REPORT TO

OXFORD FALLS GRAMMAR SCHOOL

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED CARPARK

AT

1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Date: 17 March 2021
Ref: 30807SYrptRev4

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DOCUMENT REVISION RECORD

Report Reference	Report Status	Report Date
30807SYrpt	Final Report	23 October 2017
30807SYrptRev1	Final Report Revision 1	6 December 2019
30807SYrptRev2	Final Report Revision 2	18 March 2020
30807SYrptRev3	Final Report Revision 3	2 April 2020
30807SYrptRev4	Final Report Revision 4	17 March 2021

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1 INTRODUCTION

This revised report presents the results of a geotechnical investigation for the proposed car park (development permitted without consent) and associated structures (exempt developments) at 1078 Oxford Falls Road, Oxford Falls, NSW. The investigation was commissioned by Mr Greg Morris of the Oxford Falls Grammar School and was carried out in accordance with our proposal, Ref: P45494SY. This revised report reflects the current proposed development and supersedes our previous report, Ref: 30807SYrptRev3, dated 2 April 2020.

We understand from the supplied architectural drawings prepared by AJ&C Architects (Project No. 18025, Dwg. REF001, 101, 201, 202, 203,311, 312 and 321, Rev 3 dated 2 March 2021) that the proposed development in the south-western corner of the school will comprise the following:

- Construction of a car park located in the south-eastern corner of the oval adjacent to the creek. This building is expected to be a two storey building built approximately at existing grade with some minor cut and fill works to achieve the required bulk excavation level. Approximately 0.6m of cut and 0.4m of fill is proposed over the building footprint. The carpark is considered a development permitted without consent.
- Expansion and reorientation of the existing sports field. The new sports field will run parallel to the western site boundary and will be positioned further to the west than is currently the case. Fill placement will predominantly occur over the majority of the field footprint, except in the south-west corner where cut up to 1.6m deep will occur. The sports field is considered an exempt development.
- The construction of one footbridge to provide access from the existing school buildings on the eastern side of the creek to the carpark and sports field on the western side. The footbridge is considered an exempt development.

JK Geotechnics previously carried out a geotechnical investigation in 2017 comprising of test pits and augered boreholes. The purpose of the 2017 investigation was to obtain geotechnical information on the subsurface conditions at the test locations to provide comments and recommendations on excavation, retention, earthworks, footings, soil aggression and pavements. This current investigation comprised cored boreholes and was undertaken to provide additional detailed information on the sandstone bedrock for footing design purposes.

The previous 2017 geotechnical investigation was carried out in conjunction with a waste classification and assessment of the suitability of the existing soils to support grass growth by our specialist division, JK Environments (JKE) (formerly Environmental Investigation Services (EIS)). The results of this investigation is presented in JKE’s report, Ref: E30807K, dated 23 October 2017.

2 INVESTIGATION PROCEDURE

2.1 Current Investigation

The fieldwork for the investigation was carried out on 9 and 13 March 2020 and comprised five boreholes (BH201 to BH205) drilled with track mounted drilling rigs. The boreholes were initially drilled to depths ranging between 3.73m and 5.73m below existing surface levels using spiral auger techniques with an attached Tungsten Carbide (‘TC’) bit. They were then extended to final depths ranging from 7.75m to 8.68m using an NMLC triple tube barrel fitted with a diamond coring bit and water flush.

Limited testing of the subsurface soils were carried out. Where testing was done, the strength of the subsurface soils was assessed from Standard Penetration Test (SPT) ‘N’ values and, where clayey soils were encountered this assessment was augmented by hand penetrometer tests completed on samples recovered in the SPT split tube sampler. The strength of the sandstone bedrock was assessed by observation of the auger penetration resistance using a TC drill bit, together with examination of the recovered rock cuttings. It should be noted that strengths assessed in this way are approximate and variances of one strength order should not be unexpected.

Where bedrock was diamond cored, the recovered core was returned to our NATA accredited laboratory (Soil Test Services (STS)) for photographing and Point Load Strength Index (Is_{50}) testing. Using established correlations the Unconfined Compressive Strength (UCS) of the bedrock was then calculated from the Is_{50} results. Copies of the colour photographs are provided with the borehole logs.

Groundwater observations were made in the boreholes during and on completion of drilling and at the end of the field work. We note that water is introduced into the borehole during coring and therefore the water levels measured at completion of coring may be artificially high as the water levels have not had time to stabilise. No further groundwater monitoring was carried out.

2.2 Previous 2017 Investigation

The fieldwork for the investigation was carried on 25 and 26 September to 2017 and comprised the auger drilling of 21 boreholes (BH1 to BH21) using our track mounted JK350 rig and the completion of six test pits using a backhoe. The boreholes were drilled to depths varying from 1.95m to 6m using spiral auger techniques with an attached TC bit.

The deeper boreholes (BH1 to BH4, BH6, BH8 and BH12) were drilled over the footprint of the proposed carpark and at the western abutments of the footbridges. Those boreholes drilled over the proposed sports oval were typically drilled to 1.95m, although at the south-western corner of the oval, where excavation is required, boreholes were drilled to maximum depths of 4.95m.

The test pits were excavated across the site to confirm the depth and nature of the fill present and confirm the fill depths encountered in the boreholes. As the test pits provide a greater opportunity than the boreholes to observe the fill, a better appreciation of the materials present within the fill could be made. To this end the test pits were left open for a number of days following excavation to allow prospective builders to inspect the test pits and make their own assessment of the nature of the fill. Whilst open temporary fencing was placed around the test pits to secure them until they were backfilled.

The apparent compaction of the fill and the strength/relative density of the natural soils was interpreted from the Standard Penetration Test (SPT) 'N' values. This assessment was augmented by hand penetrometer tests completed on cohesive samples returned by the SPT split tube sampler. The strength of the underlying weathered sandstone was assessed from observation of the drilling resistance, inspection of the recovered rock chip samples and subsequent correlation with moisture content test results. It must be noted that rock strength estimated in this way are approximate only and variation in one strength order should not be unexpected. Groundwater observations were made during and on completion of drilling. No longer term monitoring of groundwater levels was carried out.

Selected samples were returned to Soil Test Services Pty Ltd (STS) and Envirolab Services Pty Ltd, both NATA accredited laboratories, for testing. Tests comprised moisture content, four day soaked CBR values and pH, sulphate content, chloride content and minimum resistivity. The results of the laboratory testing are summarised in STS Tables A and B and Envirolab Services Certificate of Analysis No. 176558.

2.3 General

The fieldwork for both investigations was completed in the full-time presence of our geotechnical engineers who set out the investigation locations, nominated the testing and sampling, and prepared the attached borehole and test pit logs. The investigation locations were set out using a differential GPS surveying unit and are shown on the attached Figure 2. The northing, easting and relative level for each test location are shown on the attached logs. The height datum is the Australian Height Datum (AHD). For more details of the investigation procedures and their limitations, reference should be made to the attached Report Explanation Notes.

3 RESULTS OF INVESTIGATION

3.1 Site Description

Oxford Falls Grammar School is located in the base of a broad valley that has been formed by the down cutting of the sandstone plateau. An incised creek which meanders through the valley runs through the school splitting the site, which is on the western side of the creek, from the remainder of the school which includes all of the schools built structures.

The site is triangular in shape and comprises the sports oval which occupies approximately the south-western third of the school grounds. The sports oval is relatively flat and has been formed by cutting along the western side and filling over the eastern side adjacent to the creek. Batters are located on the western and north-western sides of the oval and slope down towards the oval at about 15°-20°. At the top of the batter on the western side of the oval is a gravel surfaced car park and vegetated area that extends to the Wakehurst

Parkway. Along the southern side of the oval is Dreadnought Road which slopes down to the east at approximately 5°. On the northern side of the oval the ground slopes down at about 10° to the creek and contains small to medium sized trees and a seating area.

3.2 Subsurface Conditions

Reference to the 1:100,000 Geological Map of the Sydney Region indicates that the site is underlain by Hawkesbury Sandstone. The investigation indicated that in general a fill layer of variable thickness covers the site with fill depths increasing towards the creek. Underlying the fill, predominantly sandy soils were encountered that in turn overlay sandstone bedrock. The pertinent details of the materials encountered are presented below. For a more detailed description of the materials encountered at a particular test location reference should be made to the attached borehole and test pit logs.

Fill

Fill was encountered at all test locations and extended to depths ranging between 0.1m and 3.5m with the greatest fill depths located closest to the creek. The fill was predominantly sandy, comprising silty sand and sand, although some sandy clay was also present. The fill contained variable amounts of sandstone, gravel, cobbles and boulders and a trace amounts of brick, timber, plastic and string. The fill was assessed to be variably compacted ranging from poorly to well compacted.

Alluvial Soils

The natural soils comprised interbedded alluvial sands, clayey sands and sandy clays. The clays were assessed to be of medium plasticity and ranged in strength from firm to very stiff. The clayey sands and sands were assessed to be of variable relative density ranging from loose to medium dense.

Sandstone Bedrock

Sandstone bedrock was encountered at depths ranging from 3.3m to 5.5m. While the surface layer is typically of hard soil strength to very low rock strength it generally increased in strength quickly to low or medium to high strength. In the case of BH6 TC bit refusal occurred at a depth of 5.6m. A notable exception to the quick increase in strength with depth of the bedrock is BH12, where extremely low strength bedrock was proved for a depth of 1.5m before increasing to low strength at a depth of 5.5m. The bedrock in the cored boreholes (BH201 to BH205) contained occasional horizontal extremely weathered seams of generally 38mm thickness, and also regular angular joints.

Groundwater

Groundwater seepage was encountered during the drilling at depths ranging from 2.8m to 5.0m. On completion of the drilling of these boreholes groundwater was measured at depths ranging from 2.8m to 4.5m.

It should be noted that at the time of drilling the groundwater levels had not had time to stabilise and therefore may not be truly representative of groundwater levels across the site. No longer term groundwater monitoring was carried out.

3.3 Laboratory Test Results

The four day soaked CBR tests on samples of the silty sand fill and alluvial silty sand compacted to 98% of Standard Maximum Dry Density (SMDD) returned results of 30% and 11%, respectively. The moisture content test results carried out on recovered rock cuttings returned higher moisture contents than would be expected for the rock encountered. This may be due to the collected rock chips being surface wet, although there are cases where bedrock of good strength has quite high natural moisture contents.

The soil pH values ranged from 5.7 to 6.5, indicating slightly acidic soil conditions. The sulphate contents ranged from <10mg/kg to 55mg/kg, the chloride contents of <10mg/kg while the minimum resistivity ranged from 23,000ohm.cm to 53,000ohm.cm.

The point load strength index test results correlated reasonably well with our field assessment of the rock strength. The estimated UCS values based on the correlation of 20 times $I_{s(50)}$ value ranged from 4MPa to 32MPa.

4 COMMENTS AND RECOMMENDATIONS

4.1 Excavation

Construction of both the new carpark and re-orientation of the sports field is anticipated to require excavation to maximum depths of about 2m. Excavation to these depths is expected to require the removal of predominantly sandy fill material and alluvial sandy and clayey soils. It is anticipated that removal of these soils will be able to be completed using conventional earthworks equipment, such as tracked excavators or similar. Sandstone bedrock is not anticipated to be encountered. Consequently, we do not consider that hard rock excavation techniques will be encountered nor that rock hammers or similar will typically be required. While the test pits encountered some large sandstone boulders these are not expected to cause significant difficulties to excavation but may require some isolated use of rock hammers to break them up into a more manageable size. Care will be required not to over excavate and disturb the materials below the basement subgrade level.

We recommend that only excavation contractors with appropriate insurances and experience on similar projects be used. Excavation contractors should be provided with a copy of this geotechnical report, including the borehole logs, so they can make their own assessment of suitable excavation equipment.

4.2 Retention

Based upon the expected cut and fill earthworks, we expect that temporary and permanent batters may be adopted, although low height retaining walls may be necessary in the south-west corner of the site due to the limited space between the playing field and the site boundary.

Where batters are formed through the sandy fill and natural sands temporary batters may be formed at no steeper than 1 Vertical (V):1.75 Horizontal (H), while permanent batters should be formed at no steeper than

1V:3.5H. Given the limited excavation depths, we do not expect to encounter the groundwater level, however surface run-off could potentially destabilise permanent batters and therefore these should be vegetated to reduce erosion. Dish drains formed just behind the crest of the batters should also be constructed such that all stormwater runoff is collected and directed around temporary and permanent batter slopes to reduce the risk of erosion.

