



REPORT TO
RENT A SPACE SELF STORAGE

ON
GEOTECHNICAL INVESTIGATION

FOR
PROPOSED STORAGE BUILDING

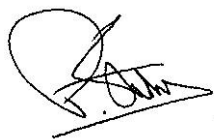
AT
4 CROSS STREET, BROOKVALE, NSW

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ATTACHMENTS

STS Table A: Moisture Content Test Report

STS Table B: Four Day Soaked California Bearing Ratio Test Report

STS Table C: Point Load Strength Index Test Report

EnviroLab Services Certificate of Analysis No. 233855

Borehole Logs 1 to 5 Inclusive (With Core Photographs)

Test Pit logs 6 and 7

CPT Logs 201 to 203 inclusive

Figure 1: Site Location Plan

Figure 2: Borehole Location Plan

Figure 3: Test Pit 6 Cross Sectional Sketch

Figure 4: Test Pit 7 Cross Sectional Sketch

Figure 5: Graphical Summary and Preliminary Geotechnical Model Section AA

Vibration Emission Design Goals

Report Explanation Notes

1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed storage building at 4 Cross Street, Brookvale, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by Motaland Pty Ltd by signed Consultancy Agreement dated 4 December 2019 and carried out in general accordance with our fee proposal, Ref. P50619Srev1, dated 4 December 2019.

We have been provided with the following information:

1. Architectural drawings (Drawing Nos. 1915 DA 100, 1915 DA 102, 1915 DA 103, 1915 DA 200, 1915 DA 201, 1915 DA 202, 1915 DA 203, 1915 DA 300, 1915 DA 301, dated October 2019) prepared by Harding Architects Pty Ltd.
2. Survey Plan (Plan Number SY074811.000.1^{Revision 1}, dated 13 November 2019).
3. Indicative building loads provided in an email from Tonkin dated 2 January 2020.

We also note that we carried out a geotechnical investigation on the property at No. 2 Cross Street in 2012 from which we have extracted subsurface information from CPT (EFCP) tests which were completed adjacent to the common boundary.

From review of the following architectural drawings, we understand that the proposed development will comprise a four storey Rent-A-Space self storage building, with no basement, founded on piles. Localised minor excavation may however be required for the centrally located lift and stair cores, and perhaps buried services. Existing floor slabs will be removed and new slabs constructed at about 0.1m to 0.2m below the existing levels.

The purpose of the investigation was to obtain additional geotechnical information on subsurface conditions as a basis for comments and recommendations for the proposed development including geotechnical design parameters for the proposed pile footings, subgrade preparation, pavement design and soil aggression.

This geotechnical investigation was carried out in conjunction with an environmental site assessment by our environmental division, JK Environments (JKE). Reference should be made to the separate report by JKE, Ref: E32885PD rpt, for the results of the environmental site assessment.

2 INVESTIGATION PROCEDURE

The fieldwork for the investigation was carried out on 10, 11, 13, 17 and 18 December 2019 and comprised the drilling of five boreholes (BH1 to BH5) to end depths of 21.65m (BH1), 29.05m (BH2), 30.55m (BH3), 20.90m (BH4) and 26.78m (BH5) using our track mounted JK308 drilling rig. Two test pits were also completed adjacent to the western neighbouring properties with supplementary auger drilling to 1.0m (TP6) and 1.5m (TP7), as well as Dynamic Cone Penetrometer (DCP) tests to 2.4m (TP6) and 1.6m (TP7).

Prior to the commencement of the fieldwork, the borehole locations were scanned for the presence of buried services by a specialist sub-contractor.

The borehole locations were set out by tape measurements from existing site features by using an available google earth aerial image. Figure 2 is based on aerial imagery sourced from 'Nearmap'. The approximate surface reduced levels (RL's) at the borehole locations were extrapolated from spot heights shown on the provided survey plan. The survey datum is the Australian Height Datum (AHD).

The concrete slabs or asphaltic concrete surfaces at each borehole were either diatube cored with water flush or spiral auger drilled. The boreholes were initially auger drilled to depths between 3.0m to 3.45m below surface level, extended by wash bore drilling (with water flush) to depths between 14.76m to 24.21m and extended to their respective termination depths between 20.90m and 30.55m by diamond core drilling using NMLC coring techniques with water flush. The relative density and strength of the alluvial sandy and clayey soils were assessed from a limited number of Standard Penetration Tests (SPT) augmented by hand penetrometer readings on cohesive samples recovered from the SPT split tube sampler, and assessed from comparison with the nearby CPT (EFCP) tests, the logs of which are included with this report for reference. Due to the limitations of the wash boring equipment, the natural soil profile within the washboring portion was largely assessed by visual and tactile examination of the water flush returns and hence is only an assessment. The strength of the bedrock within the cored portion of the boreholes was assessed by examination of the recovered rock core and subsequent correlation with laboratory Point Load Strength Index testing.

Groundwater observations were made in the boreholes during and on completion of auger drilling. We note that water is used as part of the wash boring and coring processes, and therefore water levels at the completion of wash boring and coring may not have stabilised in the short time period after drilling. No long term groundwater monitoring was carried out.

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

Our geotechnical engineers were present full-time during the fieldwork to set out the borehole locations, direct the services scanning, nominate testing and sampling and prepare the attached borehole logs (which include field test results, Point Load Strength Index test results and groundwater observations). The Report Explanation Notes define the logging terms and symbols used.

Selected soil samples were returned to our NATA registered laboratory (Soil Test Services (STS)) for 4 day soaked CBR testing, soil moisture content and liquid limit/linear shrinkage testing, and to Envirolab Services Pty Ltd for soil pH, chloride, sulfate and resistivity testing. The results are presented in the attached STS Tables A and B, and Envirolab Services 'Certificate of Analysis 233855'. The recovered rock core was returned to Soil Test Services (STS) NATA registered laboratory where it was photographed and Point Load Strength Index tests completed. The core photographs are included with the relevant cored borehole logs.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The following section should be read with reference to the attached Figures 1 and 2.

The site is located within a low lying alluvial topography within the commercial and industrial area in Brookvale. The site itself slopes gently to the south-east at about 1° to 2°. The site is a battle axe block, approximately 30m by 80m in plan, with access from the north-west and the southern side of the site. Cross Street bounds the site to the south.

At the time of fieldwork, the existing building had already been demolished but the concrete floor slabs, with associated brick and concrete strip footings, still remain and cover the majority of the site. The concrete slabs were at the general ground surface level on the western portion of the site but were raised up to 0.5m above the surface level of the adjoining site in the eastern portion, where the edge of the slab was supported by a brick sub-floor retaining wall. The northern portion of the site was asphaltic concrete covered. Shipping storage containers occupied some areas in the western portion of the site.

The neighbouring properties to the west comprised 6, 10 and 12 Cross Street and were occupied by a one storey masonry building, a two storey brick building with top level car park, and a two storey rendered masonry building respectively. All the western neighbouring buildings had walls abutting the common boundary. Properties Nos. 10 and 12 appeared to have ground floor slabs approximately 0.8m higher than the surface level within the site.

The neighbouring property to the north was occupied by a three storey rendered masonry building, with a top level carpark. The building was set back at 1.9m from the common boundary with a floor level 1.1m higher than the surface level of the site.

The neighbouring property to the east was occupied by single level warehouse with a saw-tooth roof and a two storey brick office building. The property was set back at approximately 12m from the common boundary and had a similar ground surface level to that of the site.

All the existing buildings and structures within the neighbouring properties appeared to be in reasonable external condition based on cursory inspection from within the site.

3.2 Subsurface Conditions

The Sydney 1:100 000 geological map indicates the site to be underlain by Quaternary period, stream alluvial and estuarine sediments, silty to peaty quartz sand, silt and clay, with sandstone bedrock at depth. It is not clear whether the Hawkesbury Sandstone or Narrabeen Group formations underlie the site.

Generally, the boreholes and adjacent CPT tests encountered concrete slabs or asphaltic concrete surface and shallow fill, overlying variable alluvial soils, then sandstone bedrock at depth. Reference should be made to the attached borehole logs for specific details at each location. A summary of the subsurface conditions encountered in the current boreholes is provided below:

Concrete Slabs and Asphaltic Concrete (AC) Surface

Concrete slabs, ranging in thickness between 120mm and 210mm, were encountered in BH1, BH2, BH3 and BH5. Steel reinforcement was observed in all the recovered concrete cores. In BH4, asphaltic concrete with a thickness of 70mm was encountered.

Fill

Fill was encountered in all the boreholes below the concrete slabs and AC surface. The fill comprised sand with varying fractions of gravel, silt and clay and was encountered in BH1 to BH4 to depths ranging between 0.4m and 1.2m. The depth of fill was greater on the eastern side of the site which is consistent with the surface observations. Sandy silty clay was encountered in BH5 down to a depth of 0.6m below surface level. Inclusions comprised varying sizes and fractions of igneous gravel, cemented sand, clay nodules and brick fragments. Based on the SPT results and limited hand penetrometer readings, the fill was generally assessed to be poorly compacted. In particular, the fill in BH3 comprised high plasticity silty clay of high moisture content and low strength which extended to a depth of 1.2m.

Alluvial Soils

The alluvial soil profile comprised interlayered clayey silty sand/silty sand/sand and silty clay which extended to depths between 14.76m and 24.21m below existing surface level. The sandy alluvial profile ranged through very loose, loose and medium dense; to a lesser extent a dense and very dense alluvial sand layer was encountered in BH3 below 15m, and a very dense sand layer in BH4 below 12m. The alluvial clays were of variable plasticity and predominantly of firm to stiff strength; to a lesser extent soft and very stiff layers were also encountered.

Sandstone Bedrock

Sandstone bedrock was encountered in all the boreholes at the depths and reduced levels tabulated below:

Borehole	Depth to Bedrock Surface (m)	Bedrock Surface RL (mAHD)
1	15.4	-4.07
2	22.7	-11.5
3	24.2	-13.5
4	14.8	-4.0
5	20.4	-9.1

The rock surface is generally dipping or stepping from RL -4.0m at the southern end of the site to RL -13.5m at the northern end. There is also a cross fall at the northern end towards the east.

The nature and strength of the rock varies considerably between the boreholes but a clear pattern of variation is not obvious and some of the deeper rock is of lower strength than the shallower rock. This is probably related to the fact that the deeper rock is probably part of the Narrabeen Group whilst the upper material may be the Hawkesbury Sandstone, though we cannot confirm that from our observations.

The rock classifications in accordance with Pells et al 2019 are provided in the following table:

Borehole	CLASS				
	Depth/RL to Top of Layer				
	5	4	3	2	1
1	15.4/-4.1	16.7/-5.3	18.5/-7.2*	-	-
2	-	22.7/-11.5	23.7/-12.4	26.6/-15.4 ^x	-
3	24.2/-13.5	25.4/-14.7	-	-	-
4	-	14.8/-3.9	17.3/-6.5	17.8/-7.0 ⁺	-
5	20.8/-9.5	-	21.8/-10.5*	-	-

* Rock is top end of Class 3, marginally Class 2 based on strength.

^x Rock is bottom end of Class 2 based on strength.

⁺ Rock is bottom end of Class 2 and reverts to Class 4 at 20.4m/-9.5m.

Groundwater

Groundwater seepage during auger drilling was encountered in all boreholes at the depths and RL's tabulated below:

Borehole	Depth to Groundwater Seepage During / on Completion of Auger Drilling (m)	Depth of Borehole Collapse on Completion of Auger Drilling (m)
1	2 (during)	1.7
2	1.7 (on completion)	No collapse
3	1.2 (on completion)	No collapse
4	1.2 (on completion)	No collapse
5	Assumed 2.6m as per collapsed depth	2.6

No long term groundwater monitoring was carried out.

Adjacent Footings

Test Pits 6 and 7 were excavated after saw-cutting the pavement slabs adjacent to the buildings on the western boundary. Details are shown on the cross-sectional sketches presented as Figures 3 and 4. Due to the presence of old concrete footings below the paving slab within the site, it proved impossible in the circumstances to expose the adjacent footings.

3.3 Laboratory Test Results

The Point Load Strength Index test results indicated that the rock encountered in the boreholes was of predominantly low to medium strength, with some occasional very low and high strength bands. The estimated Unconfined Compressive Strengths (UCS) ranged between <1MPa and 28MPa.

The moisture content test results on a selection of the clay soils recovered from the SPT sampler showed generally high moisture contents consistent with the field logging and being indicative of fairly low strength materials. In particular the very high moistures (c.60%) of samples from BH1 and BH3 are typical of soft and very soft clays. The clay fill/soil from 0.5 - 0.95m depth in BH3 were confirmed to be of high plasticity and moderate shrink-swell potential. Although the site and the adjacent sites are fully paved there would still be some potential for shrink-swell movement, especially if leaking services occur or have occurred.

The four-day soaked CBR values of the alluvial sand and sandy clay samples from TP6 and TP7, when compacted to 98% of their Standard Maximum Dry Density (SMDD) and surcharged with 9.0kg, are summarised in the table below:

Test Pit	Sample Depth (m)	Materials	Four day soaked CBR values (%)	In-situ Moisture Content relative to Optimum Moisture Content
6	0.3-0.6	SAND	40 (5mm penetration)	11.7 : 14.1
7	1.0-1.5	Sandy CLAY	9 (2.5mm penetration)	18.5 : 12.9

The results of the soil aggression testing are tabulated below:

Borehole	Sample Depth (m)	Description	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Resistivity (ohm.m)
1	6-6.45	Silty CLAY	5.4	<10	20	450
2	23-23.1	SANDSTONE	6.4	<10	<10	1000
3	18-18.45	Silty CLAY	5.8	25	64	150
4	9-9.45	Silty SAND	4.8	20	100	120

When compared to guideline values given in the Piling Code AS 2159-2009, the soils and rock give a moderate exposure classification to buried concrete, whilst conditions would be mild to buried steel.

