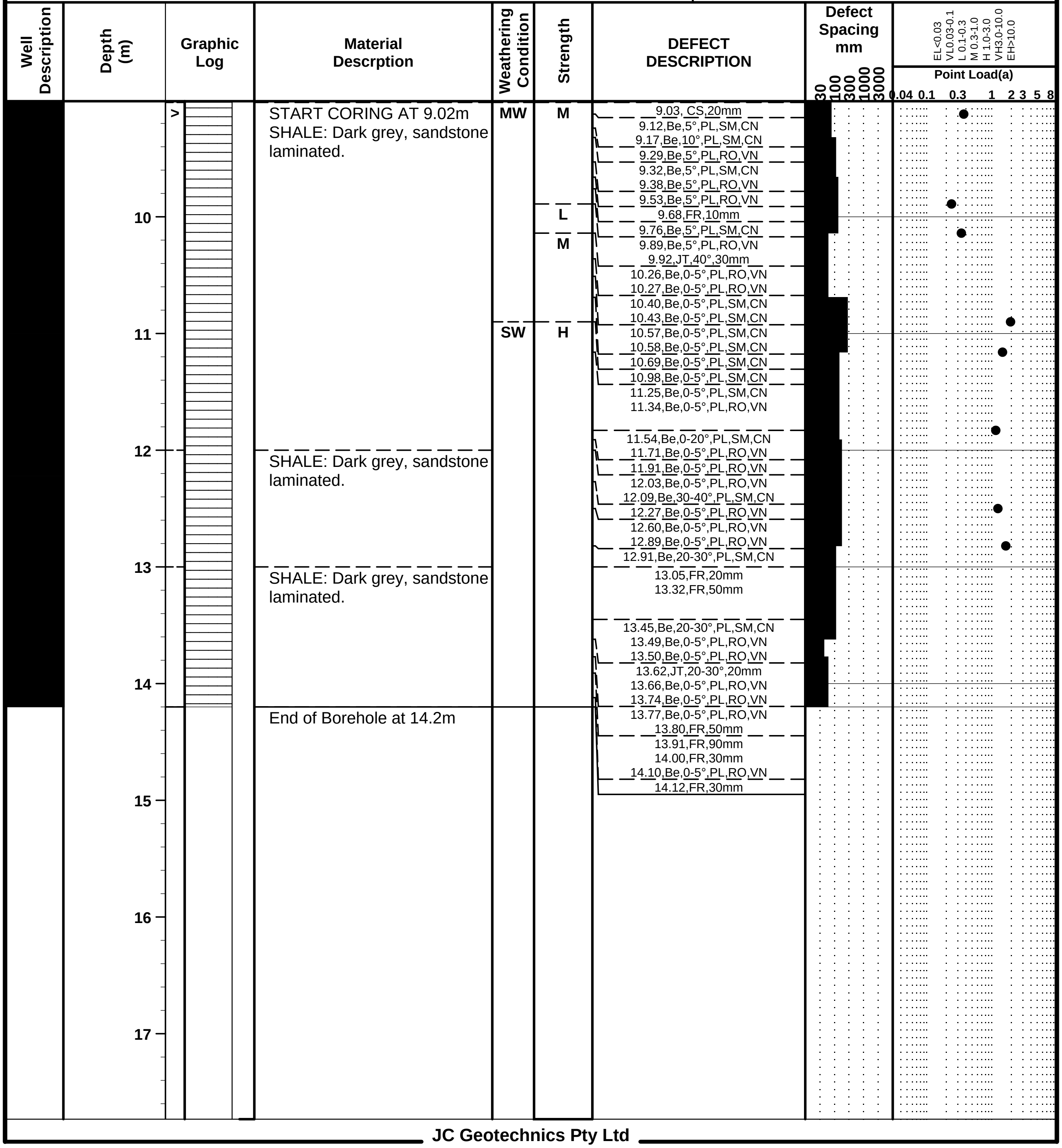
This information pertains only to this boring and should not be interpreted as being indicative of the site.



Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
		0			Ashphaltic Concrete: 450mm thicknes					Pavement
		1	▨		Fill: Silty clay, medium plasticity, dark grey.	MC>PL		■	2,1,1 N=2	Appears to be poorly to moderately compacted. HP 200 kPa
		2 3	▨		Fill: Sandy Clay, low to medium plasticity, dark grey and mottled yellow, fine to medium grained.	MC<PL		■	3,2,3 N=5	HP 50 kPa HP 30 kPa
GWL Measured on 29.04.20 ▼		4 5 6 7 8	▨	CL-CH	Silty CLAY: low plasticity, brown.	MC<PL	S			Residual
		9 10			Shale: dark grey. Refer to cored Borehole log	XW	L		35/120 R	Bedrock

CORING LOG OF BOREHOLE NO. 2

Client: Alceon Group Pty Ltd
Project No.: GR1102.1J
Project: Proposed Residential Development
Logged By: RT
Location: 2 Greenwich Road, Greenwich, NSW
Checked By:
Drilling Plant/Method: Hanjin Rig 4
Elevation: 81.8mAHD
Date Drilled: 19/03/2020 **Completed:** 19/03/2020
Casing Depth:
Depth To Water:
TOTAL DEPTH: 14.2 m



START CORING AT 9.02m
SHALE: Dark grey, sandstone laminated.

SHALE: Dark grey, sandstone laminated.

SHALE: Dark grey, sandstone laminated.

End of Borehole at 14.2m

MW
SW

M
L
M
H

9.03, CS,20mm
9.12,Be,5°,PL,SM,CN
9.17,Be,10°,PL,SM,CN
9.29,Be,5°,PL,RO,VN
9.32,Be,5°,PL,SM,CN
9.38,Be,5°,PL,RO,VN
9.53,Be,5°,PL,RO,VN
9.68,FR,10mm
9.76,Be,5°,PL,SM,CN
9.89,Be,5°,PL,RO,VN
9.92,JT,40°,30mm
10.26,Be,0-5°,PL,RO,VN
10.27,Be,0-5°,PL,RO,VN
10.40,Be,0-5°,PL,SM,CN
10.43,Be,0-5°,PL,SM,CN
10.57,Be,0-5°,PL,SM,CN
10.58,Be,0-5°,PL,SM,CN
10.69,Be,0-5°,PL,SM,CN
10.98,Be,0-5°,PL,SM,CN
11.25,Be,0-5°,PL,SM,CN
11.34,Be,0-5°,PL,RO,VN
11.54,Be,0-20°,PL,SM,CN
11.71,Be,0-5°,PL,RO,VN
11.91,Be,0-5°,PL,RO,VN
12.03,Be,0-5°,PL,RO,VN
12.09,Be,30-40°,PL,SM,CN
12.27,Be,0-5°,PL,RO,VN
12.60,Be,0-5°,PL,RO,VN
12.89,Be,0-5°,PL,RO,VN
12.91,Be,20-30°,PL,SM,CN
13.05,FR,20mm
13.32,FR,50mm
13.45,Be,20-30°,PL,SM,CN
13.49,Be,0-5°,PL,RO,VN
13.50,Be,0-5°,PL,RO,VN
13.62,JT,20-30°,20mm
13.66,Be,0-5°,PL,RO,VN
13.74,Be,0-5°,PL,RO,VN
13.77,Be,0-5°,PL,RO,VN
13.80,FR,50mm
13.91,FR,90mm
14.00,FR,30mm
14.10,Be,0-5°,PL,RO,VN
14.12,FR,30mm

JC Geotechnics Pty Ltd


GR1102.1J
BH2
CORING STARTS AT 9.02 m
9
9.02m
10
11
12


13
14
CORING ENDS AT 14.2m
BOX 2/2

Client: **Alceon Group Pty Ltd**

Project: **Proposed Residential Development**

Borehole No: 3

Project No: GR1102.1J

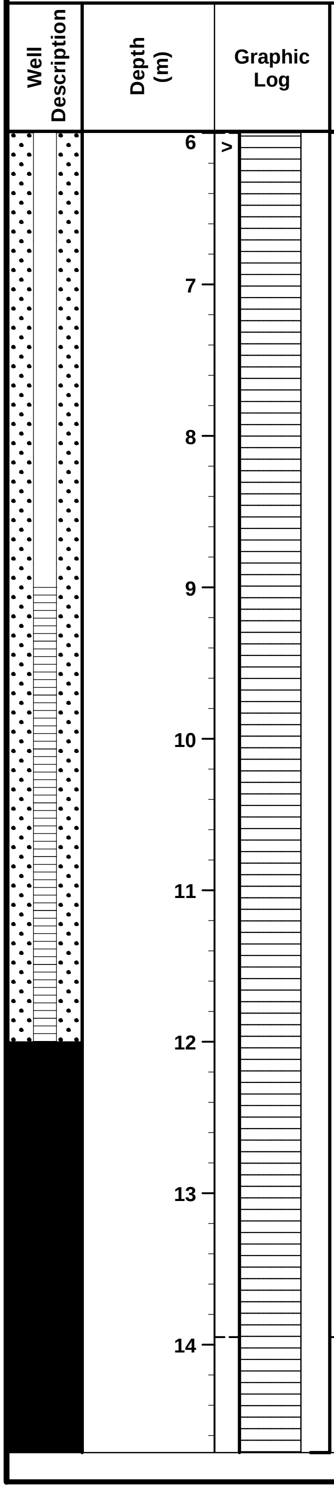
Location: 2 Greenwich Road, Greenwich, NSW	Elevation: ~83.2 m	Datum: AHD
Drilling Contractor: BG Drilling	Date Drilled: 20/03/2020	Logged By: RT
Drill Rig: Hanjin Rig 4 Depth To Water:	Date Completed: 20/03/2020	Checked By: JC

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
		0			Brick Pavement: 40mm thickness	MC<PL				Pavement
				CH	FILL: Silty Clay, low plasticity, black, trace root and organic contents.	MC>PL	VSt			Appears to be poorly compacted
										Residual
		1			Silty ClAY: High plasticity, light grey.					
								■	2,9,15 N=24	
		2			Silty CLAY: Low plasticity, dark grey.	MC<PL	S			
		3						■	3,5,14 N=19	
		4								
								■	4,8,13/75 N>21	
		5								
					SHALE: grey.	XW	VL			Bedrock
GWL Measured on 29.04.20		6			Refer to cored borehole log.					
		7								
		8								
		9								
		10								