For the envisaged low height cantilevered gravity type retaining walls supporting soil materials, we recommend that walls can be designed on the basis of an active earth pressure co-efficient (K_a) of 0.35 where some wall movements are tolerable and assuming a horizontal backfill surface. A bulk unit weight of 20kN/m^3 should be adopted for the soil profile and 22kN/m^3 for the shale profile. Where walls are laterally restrained or movements are to be reduced then we recommend the walls be designed on the basis of an 'at rest' earth pressure coefficient (K_o) of 0.6. Surcharge loads and hydrostatic pressures are additional to the above earth pressure recommendations. The above coefficients assume horizontal backfill surfaces. Where inclined backfill is proposed, the coefficients must be increased or the inclined backfill taken as a surcharge load. We recommend that walls be designed with full and effective rear of wall drainage.

For any design using computer software, such as WALLAP, we recommend adopting the following parameters for the subsurface profile:

Recommended Geotechnical Parameters				
Material	**Unit Weight (kN/m^3) Behind wall/ In front of wall**	**Drained Cohesion (kPa)**	**Internal Angle of Friction (degrees)**	**Modulus (MPa)**
Fill	20 / 15	0	28	10
Sand (L)	20 / 16	0	30	15
Sand (MD)	20 / 18	0	32	20
Clay (Vst)	20 / 18	5	28	30
Sandstone Class V	22	20	30	100
Sandstone Class IV	23	250	30	400
Sandstone Class III or Better	24	500	35	800

4.3 Earthworks

Prior to the placement of pavements or engineered fill to raise site levels we recommend that the following subgrade treatment be completed:

- Strip all topsoil and root affected soils from site,

- Proof roll the exposed subgrade with a minimum six passes using a smooth drum roller with a minimum static weight of 8 tonnes. The purpose of proof rolling is to improve the near surface compaction of the subgrade and to identify any soft or heaving areas,
- All proof rolling should be completed in the presence of an experienced geotechnician or geotechnical engineer. Where soft or heaving areas are identified they should be excavated down to a sound base and replaced with engineered fill.

Engineered fill should preferably comprise well graded granular materials, such as the sandy soils on site, provided they are free from all organic or deleterious substances and have a maximum particle size not exceeding 75mm. Such fill should be compacted in horizontal layers of roughly 200mm loose thickness, although layer thickness may be varied provided the required density is being achieved over the full layer thickness. Engineered fill should be compacted to a density between 98% and 102% of Standard Maximum Dry Density (SMDD) and at moisture contents within 2% of Standard Optimum Moisture Content (SOMC). For backfilling confined excavations such as behind retaining walls and service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then layer thicknesses will need to be reduced to achieved the required density and is likely to be in the order of 100mm loose thickness, possibly less.

Density tests should be regularly carried out on the fill to confirm the above specifications are achieved. The frequency of density testing should be at least one test per layer per 500m^2 or three tests per visit, whichever requires the most tests. Where the fill is to support building or traffic loads it should be placed under Level 1 control, as defined by AS3798. Preferably the geotechnical testing authority should be engaged directly on behalf of the client and not by the earthworks subcontractor

4.4 Footings

Due to the presence of sandy uncontrolled fill greater than 0.8m thickness and the possibility of abnormal moisture conditions due to existing trees, we consider that the site classifies as Class 'P' in accordance with AS2870-2011 ‘*Residential Slabs and Footings*’. We note that whilst strictly AS2870-2011 does not apply to a development of this type, it still provides a useful guide. Reference should also be made to AS2870 for design, construction, performance criteria and maintenance precautions on problem sites.

Due to the sandy nature of the soils and the presence of a water table above the bedrock, bored piers are unsuitable for use on this site. Suitable piling techniques for this site include grout injected or Continuous Flight Auger (CFA) piles. As high strength bedrock may be encountered, large powerful drill rigs suitable for drilling through high strength rock will be required for use on this site. In addition, it is likely that a working platform will be required to provide a safe working environment for the piling rig. The thickness of such a platform depends on the drill rig design loads and the soil conditions, but as a minimum would comprise 0.3m of 40/70 or similar and could well be as thick as 1m.

Following earthworks for the proposed carpark, we expect that the exposed subgrade will comprise the underlying alluvial sands and clays. Consequently, we recommend that both the carpark and bridge abutments be supported on the underlying sandstone bedrock, which is expected to be encountered at depths ranging from about 3.3m to 5.5m. All piles should be founded with at least a nominal socket of 0.3m into the appropriate class of sandstone.

The reduced level for the top of each rock class at each of the cored boreholes is provided in the following table. We note the classification is dependent on pile diameter and this classification has been based upon representative lengths of core and some judgement within the overlying augered portions of each borehole and should be treated as approximate only. Further, within each of the rock classes given below, there may be some subsections of rock which may be say one class higher or lower than the overall class of that band. Therefore, further confirmation of the classification must be obtained when further details of the pile diameter/socket length are known.

Borehole	**Top of Each Rock Classification**					
	Class V		**Class IV**		**Class III or Better**	
	Depth (m)	**RL (mAHD)**	**Depth (m)**	**RL (mAHD)**	**Depth (m)**	**RL (mAHD)**
201	3.5	70.30	3.9	69.90	6.5	67.30
202	4.6	69.40	-	-	5.2	68.80
203	3.4	70.70	-	-	4.8	69.30
204	4.2	69.80	4.85	69.15	5.85	68.15
205	4.2	69.20	4.8	68.60	5.73	67.67

NOTE: Rock classification has been carried out in accordance with '*Foundations on Sandstone and Shale in the Sydney Region*', Pells, Mostyn and Walker, Australian Geomechanics, Dec 1998.

Based upon the above rock classification, we recommend that the following bearing pressures and skin friction values be adopted. These bearing pressures are based on serviceability criteria to limit deflections at the base of the footing to less than 1% of the footing width/diameter.

Rock Class	**Allowable End Bearing Pressure (kPa)**	**Allowable Skin Friction in Compression (kPa)**	**Allowable Skin Friction in Tension (kPa)**
Class V	1,000	100	50
Class IV	2,000	200	100
Class III or Better	4,000	400	200

Consideration could also be given to design of footings based on limit state design analysis procedures and the following ultimate values can be adopted. Ultimate values must be used in conjunction with an appropriate geotechnical strength reduction factor (ϕ_g) which must be calculated in accordance with the methodology outlined in AS2159-2009 '*Piling Design and Installation*'. It is not possible at this stage to accurately determine the geotechnical strength factor as we have no knowledge of the design and installation factors. However, as a guide we have estimated the Average Risk Rating (ARR) and geotechnical strength reduction factor based on the following assumptions:

- The designer has extensive experience with similar foundations in similar geological conditions.
- The design method adopted is well established and soundly based.
- The method for utilising results of in-situ test data and installation data is based on indirect measurements used during installation and not calibrated to static load tests.
- There is a detailed level of construction control with professional geotechnical supervision and construction processes that are well established and relatively straightforward are adopted.
- No monitoring of the structure after construction will be undertaken.

Based on the above assumptions and our geotechnical knowledge, we estimate an ARR of 2.52 in accordance with Equation 4.3.2 and Table 4.3.2(A) of AS2159-2009. Accordingly, the overall risk category is Low to Moderate, resulting in a geotechnical strength reduction factor of 0.52 for low redundancy systems and 0.6 for high redundancy systems, in accordance with Table 4.3.2(C) of AS2159-2009. The use of ultimate values will result in higher settlements. Therefore, specific analysis of the footing settlements must be carried out to confirm that the structure will still perform satisfactorily.

Rock Class	Ultimate End Bearing Pressure (kPa)	Ultimate Skin Friction in Compression (kPa)	Ultimate Skin Friction in Tension (kPa)
Class V	3,000	150	75
Class IV	4,000	300	150
Class III or Better	8,000	700	350

We recommend that all footings be inspected by a geotechnical engineer to provide greater confidence that the piles are founded on the appropriate quality bedrock with the appropriate socket length.

4.5 Pavements

Prior to the placement of pavements the comments and recommendations provided in *Section 4.3 Earthworks* should be carefully followed.

The results of the soaked CBR tests returned values of 11% for the natural soil and 30% for the silty sand fill. These results are relatively high for the sandy soils logged in the boreholes and test pits and may well be due to gravel present in the samples tested that has resulted in an elevated test result. Consequently, for the design of flexible pavements we recommend that a soaked CBR value of not greater than 5% be adopted. For the design of rigid pavements we recommend that a modulus of subgrade reaction (based on a 760mm^2 plate) of 40kPa/mm be adopted. Please note, whilst it appears the proposed car park will be constructed over an area of cut, the designer should be aware that for any pavements constructed over fill areas, the CBR value of the fill that has been placed should be adopted for the pavement design. Furthermore, the level of compaction of the existing fill over the proposed car park footprint appears to be variable and therefore there is some degree of risk constructing pavements over the existing fill. If the recommendations followed in Section 4.3 are followed, this risk would be mitigated to some degree.

The use of a select layer, such as crushed sandstone, could be adopted to reduce the design pavement thickness of the pavement subbase and base materials. Any select material should comprise good quality crushed sandstone with a CBR of at least 10% and should have a thickness of at least 0.3m.

Surface subsoil drainage should be provided on the high side of the pavements to prevent moisture ingress into the subgrade and pavement. The subsoil drains should have an invert level of at least 300mm below the adjacent subgrade level and be excavated with a uniform longitudinal fall to appropriate discharge points so as to reduce the risk of ponding in the base of the drain. In addition, the surface of the adjacent pavement subgrade should be provided with a uniform cross fall towards the subsoil drain to assist with drainage.

Concrete pavements should have a subbase layer of at least 100mm thickness of crushed rock to RMS QA specification 3051 (2013) unbound base material (or similar good quality and durable fine crushed rock), which is compacted to at least 100% of SMDD. Concrete pavements should be designed with an effective shear transmission at all joints by way of either doweled or keyed joints.

4.6 Soil Aggression

Based on soil aggressivity test results, the soils would be classified 'mild' and 'non-aggressive' for concrete and steel piles respectively in accordance with Tables 6.4.2(C) and 6.5.2(C) of AS2159-2009 'Piling – Design and Installation'.

4.7 Earthquake Design Parameters

Based upon AS1170.4-2007 '*Structural Design Actions, Part 4: Earthquake Design Factors in Australia*', the following design parameters may be adopted:

- Hazard Factor (Z) = 0.08
- Sub-Soil Class 'C_e'

4.8 Stability of Creek Bank

The existing western creek bank adjacent to the proposed carpark currently has a maximum height of about 2.8m with the crest of the bank approximately 3.5m from the bed of the creek, which results in an average slope of about 38°. The bank is heavily vegetated with shrubs and mature trees and boulders have been placed along the bank but do not form a continuous retention system over the full height of the bank. Slopes in the order of 38° for unsupported sandy soils are over-steep and if un-vegetated would be of marginal stability. However, in this instance some support to the bank is provided by the sandstone boulders while thick established vegetation also provides support. It is our understanding that although some erosion of the bank may have occurred in places, a number of flood events where water levels have risen close to or to the top of the bank have occurred over the last 10 years and it has performed satisfactorily.

Consequently a number of approaches may be adopted depending on the level of assurance required for the bank. One approach would be to undertake numerical modelling of the bank and design an engineered retention system that would have a design life of 50 or 100 years, whatever is required. The second approach would be to do nothing and regularly monitor the bank on say a yearly or five yearly basis. Provided few changes occur to the bank and access is limited, as is currently the case, then no action need be taken provided ongoing monitoring of the bank is continued.

4.9 Further Work

As part of the detailed design stages of the proposed development, we consider that the following additional geotechnical investigation and input will be required:

- Review of this report once detailed structural drawings are available.
- Completion of proof rolling of the subgrade in the presence of an experienced geotechnical engineer or geotechnician where engineered fill or pavements are to be placed.
- Earthworks testing to confirm that the earthworks specification is complied with.
- Inspections during piling to provide greater confidence that the piles are founded on the appropriate materials.

Given no structural drawings have been issued at the time of writing this report, we recommend a review by a geotechnical engineer after the initial structural design has been completed to confirm that our recommendations have been correctly interpreted and that we have understood the proposed scope of work. It is possible that further advice/input will be required during the structural design stage to address issues that may not have been addressed in this report. We also recommend a meeting at the commencement of construction to discuss the primary geotechnical issues and inspection requirements.

5 GENERAL COMMENTS

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

The long term successful performance of floor slabs and pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience. In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility.

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.