4 COMMENTS AND RECOMMENDATIONS

4.1 Principal Geotechnical Issues

In summary, the proposed development comprises a ground floor level plus three commercial levels for storage. The building footprint extends over almost all of the site. No bulk excavation is planned but proposed finished floor levels will be about 0.1m to 0.2m lower than existing. The investigation has confirmed uncontrolled, poorly compacted fill, a high groundwater level, and deep highly variable soils over rock which occurs at varying depths and is of varying quality.

The principal geotechnical issue for this development is how to support the main structure with column loads ranging from 600kN to 1350kN. Potential acid sulphate soil conditions have been identified by JK Environments. The medium dense and dense sands were of inconsistent thickness and depth and cannot be reliably targeted with screw piles, even from one test location to another nearby location; they were underlain by loose sands or soft clays at some locations which could cause bearing capacity failure (ie excessive settlement). The sandstone bedrock is the preferred founding stratum. The rock depth and quality are very variable and targeting the founding depth for piles will require careful planning and possibly further investigation. We consider the best footing solution to be cased grout injected continuous flight auger (CFA) piles, socketed into rock. The use of a cased auger will result in less spoil arising from the borings and prevent soil mining or decompression in the weak soils near the surface which may adversely affect adjacent properties if allowed to occur.

Piling rigs large and powerful enough to achieve design sockets may require a working platform or perhaps load spreader plates to reduce the risk of punching shear failure.

The subgrade comprises varying depths of uncontrolled fill and varying soil types, which would not ordinarily be recommended as a subgrade. However, it has presumably for many decades been subject to similar loads to those proposed, and in some areas, trafficked by forklifts and other vehicles. No signs of substantial settlement of the slabs were observed and it may be possible to prepare the subgrade to an adequate standard without large scale excavation and replacement. A new retaining wall will be required along the eastern boundary.

We consider this project to be geotechnically feasible, albeit the required pile foundations will be significantly more expensive than steel screw piles which we understand were being considered prior to this investigation. The above issues and others are described in more detail in the sections below.

4.2 Dilapidation Surveys

Prior to commencement of site works consideration should be given to completing dilapidation reports on the neighbouring structures and infrastructure due to the potential for damage to occur or to be perceived from transmission of potentially damaging vibrations, surface excavations or soil decompression during pile installation.

The dilapidation surveys should include a detailed internal and external inspection of the properties with all defects rigorously described, i.e. defect location, defect type, crack width, crack length etc. The respective owners of the adjoining properties should be asked to confirm that the dilapidation reports present a fair assessment of the conditions prior to commencement of site works.

4.3 Excavation and Temporary Batters

Any excavation should be in accordance with the Safe Work Australia 'Excavation Work Code of Practice' dated July 2015.

We expect only localised excavation will be required for lift pits and perhaps services, the advice for which is adequately covered in the above referenced code of practice. In summary, temporary batters of up to 2m depth should be no steeper than 1V:2H, and any surcharges kept clear from the crest of cuts by a distance at least equal to the depth of the excavation. Should any excavations be required below groundwater level, we must be contacted for specific advice.

4.4 Retaining Walls

Retaining walls to support lift and stair pits will be rigid structures and should be designed using a coefficient of earth pressure at rest of 0.5. If the structures cannot be drained they should be designed to allow for hydrostatic pressure.

The new retaining wall along the eastern boundary will presumably be integrated with the pile capping beam so will also be a fairly rigid structure and may be designed as per the lift pit recommendations above.

Surcharge loads are additional to the earth pressures and should take account of the floor loading. A unit weight of 20kN/m³ may be assumed for the soils.

4.5 Ground Floor Slab

4.5.1 Design Issues

We presume the static design loads for the ground floor slab will be in the order of 5-10kPa. Some of the site will however be subject to traffic loads associated with proposed truck access and loading dock along the western side of the building.

The existing concrete slabs ranged from 100mm to 210mm thick covering most of the site and appeared from cursory inspection to be in reasonable condition. Only BH5, BH6 and BH7 were completed within what would have been the previous warehouse building and the remainder were in an annexe area at the southern end of the site or external parking areas. However, the subgrade has been shown to be quite variable, with a weak clay fill indicated at BH3. The subgrade beneath the slab was assessed with reference to a limited number of SPT tests. While the results indicated poorly compacted fill and soft to firm alluvial clays in some areas, given the period it has been insitu and subject to load we expect long term settlement would have occurred and provided there aren't any large soft spots, we expect it would generally be a low risk to construct a new floor slab on the existing slab & subgrade, subject to the subgrade preparation being carried out as noted below.

4.5.2 Subgrade Preparation

As it is likely that a large piling rig will be required at the site, a decision must first be made as to whether to use the existing slab to help support the rig (perhaps with the addition of spreader plates) and prepare the

subgrade for the new slab after piling, which is more difficult, or to remove the slabs first, prepare the subgrade and almost certainly use a working platform for the piling rig. Another option would be to remove some of the relatively poor quality soils that currently form the subgrade and import good quality material that could be used as a working platform and thereby improve the subgrade quality generally.

As there are building along the western boundary and elsewhere, the use of a vibrating roller for proof rolling and compaction will be restricted. We recommend using a large, say 12 tonne roller with the vibration mode only used to the extent possible without risking damage to neighbouring properties. The surface after stripping should be inspected by a geotechnical engineer or experienced geotechnician and any obviously poor quality material removed before being proof rolled with at least 6 passes of the roller with the final pass being inspected by a geotechnical engineer/experienced geotechnician. Any soft or heaving areas should be excavated, if possible to a sound base but otherwise to the depth indicated by the geotechnical engineer to enable a bridging layer to be placed. Material such as 40/70 crushed concrete may be suitable for a bridging layer depending upon exact circumstances and the use of a geogrid below the layer will enhance its properties. Of course, bridging layers can cause later problems if service trenches have to be excavated and this issue should be considered on its merits at the time.

On completion of preparation the surface should be tested to ensure that compaction to at least 98% of Standard Maximum Dry Density has been achieved. Where clay soils are present there should be an upper compaction limit of 102% SMDD and moisture content should be within 2% of Standard optimum moisture Content.

The excavated clayey fill and natural clay will require strict quality control if they are to be reused as engineered fill, due to their reactive potential and moisture sensitivity. The excavated clayey soils must be free of organic matter and free of particle sizes greater than 75mm prior to reuse as engineered fill. The clayey soils may require moisture conditioning (ie. drying or wetting up) prior to re-use in order to satisfy the compaction specifications set out below.

Engineered fill comprising the excavated soils should be compacted in maximum 200mm loose layers using a minimum 10 tonne static roller to a density and moisture content as defined above.

Materials preferred for use as good quality select fill below pavements and slabs-on-grade are well graded granular materials, such as ripped or crushed sandstone, free of organic matter and free of particle sizes greater than 75mm. The select engineered fill should be compacted in maximum 200mm loose layers using a minimum 10 tonne static roller to a minimum density of 98% of SMDD.

4.5.3 Pavement Design

The CBR tests have highlighted the variability in the quality of the subgrade soils. The higher value obtained of 40% for a sample of the natural sand from TP6 is an outlier and should not be considered indicative. Even use of the lower value of 9% for the sandy clay from TP7 is not advisable as there are almost certainly lower quality material s present. From the observations made to date we suggest preliminary design based on a value no more than 5% and that this should be confirmed, with further testing as necessary, after stripping

when the subgrade is properly exposed. This value equates to a modulus of subgrade reaction (k) of 40kPa/mm.

Building slabs-on-grade and light duty concrete pavements should be supported on at least a 100mm thick sub-base of good quality fine crushed rock such as RTA Specification 3051 unbound base (eg. DGB20) or similar quality, and compacted to a minimum density of 100% of SMDD. The sub-base material will provide a more uniform slab support and would reduce “pumping” of subgrade “fines” at joints. Slab joints should be designed to resist shear forces but not bending moments by providing dowelled or keyed joints.

Drainage should be carefully designed with a uniform longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. Discharge from the all drains should be piped to the stormwater system.

4.6 Piled Footings for Column Loads

As per the reasons explained in Section 4.1, we recommend all column loads are transferred to rock via piles. Screw piles may encounter difficulties penetrating bands of very dense sands or hard clay. They may also fail to achieve uniform end bearing on the rock so the shaft needle bit will be point loading the rock, possibly resulting in excessive settlement. Our preference would be for CFA piles since they can be socketed into rock to achieve high end bearing pressures. Cased CFA piling rigs, also known as double-rotary rigs, would be beneficial in reducing the amount of spoil generated and minimising the risk of soil decompression near boundaries and below the existing slabs as this would give rise to settlement problems.

One alternative is the use of Atlas type of displacement piles but it is our understanding that they will not be able to socket into rock and therefore will be limited to bearing pressures of the upper initially encountered rock. The main benefit is the lack of spoil disposal costs since little or no spoil occurs. Further enquiries could be made with specialist piling contractors who should be given a full copy of our report.

As a preliminary guide allowable bearing pressures (ABP) for serviceability design are presented below, based on expected settlement of not more than 1% of the width of the footing (or pile diameter).

Preliminary Serviceability Design Pressures

	Shale Bedrock			
	Class V	Class IV	Class III	Class II
ABP (kPa)	700	2,000	3,500*	6,000 [#]

*Requires further cored boreholes

[#] For piles utilising design parameters for Class II sandstone, cored boreholes at specific pile locations would be required, extending to at least 2D below the design toe of the pile.

Shaft adhesion of 10% of the ABP may be adopted for preliminary design of piles in compression, and 5% of the ABP when tension, provided a clean shaft and roughness of R2 or better, and a minimum length/diameter ratio of 4 is achieved. The contribution from the initial 0.3m of pile socket should be ignored in the calculations.

Specialist contractors may prefer to use limit state design methods and should select the input parameters to reflect the extent of investigation and confidence in the founding strata. Given the variability in rock quality we advise that reasonably conservative assumptions should be made.

4.7 Working Platform

Large piling rigs may require a working platform or alternatively steel spreader plates to prevent punching failure. Working platform material could be moved from one area to another as work progresses. Costings should factor in disposal or material could be re-used as select subgrade layer, although the geotechnical strength of the material can deteriorate when spoiled by silt fines from excavated spoil, etc.

Spreader plates could be effective given the linear layout of the piles for this project and the presence of the existing concrete slabs.

4.8 Further Geotechnical Input

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

- Further cored boreholes (the number will be a reflection of the bearing capacity required).
- Further investigation and testing of subgrade.
- Review of structural drawings to check consistency with geotechnical conditions.
- Vibration monitoring during slab and footing demolition using rock breakers or during use of vibrating rollers near to adjacent structures.

Piling using CFA rigs is normally a design and construct sub-contract and in-house certification of piles by the contractor should be provided.

5 GENERAL COMMENTS

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

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



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

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TABLE A

MOISTURE CONTENT, LIQUID LIMIT AND LINEAR SHRINKAGE TEST REPORT

Client: JK Geotechnics
Project: Proposed Storage Building
Location: 4 Cross Street, Brookvale, NSW

Ref No: 32885S
Report: A
Report Date: 13/01/2020
Page 1 of 1

AS 1289	TEST METHOD	2.1.1	3.1.2	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	LINEAR SHRINKAGE %
1	9.00 - 9.45	68.7	-	-
2	1.00 - 1.10	20.8	-	-
2	2.50 - 2.60	29.5	-	-
2	12.00 - 12.45	27.9	-	-
3	0.50 - 0.95	32.7	54	10.5
3	6.00 - 6.45	64.4	-	-
3	18.00 - 18.45	26.9	-	-
5	6.00 - 6.45	26.3	-	-
5	15.00 - 15.45	41.1	-	-

Notes:

- The test sample for liquid limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 24/12/2019.
- Sampled and supplied by client. Samples tested as received.



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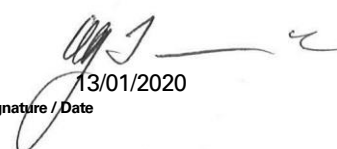

13/01/2020
Authorised Signature / Date
(D. Trewick)

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client:	JK Geotechnics	Ref No:	32885S
Project:	Proposed Storage Building	Report:	B
Location:	4 Cross Street, Brookvale, NSW	Report Date:	14/01/2020
		Page 1 of 1	

TESTPIT NUMBER	TP 101	TP 102
DEPTH (m)	0.30 - 0.60	1.00 - 1.50
Surcharge (kg)	9.0	9.0
Maximum Dry Density (t/m ³)	1.72 STD	1.89 STD
Optimum Moisture Content (%)	14.1	12.9
Moulded Dry Density (t/m ³)	1.69	1.85
Sample Density Ratio (%)	98	98
Sample Moisture Ratio (%)	100	99
Moisture Contents		
Insitu (%)	11.7	18.5
Moulded (%)	14.0	12.7
After soaking and		
After Test, Top 30mm(%)	17.0	18.5
Remaining Depth (%)	15.2	16.4
Material Retained on 19mm Sieve (%)	0	0
Swell (%)	0.0	1.0
C.B.R. value:		9
@2.5mm penetration		
@5.0mm penetration	40	

- NOTES:** Sampled and supplied by client. Samples tested as received.
- Refer to appropriate Test Pit logs for soil descriptions
 - Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
 - Date of receipt of sample: 06/01/2020.