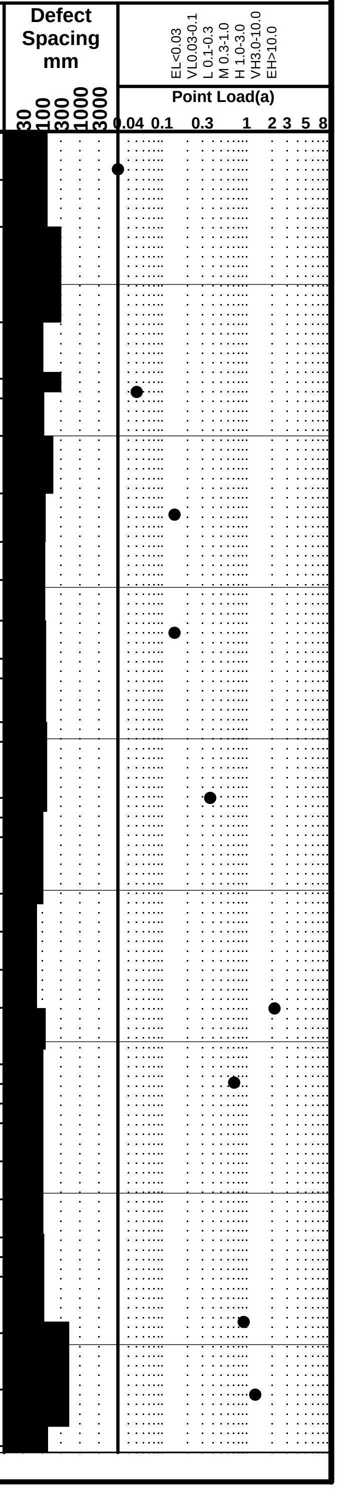
This information pertains only to this boring and should not be interpreted as being indicative of the site.

CORING LOG OF BOREHOLE NO. 3

Client: Alceon Group Pty Ltd
Project No.: GR1102.1J
Project: Proposed Residential Development
Logged By: RT
Location: 2 Greenwich Road, Greenwich, NSW
Checked By:
Drilling Plant/Method: Hanjin Rig 4
Elevation: 83.2 mAHD
Date Drilled: 19/03/2020 **Completed:** 19/03/2020
Casing Depth:
Depth To Water:
TOTAL DEPTH: 16.7 m



Material Descrpton	Weathering Condition	Strength	DEFECT DESCRIPTION
START CORING AT 6.0m SHALE: Dark grey, sandstone laminated.	XW	EL	6.02,Be,0-5°,PL,SM,CN 6.31,Be,0-5°,RO,VN 6.41,FR,30mm 6.62,FR,150mm 6.88,FR,120mm 7.25,Be, 0-10°,PL,SM,CN 7.33,Be,0-5°,PL,SM,CN 7.41,FR,80mm 7.58,FR,60mm
	DW	L	7.88,FR,10mm 8.00,FR,240mm 8.32,Be,0-10°,PL,SM,CN 8.43,Be,0-10°,PL,SM,CN 8.47,Be,0-5°,RO,VN 8.70,JT,40-50°,20mm 8.88,Be,0-5°,PL,SM,CN 8.93,Be,0-5°,PL,SM,CN 9.09,Be,0-5°,PL,SM,CN 9.22,Be,0-5°,PL,RO,VN 9.29,Be,0-5°,PL,RO,VN 9.53,Be,0-5°,PL,SM,CN 9.60,FR,40mm 9.72,Be,0-5°,PL,SM,CN 9.90,Be,0-5°,PL,SM,CN 9.96,FR,40mm 10.09,Be,0-10°,PL,RO,VN
	SW	M-H	10.32,FR,10mm 10.48,FR,10mm 10.58,Be,20-30°,PL,SM,CN 10.63,Be,0-5°,RO,VN 10.72,Be,0-5°,RO,VN 10.77,Be,0-5°,RO,VN 10.79,JT,70-80°,30mm 11.16,Be,0-5°,RO,VN 11.25,Be,0-5°,RO,VN 11.30,FR,20mm 11.39,Be,0-10°,RO,VN
	FR	H	11.44,FR,30mm 11.52,Be,0-5°,PL,SM,CN 11.55,Be,0-30°,PL,SM,CN 11.73,Be,0-10°,PL,SM,CN
	MW	M	11.78,Be,0-20°,RO,VN 11.88,Be,0-5°,RO,VN 12.05,Be,0-5°,RO,VN 12.14,Be,0-5°,RO,VN 12.26,Be,0-5°,RO,VN 12.38,Be,0-5°,RO,VN 12.41,Be,0-5°,RO,VN 12.54,Be,0-5°,RO,VN 12.71,Be,0-10°,RO,VN 12.87,FR,70mm 12.94,Be,0-10°,RO,VN 13.02,Be,0-5°,PL,SM,CN 13.16,Be,0-5°,PL,RO,VN
SHALE: Light grey, sandstone laminated.	MW	H	13.27,Be,0-5°,PL,RO,VN 13.38,Be,0-20°,PL,SM,CN 13.41,FR,30mm 13.54,FR,80mm 13.62,Be,0-5°,PL,RO,VN 13.71,Be,0-5°,PL,SM,CN



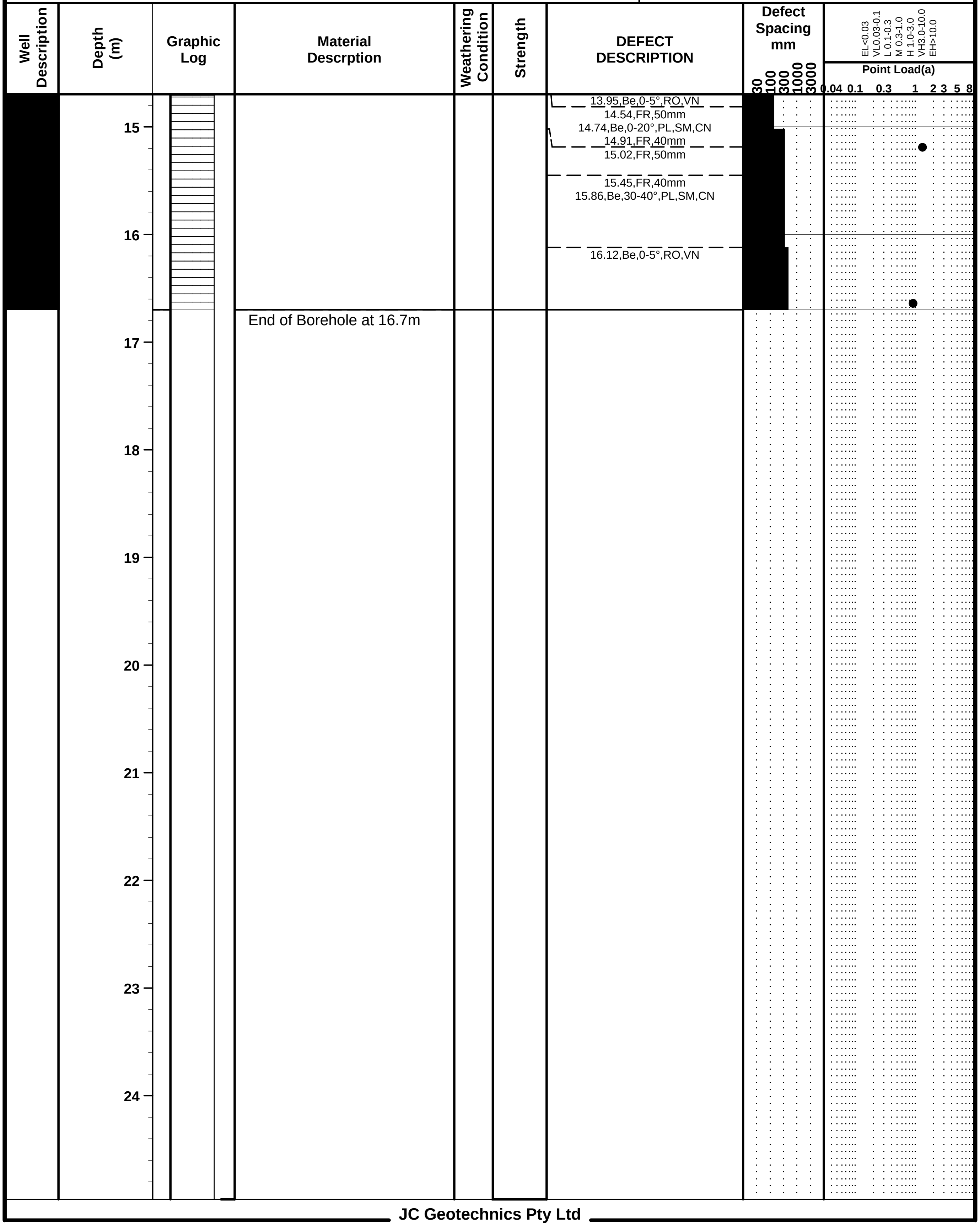
Coring Log Of Borehole No. 3 (CONTINUED)

Project: Proposed Residential Development

Project No.: GR1102.1J

Location: 2 Greenwich Road, Greenwich, NSW

Site Engineer: RT



13.95,Be,0-5°,RO,VN
14.54,FR,50mm
14.74,Be,0-20°,PL,SM,CN
14.91,FR,40mm
15.02,FR,50mm
15.45,FR,40mm
15.86,Be,30-40°,PL,SM,CN
16.12,Be,0-5°,RO,VN