A waste classification is required for any soil and/or bedrock excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), Excavated Natural Material (ENM), General Solid, Restricted Solid or Hazardous Waste. Analysis can take up to seven to ten working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) could be expected. We strongly recommend that this requirement is addressed prior to the commencement of excavation on site.

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

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SOIL TEST SERVICES
ABN 43 002 145 173

TABLE A
MOISTURE CONTENT TEST REPORT

Client: JK Geotechnics
Project: Proposed Carpark
Location: 1078 Oxford Falls Road, Oxford Falls, NSW

Ref No: 30807SY
Report: A
Report Date: 6/12/2019
Page 1 of 1

AS 1289	TEST METHOD	2.1.1
BOREHOLE NUMBER	**DEPTH m**	**MOISTURE CONTENT %**
1	5.50-6.00	9.0
2	5.50-6.00	11.3
3	5.50-6.00	10.5
4	5.50-6.00	10.9
6	5.00-5.50	21.4
8	5.00-5.50	14.9

Notes:

- Report supersedes the previously issued report 30807SY Table A dated 11/10/2017 and 06/12/2019.

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client: JK Geotechnics
Project: Proposed Carpark
Location: 1078 Oxford Falls Road, Oxford Falls, NSW

Ref No: 30807SY
Report: B
Report Date: 23/03/2021
Page 1 of 1

BOREHOLE NUMBER	20	21
DEPTH (m)	0.50 - 1.50	0.20 - 1.00
Surcharge (kg)	4.5	4.5
Maximum Dry Density (t/m^3)	1.78 STD	1.82 STD
Optimum Moisture Content (%)	10.1	12.1
Moulded Dry Density (t/m^3)	1.74	1.78
Sample Density Ratio (%)	98	98
Sample Moisture Ratio (%)	105	104
Moisture Contents		
Insitu (%)	6.8	8.5
Moulded (%)	10.6	12.6
After soaking and After Test, Top 30mm(%)	13.6	14.1
Remaining Depth (%)	13.7	15.4
Material Retained on 19mm Sieve (%)	0	6*
Swell (%)	0.0	0.0
C.B.R. value: @2.5mm penetration	11	30

NOTES: Report supersedes the previously issued report 30807SY Table B dated 11/10/2017. and 06/12/2019.

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods :
  - (a) Soaked C.B.R. : AS 1289 6.1.1
  - (b) Standard Compaction : AS 1289 5.1.1
  - (c) Moisture Content : AS 1289 2.1.1
- Date of receipt of sample: 29/09/2017
- * Denotes not used in test sample

23/03/2021
Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	30807SF2
Project:	Proposed Field of Dreams	**Report:**	C
Location:	1078 Oxford Falls Road, Oxford Falls, NSW	**Report Date:**	16/03/2020
		Page 1 of 2	

BOREHOLE NUMBER	DEPTH m	$I_{S\,(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
201	4.24 - 4.28	0.2	4
	4.75 - 4.80	0.2	4
	5.17 - 5.21	0.2	4
	5.67 - 5.72	0.2	4
	6.12 - 6.16	0.2	4
	6.63 - 6.67	0.4	8
	7.33 - 7.37	0.7	14
	7.77 - 7.81	0.3	6
	8.17 - 8.21	0.8	16
202	5.46 - 5.50	0.6	12
	5.88 - 5.92	0.6	12
	6.27 - 6.30	0.4	8
	6.87 - 6.92	0.3	6
	7.30 - 7.34	0.4	8
	7.80 - 7.85	0.6	12
	8.27 - 8.32	0.6	12
203	4.14 - 4.18	0.2	4
	4.87 - 4.91	0.3	6
	5.22 - 5.27	0.5	10
	5.81 - 5.85	0.9	18
	6.18 - 6.22	0.8	16
	6.75 - 6.79	1.4	28
	7.22 - 7.27	1.6	32
	7.75 - 7.79	1.4	28
	8.21 - 8.26	1.2	24

NOTES: See Page 2 of 2

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SOIL TEST SERVICES

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	30807SF2
Project:	Proposed Field of Dreams	**Report:**	C
Location:	1078 Oxford Falls Road, Oxford Falls, NSW	**Report Date:**	16/03/2020
		Page 2 of 2	

BOREHOLE NUMBER	DEPTH m	$I_{S\ (50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
204	5.00 - 5.04	0.4	8
	5.48 - 5.52	0.2	4
	6.06 - 6.10	0.6	12
	6.63 - 6.67	0.7	14
	7.08 - 7.12	0.7	14
	7.70 - 7.75	1.2	24
205	5.79 - 5.83	0.9	18
	6.29 - 6.34	0.8	16
	6.79 - 6.83	0.8	16
	7.29 - 7.34	0.7	14
	7.79 - 7.83	1.0	20
	8.28 - 8.32	1.0	20
	8.63 - 8.68	0.9	18

NOTES:

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

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CERTIFICATE OF ANALYSIS 176558

Client Details

Client	JK Geotechnics
Attention	Tom Clent
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**30807SY, Oxford Falls**
Number of Samples	3 Soil
Date samples received	27/09/2017
Date completed instructions received	27/09/2017

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	05/10/2017
Date of Issue	29/09/2017

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Report Comments

Sulphate
Percent recovery not available due to matrix interference, however an acceptable recovery was achieved for the LCS.

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

David

David Springer, General Manager

Client Reference: 30807SY, Oxford Falls

Misc Inorg - Soil				
Our Reference	UNITS	176558-1	176558-2	176558-3
Your Reference		BH6	BH12	BH3
Depth		1.5-1.95	3.0-3.45	3.0-3.32
Date Sampled		25/09/2017	26/09/2017	25/09/2017
Type of sample		Soil	Soil	Soil
Date prepared	-	28/09/2017	28/09/2017	28/09/2017
Date analysed	-	28/09/2017	28/09/2017	28/09/2017
pH 1:5 soil:water	pH Units	6.5	5.7	5.9
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	55	<10
Resistivity in soil*	ohm m	530	230	500

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.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	176558-2
Date prepared	-			28/09/2017	1	28/09/2017	28/09/2017		28/09/2017	28/09/2017
Date analysed	-			28/09/2017	1	28/09/2017	28/09/2017		28/09/2017	28/09/2017
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	6.5	6.5	0	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	98	97
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	102	#
Resistivity in soil*	ohm m	1	Inorg-002	<1	1	530	550	4	[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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

BOREHOLE LOG

Borehole No.
1
1/1

E 337534
N 6265349

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 74.2m
Date: 25-9-17
Datum: AHD
Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0		FILL: Silty sand, fine to medium grained, brown, with nedium to coarse grained sandstone gravel and cobbles, trace of roots, bricks, metal and plastic fragments.	M			GRASS COVER
				■	N > 10 2,10/50mm REFUSAL							MODERATE TO HIGH 'TC' BIT RESISTANCE
	■					1						
								FILL: Sand, fine to medium grained, orange brown and dark grey, with fine to coarse grained sandstone gravel.				SOIL RESISTANCE APPEARS MODERATELY COMPACTED
							SC	CLAYEY SAND: fine to medium grained, grey and orange brown.	M	(L)		ALLUVIAL
	■					2						
								CLAYEY SAND: fine to coarse grained, grey and dark grey.		L		
	■				N = 9 3,5,4	3						
						4						
AFTER 1 HR ▼ ▶	■			■	N > 30 9,20, 10/50mm REFUSAL							
							-	SANDSTONE: fine to coarse grained, grey.	XW	EL		LOW RESISTANCE
▶						5			DW	M		MODERATE TO HIGH RESISTANCE
				■								
						6		END OF BOREHOLE AT 6.0m				
						7						

BOREHOLE LOG

Borehole No.
2
1/1

E 337534
N 6265380

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 74.2m

Date: 25-9-17
Datum: AHD

Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0			FILL: Silty sand, fine to medium grained, dark brown.	M			GRASS COVER
	■			■	N = 25 8,10,15	1			FILL: Sand, fine to coarse grained, dark brown, grey and orange brown, with clay and fine to medium grained sandstone gravel.				APPEARS WELL COMPACTED
	■			■	N = 5 3,2,3	2							APPEARS POORLY COMPACTED
AFTER 1 HR ▼	■							CL	SANDY CLAY: medium plasticity, brown.	MC≈PL	(F)		ALLUVIAL
▶				■	N = 14 5,7,7	3 4		SP	SAND: fine to coarse grained, grey and orange brown, with clay.	M	MD		
				■	N > 25 8,15, 10/50mm REFUSAL			-	SANDSTONE: fine to coarse grained, grey and dark grey.	XW	EL		
						5				DW	M		MODERATE TO HIGH 'TC' BIT RESISTANCE
				■					SANDSTONE: fine to medium grained, grey.				HIGH RESISTANCE
						6 7			END OF BOREHOLE AT 6.0m				

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BOREHOLE LOG

Borehole No.
3
1/1

E 33753
N 6265408

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 73.7m

Date: 25-9-17
Datum: AHD

Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0			FILL: Silty sand, fine to coarse grained, brown, with root fibres.	M			GRASS COVER
	■			■	N = 4 2,2,2	1			FILL: Sandy clay, medium plasticity, red brown, fine to medium grained sand, trace of fine to coarse grained sandstone gravel, cobbles and boulders.	MC≈PL			APPEARS POORLY COMPACTED
	■			■	N = 23 3,8,15				FILL: Silty sand, fine to medium grained, orange brown, grey and brown, with fine to coarse grained sandstone gravel, cobbles and boulders, trace of brick.	M			APPEARS WELL COMPACTED
						2		SC	CLAYEY SAND: fine to coarse grained, grey.	M	MD		ALLUVIAL ORGANIC ODOUR
AFTER 1 HR ▼	■			■	N > 16 1,5,11/ 20mm REFUSAL	3							
				■		4		-	SANDSTONE: fine to medium grained, orange brown and grey.	DW	VL-L		LOW 'TC' BIT RESISTANCE
						5			SANDSTONE: fine to coarse grained, grey.		L-M		MODERATE RESISTANCE
				■							M		MODERATE TO HIGH RESISTANCE
						6 7			END OF BOREHOLE AT 6.0m				

BOREHOLE LOG

Borehole No.
4
1/1

E 337513
N 6265402

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 74.0m

Date: 25-9-17
Datum: AHD

Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0			FILL: Silty sand, fine to medium grained, brown and orange brown, trace of medium to coarse grained sandstone gravel, cobbles and boulders.	M			GRASS COVER
	■			■	N = 10 6,6,4				FILL: Sandy clay, medium plasticity, light brown mottled red and yellow brown, with medium to coarse grained sandstone gravel.				APPEARS WELL COMPACTED
						1		SC	CLAYEY SAND: fine to medium grained, grey mottled dark grey and orange brown.	M	L		ALLUVIAL
	■			■	N = 8 3,4,4								
						2							
	■			■	N = 14 3,5,9	3					MD		
AFTER 1 HR						4		SP	SAND: fine to coarse grained, orange brown, with medium grained, sub rounded to sub angular quartz gravel.	W			
	■			■	N > 17 6,7,10/ 20mm REFUSAL								
						5							
				■				-	SANDSTONE: fine to coarse grained, grey and orange brown.	DW	L-M		LOW TO MODERATE 'TC' BIT RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

JKGeotechnics

BOREHOLE LOG

Borehole No.
5
1/1

E 337510
N 6265456

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY

Method: SPIRAL AUGER
JK350

R.L. Surface: 73.6m

Date: 25-9-17

Datum: AHD

Plant Type:

Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0	▨		FILL: Silty sand, fine to medium grained, brown, with root fibres, trace of medium to coarse grained sandstone gravel.	D			GRASS COVER
	■			■	N > 10 10/20mm REFUSAL		▨		FILL: Silty sand, fine to medium grained, orange brown, with fine to coarse grained sandstone gravel, cobbles and boulders.	M			APPEARS POORLY TO MODERATELY COMPACTED
						1	▨						
				■	N = 6 2,3,3		▨						
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

JKGeotechnics

BOREHOLE LOG

Borehole No.
6
1/1

E 337518
N 6265448

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 73.6m

Date: 25-9-17
Datum: AHD

Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		0		FILL: Silty sand, fine to coarse grained, brown, trace of fine to medium grained sandstone gravel.	M			GRASS COVER
				FILL: Sandstone boulder	-			HIGH 'TC' BIT RESISTANCE
	N = 15 4,11,4	1 2		FILL: Silty sand, fine to coarse grained, brown, orange brown and grey, with fine to medium grained sandstone gravel, trace of timber and plastic fragments.	M			SOIL RESISTANCE APPEARS MODERATELY COMPACTED
ON COMPLETION	N = 6 3,3,3	3		FILL: Sand, fine to coarse grained, dark grey and orange brown, with string fibrefragments.				APPEARS POORLY COMPACTED
		4	SC	CLAYEY SAND: fine to coarse grained, grey.	M-W	(MD)		ALLUVIAL
	N = SPT 20/70mm REFUSAL		-	SANDSTONE: fine to coarse grained, grey.	DW	VL-L		LOW 'TC' BIT RESISTANCE
		5				M-H		HIGH RESISTANCE
		6 7		END OF BOREHOLE AT 5.6m				'TC' BIT REFUSAL