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14/01/2020
Authorised Signature / Date
(D. Trewick)

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	Ref No:	32885S
Project:	Proposed Storage Building	Report:	C
Location:	4 Cross Street, Brookvale, NSW	Report Date:	20/12/2019

Page 1 of 3

BOREHOLE NUMBER	DEPTH m	I _s (50) MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
1	15.52 - 15.57	0.4	8
	15.80 - 15.85	0.5	10
	16.17 - 16.23	0.4	8
	16.73 - 16.78	0.4	8
	17.25 - 17.30	0.6	12
	17.75 - 17.80	0.3	6
	18.11 - 18.15	0.4	8
	18.85 - 18.89	0.7	14
	19.15 - 19.20	0.8	16
	19.95 - 20.00	0.5	10
	20.20 - 20.25	0.8	16
	20.60 - 20.65	0.8	16
	21.26 - 21.31	1.1	22
2	23.31 - 23.36	0.3	6
	23.73 - 23.78	0.4	8
	24.39 - 24.43	0.6	12
	24.70 - 24.74	0.4	8
	25.22 - 25.26	0.5	10
	25.76 - 25.80	0.7	14
	26.28 - 26.31	0.5	10
	26.72 - 26.75	0.9	18
	27.20 - 27.24	0.7	14
	27.88 - 27.93	0.8	16
	28.40 - 28.44	0.5	10
	28.78 - 28.82	0.8	16

NOTES: See Page 3 of 3

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	Ref No:	32885S
Project:	Proposed Storage Building	Report:	C
Location:	4 Cross Street, Brookvale, NSW	Report Date:	20/12/2019

Page 2 of 3

BOREHOLE NUMBER	DEPTH m	I _s (50) MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
3	24.36 - 24.39	0.03	1
	25.36 - 25.39	0.2	4
	25.87 - 25.90	0.3	6
	26.17 - 26.20	0.1	2
	26.80 - 26.83	0.3	6
	27.23 - 27.26	0.2	4
	27.69 - 27.72	0.2	4
	28.21 - 28.24	0.1	2
	28.76 - 28.79	0.07	1
	29.23 - 29.26	0.3	6
	29.79 - 29.82	0.05	1
	30.07 - 30.10	0.4	8
	30.52 - 30.55	0.4	8
4	14.83 - 14.86	0.3	6
	15.11 - 15.14	0.4	8
	15.84 - 15.87	0.4	8
	16.19 - 16.22	0.3	6
	16.86 - 16.89	0.3	6
	17.18 - 17.21	0.3	6
	17.82 - 17.85	0.5	10
	18.10 - 18.13	0.7	14
	18.79 - 18.82	0.8	16
	19.11 - 19.14	0.9	18
	19.78 - 19.81	1.4	28
	20.11 - 20.14	0.3	6

NOTES: See Page 3 of 3

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	Ref No:	32885S
Project:	Proposed Storage Building	Report:	C
Location:	4 Cross Street, Brookvale, NSW	Report Date:	20/12/2019

Page 3 of 3

BOREHOLE NUMBER	DEPTH m	I _{s (50)} MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
4	20.43 - 20.46	0.2	4
5	20.89 - 20.92	0.02	<1
	21.28 - 21.31	0.02	<1
	21.85 - 21.88	0.9	18
	22.08 - 22.12	0.5	10
	22.74 - 22.77	0.3	6
	23.28 - 23.31	0.6	12
	23.71 - 23.74	1.1	22
	24.20 - 24.23	0.4	8
	24.80 - 24.83	0.7	14
	25.16 - 25.19	0.6	12
	25.77 - 25.80	0.5	10
	26.11 - 26.14	0.6	12
	26.75 - 26.78	0.3	6

NOTES:

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

CERTIFICATE OF ANALYSIS 233855

Client Details

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

Sample Details

Your Reference	<u>32885S, Brookvale</u>
Number of Samples	4 Soil
Date samples received	02/01/2020
Date completed instructions received	02/01/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	09/01/2020
Date of Issue	07/01/2020
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil					
Our Reference		233855-1	233855-2	233855-3	233855-4
Your Reference	UNITS	BH4	BH2	BH1	BH3
Depth		9-9.95	23-23.1	6-6.45	18-18.45
Date Sampled		17/12/2019	11/12/2019	10/12/2019	13/12/2019
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	06/01/2020	06/01/2020	06/01/2020	06/01/2020
Date analysed	-	06/01/2020	06/01/2020	06/01/2020	06/01/2020
pH 1:5 soil:water	pH Units	4.8	6.4	5.4	5.8
Chloride, Cl 1:5 soil:water	mg/kg	20	<10	<10	25
Sulphate, SO4 1:5 soil:water	mg/kg	100	<10	20	64
Resistivity in soil*	ohm m	120	1,000	450	150

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

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			06/01/2020	[NT]	[NT]	[NT]	[NT]	06/01/2020	[NT]
Date analysed	-			06/01/2020	[NT]	[NT]	[NT]	[NT]	06/01/2020	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	109	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	94	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S

Method: SPIRAL AUGER /
WASHBORE

R.L. Surface: ~11.33 m

Date: 10/12/19

Datum: AHD

Plant Type: JK305

Logged/Checked By: J.L./P.S.

Groundwater Record	SAMPLES	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS							
							CONCRETE: 120mm.t				6mm DIA. REINFORCEMENT 90mm TOP COVER
				11		-	FILL: Sand, fine to medium grained, grey brown, trace of fine to medium grained igneous gravel, cemented sand nodules and brick fragments.	M			POSSIBLY FILL
				1		SP	SAND: fine to medium grained, grey brown, trace of clayey sand nodules.	M	MD		
				10			SAND: fine to medium grained orange brown.				
				10			SAND: fine to medium grained, brown.	M	L		ALLUVIAL
				2			as above, but trace of clayey sand nodules, yellow brown.	W			
				9							
				3		ML	Clayey silty SAND: fine to medium grained, grey.				
				8					MD	150 100 80	COMMENCE WASHBORING
				4							
				7		SM	Silty SAND: fine to medium grained, grey.				
				5							
				6							
				6		CL-CI	Silty CLAY: low to medium plasticity, grey, with fine to medium grained sand.	w>PL	St		
				5						120 160 100	

JK 9.024.LIB.GLB Log JK AUGERHOLE - MASTER 28885S BROOKVALE.GPJ <<DrawingFile>> 23/07/2020 09:46 10.01.00.01 D:\gel\lib and in situ Tool - DGD Lib JK 9.024 2019-05-31 Proj JK 9.01.0 2018-03-20

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Method:** SPIRAL AUGER / WASHBORE **R.L. Surface:** ~11.33 m
Date: 10/12/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
							4		SM	Silty SAND: fine to medium grained, grey.	W	MD		
					N = 13 5,6,7		8							
							3							
							9		CI-CH	Silty CLAY: medium to high plasticity, dark grey.	w>PL	F		
					N = 3 0,1,2		2						80 70 50	
							10							
							1		SM	Silty SAND: fine to medium grained, dark grey, trace of clay nodules.	W	L		
					N = 8 5,5,3		11							
							0							
							12							
							-1							
							13							
							-2							
												VL		NO SAMPLE RECOVERY
					N = 3 3,1,2									

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE Project: PROPOSED STORAGE BUILDING Location: 4 CROSS STREET, BROOKVALE, NSW														
Job No.: 32885S Date: 10/12/19 Plant Type: JK305				Method: SPIRAL AUGER / WASHBORE Logged/Checked By: J.L./P.S.				R.L. Surface: ~11.33 m Datum: AHD						
Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
						-3			SM	Silty SAND: fine to medium grained, dark grey, trace of clay nodules. (continued)	W	VL		
						15								
						-4								
										REFER TO CORED BOREHOLE LOG				
						16								
						-5								
						17								
						-6								
						18								
						-7								
						19								
						-8								
						20								
						-9								

CORED BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Core Size:** NMLC **R.L. Surface:** ~11.33 m
Date: 10/12/19 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** J.L./P.S.

Water Loss/Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_p(50)$	SPACING (mm)	DEFECT DETAILS		Formation
										DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness	General	
		-4			START CORING AT 15.40m							
			16		SANDSTONE: fine to medium grained, light grey, light orange brown and red brown, bedded sub horizontally.	MW	M					
		-5			NO CORE 0.20m							
			17		SANDSTONE: fine to medium grained, light grey, light orange brown and red brown, bedded sub horizontally.	MW	M					
		-6								(17.14m) CS, 0°, 8 mm.t		
										(17.53m) CS, 0°, 45 mm.t		
		-7								(18.05m) CS, 0°, 10 mm.t		
			18							(18.40m) XWS, 0°, 200 mm.t		
										(18.64m) CS, 0°, 10 mm.t		
		-8			SANDSTONE: fine to medium grained, light grey, with grey laminae, bedded at 20°.	FR	M					
			19									
		-9								(20.71m) XWS, 10°, 20 mm.t		
										(20.82m) XWS, 10°, 15 mm.t		
			20							(20.99m) CS, 10°, 15 mm.t		
		-10					H			(21.48m) CS, 20°, 4 mm.t		
			21									
					END OF BOREHOLE AT 21.65 m							

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32885S BROOKVALE.GPJ <<DrawingFile>> 23/01/2020 09:46 10.01.00.01 Datalib and In Situ Tool - DGD Lib JK 9.02.4 2019-05-31 Proj JK 9.01.0 2018-03-20

JK Geotechnics

JOB NO 32885S BH1 START CORING AT 15.40m

15

16

NO CORE 200mm

17

18

19

20

21

END OF BH1 AT 21.65m

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Method:** SPIRAL AUGER / WASHBORE **R.L. Surface:** ~11.25 m
Date: 11/12/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
							11		-	CONCRETE: 200mm.t				5mm DIA. REINFORCEMENT 90mm TOP COVER
					N = 5 2,2,3		1		CL	FILL: Gravelly silty sand, fine to medium grained, dark brown, fine to medium grained igneous gravel. Sandy silty CLAY: low plasticity, grey and light orange brown, fine to medium grained sand.	M w>PL	S - F	40 60 70	ALLUVIAL
					N = 7 3,4,3		2		SM	Clayey silty SAND: fine to medium grained, grey and light orange brown.	M W	L		SPT, NO SAMPLE RECOVERY
							9		SP	SAND: fine to medium grained, grey.				
					N = 18 6,8,10		3		CL	Sandy silty CLAY: low plasticity, grey brown, fine to medium grained sand.	w>PL	S - F	40 50 60	ON REMOULDED SAMPLE
							8		SM	Silty SAND: fine to medium grained, light grey, trace of clay fines.	W	MD		COMMENCE WASHBORING
					N = 14 4,6,8		5							SPT, NO SAMPLE RECOVERY
					N = 2 0,0,2		5		CI-CH	Silty CLAY: medium to high plasticity, dark grey.	(w>PL)	(S)		SPT, NO SAMPLE RECOVERY

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S

Method: SPIRAL AUGER /
WASHBORE

R.L. Surface: ~11.25 m

Date: 11/12/19

Datum: AHD

Plant Type: JK305

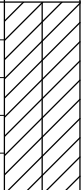
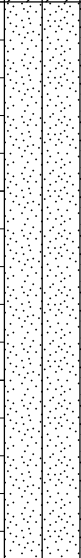
Logged/Checked By: J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
							4		CI-CH	Silty CLAY: medium to high plasticity, dark grey. <i>(continued)</i>	(w>PL)	(S)		
					N = 1 0,0,1		8		CL-CI	Silty CLAY: low to medium plasticity, dark grey, trace of fine to medium grained sand.	W	S	10 40 40	
						3								
							9		SM	Silty SAND: fine to medium grained, dark grey.	W	L		
					N = 5 1,2,3	2								
							10							
						1								
					N = 17 9,11,6		11					MD		SPT, NO SAMPLE RECOVERY
							12		CL-CI	Silty CLAY: low to medium plasticity, dark grey, trace of fine grained sand.	w>PL	S - F	90 50 40	
					N = 1 0,0,1	-1								
							13							
						-2								

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S**Method:** SPIRAL AUGER / WASHBORE**R.L. Surface:** ~11.25 m**Date:** 11/12/19**Datum:** AHD**Plant Type:** JK305**Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
							-3		CL-CI	Silty CLAY: low to medium plasticity, dark grey, trace of fine grained sand. (continued)	w>PL	S - F		
					N = 9 5,5,4		15		SM	Silty SAND: fine to medium grained, grey brown, with clay fines.	W	L	260 140 420	
							16							
							-5							
							17							
							-6							
							18					MD		
					N = 15 6,8,7		-7							SPT, NO SAMPLE RECOVERY
							19							
							-8							
							20							
							-9							

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S**Method:** SPIRAL AUGER /
WASHBORE**R.L. Surface:** ~11.25 m**Date:** 11/12/19**Datum:** AHD**Plant Type:** JK305**Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	US0	DB	DS										
					N = 12 5,6,6	-10			SM	Silty SAND: fine to medium grained, grey brown, with clay fines. <i>(continued)</i>	W	MD		SPT, NO SAMPLE RECOVERY
							22							
						-11								
							23			REFER TO CORED BOREHOLE LOG				
						-12								
							24							
						-13								
							25							
						-14								
							26							
						-15								
							27							
						-16								

CORED BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Core Size:** NMLC **R.L. Surface:** ~11.25 m
Date: 11/12/19 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** J.L./P.S.