End of Borehole at 16.7m

JC Geotechnics Pty Ltd


GR1102.1J BH3 CORING STARTS FROM 6.0m
6
7
8
9


10
11
12
13
14


15
16
CORING ENDS AT 16.7m

Client: **Alceon Group Pty Ltd**

Project: **Proposed Residential Development**

Borehole No: 4

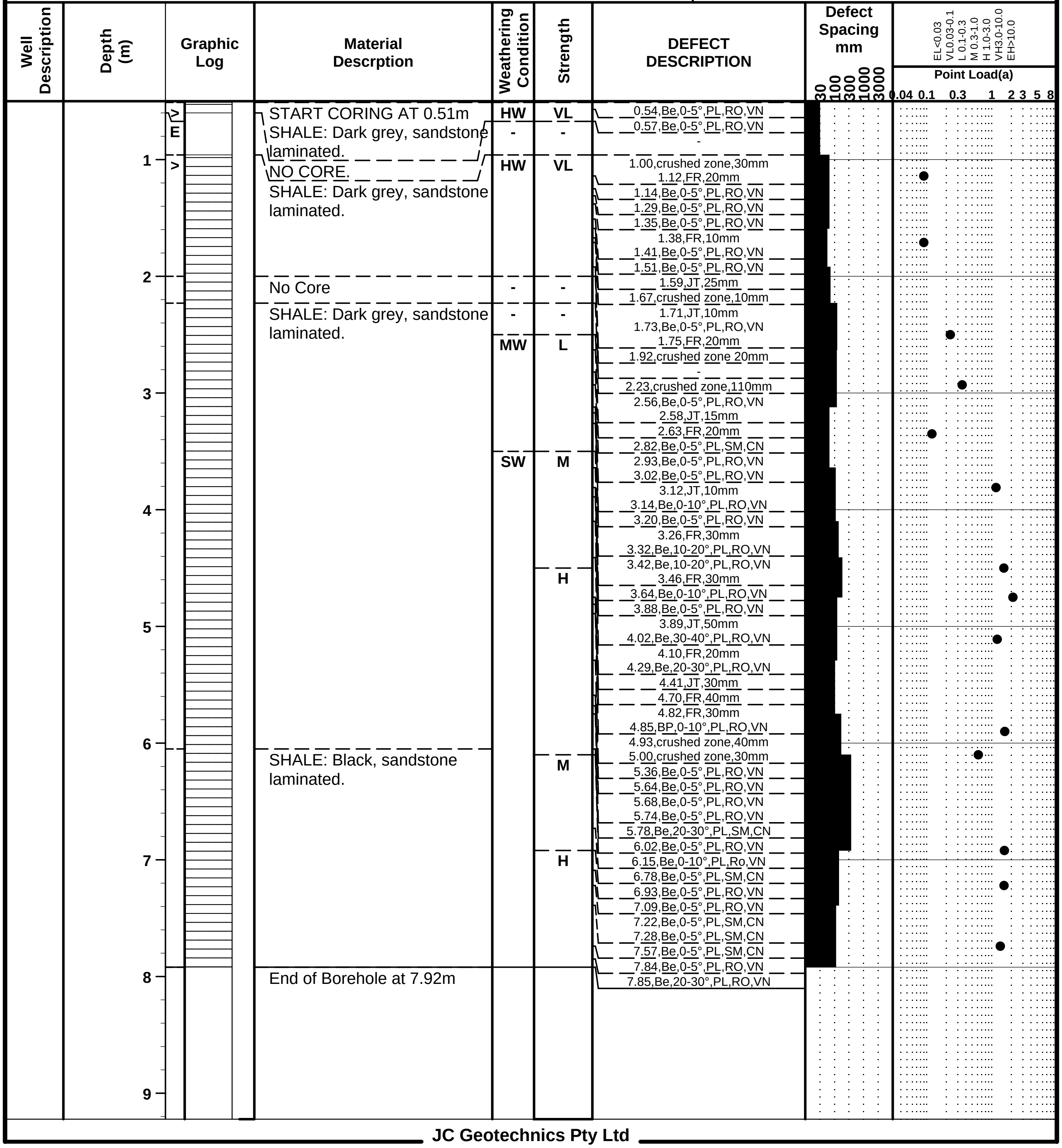
Project No: GR1102.1J

Location: 2 Greenwich Road, Greenwich, NSW		Elevation: ~76.7m	Datum: AHD
Drilling Contractor: BG Drilling		Date Drilled: 31/03/2020	Logged By: RT
Drill Rig: Hand portable	Depth To Water:	Date Completed: 19/03/2020	Checked By: JC

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
		0			Conrete Slab: 210mm thickness					Pavement
			▨	CL-CH	Silty clay: medium plasticity, dark grey.	MC>PL				Residual HP 250kPa
					Shale: dark grey. Refer Cored Borehole log.	XW	L			Bedrock
		1								
		2								
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								

CORING LOG OF BOREHOLE NO. 4

Client: Alceon Group Pty Ltd	**Project No.:** GR1102.1J
Project: Proposed Residential Development	**Logged By:** RT
Location: 2 Greenwich Road, Greenwich, NSW	**Checked By:**
Drilling Plant/Method: Hanjin Rig 4	**Elevation:** 76.7 mAHD
Date Drilled: 19/03/2020 **Completed:** 19/03/2020	**Casing Depth:**
Depth To Water:	**TOTAL DEPTH:** 7.92 m



Material Descrption	Weathering Condition	Strength
START CORING AT 0.51m SHALE: Dark grey, sandstone laminated.	HW	VL
NO CORE.	-	-
SHALE: Dark grey, sandstone laminated.	HW	VL
No Core	-	-
SHALE: Dark grey, sandstone laminated.	-	-
	MW	L
	SW	M
		H
SHALE: Black, sandstone laminated.		M
		H
End of Borehole at 7.92m		

DEFECT DESCRIPTION

0.54,Be,0-5°,PL,RO,VN
0.57,Be,0-5°,PL,RO,VN
-
1.00,crushed zone,30mm
1.12,FR,20mm
1.14,Be,0-5°,PL,RO,VN
1.29,Be,0-5°,PL,RO,VN
1.35,Be,0-5°,PL,RO,VN
1.38,FR,10mm
1.41,Be,0-5°,PL,RO,VN
1.51,Be,0-5°,PL,RO,VN
1.59,JT,25mm
1.67,crushed zone,10mm
1.71,JT,10mm
1.73,Be,0-5°,PL,RO,VN
1.75,FR,20mm
1.92,crushed zone 20mm
-
2.23,crushed zone,110mm
2.56,Be,0-5°,PL,RO,VN
2.58,JT,15mm
2.63,FR,20mm
2.82,Be,0-5°,PL,SM,CN
2.93,Be,0-5°,PL,RO,VN
3.02,Be,0-5°,PL,RO,VN
3.12,JT,10mm
3.14,Be,0-10°,PL,RO,VN
3.20,Be,0-5°,PL,RO,VN
3.26,FR,30mm
3.32,Be,10-20°,PL,RO,VN
3.42,Be,10-20°,PL,RO,VN
3.46,FR,30mm
3.64,Be,0-10°,PL,RO,VN
3.88,Be,0-5°,PL,RO,VN
3.89,JT,50mm
4.02,Be,30-40°,PL,RO,VN
4.10,FR,20mm
4.29,Be,20-30°,PL,RO,VN
4.41,JT,30mm
4.70,FR,40mm
4.82,FR,30mm
4.85,BP,0-10°,PL,RO,VN
4.93,crushed zone,40mm
5.00,crushed zone,30mm
5.36,Be,0-5°,PL,RO,VN
5.64,Be,0-5°,PL,RO,VN
5.68,Be,0-5°,PL,RO,VN
5.74,Be,0-5°,PL,RO,VN
5.78,Be,20-30°,PL,SM,CN
6.02,Be,0-5°,PL,RO,VN
6.15,Be,0-10°,PL,Ro,VN
6.78,Be,0-5°,PL,SM,CN
6.93,Be,0-5°,PL,RO,VN
7.09,Be,0-5°,PL,RO,VN
7.22,Be,0-5°,PL,SM,CN
7.28,Be,0-5°,PL,SM,CN
7.57,Be,0-5°,PL,SM,CN
7.84,Be,0-5°,PL,RO,VN
7.85,Be,20-30°,PL,RO,VN