JKGeotechnics

BOREHOLE LOG

Borehole No.
7
1/1

E 337443
N 6265377

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 76.1m
Date: 25-9-17
Datum: AHD
Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0			FILL: Silty sand, fine to medium grained, brown, with root fibres.	M			GRASS COVER
								SP	SAND: fine to coarse grained, orange brown, with clay.	M	MD		ALLUVIAL
	■			■	N = 12 4,6,6								
						1							
	■			■	N = 14 3,6,8								
						2							
								SC	CLAYEY SAND: fine to coarse grained, grey, orange brown and red brown.				
	■			■	N = 17 7,7,10	3							
						4							
				■	N = 23 10,10,15			-	SANDSTONE: fine to coarse grained, grey, orange brown and red brown.	XW	EL		
						5			END OF BOREHOLE AT 4.95m				
						6							
						7							

JKGeotechnics

BOREHOLE LOG

Borehole No.
8
1/1

E 337503
N 6265355

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY

Method: SPIRAL AUGER JK350

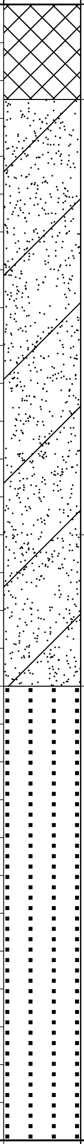
R.L. Surface: 74.3m

Date: 26-9-17

Datum: AHD

Plant Type:

Logged/Checked by: T.C./W.T.



Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0		FILL: Silty sand, fine to medium grained, brown, yellow brown mottled red and light brown, with medium to coarse grained sandstone gravel and cobbles.	M			GRASS COVER
	■			■	N = 14 5,7,7		SC	CLAYEY SAND: fine to coarse grained, grey.	M	MD		ALLUVIAL
						1						
	■			■	N = 14 5,6,8							
						2						
							SC	CLAYEY SAND: fine to coarse grained, grey and orange brown.				
AFTER 1 HR ▼				■	N = 21 10,11,10	3						
							-	SANDSTONE: fine to coarse grained, grey.	DW	L-M		LOW 'TC' BIT RESISTANCE
						4						
				■		5				M		MODERATE TO HIGH RESISTANCE
						6		END OF BOREHOLE AT 6.0m				
						7						

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BOREHOLE LOG

Borehole No.
9
1/1

E 337457
N 6265456

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 73.6m

Date: 26-9-17
Datum: AHD

Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0			FILL: Silty sand, fine to medium grained, brown, with fine to coarse grained sandstone gravel.	M			GRASS COVER
								SC	CLAYEY SAND: fine to medium grained, orange brown.	M	L		ALLUVIAL
	■			■	N = 7 4,4,3								
						1							
									CLAYEY SAND: fine to coarse grained, grey and orange brown, trace of ironstone gravel.				
	■			■	N = 7 3,4,3								
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

JKGeotechnics

BOREHOLE LOG

Borehole No.
10
1/1

E 337478
N 6265347

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 75.8m
Date: 26-9-17
Datum: AHD
Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0		FILL: Silty sand, fine to coarse grained, brown, with roots.	D			GRASS COVER
							SP	SAND: fine to coarse grained, orange brown, with clay.	M	L		ALLUVIAL
	■			■	N = 9 3,4,5							
						1						
							SC	CLAYEY SAND: fine to coarse grained, orange brown and grey.		MD		
				■	N = 10 3,4,6							
						2						
							SP	SAND: fine to coarse grained, grey, orange brown and red brown.				
						3						
				■	N = 17 7,8,9							
						4	-	SANDSTONE: fine to coarse grained, orange brown.	XW-DW	EL-VL		VERY LOW TO LOW 'TC' BIT RESISTANCE
								END OF BOREHOLE AT 4.5m				
						5						
						6						
						7						

JKGeotechnics

BOREHOLE LOG

Borehole No.
11
1/1

E 337442
N 6265352

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY

Method: SPIRAL AUGER
JK350

R.L. Surface: 77.0m

Date: 26-9-17

Datum: AHD

Plant Type:

Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS								
	■					0		FILL: Silty sand, fine to medium grained, brown, with roots.	D			GRASS COVER
							SC	CLAYEY SAND: fine to coarse grained, orange brown.	M	MD		ALLUVIAL
	■			■	N = 10 4,4,6							
						1						
								CLAYEY SAND: fine to coarse grained, orange brown and red brown.				
				■	N = 14 5,6,8							
						2						
							SP	SAND: fine to coarse grained, red brown and grey.				
▶ AFTER 1 HR ▼				■	N = 20 5,6,14	3						
				■		4		SAND: fine to coarse grained, red brown, with clay.	W	(MD)		
							-	SANDSTONE: fine to coarse grained, orange brown, grey and red brown.	XW	EL		VERY LOW TO LOW 'TC' BIT RESISTANCE
						5						
									DW	L		LOW RESISTANCE
								END OF BOREHOLE AT 5.5m				
						6						
						7						

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BOREHOLE LOG

Borehole No.
12
1/1

E 337510
N 6265378

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 74.3m

Date: 26-9-17
Datum: AHD

Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0			FILL: Silty sand, fine to medium grained, brown, with roots.	M			GRASS COVER
	■			■	N = 30 6,20,10				FILL: Sand, fine to coarse grained, orange brown and grey, with clay, trace of fine grained sandstone gravel.				APPEARS WELL COMPACTED
				■	N = 9 3,4,5	1		SP	SAND: fine to coarse grained, grey and dark grey, trace of clay.	M	L		ALLUVIAL
AFTER 1 HR ▼				■	N = 7 2,3,4	2		CL	SANDY CLAY: medium plasticity, grey, fine to coarse grained sand.	MC≈PL	VSt	300 350	
▶				■	N = 25 6,7,18	4		-	SANDSTONE: fine to coarse grained, orange brown and grey.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

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BOREHOLE LOG

Borehole No.
13
1/1

E 337501
N 6265426

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY

Method: SPIRAL AUGER
JK350

R.L. Surface: 74.0m

Date: 26-9-17

Datum: AHD

Plant Type:

Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0	▨		FILL: Silty sand, fine to coarse grained, brown, with roots.	M			GRASS COVER
	■				N > 13 8,13/10mm REFUSAL		▨		FILL: Sand, fine to coarse grained, orange brown and dark grey, with clay.				APPEARS MODERATELY COMPACTED
						1	▨						
				■	N = 13 7,6,7		▨		FILL: Sand, fine to coarse grained, red brown and dark grey, with medium grained sandstone gravel.				
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
14
1/1

E 337480
N 6265454

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 73.8m
Date: 26-9-17
Datum: AHD
Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0	▨		FILL: Silty sand, fine to coarse grained, brown, with root fibres.	D			GRASS COVER
							▨		FILL: Sand, fine to coarse grained, grey and brown, with medium to coarse grained sandstone gravel.	M			APPEARS MODERATELY COMPACTED
	■			■	N = 10 2,2,8		▨						
						1	▨		as above, but with polystyrene fragments.				
				■	N = 14 6,7,7		▨						
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
15
1/1

E 337451
N 6265425

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER JK350
R.L. Surface: 74.0m

Date: 26-9-17
Datum: AHD

Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
	■					0			FILL: Silty sand, fine to coarse grained, brown, with roots.	M			GRASS COVER
								SP	SAND: fine to coarse grained, orange brown, trace of clay.	M	L		ALLUVIAL
				■	N = 8 3,4,4								
						1		SC	CLAYEY SAND: fine to coarse grained, orange brown and grey.				
				■	N = 10 3,4,6						MD		
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

BOREHOLE LOG

Borehole No.
16
1/1

E 337451
N 6265433

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY **Method:** SPIRAL AUGER JK350 **R.L. Surface:** 73.7m

Date: 26-9-17 **Datum:** AHD

Plant Type: **Logged/Checked by:** T.C./W.T.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0	▩		FILL: Silty sand, fine to coarse grained, brown, with roots.	M			GRASS COVER
				■	N = 8 3,4,4	1	▨	SC	CLAYEY SAND: fine to coarse grained, orange brown.	M	L		ALLUVIAL
				■	N = 14 5,6,8		▨		CLAYEY SAND: fine to coarse grained, orange brown and grey.		MD		
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
17
1/1

E 337449
N 6265404

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY

Method: SPIRAL AUGER JK350

R.L. Surface: 74.4m

Date: 26-9-17

Datum: AHD

Plant Type:

Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
	■					0			FILL: Silty sand, fine to coarse grained, brown, with root fibres.	M			GRASS COVER
								SP	SAND: fine to coarse grained, dark brown, with clay.	M	L		ALLUVIAL
				■	N = 7 3,3,4								
						1							
								SC	CLAYEY SAND: fine to coarse grained, red brown and grey.		MD		
				■	N = 20 4,10,10								
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
18
1/1

E 337482
N 6265396

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY

Method: SPIRAL AUGER
JK350

R.L. Surface: 74.1m

Date: 26-9-17

Datum: AHD

Plant Type:

Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0	▨		FILL: Silty sand, fine to coarse grained, brown, with root fibres.	M			GRASS COVER
							▨		FILL: Clayey sand, fine to coarse grained, orange brown.				APPEARS WELL COMPACTED
				■	N = 17 20,11,6		▨						
						1	▨						
							▨		FILL: Clayey sand, fine to coarse grained, grey and brown, timber and plastic fragments.	W			
	■			■	N = 1 0,0,1		▨						APPEARS POORLY COMPACTED
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
19
1/1

E 337480
N 6265371

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY

Method: SPIRAL AUGER JK350

R.L. Surface: 74.2m

Date: 26-9-17

Datum: AHD

Plant Type:

Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■					0			FILL: Silty sand, fine to coarse grained, brown, with root fibres.	M			GRASS COVER
								SC	CLAYEY SAND: fine to coarse grained, orange brown and grey.	M	MD		ALLUVIAL
	■			■	N = 10 8,6,4								
						1							
									CLAYEY SAND: fine to coarse grained, orange brown and grey.				
				■	N = 10 5,4,6								
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
20
1/1

E 337509
N 6565341

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY

Method: SPIRAL AUGER JK350

R.L. Surface: 74.6m

Date: 26-9-17

Datum: AHD

Plant Type:

Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty sand, fine to coarse grained, brown, with roots.	M			GRASS COVER
								SM	SILTY SAND: fine to coarse grained, brown and orange brown, with clay.	M	L		ALLUVIAL
					N = 13 6,8,5								
						1							
						2			END OF BOREHOLE AT 1.95m				
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
21
1/1

E 337554
N 6265336

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: SPIRAL AUGER
JK350
R.L. Surface: 73.5m

Date: 26-9-17
Datum: AHD

Plant Type:
Logged/Checked by: T.C./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			■			0	▨		FILL: Silty sand, fine to coarse grained, brown and orange brown, with fine to medium grained sandstone gravel, trace of clay.	M			GRASS COVER
				■	N = 6 4,4,2		░	SC	CLAYEY SAND: fine to coarse grained, orange brown and grey.	M	L		ALLUVIAL
						2			END OF BOREHOLE AT 1.95m				

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7

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TEST PIT LOG

Test Pit No.
101
1/1

E 337534
N 6265349

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: BACKHOE
R.L. Surface: 74.2m

Date: 26-9-17
Datum: AHD

Plant Type:
Logged/Checked by: M.S./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0	▨		FILL: Silty sand, fine to medium grained, brown, with medium to coarse grained sandstone gravel and cobbles to boulder size sandstone, trace of whole bricks and roots, metal and plastic fragments.	M			GRASS COVER PLASTIC AND TIMBER
						1	▨		FILL: Sand, fine to medium grained, orange brown, trace of fine to coarse grained sandstone gravel.				
							▨		as above, but dark grey.				
							░	SC	CLAYEY SAND: fine to medium grained, grey and brown.	M			ALLUVIAL
						2	░		as above, but brown.				
									END OF TEST PIT AT 2.3m				
						3							
						4							
						5							
						6							
						7							