Water Loss/Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_p(50)$	SPACING (mm)	DEFECT DETAILS		Formation
										DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness	General	
		-11			START CORING AT 22.73m							
		-12	23		SANDSTONE: fine to medium grained, light grey, with a few grey laminae, bedded at 20°.	FR	M - H					
		-13	24									
		-14	25							(24.43m) J, 20°, C, R, Cn		
		-15	26		SANDSTONE: fine to medium grained, mainly orange brown, indistinct bedding at 0-20°.	SW				(24.82m) J, 70°, Ir, R, Cn (24.96m) CS, 20°, 2 mm.t (25.33m) J, 50°, Ir, R, Cn (25.72m) CS, 20°, 5 mm.t (26.18m) Be, 20°, P, R, Fe Sn (26.32m) Be, 20°, P, R, Fe Sn (26.61m) Cr, 10°, 10 mm.t		
		-16	27									
		-17	28							(27.82m) Be, 0°, C, R, Fe Sn (28.20m) J, 70°, Ir, RF, Fe Sn (28.84m) Be, 15°, P, R, Fe Sn		

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32885S BROOKVALE.GPJ <<DrawingFile>> 23/01/2020 09:47 10.01.0001 Datalog Lib and In Situ Tool DGD Lib JK 9.02.4 2019-05-31 Proj JK 9.01.0 2018-03-20

CORED BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Core Size:** NMLC **R.L. Surface:** ~11.25 m
Date: 11/12/19 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** J.L./P.S.

Water Loss/Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_p(50)$	DEFECT DETAILS		Formation
									SPACING (mm)	DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness	
								VL-0.1 L-0.3 M-1 H-3 VH-10 EH	600 200 60 20	Specific General	
		-18			END OF BOREHOLE AT 29.05 m						
			30								
		-19									
			31								
		-20									
			32								
		-21									
			33								
		-22									
			34								
		-23									
			35								
		-24									

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32885S BROOKVALE.GPJ <<DrawingFile>> 23/01/2020 09:47 10.01.0001 Datalog Lib and In Situ Tool DGD Lib JK 9.02.4 2019-05-31 Proj JK 9.01.0 2018-03-20

JK Geotechnics

JOB NO 32885S BH2 START CORING AT 22.73m

23

24

25

26

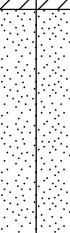
27

28

29

END OF BH2 AT 29.05m

Borehole No.
3
1 / 5

Client: RENT-A-SPACE SELF STORAGE															
Project: PROPOSED STORAGE BUILDING															
Location: 4 CROSS STREET, BROOKVALE, NSW															
Job No.: 32885S				Method: SPIRAL AUGER / WASHBORE				R.L. Surface: ~10.7 m							
Date: 13/12/19				Datum: AHD											
Plant Type: JK305				Logged/Checked By: J.L./P.S.											
Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks	
	ES	U50	DB	DS											
					N = 5 5,2,3	10	1		-	CONCRETE: 210mm.t FILL: Clayey silty sand, fine to medium grained, grey brown, trace of fine to coarse grained igneous gravel. FILL: Silty clay, high plasticity, grey brown, trace of fine grained sand.	M w>PL		20 30 40	6mm DIA. REINFORCEMENT 75mm TOP COVER 145mm TOP COVER 160mm TOP COVER POSSIBLY ALLUVIAL APPEARS POORLY COMPACTED	
					N = 13 4,6,7	9			CL	Silty CLAY: low plasticity, grey, trace of fine grained sand.	w>PL	F - St	90 90 100	ALLUVIAL	
					N = 5 1,1,4	8	2		SM	Silty SAND: fine to medium grained, light grey brown.	M	L - MD	270 220 180		
						7	3		CL-CI	Silty CLAY: low to medium plasticity, grey, trace of fine grained sand.	w>PL	St - VSt		COMMENCE WASHBORING	
						6	4					S		ASSUMED CHANGE IN STRENGTH	
						5	5								
						4	6								
					N = 1 0,0,1									30 30 40	
							4								

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Method:** SPIRAL AUGER / WASHBORE **R.L. Surface:** ~10.7 m
Date: 13/12/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
							3		CL-CI	Silty CLAY: low to medium plasticity, grey, trace of fine grained sand. (continued)	w>PL	S		
							8							
							2		SM	Silty SAND: fine to medium grained, grey.	W	VL		
							9							SPT, NO SAMPLE RECOVERY
					N = 3 6,2,1		1							WITH CLAY BANDS
							10							
							0							
							11							
							-1							
							12					MD	280 220 160	HP TESTING FROM CLAY LAYER
					N = 11 11,7,4		-2							
							13							
							-3							

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Method:** SPIRAL AUGER / WASHBORE **R.L. Surface:** ~10.7 m
Date: 13/12/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
									SM	Silty SAND: fine to medium grained, grey. <i>(continued)</i>	W	MD		
							-4		SC	Clayey SAND: fine to medium grained, grey.				
					N = 30 9,13,17		15					MD - D	110 30 60	
							-5							
							16							
							-6							
							17							
							-7		CI	Silty CLAY: medium plasticity, grey, trace of fine grained sand.	w>PL	F		
					N = 2 2,0,2		18						70 70 80	
							-8							
							19							
							-9							
							20							
							-10		SP	SAND: fine to medium grained, light grey.	W	D		

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Method:** SPIRAL AUGER / WASHBORE **R.L. Surface:** ~10.7 m
Date: 13/12/19 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
					N = 36 7, 14, 22				SP	SAND: fine to medium grained, light grey. (continued)	W	D		
						-11								
						22								
						-12								
						23								
						-13								
						24								
						-14				REFER TO CORED BOREHOLE LOG				
						25								
						-15								
						26								
						-16								
						27								
						-17								

CORED BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Core Size:** NMLC **R.L. Surface:** ~10.7 m
Date: 13/12/19 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** J.L./P.S.

Water Loss/Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_p(50)$	SPACING (mm)	DEFECT DETAILS		Formation
										DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness	General	
					START CORING AT 24.21m							
					SANDSTONE: fine to medium grained, light grey.	HW	VL					
					NO CORE 0.35m							
			-14									
			25		Extremely Weathered sandstone: silty SAND, fine to medium grained, light grey.	XW	VD					
					SANDSTONE: fine to medium grained, light grey, some red brown staining locally.	SW	L					
			-15									
			26									
			-16							(26.09m) J, 60°, P, R, Fe Sn		
			27									
			-17									
			28							(27.82m) XWS, 0°, 20 mm.t (27.88m) XWS, 0°, 10 mm.t		
			-18									
			29									
			-19									
			30				L - M			(29.84m) CS, 0°, 25 mm.t		
			-20		END OF BOREHOLE AT 30.55 m							

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32885S BROOKVALE.GPJ <<DrawingFile>> 23/01/2020 09:47 10.01.0001 Datalib and In Situ Tool DGD Lib JK 9.02.4 2019-05-31 Proj JK 9.01.0 2018-03-20

JK Geotechnics

JOB NO 32885S BH3 START CORING AT 24.21m

24

NO CORE 0.35m

25

26

27

28

29

30

END OF BH3 AT 30.55m

Borehole No.
4
1 / 4

Client: RENT-A-SPACE SELF STORAGE Project: PROPOSED STORAGE BUILDING Location: 4 CROSS STREET, BROOKVALE, NSW														
Job No.: 32885S Date: 17/12/19 Plant Type: JK500				Method: SPIRAL AUGER / WASHBORE Logged/Checked By: J.L./P.S.				R.L. Surface: ~10.85 m Datum: AHD						
Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
DRY ON COMPLETION OF AUGERING 									-	ASPHALTIC CONCRETE: 70mm.t	D			
					N = 5 2,2,3		1			FILL: Silty sand, fine to medium grained, brown and orange brown, trace of fine to medium grained gravel, and clay nodules. FILL: Silty sand, fine to medium grained, grey and orange brown, with clay nodules.	M			POSSIBLY ALLUVIAL
								SM	Silty SAND: fine to medium grained, orange brown. Silty SAND: fine to medium grained, light grey and orange brown, with clay fines.	M	L		ALLUVIAL APPEARS POORLY COMPACTED	
					N = 7 4,4,3		2		SC	Clayey silty SAND: fine to medium grained, grey.	W			
							3					D		
					N = 30 16,15,15									
							4							COMMENCE WASHBORING
							5		SM	Silty SAND: fine to medium grained, dark grey.		(L)		
					N = 5 3,3,2		6							
								CI	Silty CLAY: medium plasticity, dark grey.	w>PL	St	150 150 130		
						4								

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S

Method: SPIRAL AUGER /
WASHBORE

R.L. Surface: ~10.85 m

Date: 17/12/19

Datum: AHD

Plant Type: JK500

Logged/Checked By: J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
							3		CI	Silty CLAY: medium plasticity, dark grey. (continued)	w>PL	St		
							8		SM	Silty SAND: fine to medium grained, dark grey, with clay bands.	W	L		
					N = 6 1,2,4		9							
							10							
							11							
							12		SP	SAND: fine to medium grained, light grey.		VD		
					N > 30 10,30/ 130mm REFUSAL		13							
							-3							

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S**Method:** SPIRAL AUGER /
WASHBORE**R.L. Surface:** ~10.85 m**Date:** 17/12/19**Datum:** AHD**Plant Type:** JK500**Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
									SP	SAND: fine to medium grained, light grey. <i>(continued)</i>	W	VD		
						-4	15			REFER TO CORED BOREHOLE LOG				
						-5	16							
						-6	17							
						-7	18							
						-8	19							
						-9	20							
						-10								

Borehole No.
4
4 /

JK CORED BOREHOLE - MASTER 328855 BROOKVALE GP1 <<DrawingFile>> 23/01/2020 09:47 10 01 00 01 Dated: Lab and In Situ Tool - DGD 11 lb: IK 9 02 2019-05-31 Pri: IK 9 01 0 2018-03-20

JK Geotechnics

JOB NO 328855 BH4 START CORING AT 14.76m

15

16

17

18

19

20

END OF BH4 AT 20.90m

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Method:** SPIRAL AUGER / WASHBORE **R.L. Surface:** ~11.28 m
Date: 17/12/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
DRY ON COMPLETION OF AUGERING							11		-	CONCRETE: 190mm.t				150mm DIA. REINFORCEMENT 6mm TOP COVER POSSIBLY FILL
					N = 7 4,4,3				SM	FILL: Sandy silty clay, low plasticity, light brown and brown, fine to medium grained sand, trace of fine to medium grained ironstone and sandstone gravel. Silty SAND: fine to medium grained, dark grey brown, trace of clay nodules. Silty SAND: fine to medium grained, light grey mottled orange brown.	w-PL M	(L)		
							1				M	L		ALLUVIAL
							10		CL	Sandy CLAY: low plasticity, light grey mottled orange brown, fine to medium grained sand.	w-PL	F - St	80 80 100	
					N = 10 3,4,6				CI	Silty CLAY: medium plasticity, light grey mottled orange brown, with fine to medium grained sand.	w>PL		110 120 130	
							2							
							9		SM	Silty SAND: fine to medium grained, light grey.	M	MD		WITH CLAY BANDS FIRM TO STIFF
											W			
					N = 14 11,8,6		3						110 80 50	
							8							
							4							COMMENCE WASHBORING
							7							
							5							
							6							
							6		CI	Silty CLAY: medium plasticity, dark grey and grey, trace of fine grained sand.	w>PL	F		
					N = 3 0,0,3		5						50 80 60	

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S

Method: SPIRAL AUGER /
WASHBORE

R.L. Surface: ~11.28 m

Date: 17/12/19

Datum: AHD

Plant Type: JK500

Logged/Checked By: J.L./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
							4		CI	Silty CLAY: medium plasticity, dark grey and grey, trace of fine grained sand. (continued)	w>PL	F		
							8							
							3							
							9		SM	Silty SAND: fine to medium grained, dark grey.	W	VL		
					N = 4 5,2,2		2							
							10							
							1							WITH CLAY BANDS FIRM TO STIFF
							11							
							0							
							12							
					N = 25 11,12,13		-1					MD		
							13							
							-2							

BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Method:** SPIRAL AUGER / WASHBORE **R.L. Surface:** ~11.28 m
Date: 17/12/19 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** J.L./P.S.

Groundwater Record	SAMPLES			Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS									
						-3		CI	Silty CLAY: medium plasticity, dark grey.	w>PL	S		
						15						30	
						-4						30	
												40	
						16							
						-5							
						17							
						-6							
						18		SM	Silty SAND: fine to medium grained, dark grey.	W	MD		
						-7							
						19							
						-8							
						20							
						-9							
								-	SANDSTONE: fine to medium grained, light grey.	HW	VL - L		HAWKESBURY SANDSTONE
													VERY LOW TO LOW 'TC' BIT RESISTANCE
									REFER TO CORED BOREHOLE LOG				

CORED BOREHOLE LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Core Size:** NMLC **R.L. Surface:** ~11.28 m
Date: 17/12/19 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK500 **Bearing:** N/A **Logged/Checked By:** J.L./P.S.