JC Geotechnics Pty Ltd


GR1102.1J
BH4
CORING STARTS FROM 0.51m
0
0.51m
CORE LOSS FROM 0.60m - 0.96m
1
2
CORE
LOSS FROM 2.0m - 2.23m
3

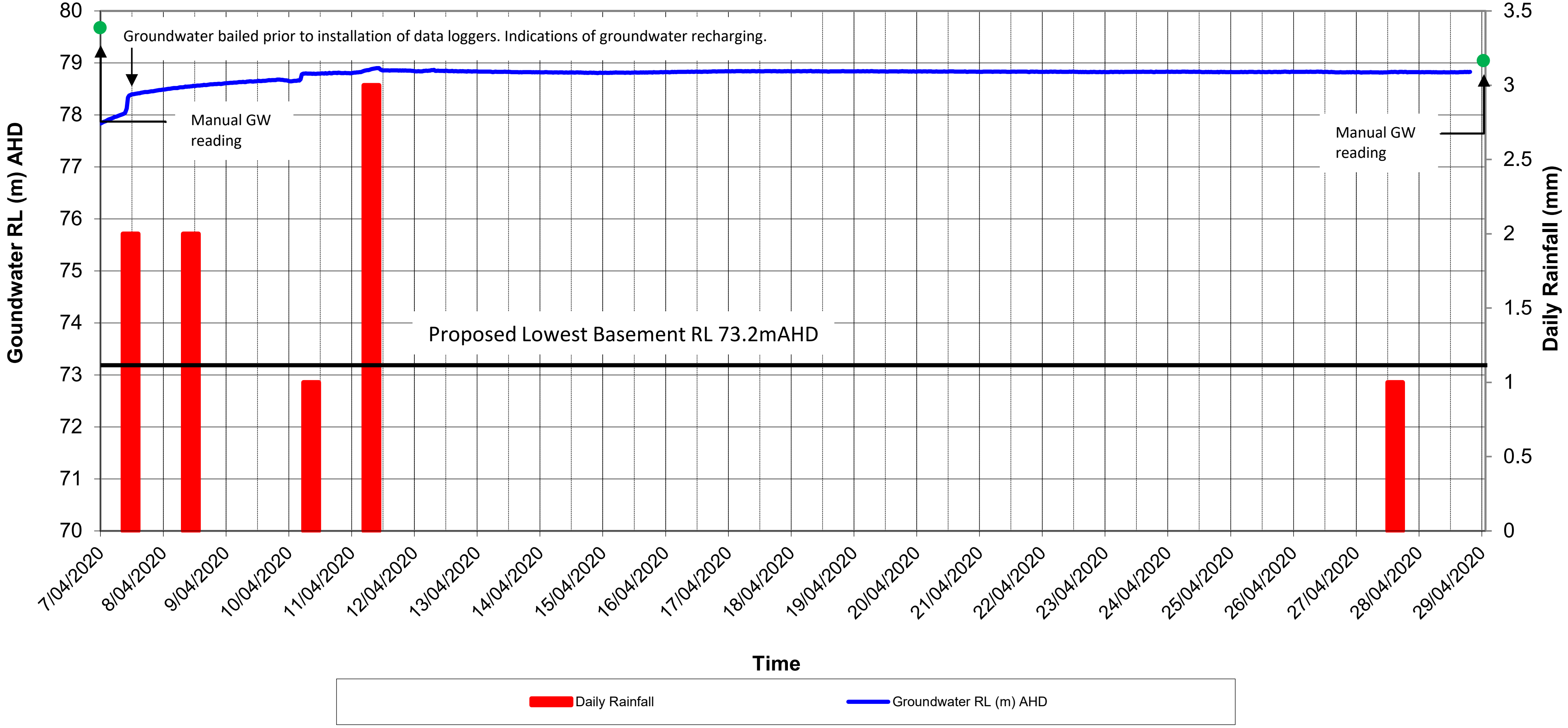

4
5
6
7
7.92m
CORING ENDS AT 7.92m
BOX 2/2

APPENDIX D

Groundwater Monitoring Plots

BH1

Groundwater Level and Daily Rainfall vs Time

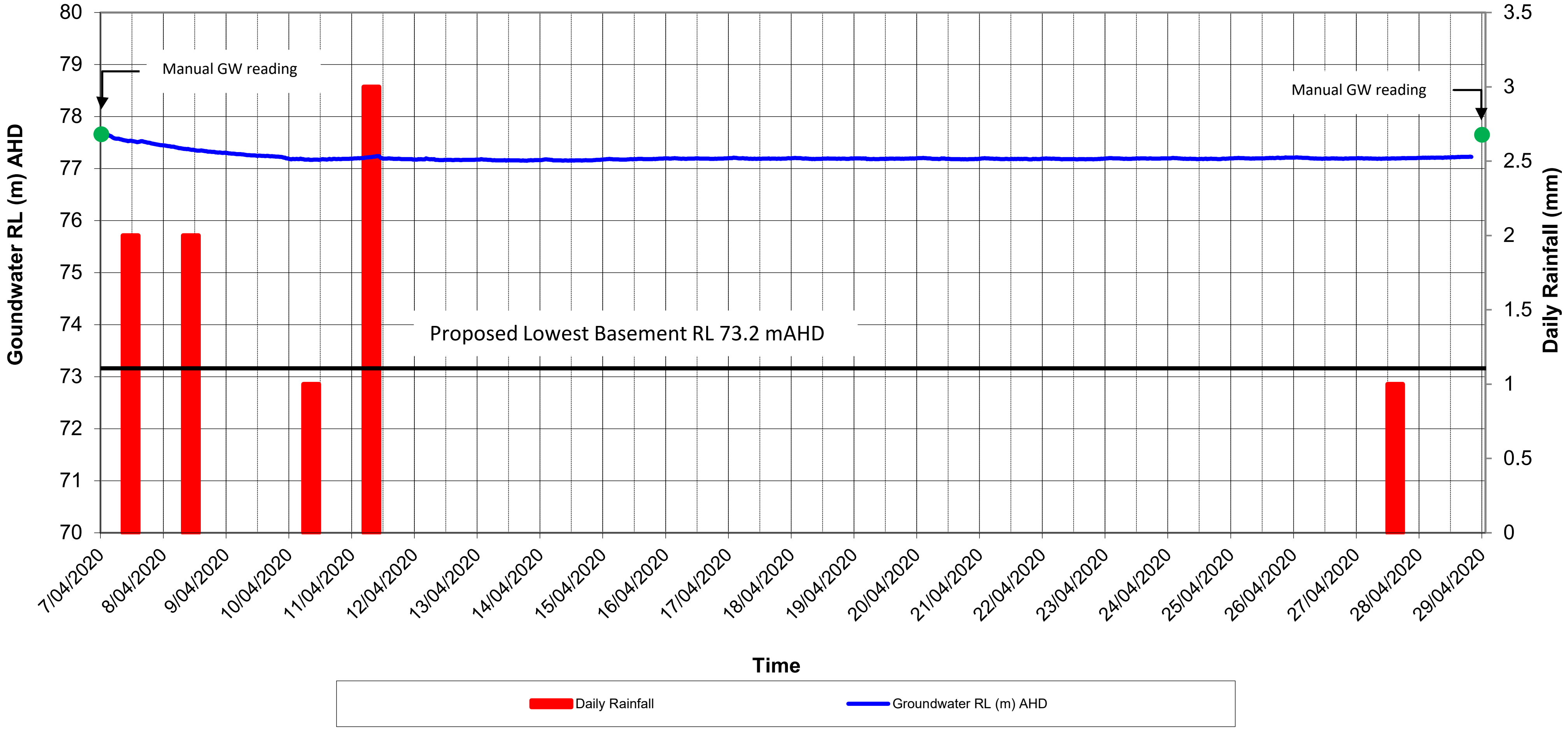


Ground Level of	**Drawn by**	RT	**Client:**	Alceon Group Pty Ltd
Screen Interval (mAHD)	**Approved by**	JC	**Project:**	Proposed Greenwich Seniors Living
Rainfall Data is from the Bureau of Meteorology Website at www.bom.gov.au	**Date**	29/04/2020	**Title:**	Groundwater Level and Daily Rainfall vs Time
	Scale	1:1	**Project No:**	GR1102.1J
	Original Size	A3	**Figure No:**	Figure 2

JC Geotechnics

BH2

Groundwater Level and Daily Rainfall vs Time

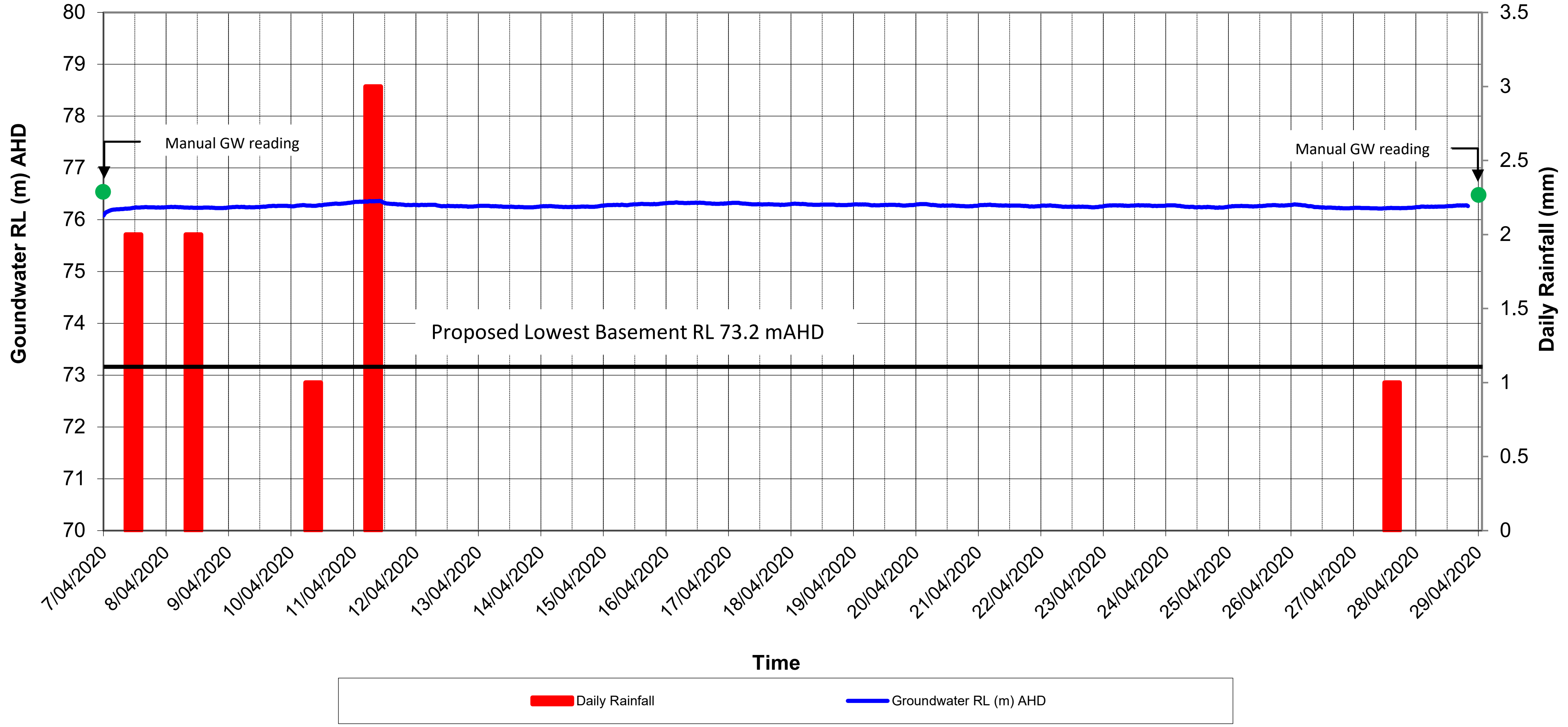


Ground Level of	**Drawn by**	RT	**Client:**	Alceon Group Pty Ltd
Screen Interval (mAHD)	**Approved by**	JC	**Project:**	Proposed Greenwich Seniors Living
Rainfall Data is from the Bureau of Meteorology Website at www.bom.gov.au	**Date**	29/04/2020	**Title:**	Groundwater Level and Daily Rainfall vs Time
	Scale	1:1	**Project No:**	GR1102.1J
	Original Size	A3	**Figure No:**	Figure 3