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TEST PIT LOG

Test Pit No.
102
1/1

E 337534
N 6265408

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY **Method:** BACKHOE **R.L. Surface:** 73.7m

Date: 26-9-17 **Datum:** AHD

Plant Type: **Logged/Checked by:** M.S./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty sand, fine to medium grained, brown, with root fibres.	M			GRASS COVER
									FILL: Sandy clay, low to medium plasticity, red brown, fine to medium grained sand, trace of fine to coarse grained sandstone gravel, cobbles and boulders.	MC<PL			
						1			FILL: Silty sand, fine to medium grained, orange brown and brown, with fine to coarse grained sandstone gravel, cobbles and boulders, trace of half and whole bricks and clay.				RUBBER TYRE
ON COMPLETION ▼						2		SC	CLAYEY SAND: fine to medium grained, dark grey, trace of root fibres.	M			ALLUVIAL
									as above, but orange brown and grey.	W			
						3			END OF TEST PIT AT 2.8m				
						4							
						5							
						6							
						7							

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TEST PIT LOG

Test Pit No.
103
1/1

E 337513
N 6265402

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY **Method:** BACKHOE **R.L. Surface:** 74.0m

Date: 26-9-17 **Datum:** AHD

Plant Type: **Logged/Checked by:** M.S./W.T.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
						0	▨		FILL: Silty sand, fine to medium grained, brown, trace of medium to coarse grained sandstone gravel, cobbles and boulders.	M			GRASS COVER
							▨		FILL: Sandy clay, medium plasticity, light brown mottled red and yellow brown, with medium to coarse grained sandstone gravel.				
						1	░	SC	CLAYEY SAND: fine to medium grained, grey mottled dark grey and orange brown.	M			ALLUVIAL
									END OF TEST PIT AT 1.7m				
						2							
						3							
						4							
						5							
						6							
						7							

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TEST PIT LOG

Test Pit No.
104
1/1

E 337503
N 6265355

Client: OXFORD FALLS GRAMMAR SCHOOL

Project: PROPOSED CARPARK

Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: BACKHOE
R.L. Surface: 74.3m

Date: 26-9-17
Datum: AHD

Plant Type:
Logged/Checked by: M.S./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0	▩		FILL: Silty sand, fine to medium grained, brown.	M			GRASS COVER
							▩		as above, but yellow brown mottled red and light brown, with medium to coarse grained sandstone gravel and cobbles.				
							░	SC	CLAYEY SAND: fine to medium grained, orange brown mottled yellow and red brown.	M			ALLUVIAL
						1	░		as above, but grey mottled orange and red brown.				
									END OF TEST PIT AT 1.3m				
						2							
						3							
						4							
						5							
						6							
						7							

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TEST PIT LOG

Test Pit No.
105
1/1

E 337510
N 6265456

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY **Method:** BACKHOE **R.L. Surface:** 73.6m
Date: 26-9-17 **Datum:** AHD
Plant Type: **Logged/Checked by:** M.S./W.T.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
						0	▨		FILL: Silty sand, fine to medium grained, brown, with root fibres, trace of medium to coarse grained sandstone gravel.	M			GRASS COVER
							▨		FILL: Silty sand, fine to medium grained, orange brown, with fine to coarse grained sandstone gravel, cobbles and boulders.				
						1	▨						
						2			END OF TEST PIT AT 2.0m				
						3							
						4							
						5							
						6							
						7							

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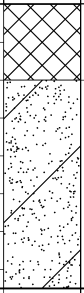
TEST PIT LOG

Test Pit No.
106
1/1
E 337457
N 6265456

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SY
Method: BACKHOE
R.L. Surface: 73.6m
Date: 26-9-17
Datum: AHD
Plant Type:
Logged/Checked by: M.S./W.T.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty sand, fine to medium grained, brown, with fine to coarse grained sandstone gravel.	M			GRASS COVER
								SC	CLAYEY SAND: fine to medium grained, orange brown.	M			ALLUVIAL
						1							
									as above, but light brown.				
									END OF TEST PIT AT 1.5m				
						2							
						3							
						4							
						5							
						6							
						7							

BOREHOLE LOG

Borehole No.
201

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2 **Method:** SPIRAL AUGER **R.L. Surface:** ~73.8 m
Date: 13/3/20 **Datum:** AHD
Plant Type: HANJIN D&B8 **Logged/Checked By:** B.Z./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
						73	1	▨		FILL: Silty sand, fine to coarse grained, dark brown, with clayey sand nodules, and fine to medium grained sandstone gravel.	M	L		GRASS COVER
						72	2	▨	SC	Clayey SAND: fine to medium grained, brown, fine to medium plasticity clay.	M	(L)		ALLUVIAL RELATIVE DENSITY ESTIMATION BASED ON NEARBY BOREHOLES DRILLED IN 2017
▶						71	3	▨	SM	Silty SAND: fine to medium grained, dark grey.	W			ORGANIC ODOUR
						70		▨	-	Extremely Weathered sandstone: clayey SAND, fine to coarse grained, brown and grey, medium plasticity clay.	XW	(D)		HAWKESBURY SANDSTONE VERY LOW 'TC' BIT RESISTANCE
						69 68 67	4 5 6			REFER TO CORED BOREHOLE LOG				

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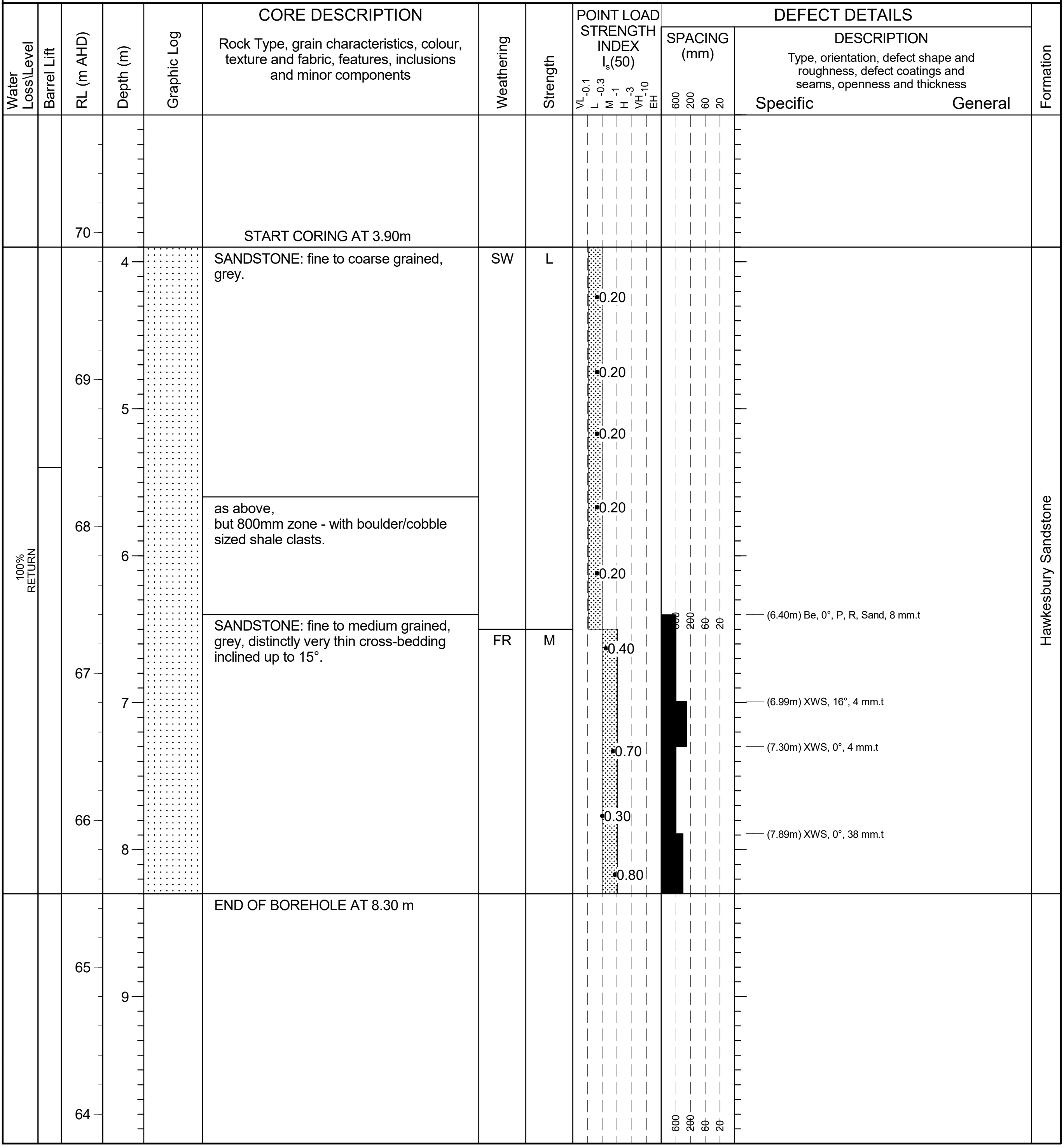
CORED BOREHOLE LOG

Borehole No.
201
2 / 2

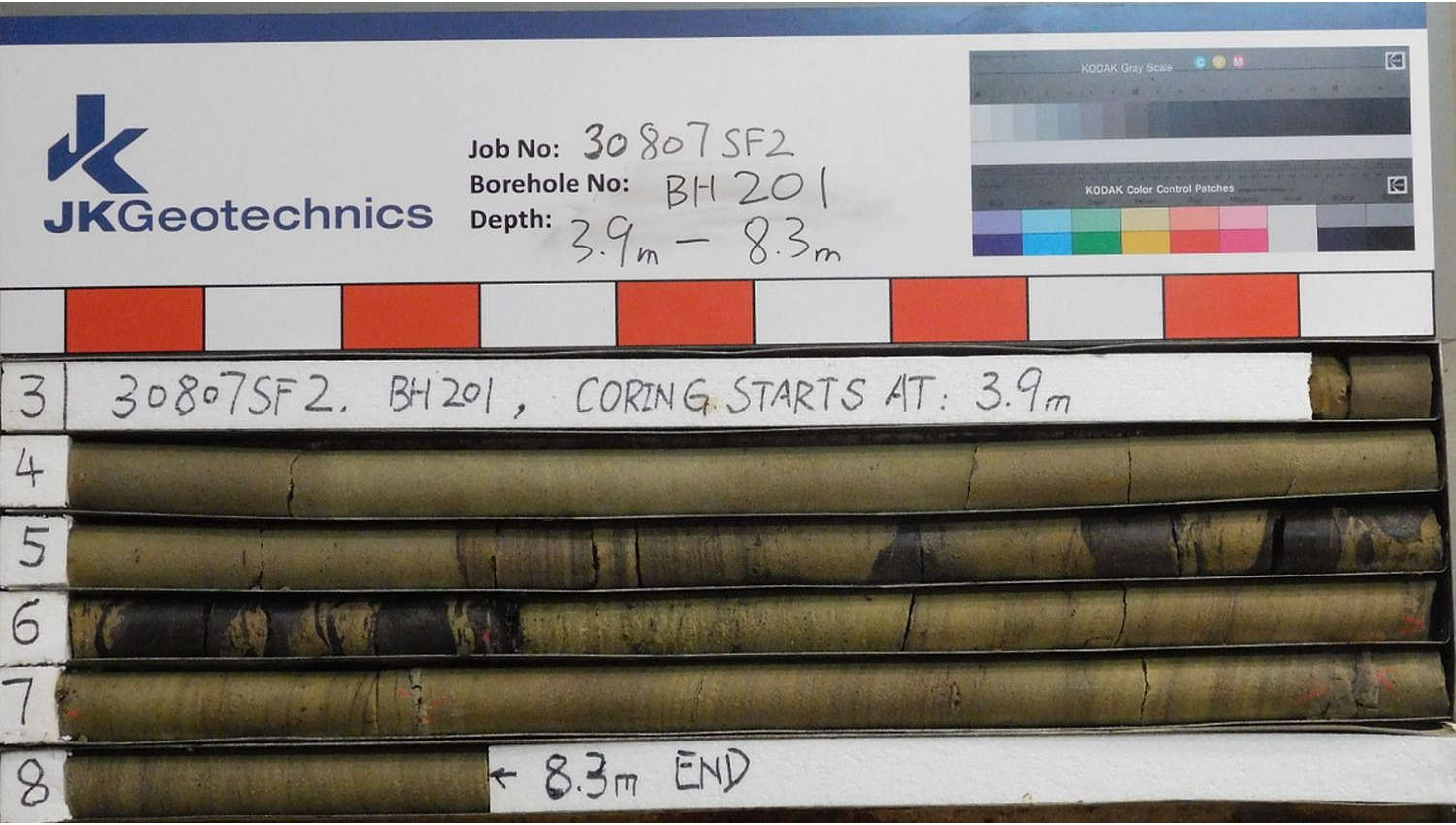
Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2 **Core Size:** NMLC **R.L. Surface:** ~73.8 m
Date: 13/3/20 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: HANJIN D&B8 **Bearing:** N/A **Logged/Checked By:** B.Z./O.F.



Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS – DESCRIPTION: Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness (Specific / General)	Formation
		70			START CORING AT 3.90m					
100% RETURN		69	4 5		SANDSTONE: fine to coarse grained, grey.	SW	L	0.20 0.20 0.20		Hawkesbury Sandstone
		68	6		as above, but 800mm zone - with boulder/cobble sized shale clasts.			0.20 0.20		
		67 66	7 8		SANDSTONE: fine to medium grained, grey, distinctly very thin cross-bedding inclined up to 15°.	FR	M	0.40 0.70 0.30 0.80	(6.40m) Be, 0°, P, R, Sand, 8 mm.t (6.99m) XWS, 16°, 4 mm.t (7.30m) XWS, 0°, 4 mm.t (7.89m) XWS, 0°, 38 mm.t	
		65 64	9		END OF BOREHOLE AT 8.30 m					

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS



Job No: 30807SF2

Borehole No: BH201

Depth: 3.9m – 8.3m

BOREHOLE LOG

Borehole No.
202
1 / 2

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2
Method: SPIRAL AUGER
R.L. Surface: ~74.0 m
Date: 13/3/20
Datum: AHD
Plant Type: HANJIN D&B8
Logged/Checked By: B.Z./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
										FILL: Silty sand, fine to coarse grained, dark brown, with clay nodules, and fine to coarse grained sandstone gravel.	M			GRASS COVER
									SC	Clayey SAND: fine to medium grained, red brown, with medium plasticity clay.	M	(L)		ALLUVIAL RELATIVE DENSITY ESTIMATION BASED ON NEARBY BOREHOLES DRILLED IN 2017
						73	1							
						72	2							
										as above, but brown.				
						71	3							
▶						70	4		SM	Silty SAND: fine to medium grained, dark brown and dark grey.	W	(L)		
									-	Extremely Weathered sandstone: clayey SAND, fine to medium grained, light brown and grey, medium plasticity clay.	XW	(D)		HAWKESBURY SANDTONE VERY LOW 'TC' BIT RESISTANCE
						69	5			REFER TO CORED BOREHOLE LOG				MODERATE TO HIGH 'TC' BIT RESISTANCE
						68	6							

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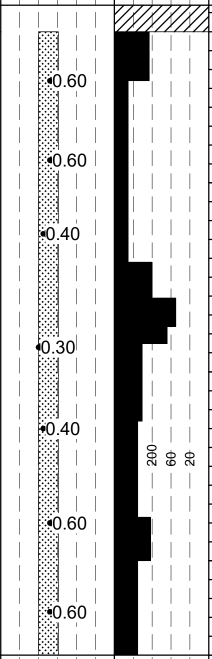
CORED BOREHOLE LOG

Borehole No.
202
2 / 2

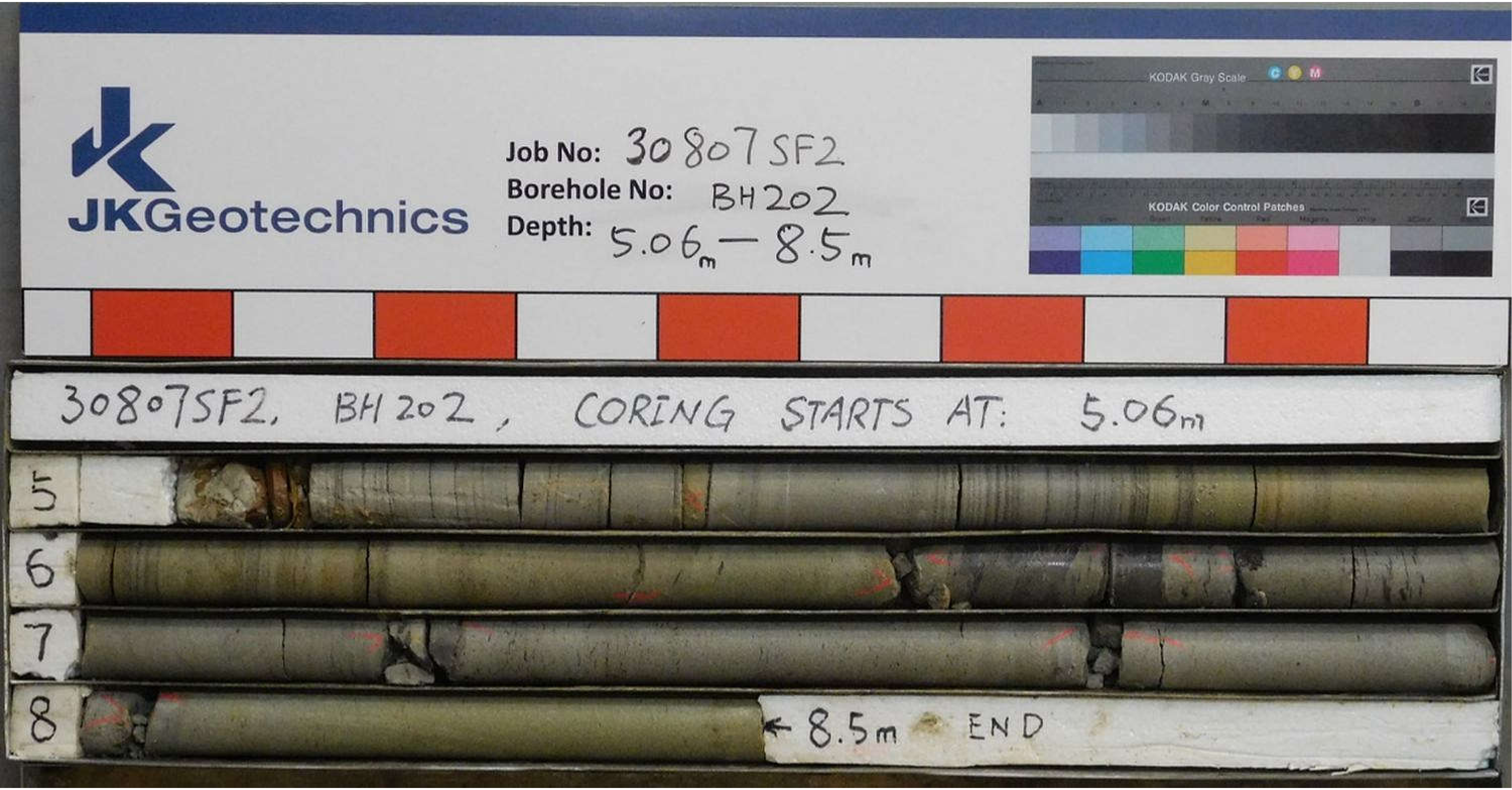
Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2	**Core Size:** NMLC	**R.L. Surface:** ~74.0 m
Date: 13/3/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: HANJIN D&B8	**Bearing:** N/A	**Logged/Checked By:** B.Z./O.F.



Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness — Specific	General	Formation
		69	5		START CORING AT 5.06m						
100% RETURN					Extremely Weathered sandstone: clayey SAND, fine to medium grained, light brown, with medium plasticity clay.	XW	VSt				Hawkesbury Sandstone
					SANDSTONE: fine to medium grained, grey, banded with indistinctly very thin cross-bedding.	SW	M	0.60	(5.46m) Be, 0°, P, R, Sand Ct		
		68	6					0.60			
								0.40	(6.42m) J, 34°, P, R, Cn		
									(6.61m) J x 2, 30 - 60°, C, R, Cn		
									(6.76m) XWS, 0°, 2 mm.t		
								0.30	(6.85m) XWS, 0°, 5 mm.t		
		67	7			FR		0.40	(7.26m) XWS, 0°, 38 mm.t		
								0.60	(7.77m) Be, 0°, Un, R, Sand, 3 mm.t		
		66	8						(8.00m) XWS, 18°, 2 mm.t		
								0.60	(8.03m) XWS, 0°, 12 mm.t		
					END OF BOREHOLE AT 8.50 m						
		65	9								
		64	10								

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS



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Job No: 30807SF2

Borehole No: BH202

Depth: 5.06m – 8.5m

30807SF2, BH202, CORING STARTS AT: 5.06m

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BOREHOLE LOG

Borehole No.
203
1 / 2

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2 **Method:** SPIRAL AUGER **R.L. Surface:** ~74.1 m
Date: 13/3/20 **Datum:** AHD
Plant Type: HANJIN D&B8 **Logged/Checked By:** B.Z./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
						74				FILL: Silty sand, fine to medium grained, dark brown.	M			GRASS COVER
										FILL: Sandy clay, medium plasticity, red brown, fine to coarse grained sand.	w>PL			
						73	1							
						72	2							
									SC	Clayey SAND: fine to coarse grained, brown, with medium plasticity clay.	M	(L)		ALLUVIAL RELATIVE DENSITY ESTIMATION BASED ON NEARBY BOREHOLES DRILLED IN 2017
▶									SP	SAND: fine to coarse grained, dark brown.	W	(D)		
						71	3							
									-	Extremely Weathered sandstone: clayey SAND, fine to coarse grained, light brown, with medium plasticity clay.	XW			HAWKESBURY SANDSTONE
										REFER TO CORED BOREHOLE LOG				VERY LOW 'TC' BIT RESISTANCE
						70	4							
						69	5							
						68	6							

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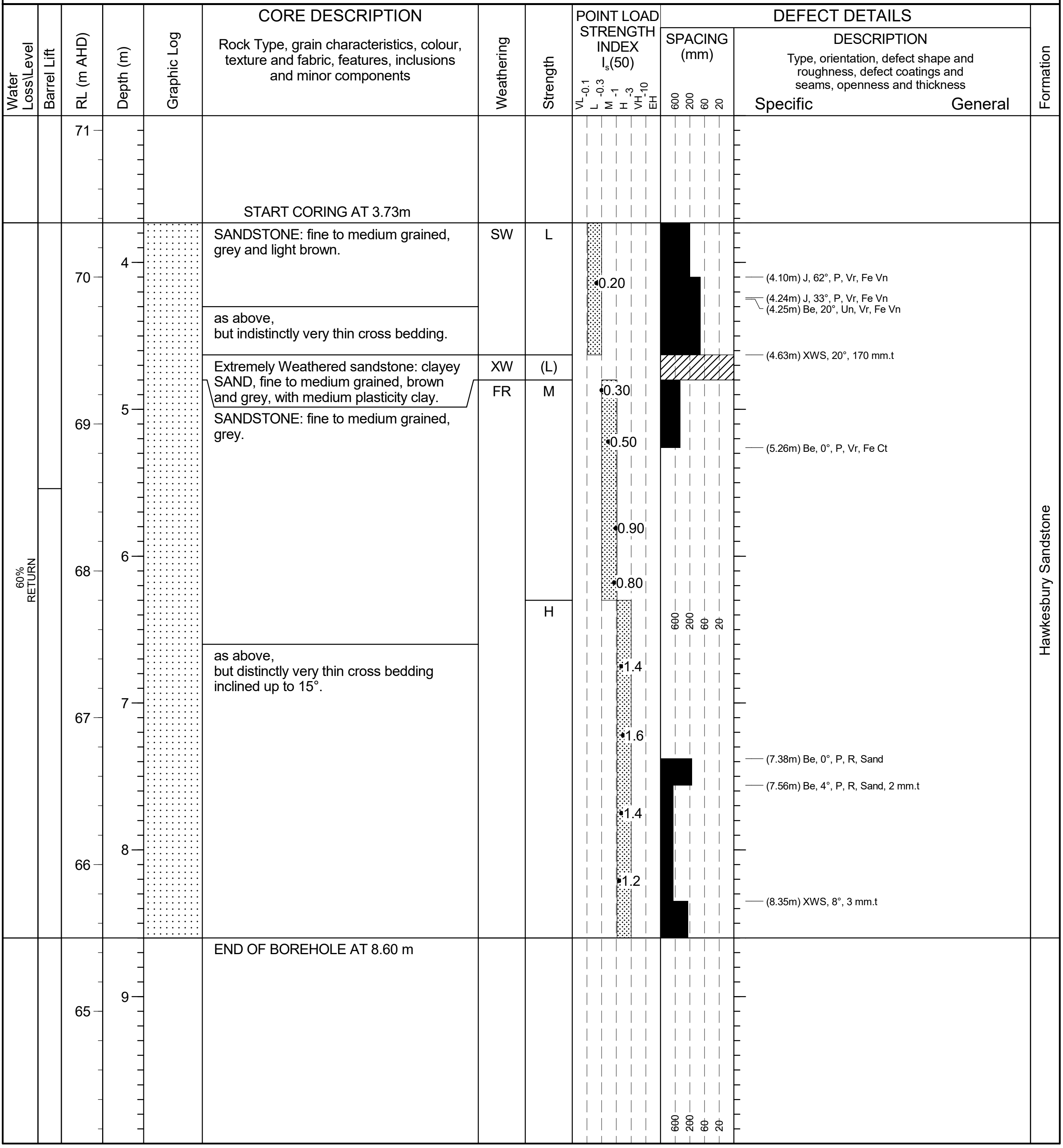
CORED BOREHOLE LOG

Borehole No.
203
2 / 2

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2
Core Size: NMLC
R.L. Surface: ~74.1 m
Date: 13/3/20
Inclination: VERTICAL
Datum: AHD
Plant Type: HANJIN D&B8
Bearing: N/A
Logged/Checked By: B.Z./O.F.