Water Loss Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX I _p (50)	DEFECT DETAILS			Formation	
									DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness				
								VL -0.1 L -0.3 M -1 H -3 VH -10 EH	SPACING (mm)	Specific	General		
			-9		START CORING AT 20.83m								
100% RETURN			21		SANDSTONE: fine to medium grained, with extremely weathered bands.	HW	VL			(21.14m) XWS, 10°, 40 mm.t (21.39m) XWS, 10°, 20 mm.t (21.65m) XWS, 0°, 260 mm.t		Possibly Hawkesbury Sandstone	
		-10	22		SANDSTONE: fine to medium grained, orange brown and red brown, bedded at 20°.	MW	M			(22.24m) J, 80°, lr, R, Fe Sn (22.59m) Jh, 80°, lr, Fe Sn (22.66m) CS, 30°, 40 mm.t (22.94m) Jh, 50°, lr (23.04m) J, 50°, P, R, Fe Sn (23.35m) Jh, 50°, P, 50 mm.t (23.65m) Jh, 40°, lr, 40 mm.t			
		-11	23							(24.04m) CS, 0 - 40°, 60 mm.t (24.18m) XWS, 0°, 50 mm.t			
		-12	24										
		-13	25										
		-14	26										
		-15											
					END OF BOREHOLE AT 26.78 m								

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32885S BROOKVALE.GPJ <<DrawingFile>> 23/01/2020 09:47 10.01.0001 Datalab and In Situ Tool - DGD Lib JK 9.02.4 2019-05-31 Proj JK 9.01.0 2018-03-20

JK Geotechnics

JOB NO 328855 BH5 START CORING AT 20.83m

21

22

23

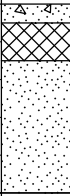
24

25

26

END OF BH5 AT 26.78m

Test Pit No.
6
1 / 1

Client: RENT-A-SPACE SELF STORAGE														
Project: PROPOSED STORAGE BUILDING														
Location: 4 CROSS STREET, BROOKVALE, NSW														
Job No.: 32885S Method: 200mm SPIRAL AUGER R.L. Surface: ~11.31 m														
Date: 13/12/19 Datum: AHD														
Plant Type: JKK Logged/Checked By: B.Z./P.S.														
Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
DRY ON COMPLETION					REFER TO DCP TEST RESULTS	11			-	CONCRETE: 100mm.t	M			NO OBSERVED REINFORCEMENT APPEARS POORLY COMPACTED ALLUVIAL
									SP	FILL: Sand, medium to coarse grained, dark brown and light orange brown. SAND: medium to coarse grained, light grey. as above, but brown, with weakly cemented sand nodules and bands.	M	L		
						1				END OF TEST PIT AT 1.00 m				
						10								
						2								
						9								
						3								
						8								
						4								
						7								
						5								
						6								
						6								
						5								

TEST PIT LOG

Client: RENT-A-SPACE SELF STORAGE
Project: PROPOSED STORAGE BUILDING
Location: 4 CROSS STREET, BROOKVALE, NSW

Job No.: 32885S **Method:** 200mm SPIRAL AUGER **R.L. Surface:** ~11.3 m
Date: 13/12/19 **Datum:** AHD
Plant Type: JKX **Logged/Checked By:** B.Z./P.S.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
DRY ON COMPLETION					REFER TO DCP TEST RESULTS	11			-	CONCRETE: 100mm.t	M			NO OBSERVED REINFORCEMENT APPEARS POORLY COMPACTED ALLUVIAL
						1			SP	FILL: Sand, medium to coarse grained, dark brown. SAND: medium to coarse grained, light grey.	M	L		
						10			CI-CH	Sandy CLAY: medium to high plasticity, yellow brown and grey, medium to coarse grained sand, with clayey sand bands.	w-PL	(St)		
										END OF TEST PIT AT 1.50 m				
							2							
						9								
							3							
						8								
							4							
						7								
							5							
						6								
							6							
						5								

CONE PENETROMETER TEST RESULTS

Client: RENT-A-SPACE SELF STORAGE

Project: PROPOSED STORAGE BUILDING

Location: 2 CROSS STREET & 13-15 GREEN STREET, BROOKVALE, NSW

Job No.: 32885S

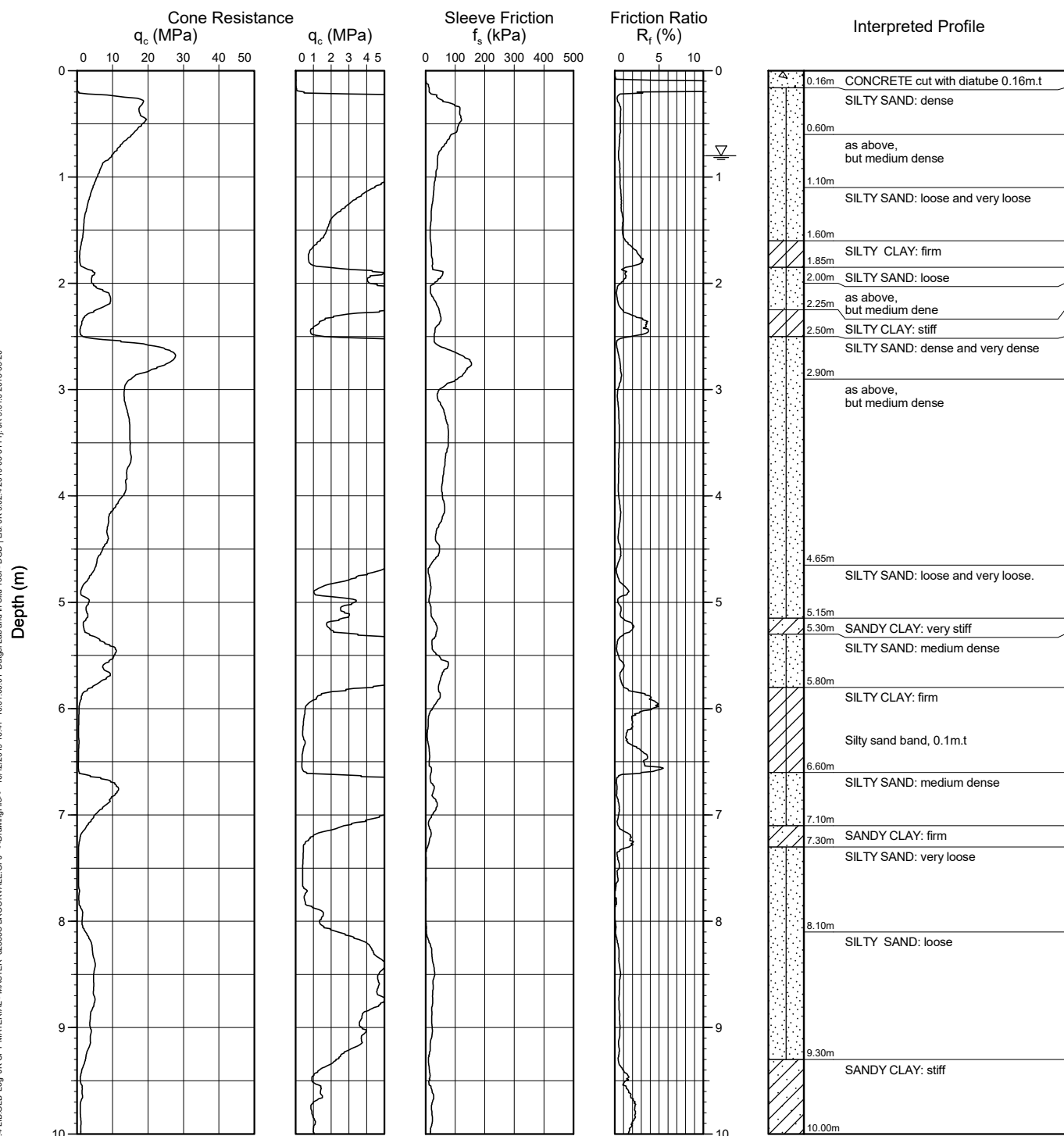
R.L. Surface: N/A

Data File: 26128V_201A.GEF

Date: 12/11/12

Datum:

Operator: D.F.



Interpreted by: D.F.
Checked by:

CONE PENETROMETER TEST RESULTS

Client: RENT-A-SPACE SELF STORAGE

Project: PROPOSED STORAGE BUILDING

Location: 2 CROSS STREET & 13-15 GREEN STREET, BROOKVALE, NSW

Job No.: 32885S

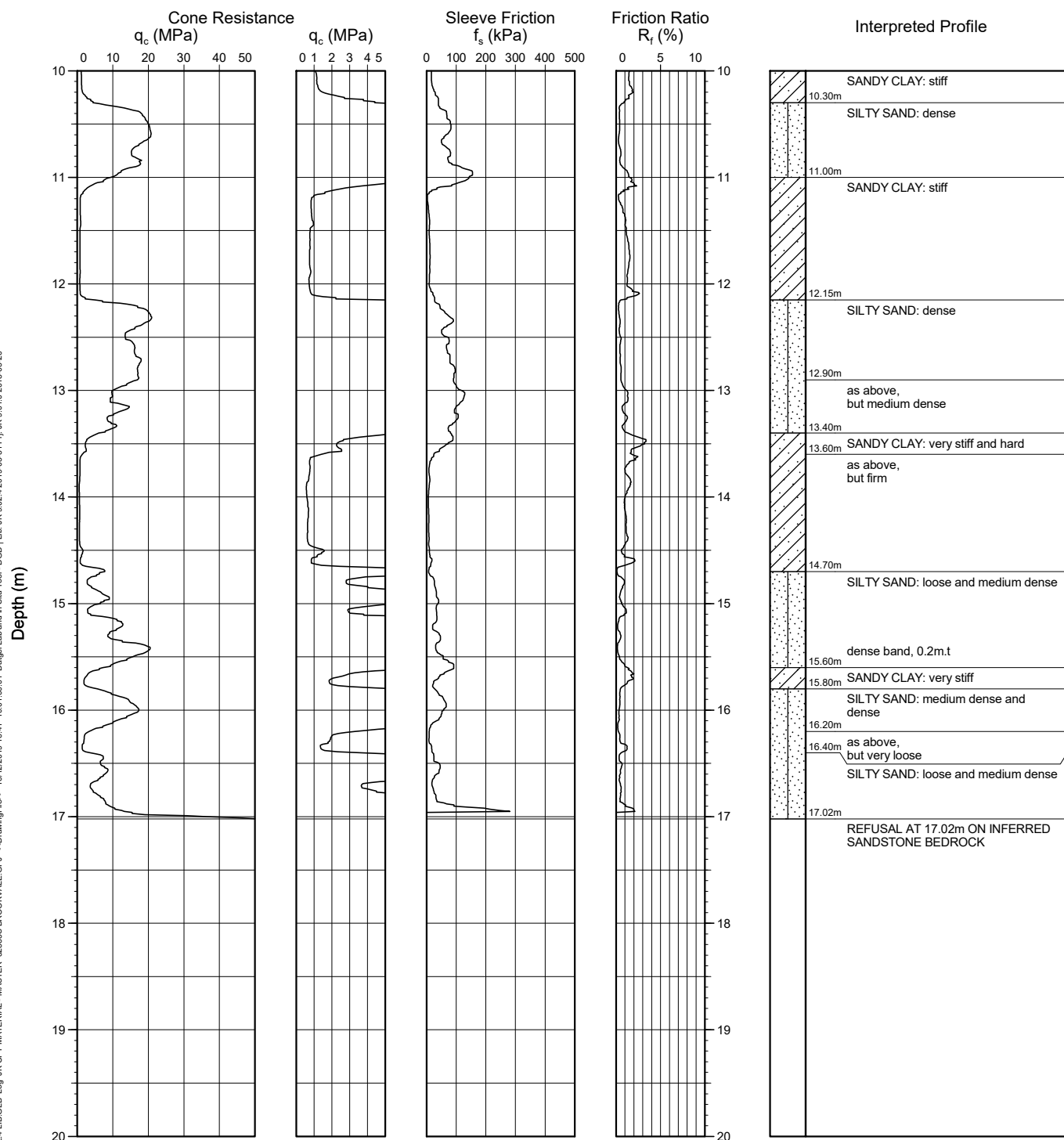
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Data File: 26128V_201A.GEF

Date: 12/11/12

Datum:

Operator: D.F.