JC Geotechnics

BH3

Groundwater Level and Daily Rainfall vs Time



Ground Level of	**Drawn by**	RT	Geotechnics	**Client:**	Alceon Group Pty Ltd		
Screen Interval (mAHD)	**Approved by**	JC		**Project:**	Proposed Greenwich Seniors Living		
Rainfall Data is from the Bureau of Meteorology Website at www.bom.gov.au	**Date**	29/04/2020		**Title:**	Groundwater Level and Daily Rainfall vs Time		
	Scale	1:1		**Project No:**	GR1102.1J	**Figure No:**	Figure 4
	Original Size	A3					

APPENDIX E

Laboratory Testing Results

CERTIFICATE OF ANALYSIS

Work Order : **ES2011478**
Client : **JC Geotechnics**
Contact : Joseph Chaghouri
Address : Shop 2-4 143-146 Parramatta Road
Concord 2137
Telephone : ----
Project : GR1102.1J Greenwich
Order number : ----
C-O-C number : ----
Sampler : Robert
Site : ----
Quote number : EN/333
No. of samples received : 3
No. of samples analysed : 3

Page : 1 of 2
Laboratory : Environmental Division Sydney
Contact : Customer Services ES
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 02-Apr-2020 17:05
Date Analysis Commenced : 03-Apr-2020
Issue Date : 06-Apr-2020 15:30

NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BH1(1.5m-1.95m)**	**BH3(1.5m-1.95m)**	**BH4(0.4m-0.5m)**	**----**	**----**
			Client sampling date / time	19-Mar-2020 09:30	20-Mar-2020 11:00	31-Mar-2020 12:30	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2011478-001**	**ES2011478-002**	**ES2011478-003**	**--------**	**--------**
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.0**	**5.6**	**5.5**	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**463**	**119**	**69**	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**14.3**	**14.5**	**14.0**	----	----
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	**380**	**280**	**290**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**150**	**60**	<10	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order : **ES2011478**

Client : **JC Geotechnics**
Contact : Joseph Chaghouri
Address : Shop 2-4 143-146 Parramatta Road
Concord 2137

Telephone : ----
Project : GR1102.1J Greenwich
Order number : ----
C-O-C number : ----
Sampler : Robert
Site : ----
Quote number : EN/333
No. of samples received : 3
No. of samples analysed : 3

Page : 1 of 3

Laboratory : Environmental Division Sydney
Contact : Customer Services ES
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164

Telephone : +61-2-8784 8555
Date Samples Received : 02-Apr-2020
Date Analysis Commenced : 03-Apr-2020
Issue Date : 06-Apr-2020

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA002: pH 1:5 (Soils) (QC Lot: 2952972)									
ES2011367-001	Anonymous	EA002: pH Value	----	0.1	pH Unit	7.8	6.5	18.0	0% - 20%
EA010: Conductivity (1:5) (QC Lot: 2952971)									
ES2011312-003	Anonymous	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	2600	2670	2.77	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2953664)									
EP2003290-036	Anonymous	EA055: Moisture Content	----	0.1	%	14.4	13.8	4.72	0% - 20%
ED040T : Total Sulfate by ICPAES (QC Lot: 2952504)									
ES2011478-001	BH1(1.5m-1.95m)	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	380	340	11.5	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 2952973)									
ES2011367-001	Anonymous	ED045G: Chloride	16887-00-6	10	mg/kg	10	10	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA010: Conductivity (1:5) (QCLot: 2952971)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	105	92.0	108
ED040T : Total Sulfate by ICPAES (QCLot: 2952504)								
ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	----	----	----	----
ED045G: Chloride by Discrete Analyser (QCLot: 2952973)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10 <10	50 mg/kg 5000 mg/kg	91.9 93.4	75.0 79.0	125 117

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 2952973)							
ES2011367-001	Anonymous	ED045G: Chloride	16887-00-6	1250 mg/kg	104	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES2011478**	Page	: 1 of 5
Client	: **JC Geotechnics**	Laboratory	: Environmental Division Sydney
Contact	: Joseph Chaghouri	Telephone	: +61-2-8784 8555
Project	: GR1102.1J Greenwich	Date Samples Received	: 02-Apr-2020
Site	: ----	Issue Date	: 06-Apr-2020
Sampler	: Robert	No. of samples received	: 3
Order number	: ----	No. of samples analysed	: 3

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	**Days overdue**	Date analysed	Due for analysis	**Days overdue**
EA002: pH 1:5 (Soils)						
Snap Lock Bag BH1(1.5m-1.95m)	03-Apr-2020	26-Mar-2020	**8**	----	----	----
Snap Lock Bag BH3(1.5m-1.95m)	03-Apr-2020	27-Mar-2020	**7**	----	----	----
EA010: Conductivity (1:5)						
Snap Lock Bag BH1(1.5m-1.95m)	03-Apr-2020	26-Mar-2020	**8**	----	----	----
Snap Lock Bag BH3(1.5m-1.95m)	03-Apr-2020	27-Mar-2020	**7**	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)						
Snap Lock Bag BH1(1.5m-1.95m)	----	----	----	03-Apr-2020	02-Apr-2020	**1**
ED040: Sulfur as SO4 2-						
Snap Lock Bag BH1(1.5m-1.95m)	03-Apr-2020	26-Mar-2020	**8**	----	----	----
Snap Lock Bag BH3(1.5m-1.95m)	03-Apr-2020	27-Mar-2020	**7**	----	----	----

Outliers : Frequency of Quality Control Samples

Matrix: **SOIL**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Moisture Content	1	13	7.69	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*

Matrix: **SOIL**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA002: pH 1:5 (Soils)							
Snap Lock Bag (EA002) BH1(1.5m-1.95m)	**19-Mar-2020**	**03-Apr-2020**	26-Mar-2020	✗	**03-Apr-2020**	03-Apr-2020	✓
Snap Lock Bag (EA002) BH3(1.5m-1.95m)	**20-Mar-2020**	**03-Apr-2020**	27-Mar-2020	✗	**03-Apr-2020**	03-Apr-2020	✓
Snap Lock Bag (EA002) BH4(0.4m-0.5m)	**31-Mar-2020**	**03-Apr-2020**	07-Apr-2020	✓	**03-Apr-2020**	03-Apr-2020	✓
EA010: Conductivity (1:5)							
Snap Lock Bag (EA010) BH1(1.5m-1.95m)	**19-Mar-2020**	**03-Apr-2020**	26-Mar-2020	✗	**03-Apr-2020**	01-May-2020	✓
Snap Lock Bag (EA010) BH3(1.5m-1.95m)	**20-Mar-2020**	**03-Apr-2020**	27-Mar-2020	✗	**03-Apr-2020**	01-May-2020	✓
Snap Lock Bag (EA010) BH4(0.4m-0.5m)	**31-Mar-2020**	**03-Apr-2020**	07-Apr-2020	✓	**03-Apr-2020**	01-May-2020	✓
EA055: Moisture Content (Dried @ 105-110°C)							
Snap Lock Bag (EA055) BH1(1.5m-1.95m)	**19-Mar-2020**	**----**	----	----	**03-Apr-2020**	02-Apr-2020	✗
Snap Lock Bag (EA055) BH3(1.5m-1.95m)	**20-Mar-2020**	**----**	----	----	**03-Apr-2020**	03-Apr-2020	✓
Snap Lock Bag (EA055) BH4(0.4m-0.5m)	**31-Mar-2020**	**----**	----	----	**03-Apr-2020**	14-Apr-2020	✓
ED040: Sulfur as SO4 2-							
Snap Lock Bag (ED040T) BH1(1.5m-1.95m)	**19-Mar-2020**	**03-Apr-2020**	26-Mar-2020	✗	**03-Apr-2020**	01-May-2020	✓
Snap Lock Bag (ED040T) BH3(1.5m-1.95m)	**20-Mar-2020**	**03-Apr-2020**	27-Mar-2020	✗	**03-Apr-2020**	01-May-2020	✓
Snap Lock Bag (ED040T) BH4(0.4m-0.5m)	**31-Mar-2020**	**03-Apr-2020**	07-Apr-2020	✓	**03-Apr-2020**	01-May-2020	✓
ED045G: Chloride by Discrete Analyser							
Snap Lock Bag (ED045G) BH1(1.5m-1.95m)	**19-Mar-2020**	**03-Apr-2020**	16-Apr-2020	✓	**03-Apr-2020**	01-May-2020	✓
Snap Lock Bag (ED045G) BH3(1.5m-1.95m)	**20-Mar-2020**	**03-Apr-2020**	17-Apr-2020	✓	**03-Apr-2020**	01-May-2020	✓
Snap Lock Bag (ED045G) BH4(0.4m-0.5m)	**31-Mar-2020**	**03-Apr-2020**	28-Apr-2020	✓	**03-Apr-2020**	01-May-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		*Count*		*Rate (%)*			*Quality Control Specification*
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Chloride Soluble By Discrete Analyser	ED045G	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	1	13	**7.69**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chloride Soluble By Discrete Analyser	ED045G	2	5	**40.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride Soluble By Discrete Analyser	ED045G	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride Soluble By Discrete Analyser	ED045G	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
pH (1:5)	EA002	SOIL	In house: Referenced to Rayment and Lyons 4A1 and APHA 4500H+. pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Electrical Conductivity (1:5)	EA010	SOIL	In house: Referenced to Rayment and Lyons 3A1 and APHA 2510. Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 6.1 and Table 1 (14 day holding time).
Sulfate as SO4 2- Total	ED040T	SOIL	In house: Total Sulfate is determined off a HCl digestion by ICPAES as S , and reported as SO4
Chloride Soluble By Discrete Analyser	ED045G	SOIL	In house: Referenced to APHA 4500-Cl- E. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm. Analysis is performed on a 1:5 soil / water leachate.

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
HCl Digest	EN24	SOIL	1g of soil is digested in 30 ml of 30% HCl and the resultant digest bulked and filtered for analysis by ICP.
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.