Water Loss\Level	Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS – DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness – Specific	Formation
	3.73	START CORING AT 3.73m					
60% RETURN		SANDSTONE: fine to medium grained, grey and light brown.	SW	L	0.20	(4.10m) J, 62°, P, Vr, Fe Vn (4.24m) J, 33°, P, Vr, Fe Vn (4.25m) Be, 20°, Un, Vr, Fe Vn	Hawkesbury Sandstone
		as above, but indistinctly very thin cross bedding.					
		Extremely Weathered sandstone: clayey SAND, fine to medium grained, brown and grey, with medium plasticity clay.	XW	(L)		(4.63m) XWS, 20°, 170 mm.t	
		SANDSTONE: fine to medium grained, grey.	FR	M	0.30 0.50 0.90 0.80	(5.26m) Be, 0°, P, Vr, Fe Ct	
				H	1.4		
		as above, but distinctly very thin cross bedding inclined up to 15°.			1.6 1.4 1.2	(7.38m) Be, 0°, P, R, Sand (7.56m) Be, 4°, P, R, Sand, 2 mm.t (8.35m) XWS, 8°, 3 mm.t	
	8.60	END OF BOREHOLE AT 8.60 m					

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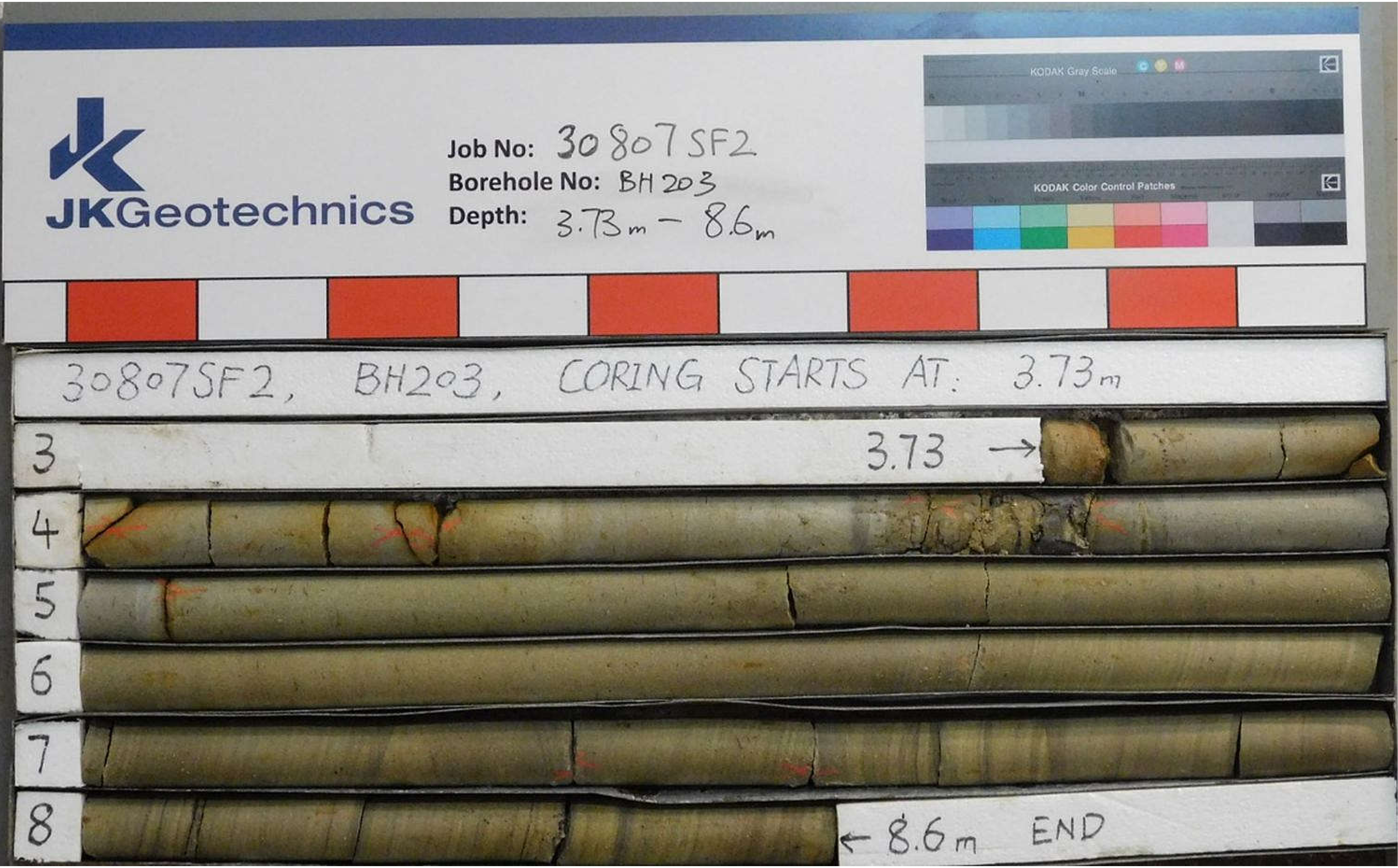

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Job No: 30807SF2

Borehole No: BH203

Depth: 3.73m – 8.6m

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BOREHOLE LOG

Borehole No.
204
1 / 2

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2
Method: SPIRAL AUGER
R.L. Surface: ~74.0 m
Date: 9/3/20
Datum: AHD
Plant Type: JK500
Logged/Checked By: D.A.F./O.F.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
										FILL: Silty sand, fine to coarse grained, light brown, with fine to medium grained sandstone gravel, trace of clay.	M			GRASS COVER APPEARS POORLY COMPACTED
				■	N = 5 3,3,2									
						73	1							
				■	N = 2 1,1,1									APPEARS MODERATELY COMPACTED
						72	2							
									SM	Silty SAND: fine to coarse grained, dark brown.	M	MD		ALLUVIAL
ON COMPLETION OF CORING				■	N = 10 4,5,5	71	3				W			
										as above, but light brown.				
						70	4							
									-	SANDSTONE: fine to coarse grained, light grey and grey.	DW	VL - L		HAWKESBURY SANDSTONE BANDED VERY LOW 'TC' BIT RESISTANCE
										REFER TO CORED BOREHOLE LOG				
						69	5							
						68	6							

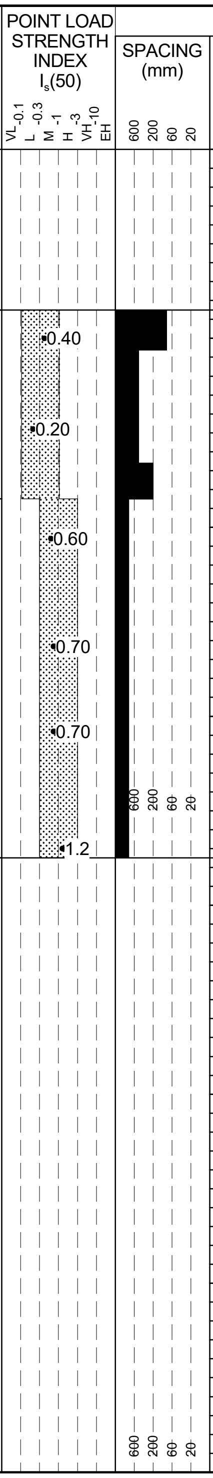
CORED BOREHOLE LOG

Borehole No.
204
2 / 2

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2	**Core Size:** NMLC	**R.L. Surface:** ~74.0 m
Date: 9/3/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** D.A.F./O.F.

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	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness — Specific	General	Formation
					START CORING AT 4.85m					
50% RETURN		69	5	⁚⁚	SANDSTONE: fine to coarse grained, light grey, with grey laminae, bedded at 0-10°.	SW	L - M	(4.92m) J, 55°, P, R, Cn (5.06m) Be, 0°, P, R, Cn (5.66m) Cr, 0°, 15 mm.t (5.85m) Be, 10°, P, R, Cn		Hawkesbury Sandstone
		68	6			FR	M - H			
		67	7							
		66	8		END OF BOREHOLE AT 7.75 m					
		65	9							
		64	10							



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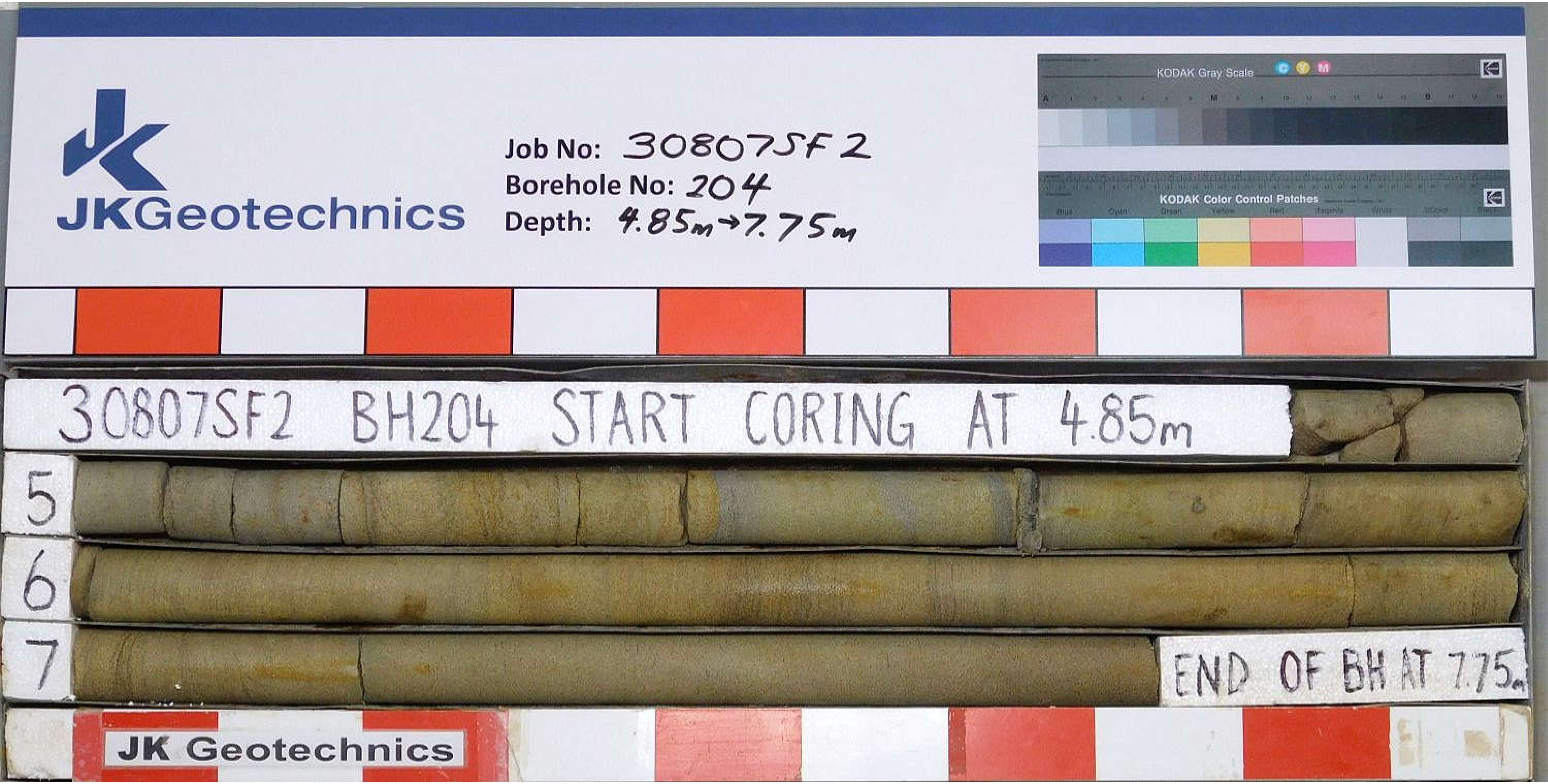