Interpreted by: D.F.
Checked by:

CONE PENETROMETER TEST RESULTS

Client: RENT-A-SPACE SELF STORAGE

Project: PROPOSED STORAGE BUILDING

Location: 2 CROSS STREET & 13-15 GREEN STREET, BROOKVALE, NSW

Job No.: 32885S

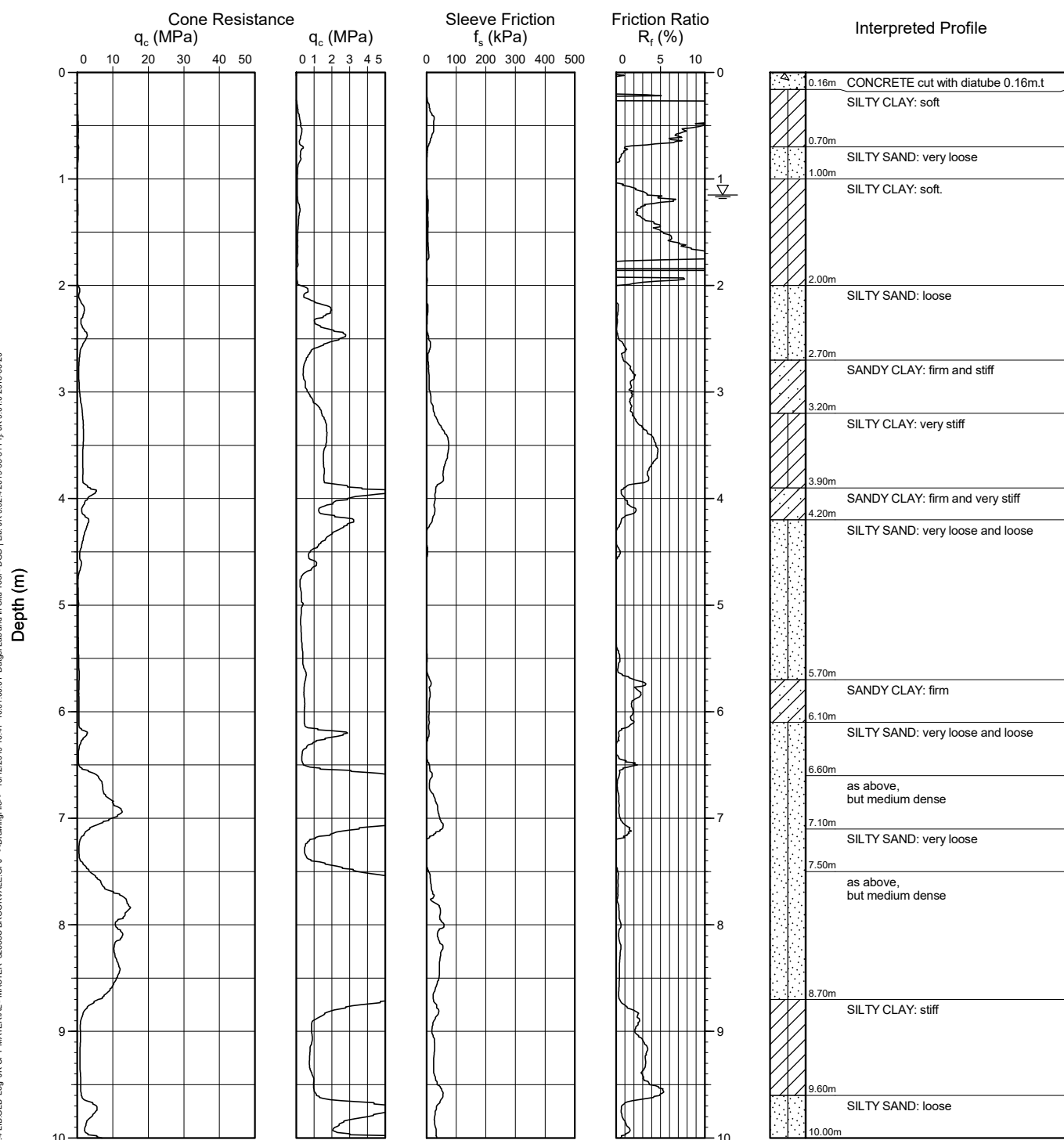
R.L. Surface: N/A

Data File: 26128V_202B.GEF

Date: 5/11/12

Datum:

Operator: D.F.



CONE PENETROMETER TEST RESULTS

Client: RENT-A-SPACE SELF STORAGE

Project: PROPOSED STORAGE BUILDING

Location: 2 CROSS STREET & 13-15 GREEN STREET, BROOKVALE, NSW

Job No.: 32885S

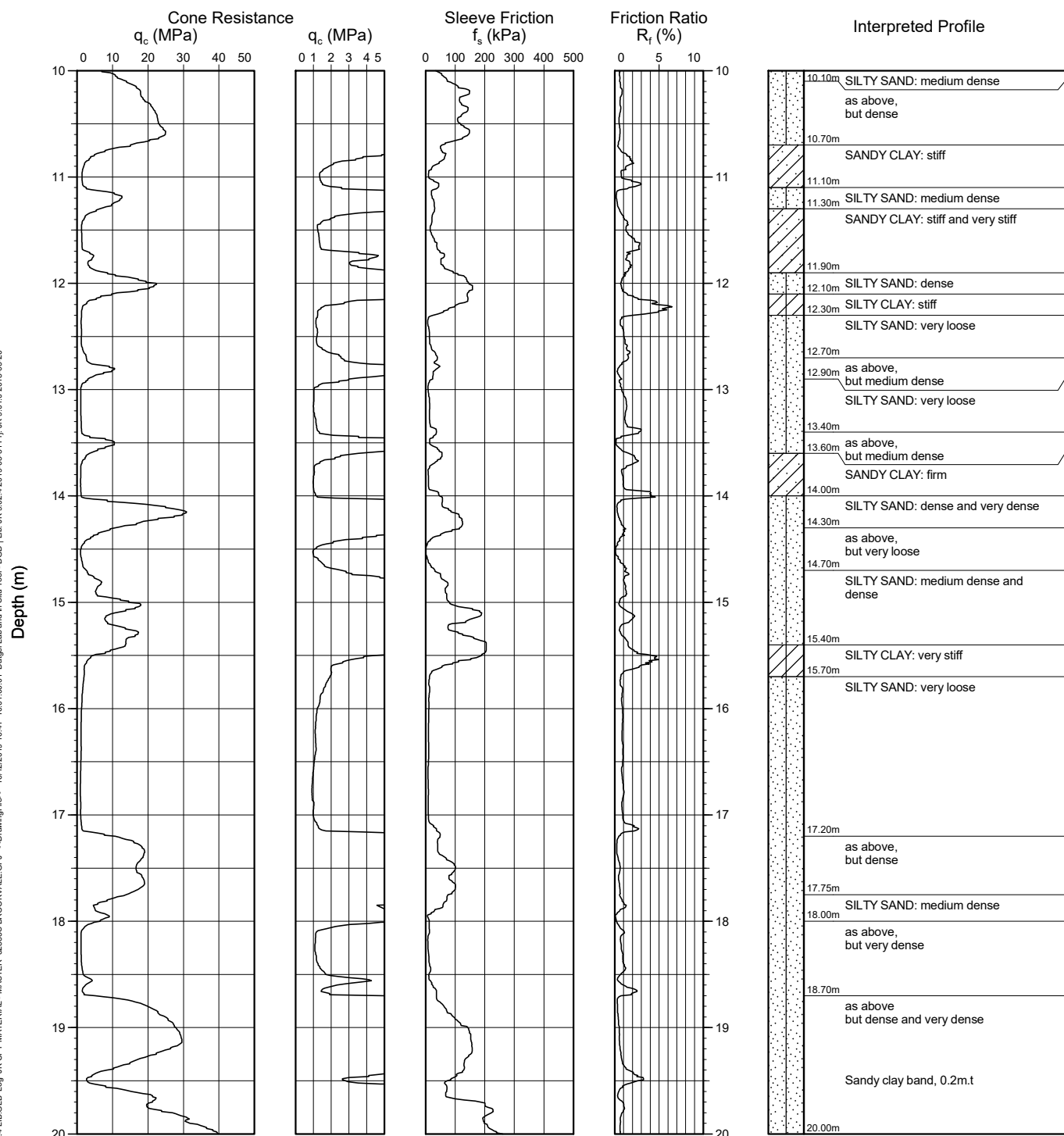
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Data File: 26128V_202B.GEF

Date: 5/11/12

Datum:

Operator: D.F.



Interpreted by: D.F.
Checked by:

CONE PENETROMETER TEST RESULTS

Client: RENT-A-SPACE SELF STORAGE

Project: PROPOSED STORAGE BUILDING

Location: 2 CROSS STREET & 13-15 GREEN STREET, BROOKVALE, NSW

Job No.: 32885S

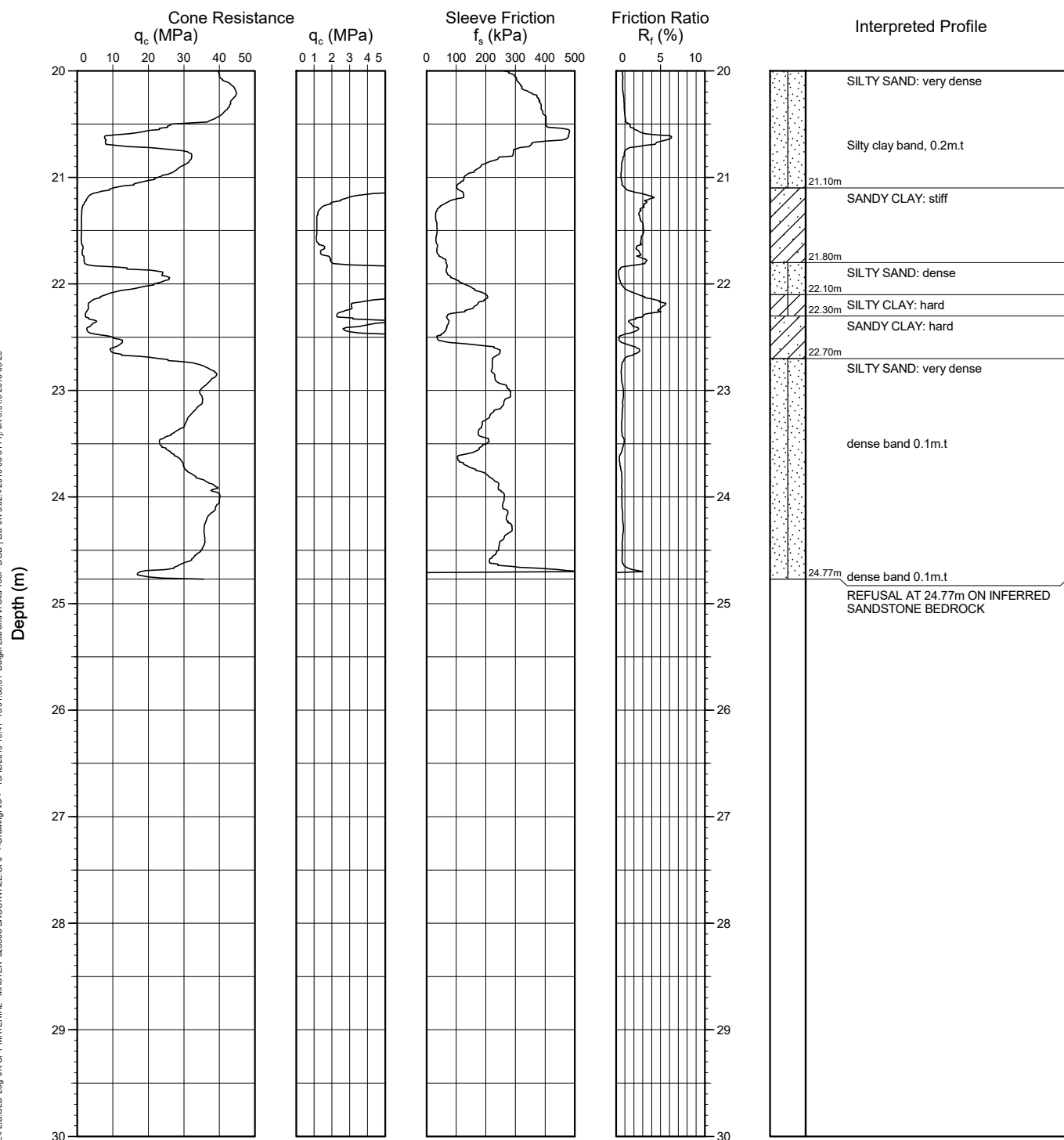
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Data File: 26128V_202B.GEF

Date: 5/11/12

Datum:

Operator: D.F.



CONE PENETROMETER TEST RESULTS

Client: RENT-A-SPACE SELF STORAGE

Project: PROPOSED STORAGE BUILDING

Location: 2 CROSS STREET & 13-15 GREEN STREET, BROOKVALE, NSW

Job No.: 32885S

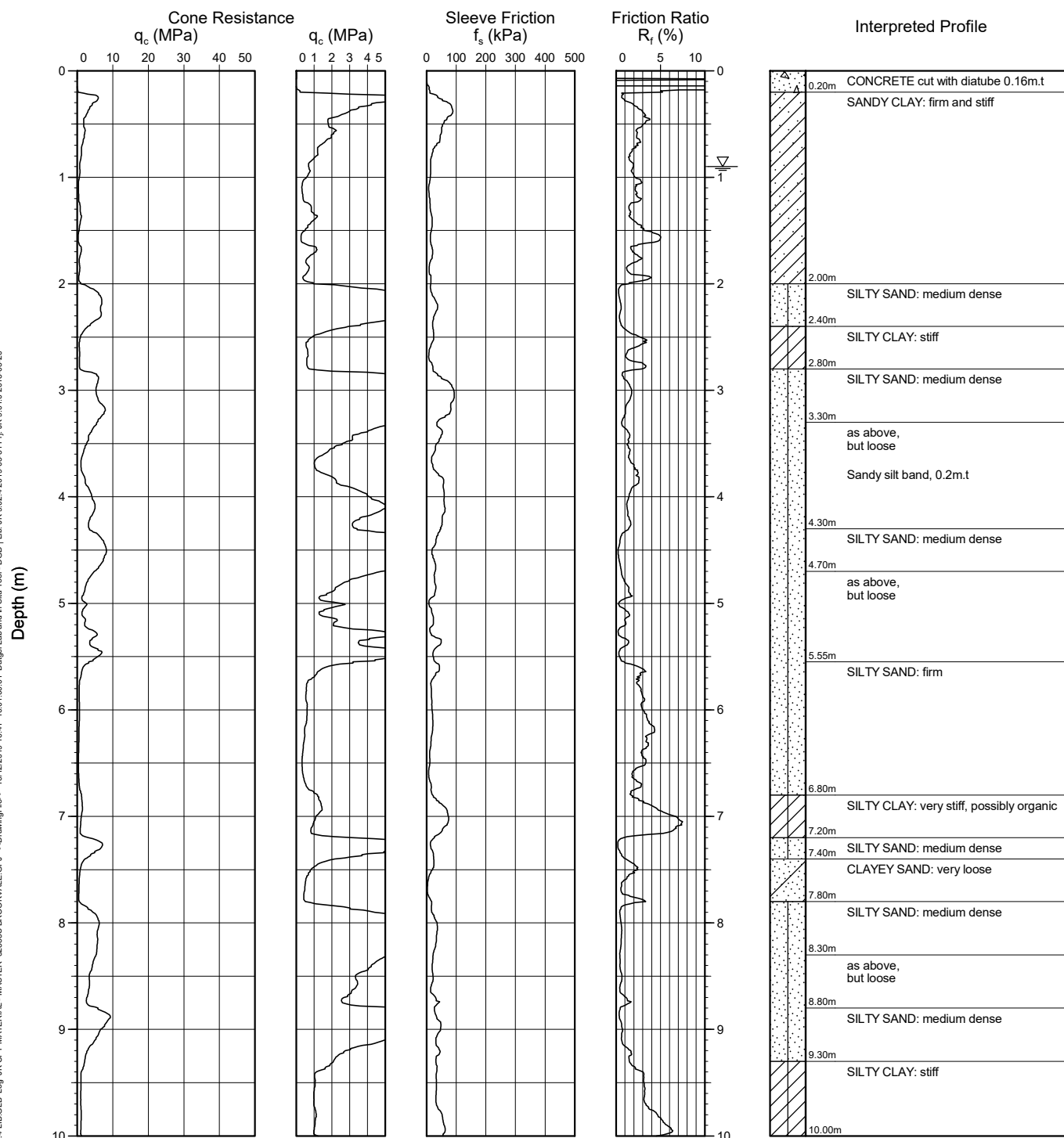
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Data File: 26128V_203.GEF

Date: 5/11/12

Datum:

Operator: D.F.