MOISTURE CONTENT TEST REPORT

Client:	JC Geotechnics Pty Ltd	**Job No:**	S20152-2
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Report No:**	S59054-MC
Project:	Proposed New Development (GR1102 1J)		

Test Procedure:

- ☑ AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
- ☐ AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
- ☐ RMS T120 Moisture content of road construction materials (Standard method)
- ☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	26/03/2020

Preparation: Prepared in accordance with the test method

Sample No.	Source	Sample Description	Moisture Content %
S59054	BH3 (0.7m-0.8m)	Rock Chips	**24.4**
S59055	BH1 (5.5m-6m)	Rock Chips	**11.0**
S59056	BH2 (9m-9.12m)	Rock Chips	**16.3**
S59057	BH3 (6m-6.1m)	Rock Chips	**10.4**

Notes:

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

6/04/2020

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

SOIL CLASSIFICATION REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH3 (0.7m-0.8m)
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY
Project	Proposed New Development (GR1102 1J)	**Report No**	S59054-PI
Job No	S20152-2	**Lab No**	S59054

Test Procedure:

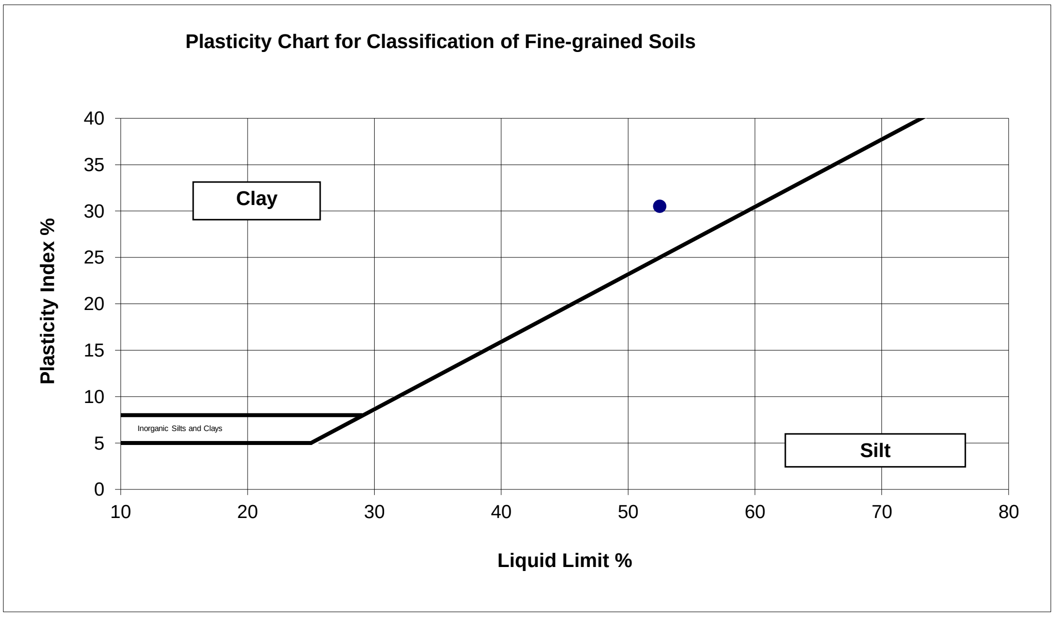
☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client - results apply to the sample as received

Date Sampled: 26/03/2020

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	53	**Linear Shrinkage (%)**	8.5
Plastic Limit (%)	22	**Plasticity Index**	31



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

15/04/2020
Date:

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

POINT LOAD STRENGTH INDEX REPORT

Client:	JC Geotechnics Pty Ltd	**Moisture Content Condition:**	As received
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Storage History:**	Core boxes
Project:	Proposed New Development (GR1102 1J)	**Report No:**	S58858-PL
Job No:	S20152-1	**Date Tested:**	31/03/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 19/03/2020

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S58858	BH1 6.37 - 6.42m	Shale	Axial	51.8	44.0	0.04	0.01	0.01	1
S58859	BH1 7.39 - 7.47m	Shale	Axial	51.8	36.0	0.24	0.10	0.10	1
S58860	BH1 8.40 - 8.47m	Shale	Axial	51.0	29.0	0.09	0.05	0.04	1
S58861	BH1 9.41 - 9.50m	Shale	Axial	51.0	33.0	0.10	0.05	0.05	1
S58862	BH1 10.43 - 10.52m	Shale	Axial	51.2	33.0	0.30	0.14	0.13	1
S58863	BH1 11.60 - 11.68m	Shale	Axial	51.5	29.0	0.19	0.10	0.09	1
S58864	BH1 12.60 - 12.68m	Shale	Axial	51.4	32.0	0.28	0.13	0.13	1
S58865	BH1 13.27 - 13.35m	Shale	Axial	51.7	36.0	0.82	0.35	0.34	1
S58866	BH1 14.46 - 14.60m	Shale	Axial	51.5	42.0	0.91	0.33	0.34	1
S58867	BH1 15.46 - 15.52m	Shale	Axial	51.5	33.0	2.72	1.26	1.22	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

31/03/2020

Date

MACQUARIE GEOTECH

Macquarie Geotechn
U7/8 10 Bradford
Street
Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	JC Geotechnics Pty Ltd	**Moisture Content Condition:**	As received
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Storage History:**	Core boxes
Project:	Proposed New Development (GR1102 1J)	**Report No:**	S58868-PL
Job No:	S20152-1	**Date Tested:**	26/03/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 19/03/2020

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S58868	BH1 16.49 - 16.58m	Shale	Axial	51.6	35.0	3.55	1.54	1.52	1
S58869	BH1 17.19 - 17.26m	Shale	Axial	51.6	35.0	3.52	1.53	1.50	1
S58870	BH3 6.24 - 6.33m	Shale	Axial	53.0	35.0	0.05	0.02	0.02	1
S58871	BH3 7.71 - 7.77m	Shale	Axial	50.3	28.0	0.10	0.06	0.05	1
S58872	BH3 8.52 - 8.61m	Shale	Axial	51.0	39.0	0.36	0.14	0.14	3
S58873	BH3 9.30 - 9.34m	Shale	Axial	51.2	37.0	0.33	0.14	0.14	1
S58874	BH3 10.39 - 10.44m	Shale	Axial	51.4	18.0	0.52	0.44	0.37	1
S58875	BH3 11.78 - 11.87m	Shale	Axial	51.6	31.0	4.55	2.23	2.13	1
S58876	BH3 12.27 - 12.38m	Shale	Axial	51.7	33.0	1.59	0.73	0.71	1
S58877	BH3 13.85 - 13.94m	Shale	Axial	51.8	40.0	2.39	0.91	0.92	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

31/03/2020

Date

MACQUARIE GEOTECH

Macquarie Geotechn
U7/8 10 Bradford
Street
Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	JC Geotechnics Pty Ltd	**Moisture Content Condition:**	As received
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Storage History:**	Core boxes
Project:	Proposed New Development (GR1102 1J)	**Report No:**	S58878-PL
Job No:	S20152-1	**Date Tested:**	26/03/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 19/03/2020

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S58878	BH3 14.33 - 14.38m	Shale	Axial	51.7	43.0	3.48	1.23	1.26	1
S58879	BH3 15.19 - 15.27m	Shale	Axial	51.7	34.0	3.02	1.35	1.32	1
S58880	BH3 16.64 - 16.72m	Shale	Axial	51.7	40.0	2.40	0.91	0.92	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

31/03/2020

Date

Macquarie Geotechn
U7/8 10 Bradford
Street
Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	JC Geotechnics Pty Ltd	**Moisture Content Condition:**	As received
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Storage History:**	Core boxes
Project:	Proposed New Development (GR1102 1J)	**Report No:**	S59348-PL
Job No:	S20173-2	**Date Tested:**	23/04/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 31/03/2020

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S59348	BH4 1.10-1.20m	Shale	Axial	50.5	32.0	0.19	0.09	0.09	1
S59349	BH4 1.75-1.85m	Shale	Axial	49.4	39.0	0.22	0.09	0.09	1
S59350	BH4 2.40-2.50m	Shale	Axial	51.5	32.0	0.50	0.24	0.23	1
S59351	BH4 2.90-3.0m	Shale	Axial	51.3	33.0	0.78	0.36	0.35	1
S59352	BH4 3.35-3.45m	Shale	Axial	51.4	31.0	0.26	0.13	0.12	1
S59353	BH4 3.75-3.85m	Shale	Axial	51.4	35.0	2.72	1.19	1.16	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

23/04/2020

Date

MACQUARIE GEOTECH

Macquarie Geotechn
U7/8 10 Bradford
Street
Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	JC Geotechnics Pty Ltd	**Moisture Content Condition:**	As received
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Storage History:**	Core boxes
Project:	Proposed New Development (GR1102 1J)	**Report No:**	S59144-PL
Job No:	S20173-1	**Date Tested:**	9/04/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S59139	BH2 9.04 - 9.12m	Shale	Axial	51.2	35.0	0.86	0.38	0.37	1
S59140	BH2 9.80 - 9.90m	Shale	Axial	51.4	38.0	0.60	0.24	0.24	1
S59141	BH2 10.14 - 10.24m	Shale	Axial	51.5	37.0	0.82	0.34	0.34	1
S59142	BH2 10.90 - 10.97m	Shale	Axial	51.3	34.0	4.42	1.99	1.94	1
S59143	BH2 11.16 - 11.25m	Shale	Axial	51.2	40.0	3.77	1.45	1.46	1
S59144	BH2 11.83 - 11.91m	Shale	Axial	51.4	37.0	2.81	1.16	1.15	1
S59145	BH2 12.50 - 12.59m	Shale	Axial	51.5	42.0	3.33	1.21	1.24	1
S59146	BH2 12.82 - 12.89m	Shale	Axial	51.1	35.0	3.81	1.67	1.64	1
S59147	BH4 4.50 - 4.59m	Shale	Axial	51.6	31.0	3.27	1.61	1.53	1
S59148	BH4 4.75 - 4.81m	Shale	Axial	51.8	30.0	4.40	2.22	2.11	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

14/04/2020

Date

MACQUARIE GEOTECH

Macquarie Geotechn
U7/8 10 Bradford
Street
Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	JC Geotechnics Pty Ltd	**Moisture Content Condition:**	As recevied
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Storage History:**	Core boxes
Project:	Proposed New Development (GR1102 1J)	**Report No:**	S59154-PL
Job No:	S20173-1	**Date Tested:**	9/04/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index Is$_{(50)}$ (MPa)	Failure Mode
S59149	BH4 5.11 - 5.18m	Shale	Axial	51.5	34.0	2.76	1.24	1.21	1
S59150	BH4 5.90 - 5.99m	Shale	Axial	51.7	36.0	3.78	1.60	1.58	1
S59151	BH4 6.1 0- 6.20m	Shale	Axial	51.4	40.0	1.60	0.61	0.62	1
S59152	BH4 6.92 - 6.99m	Shale	Axial	51.7	36.0	3.75	1.58	1.56	1
S59153	BH4 7.22 - 7.28m	Shale	Axial	51.4	37.0	3.75	1.55	1.54	1
S59154	BH4 7.74 - 7.84m	Shale	Axial	51.6	40.0	3.50	1.33	1.35	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

14/04/2020

Date

MACQUARIE GEOTECH

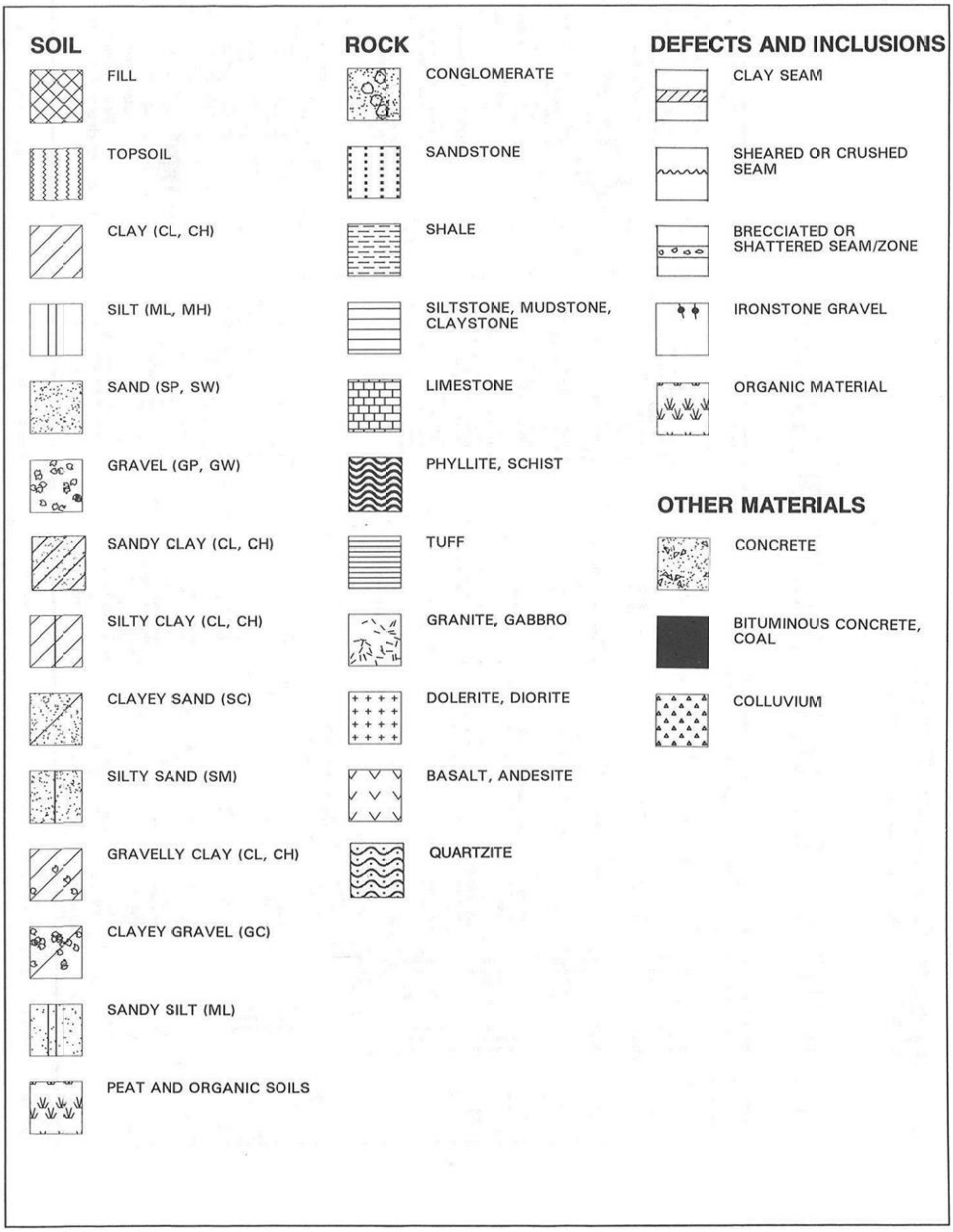
Macquarie Geotechn
U7/8 10 Bradford
Street
Alexandria NSW

APPENDIX F

Explanatory Notes

JC GEOTECHNICS

GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS



The following information is intended to assist in the interpretation of terms and symbols used in geotechnical borehole logs, test pit logs and reports issued by or for the JC Geotechnics Pty Ltd. More detailed information relating to specific test methods is available in the relevant Australian Standards AS1726-2017.

Soil Descriptions

Description and Classification of Soils for Geotechnical Purposes: Refer to AS1726-2017 (Clause 6.1.6)

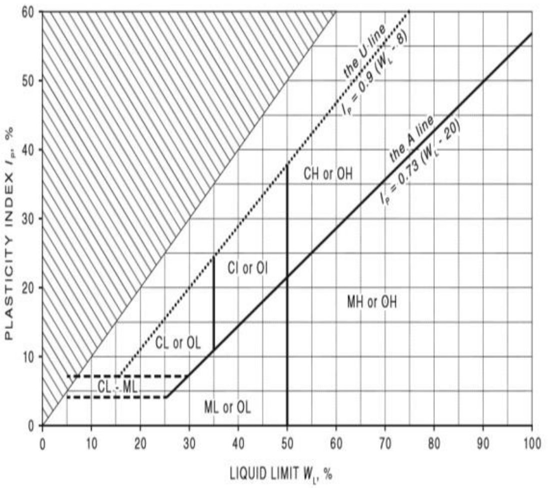
The following chart (adapted from AS1726-2017, Clause 6.1.6, Table A1) is based on the Unified Soil Classification System (USCS).

Table 1

Major Divisions		**Particle size mm**	**USCS Group Symbol**	**Typical Names**	**Field classification of sand and gravel**	**Laboratory Classification**					
COARSE GRAINED SOILS (more than 65% of soil excluding oversize fraction is greater than 0.075 mm)	BOULDERS COBBLES	200 63				% < 0.075 mm		Plasticity of fine fraction	$C_u = \frac{D_{60}}{D_{10}}$	$C_u = \frac{(D_{30})^2}{(D_{10})(D_{60})}$	NOTES
	GRAVELS (more than half of coarse fraction is larger than 2.36 mm)	coarse 20 medium 6 fine 2.36	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	Use the gradation curve of material passing 63 mm for classification of fractions	≤ 5% fines	—	>4	Between 1 and 3	(1) Identify fines by the method given for fine-grained soils. (2) Borderline classifications occur when the percentage of fines (fraction smaller than 0.075 mm size) is greater than 5% and less than 12%. Borderline classifications require the use of SP-SM, GW-GC.
			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	Below 'A' line or PI<4	—	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	Above 'A' line and PI>7	—	Fines behave as clay	
	SANDS (more than half of coarse fraction is smaller than 2.36 mm)	coarse 0.6 medium 0.2 fine 0.075	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	—	>6	Between 1 and 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	Below 'A' line or PI<4	—	—	
			SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength		≥ 12% fines, fines are clayey	Above 'A' line and PI>7		—	

Classification of fine-grained soils

z

<table>
<tr><th colspan="2" rowspan="2">Major Divisions</th><th rowspan="2">USCS Group Symbol</th><th rowspan="2">Typical Names</th><th colspan="3">Field classification of sand and gravel</th><th>Laboratory classification</th><th rowspan="9"> </th></tr>
<tr><th>Dry Strength</th><th>Dilatancy</th><th>Toughness</th><th>% < 0.075 mm</th></tr>
<tr><td rowspan="7">FINE GRAINED SOILS
(more than 35% of soil excluding oversize fractions is less than 0.075 mm)</td><td rowspan="3">SILT and CLAY (low to medium plasticity, %)
(Liquid Limit ≤50%)</td><td>ML</td><td>Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity</td><td>None to low</td><td>Slow to rapid</td><td>Low</td><td>Below A line</td></tr>
<tr><td>CL
CI</td><td>Inorganic clay of low to medium plasticity, gravelly clay, sandy clay</td><td>Medium to high</td><td>None to slow</td><td>Medium</td><td>Above A line</td></tr>
<tr><td>OL</td><td>Organic silts and clays of low plasticity</td><td>Low to medium</td><td>Slow</td><td>Low</td><td>Below A line</td></tr>
<tr><td rowspan="3">SILT and CLAY (high plasticity)
(Liquid Limit >50%)</td><td>MH</td><td>Inorganic silts, mic- aceous or diato-maceous fine sands or silts, elastic silts</td><td>Low to medium</td><td>None to slow</td><td>Low to medium</td><td>Below A line</td></tr>
<tr><td>CH</td><td>Inorganic clays of high plasticity, fat clays</td><td>High to very high</td><td>None</td><td>High</td><td>Above A line</td></tr>
<tr><td>OH</td><td>Organic clay of medium to high plasticity, organic silt</td><td>Medium to high</td><td>None to very slow</td><td>Low to medium</td><td>Below A line</td></tr>
<tr><td>HIGHLY ORGANIC SOILS</td><td>PT</td><td>Peat and other highly organic soils</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Soil Colour: Is described in the moist condition using black, white, grey, red, brown, orange, yellow, green or blue. Borderline cases can be described as a combination of two colours, with the weaker followed by the stronger. Modifiers such as pale, dark or mottled, can be used as necessary. Where colour consists of a primary colour with secondary mottling, it should be described as follows: (Primary) mottled (Secondary). Refer to AS 1726-2017, Clause 6.1.5

Soil Moisture Condition: Is based on the appearance and feel of soil. Refer to AS 1726-2017, Clause 6.1.7

Term	Description
Dry (D)	Cohesive soils; hard and friable or powdery, well dry of plastic limit. Granular soils; cohesionless and free-running.
Moist	Soil feels cool, darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet	Soil feels cool, darkened in colour. Cohesive soils usually weakened and free water forms on hands when handling. Granular soils tend to cohere and free water forms on hands when handling.