Interpreted by: D.F.
Checked by:

CONE PENETROMETER TEST RESULTS

Client: RENT-A-SPACE SELF STORAGE

Project: PROPOSED STORAGE BUILDING

Location: 2 CROSS STREET & 13-15 GREEN STREET, BROOKVALE, NSW

Job No.: 32885S

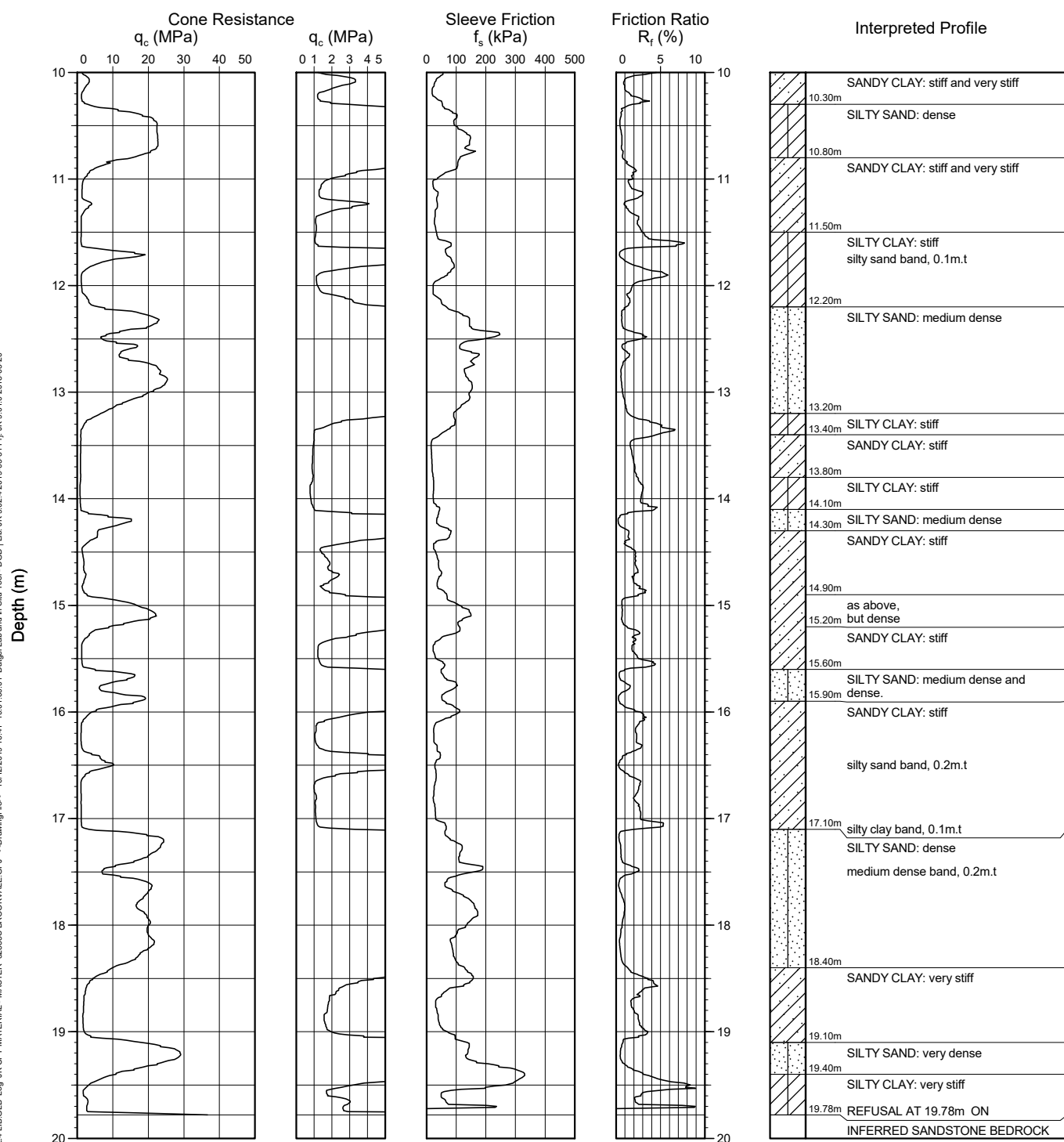
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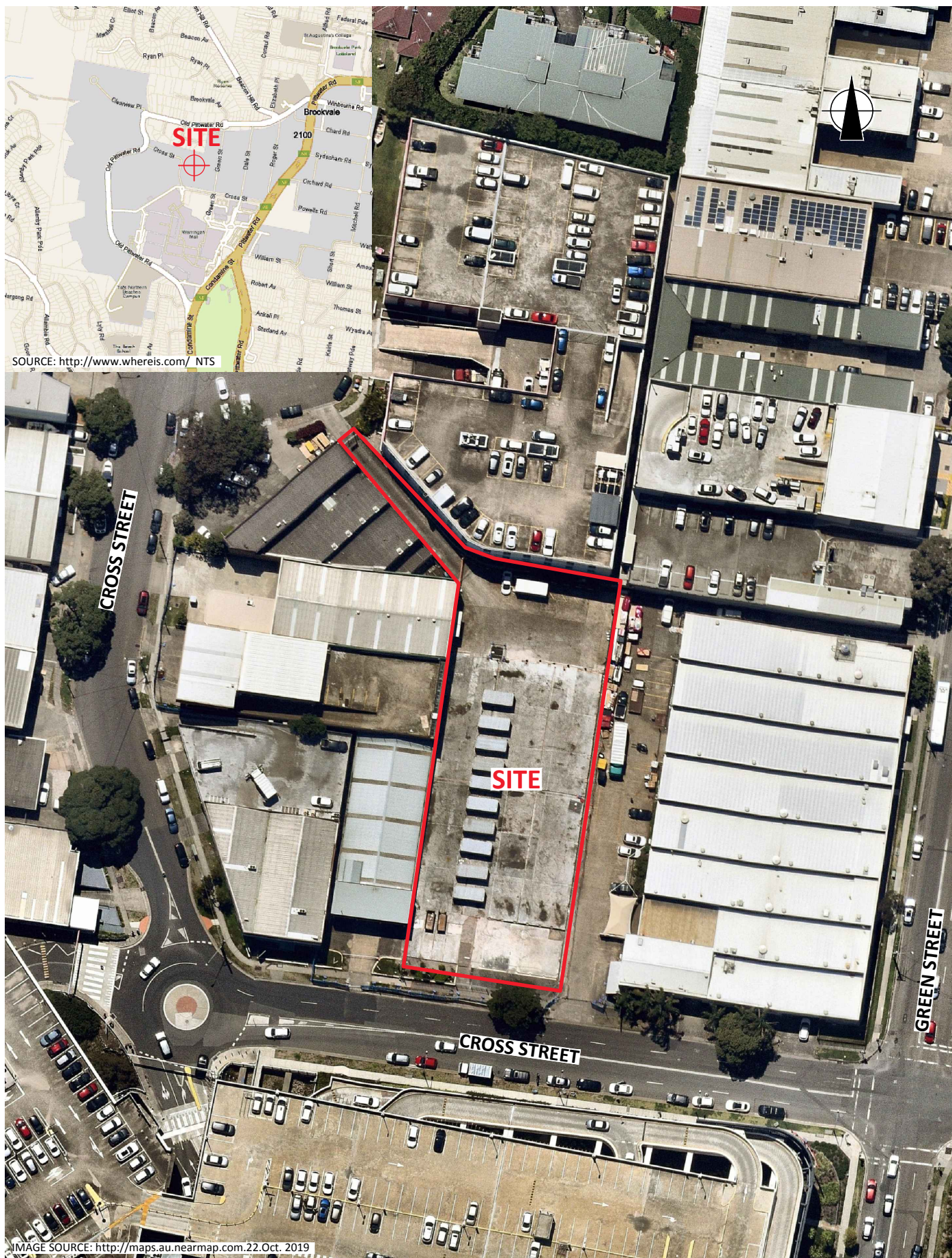
Date: 5/11/12

Datum:

Operator: D.F.



Interpreted by: D.F.
Checked by:



0 10 20 30 40 50
SCALE 1:1000 @A4 m

Title:

SITE LOCATION PLAN

Location:

4 CROSS STREET
BROOKVALE, NSW

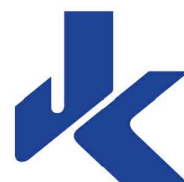
Report No:

32885S

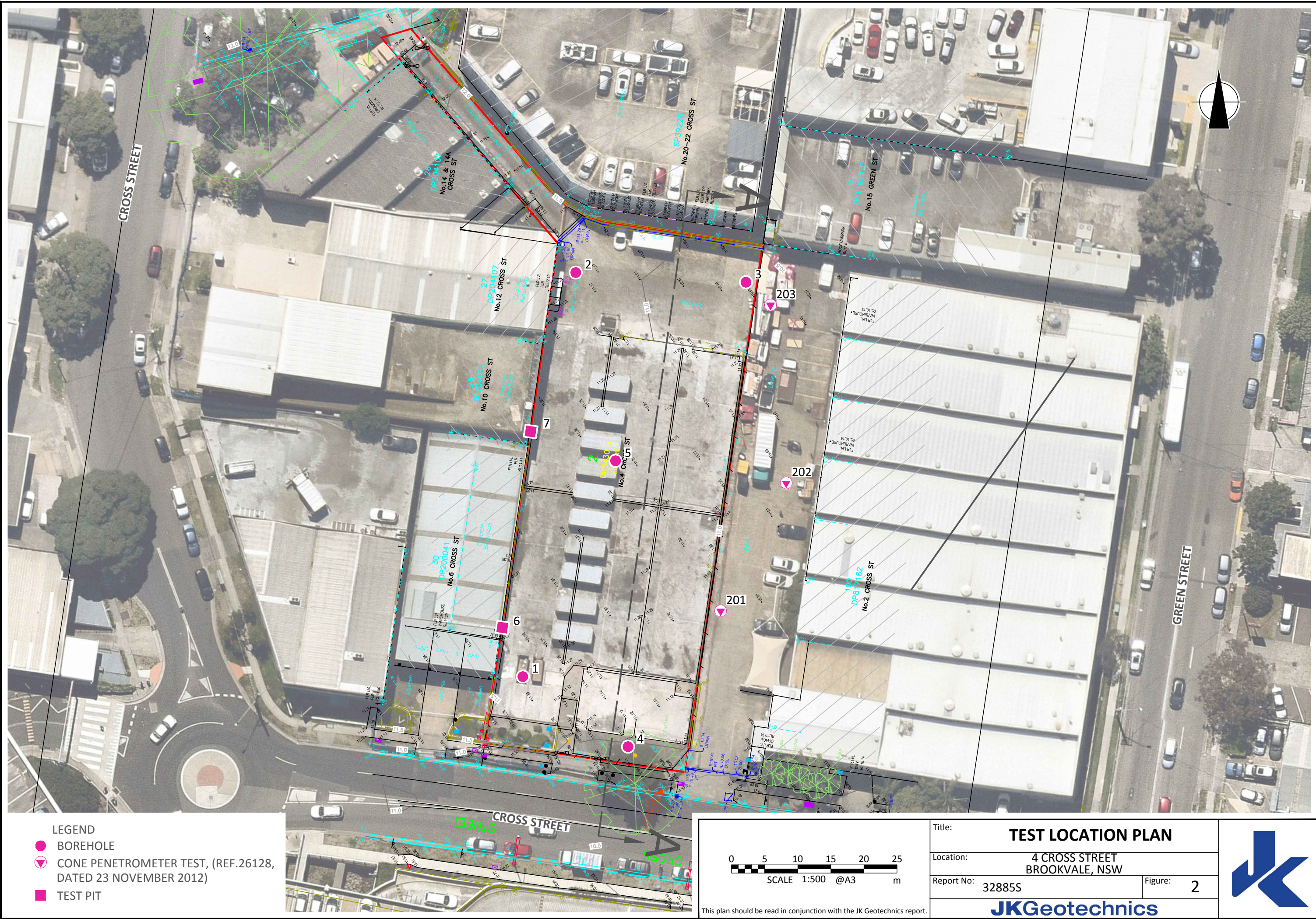
Figure:

1

JKGeotechnics



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

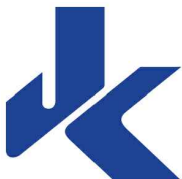


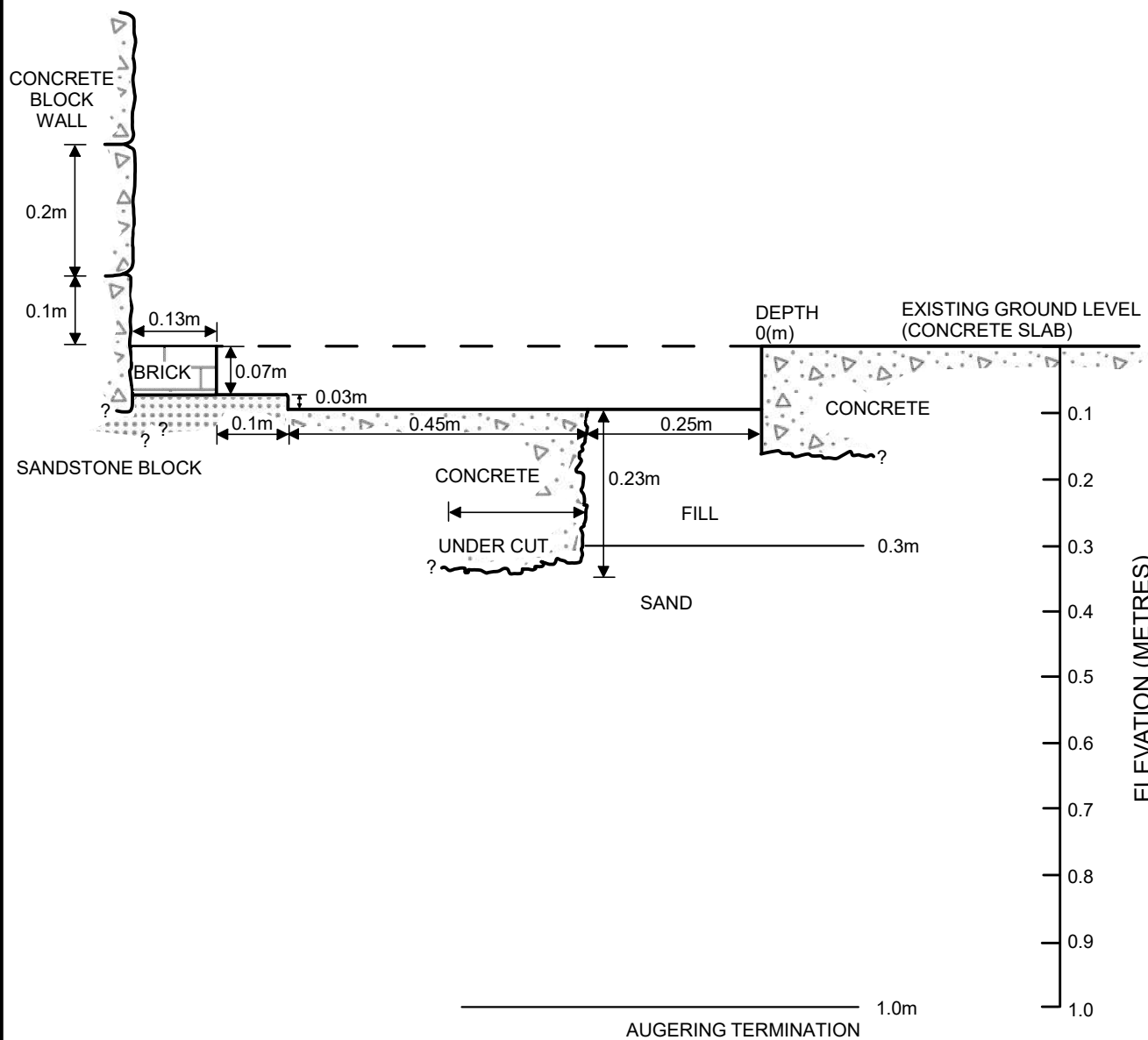
- LEGEND**
- BOREHOLE
 - ▼ CONE PENETROMETER TEST, (REF.26128, DATED 23 NOVEMBER 2012)
 - TEST PIT

0 5 10 15 20 25
SCALE 1:500 @A3 m

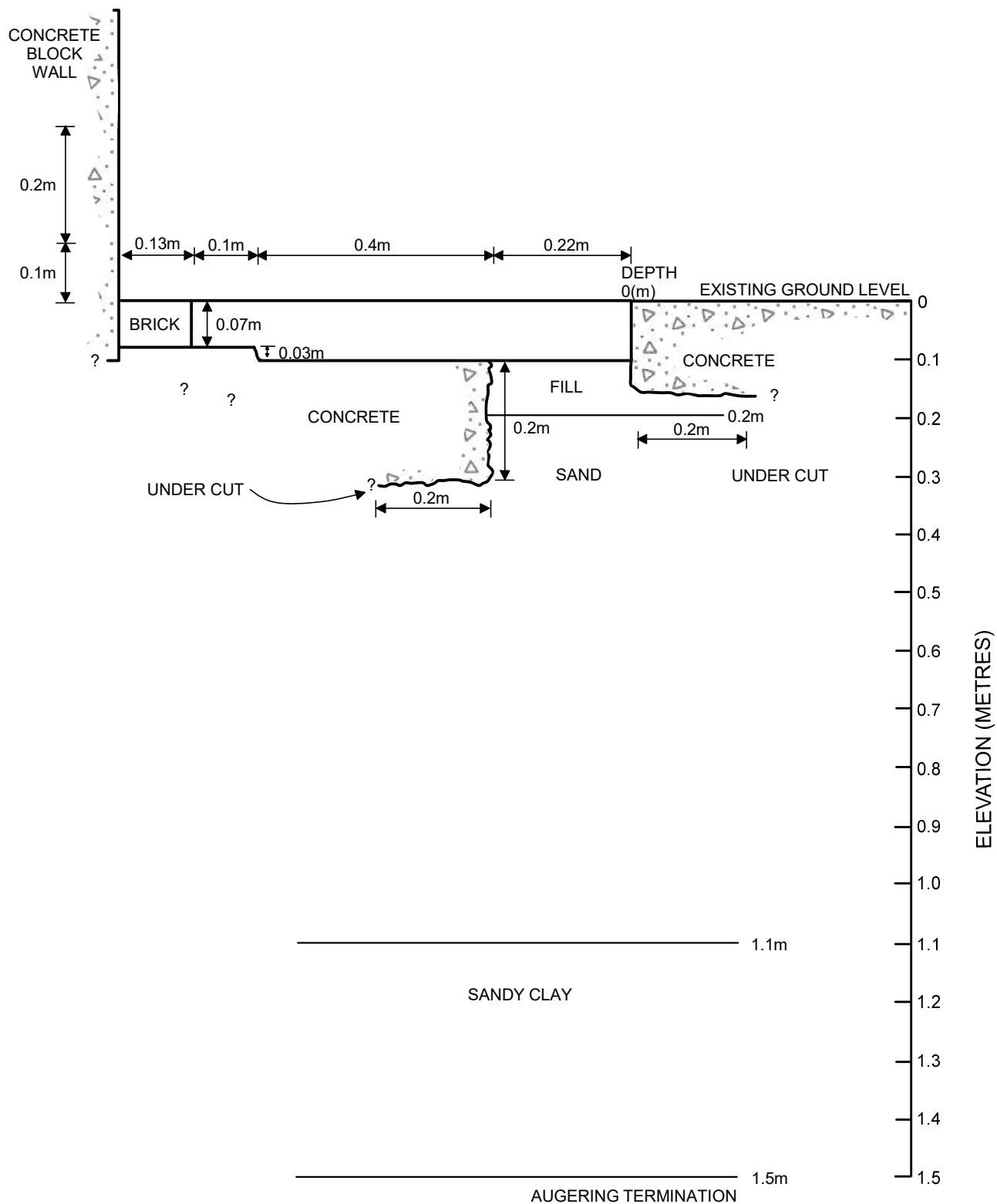
This plan should be read in conjunction with the JK Geotechnics report.

Title: TEST LOCATION PLAN	
Location: 4 CROSS STREET BROOKVALE, NSW	
Report No: 328855	Figure: 2
JKGeotechnics	





TEST PIT 6 CROSS SECTIONAL SKETCH LOOKING NORTH



TEST PIT 7 CROSS SECTIONAL SKETCH LOOKING NORTH



JKGeotechnics

Report No. 32885S

Figure No. 4



VIBRATION EMISSION DESIGN GOALS

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

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

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

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

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

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

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

REPORT EXPLANATION NOTES

INTRODUCTION

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

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

DESCRIPTION AND CLASSIFICATION METHODS

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

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

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

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

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

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

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

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

SAMPLING

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

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

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

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

INVESTIGATION METHODS

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

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

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

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

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

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

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

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

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

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

The test results are reported in the following form:

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

N = 13
4, 6, 7

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

N > 30
15, 30/40mm

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

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

Cone Penetrometer Testing (CPT) and Interpretation:

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

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

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

The information provided on the charts comprise:

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

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

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

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

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

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

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

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

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

The DMT is used to measure material index (I_D), horizontal stress index (K_D), and dilatometer modulus (E_D). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient (K_0), over-consolidation ratio (OCR), undrained shear strength (C_u), friction angle (ϕ), coefficient of consolidation (C_v), coefficient of permeability (K_h), unit weight (γ), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity (V_s). Using established correlations, the SDMT results can also be used to assess the small strain modulus (G_0).

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

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

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

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

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

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

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

LOGS

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

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

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

GROUNDWATER

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

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

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

FILL

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

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

LABORATORY TESTING

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

ENGINEERING REPORTS

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

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

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

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

SITE ANOMALIES

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

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would

be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

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

REVIEW OF DESIGN

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

SITE INSPECTION

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

Requirements could range from:

- i) a site visit to confirm that conditions exposed are no worse than those interpreted, to
- ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types and appropriate footing or pile founding depths, or
- iii) full time engineering presence on site.

SYMBOL LEGENDS

SOIL



FILL



TOPSOIL



CLAY (CL, CI, CH)



SILT (ML, MH)



SAND (SP, SW)



GRAVEL (GP, GW)



SANDY CLAY (CL, CI, CH)



SILTY CLAY (CL, CI, CH)



CLAYEY SAND (SC)



SILTY SAND (SM)



GRAVELLY CLAY (CL, CI, CH)



CLAYEY GRAVEL (GC)



SANDY SILT (ML, MH)



PEAT AND HIGHLY ORGANIC SOILS (Pt)

ROCK



CONGLOMERATE



SANDSTONE



SHALE/MUDSTONE



SILTSTONE



CLAYSTONE



COAL



LAMINITE



LIMESTONE



PHYLLITE, SCHIST



TUFF



GRANITE, GABBRO



DOLERITE, DIORITE



BASALT, ANDESITE



QUARTZITE

OTHER MATERIALS



BRICKS OR PAVERS



CONCRETE



ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions	Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 60% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm)	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines $C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines $C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey N/A

Laboratory Classification Criteria

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

$$C_u = \frac{D_{60}}{D_{10}} \quad \text{and} \quad C_c = \frac{(D_{30})^2}{D_{10} D_{60}}$$

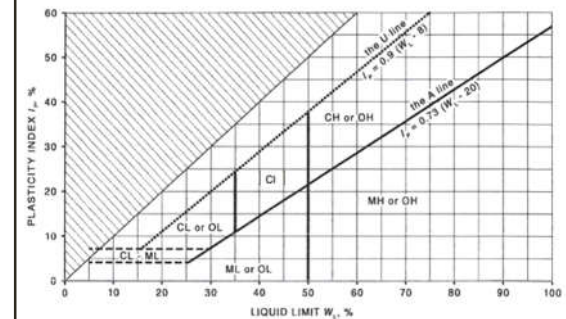
Where D_{10} , D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

NOTES:

- For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.
- Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.
- Clay soils with liquid limits $> 35\%$ and $\leq 50\%$ may be classified as being of medium plasticity.
- The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

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

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



LOG SYMBOLS

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

Log Column	Symbol	Definition
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Twin pronged tungsten carbide bit.
	T ₆₀	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as:
	RESIDUAL	– soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock.
	EXTREMELY WEATHERED	– soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock.
	ALLUVIAL	– soil deposited by creeks and rivers.
	ESTUARINE	– soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents.
	MARINE	– soil deposited in a marine environment.
	AEOLIAN	– soil carried and deposited by wind.
	COLLUVIAL	– soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits.
	LITTORAL	– beach deposited soil.

Classification of Material Weathering

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

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: 'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'. There is some change in rock strength.

Rock Material Strength Classification

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

Abbreviations Used in Defect Description

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