Consistency of Cohesive Soils: May be estimated using simple field tests, or described in terms of a strength scale. In the field, the undrained shear strength (s_u) can be assessed using a simple field tool appropriate for cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-2017, Table 11.

Consistency - Essentially Cohesive Soils					
Term	Field Guide	Symbol	SPT "N" Value	Undrained Shear Strength s_u (kPa)	Unconfined Compressive Strength q_u (kPa)
Very soft	Exudes between the fingers when squeezed in hand	VS	0-2	<12	<25
Soft	Can be moulded by light finger pressure	S	2-4	12-25	25-50
Firm	Can be moulded by strong finger pressure	F	4-8	25-50	50-100
Stiff	Cannot be moulded by fingers	St	8-15	50-100	100-200
Very stiff	Can be indented by thumb nail	VSt	15-30	100-200	200-400
Hard	Can be indented with difficulty by thumb nail.	H	>30	>200	>400
Friable (Fr)	Can be easily crumbled or broken into small pieces by hand	Fr	-	-	-

Soil Particle Sizes	
Term	Size Range
BOULDERS	>200 mm
COBBLES	63-200 mm
Coarse GRAVEL	20-63 mm
Medium GRAVEL	6-20 mm
Fine GRAVEL	2.36-6 mm
Coarse SAND	0.6-2.36 mm
Medium SAND	0.2-0.6 mm
Fine SAND	0.075-0.2 mm
SILT	0.002-0.075 mm
CLAY	<0.002 mm

Note: SPT - N to q_u correlation from Terzaghi and Peck, 1967. (General guide only).

Consistency of Non-Cohesive Soils: Is described in terms of the density index, as defined in AS 1289.0-2014. This can be assessed using a field tool appropriate for non-cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-2017, Table 12

Consistency - Essentially Non-Cohesive Soils				
Term	Symbol	SPT N Value	Field Guide	Density Index (%)
Very loose	VL	0-4	Foot imprints readily	0-15
Loose	L	4-10	Shovels Easily	15-35
Medium dense	MD	10-30	Shoveling difficult	35-65
Dense	D	30-50	Pick required	65-85
Very dense	VD	>50	Picking difficult	85-100

Standard Penetration Test (SPT): Refer to. AS 1289.6.3.1-2004 (R2016). Example report formats for SPT results are shown below:

Test Report	Penetration Resistance (N)	Explanation / Comment
4, 7, 11	N=18	Full penetration; N is reported on engineering borehole log
18, 27, 32	N=59	Full penetration; N is reported on engineering borehole log
4, 18, 30/15 mm	N is not reported	30 blows causes less than 100 mm penetration (3rd interval) – test discontinued
30/80 mm	N is not reported	30 blows causes less than 100 mm penetration (1st interval) – test discontinued
rw	N<1	Rod weight only causes full penetration
hw	N<1	Hammer and rod weight only causes full penetration

hb	N is not reported	Hammer bouncing for 5 consecutive blows with no measurable penetration – test discontinued

Rock Descriptions

Refer to AS 1726-2017 Clause 6.2.3 for the description and classification of rock material composition, including:

(a) Rock name (Table 15, 16, 17, 18)
(b) Grain size
(c) Texture and fabric
(d) Colour (describe as per soil)
(e) Features, inclusion and minor components.
(f) Moisture content
(g) Durability

The condition of a rock material refers to its weathering characteristics, strength characteristics and rock mass properties. Refer to AS 1726-2017 (Clause 6.2.4 Tables 19, 20 and 21).

Weathering Condition (Degree of Weathering):

The degree of weathering is a continuum from fresh rock to soil. Boundaries between weathering grades may be abrupt or gradational.

Rock Material Weathering Classification

Weathering Grade		Symbol		Definition
Residual Soil (Note 1)		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 Rock (Note 2)		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 Rock (Note 2)	Distinctly Weathered (Note 2)	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 recognizable. 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
Moderately Weathered Rock (Note 2)		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 recognizable, but shows little or no change of strength from fresh rock.
Slightly Weathered Rock		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock
Fresh Rock		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

Notes:

1. Minor variations within broader weathering grade zones will be noted on the engineering borehole logs.
2. Extremely weathered rock is described in terms of soil engineering properties.
3. Weathering may be pervasive throughout the rock mass, or may penetrate inwards from discontinuities to some extent.
4. Where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock the term 'Distinctly Weathered' may be used. '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.

Strength Condition (Intact Rock Strength):

Strength of Rock Material

(Based on Point Load Strength Index, corrected to 50 mm diameter – $I_{s(50)}$. Field guide used if no tests available. Refer to AS 4133.4.1-2007 (R2016).

Term	Sym	Point Load Index (MPa) $I_{s(50)}$	Field Guide to Strength
Extremely Low	EL	≤0.03	Easily remoulded by hand to a material with soil properties.
Very Low	VL	>0.0 ≤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 3 cm thick can be broken by finger pressure.

Low	L	>0.1	≤0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	>0.3	≤1.0	Readily scored with a knife; broken by hand with difficult a piece of core 150 mm long by 50 mm diameter can be y.
High	H	>1	≤3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	VH	>3	≤10	pick after more than one blow; rock rings under hammer.
Extremely High	EH	>10		Specimen requires many blow rock ring with geological pick to break through intact material; under hammer

Notes:

1. These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considerably weaker due to the effect of rock defects.
2. Anisotropy of rock material samples may affect the field assessment of strength.

Discontinuity Description: Refer to AS 1726-2017, Table 22.

Anisotropic Fabric	
BED	Bedding
FOL	Foliation
LIN	Mineral lineation
Defect Type	
LP	Lamination Parting
BP	Bedding Parting
FP	Cleavage / Foliation Parting
J, Js	Joint, Joints
SZ	Sheared Zone
CZ	Crushed Zone
BZ	Broken Zone
HFZ	Highly Fractured Zone
AZ	Alteration Zone
VN	Vein

Roughness (e.g. Planar, Smooth is abbreviated Pl / Sm)		Class
Stepped (Stp)	Rough or irregular (Ro)	I
	Smooth (Sm)	II
	Slickensided (Sl)	III
Undulating (Un)	Rough (Ro)	IV
	Smooth (Sm)	V
	Slickensided (Sl)	VI
Planar (Pl)	Rough (Ro)	VII
	Smooth (Sm)	VIII
	Slickensided (Sl)	IX

Aperture		**Infilling**		
Closed	CD	No visible coating or infill	Clean	Cn
Open	OP	Surfaces discoloured by mineral/s	Stain	St
Filled	FL	Visible mineral or soil infill <1mm	Veneer	Vr
Tight	TI	Visible mineral or soil infill >1mm	Coating	Ct

Other	
Cly	Clay
Fe	Iron
Co	Coal
Carb	Carbonaceous
Sinf	Soil Infill Zone
Qz	Quartz
CA	Calcite
Chl	Chlorite
Py	Pyrite
Int	Intersecting
Inc	Incipient
DI	Drilling Induced
H	Horizontal
V	Vertical

Note: Describe 'Zones' and 'Coatings' in terms of composition and thickness (mm).

Discontinuity Spacing: On the geotechnical borehole log, a graphical representation of defect spacing vs depth is shown. This representation takes into account all the natural rock defects occurring within a given depth interval, excluding breaks induced by the drilling / handling of core. Refer to AS 1726-2017, BS5930-2015.

Defect Spacing			**Bedding Thickness (Sedimentary Rock**	
Spacing/Width (mm)	**Descriptor**	**Symbol**	**Descriptor**	**Spacing/Width (mm)**
			Thinly Laminated	< 6
<20	Extremely Close	EC	Thickly Laminated	6 – 20
20 – 60	Very Close	VC	Very Thinly Bedded	20 – 60
60 – 200	Close	C	Thinly Bedded	60 – 200
200 – 600	Medium	M	Medium Bedded	200 – 600
600 – 2000	Wide	W	Thickly Bedded	600 – 2000
2000 – 6000	Very Wide	VW	Very Thickly Bedded	> 2000
>6000	Extremely Wide	EW		

Defect Spacing in 3D	
Term	**Description**
Blocky	Equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section

Defect Persistence (areal extent)
Trace length of defect given in metres

Symbols

The list below provides an explanation of terms and symbols used on the geotechnical borehole, test pit and penetrometer logs.

Test Results			
PI	Plasticity Index	c'	Effective Cohesion
LL	Liquid Limit	c_u	Undrained Cohesion
LI	Liquidity Index	c'_R	Residual Cohesion
DD	Dry Density	ϕ'	Effective Angle of Internal Friction
WD	Wet Density	ϕ_u	Undrained Angle of Internal Friction
LS	Linear Shrinkage	ϕ'_R	Residual Angle of Internal Friction
MC	Moisture Content	c_v	Coefficient of Consolidation
OC	Organic Content	m_v	Coefficient of Volume Compressibility
WPI	Weighted Plasticity Index	$c_{\alpha\varepsilon}$	Coefficient of Secondary Compression

Test Symbols	
DCP	Dynamic Cone Penetrometer
SPT	Standard Penetration Test
CPTu	Cone Penetrometer (Piezocone) Test
PANDA	Variable Energy DCP
PP	Pocket Penetrometer Test
U50	Undisturbed Sample 50 mm (nominal diameter)
U100	Undisturbed Sample 100mm (nominal diameter)
UCS	Uniaxial Compressive Strength
Pm	Pressuremeter

Test Results			
WLS	Weighted Linear Shrinkage	e	Voids Ratio
DoS	Degree of Saturation	ϕ'_{cv}	Constant Volume Friction Angle
APD	Apparent Particle Density	q_t / q_c	Piezocone Tip Resistance (corrected / uncorrected)
s_u	Undrained Shear Strength	q_d	PANDA Cone Resistance
q_u	Unconfined Compressive Strength	$I_{s(50)}$	Point Load Strength Index
R	Total Core Recovery	*RQD*	Rock Quality Designation

Test Symbols	
FSV	Field Shear Vane
DST	Direct Shear Test
PR	Penetration Rate
A	Point Load Test (axial)
D	Point Load Test (diametral)
L	Point Load Test (irregular lump)

▽ 28/11/13	Groundwater level on the date shown	▶	Water Inflow	◁	Water Outflow