Job No: 30807SF2
Borehole No: 204
Depth: 4.85m→7.75m

BOREHOLE LOG

Borehole No.
205
1 / 2

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2
Method: SPIRAL AUGER
R.L. Surface: ~73.4 m
Date: 9/3/20
Datum: AHD
Plant Type: JK500
Logged/Checked By: D.A.F./O.F.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
						73				FILL: Silty sand, fine to coarse grained, brown, with clay, trace of fine to medium grained igneous and sandstone gravel.	M			GRASS COVER APPEARS POORLY COMPACTED
				■	N = 2 1,1,1	72	1							
				■	N = 20 8,11,9	71	2							APPEARS WELL COMPACTED
							3			as above, but trace of plastic.				
ON COMPLETION OF AUGERING				■	N=0 2,0,0									
						70	4		ML	Sandy SILT: grey and brown.	w~LL	S		ALLUVIAL
						69			-	SANDSTONE: light grey and grey.	DW	VL - L		HAWKESBURY SANDSTONE BANDED VERY LOW 'TC' BIT RESISTANE
							5					L - M		LOW RESISTANCE
				■		68								
						67	6			REFER TO CORED BOREHOLE LOG				

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CORED BOREHOLE LOG

Borehole No.
205
2 / 2

Client: OXFORD FALLS GRAMMAR SCHOOL
Project: PROPOSED CARPARK
Location: 1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Job No.: 30807SF2
Core Size: NMLC
R.L. Surface: ~73.4 m
Date: 9/3/20
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: D.A.F./O.F.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DETAILS: SPACING (mm) 600 200 60 20	DEFECT DETAILS: DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness): Specific	General	Formation
		68			START CORING AT 5.73m							
50% RETURN		67 66 65	6 7 8		SANDSTONE: light grey and grey, with grey laminae, bedded at 10-20°.	SW	M	0.90				Hawkesbury Sandstone
						FR	M - H	0.80 0.80 0.70 1.0 1.0 0.90		(6.24m) CS, 20°, 10 mm.t		
		64 63 62	9 10 11		END OF BOREHOLE AT 8.68 m							

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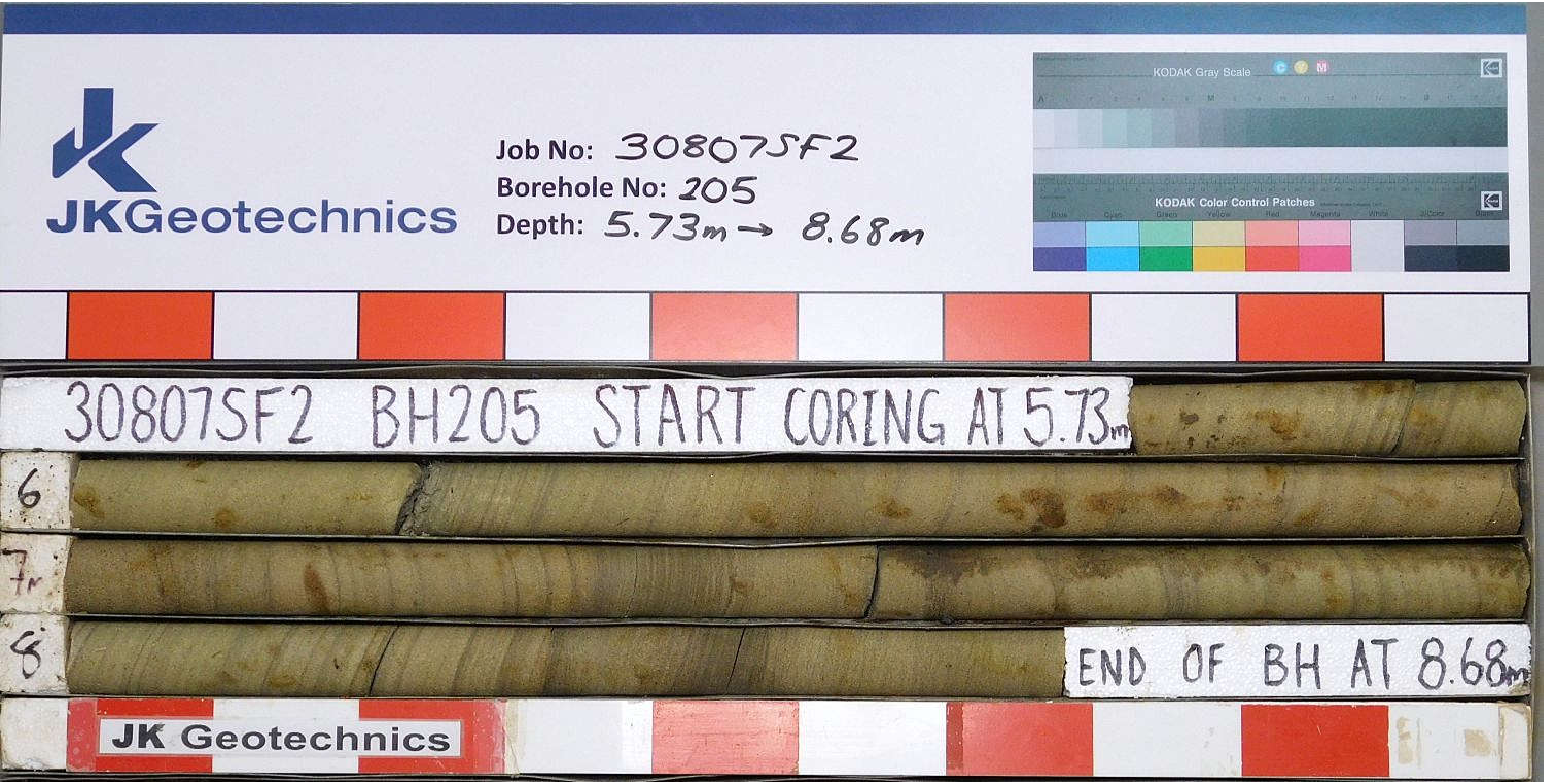
FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS



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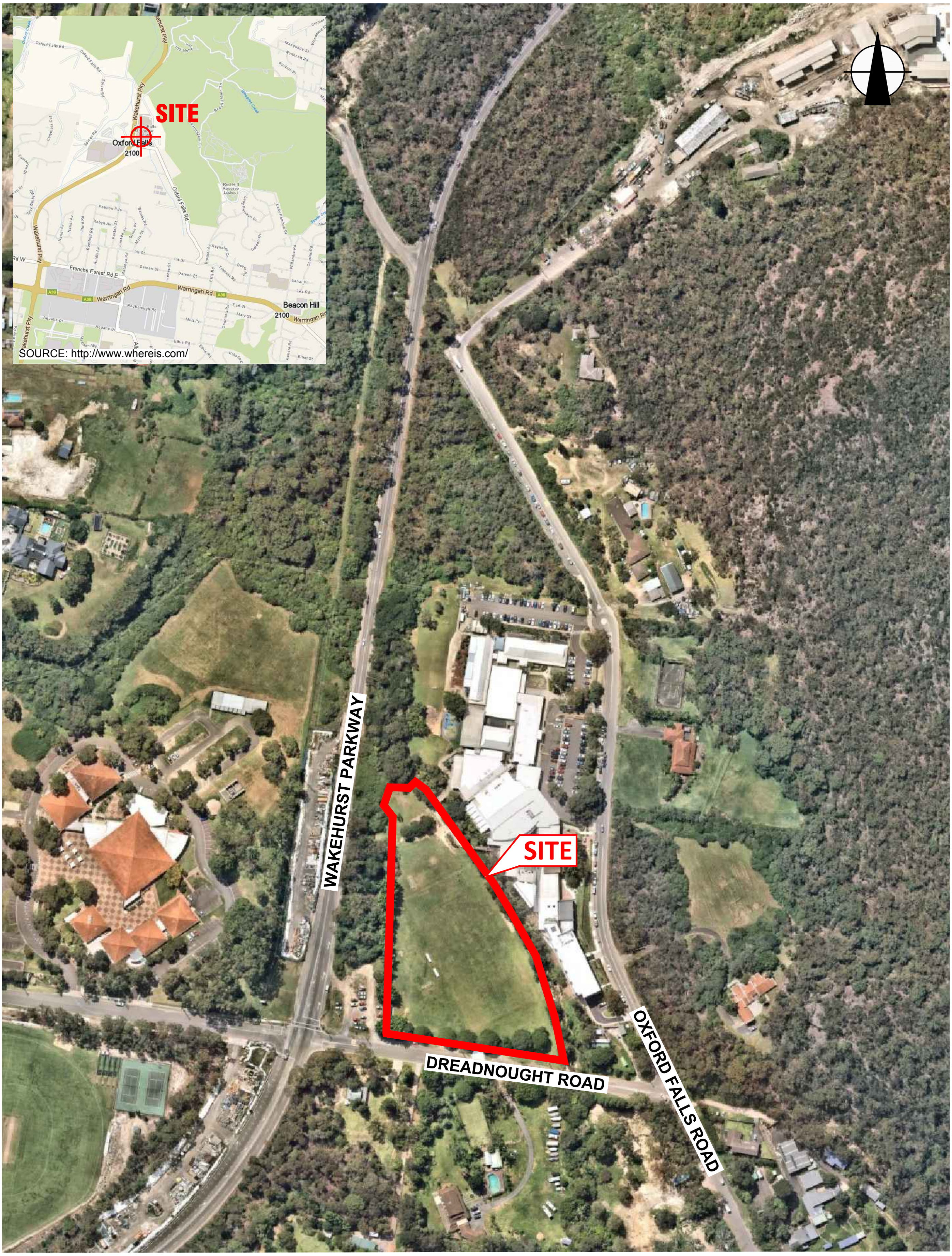
Job No: 30807SF2

Borehole No: 205

Depth: 5.73m → 8.68m



AERIAL IMAGE SOURCE: NEARMAP.COM

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

Title:

SITE LOCATION PLAN

Location: OXFORD FALLS GRAMMAR SCHOOL
1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Report No:	Figure No:
30807SY2	1

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PLOT DATE: 18/03/2020 1:47:12 PM DWG FILE: Z:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\30000'S\30807SY OXFORD FALLS\CAD\30807SF2\30807SF2.DWG

LEGEND

● BOREHOLE

TP TEST PIT

NOTES:
1. BOREHOLES 1 TO 21 ARE FROM OUR PREVIOUS INVESTIGATION.
2. BOREHOLES 201 TO 205 ARE FROM OUR CURRENT INVESTIGATION.

0 10 20 30 40 50

SCALE 1:1000 @A3 METRES

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

Title:

INVESTIGATION LOCATION PLAN

Location: OXFORD FALLS GRAMMAR SCHOOL
1078 OXFORD FALLS ROAD, OXFORD FALLS, NSW

Report No: 30807SY2

Figure No: 2

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PLOT DATE: 18/03/2020 1:46:39 PM DWG FILE: Z:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\30000'S\30807SY OXFORD FALLS\CAD\30807SF2\30807SF2.DWG

REPORT EXPLANATION NOTES

INTRODUCTION

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

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

DESCRIPTION AND CLASSIFICATION METHODS

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

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

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

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

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

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

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

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

SAMPLING

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

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

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

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

INVESTIGATION METHODS

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

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

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

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

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

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

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

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

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

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

The test results are reported in the following form:

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

  N = 13
  4, 6, 7

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

  N > 30
  15, 30/40mm

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

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

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

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

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

The information provided on the charts comprise:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

LOGS

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

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

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

GROUNDWATER

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

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

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

FILL

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

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

LABORATORY TESTING

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

ENGINEERING REPORTS

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

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

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

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

SITE ANOMALIES

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

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

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

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

REVIEW OF DESIGN

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

SITE INSPECTION

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

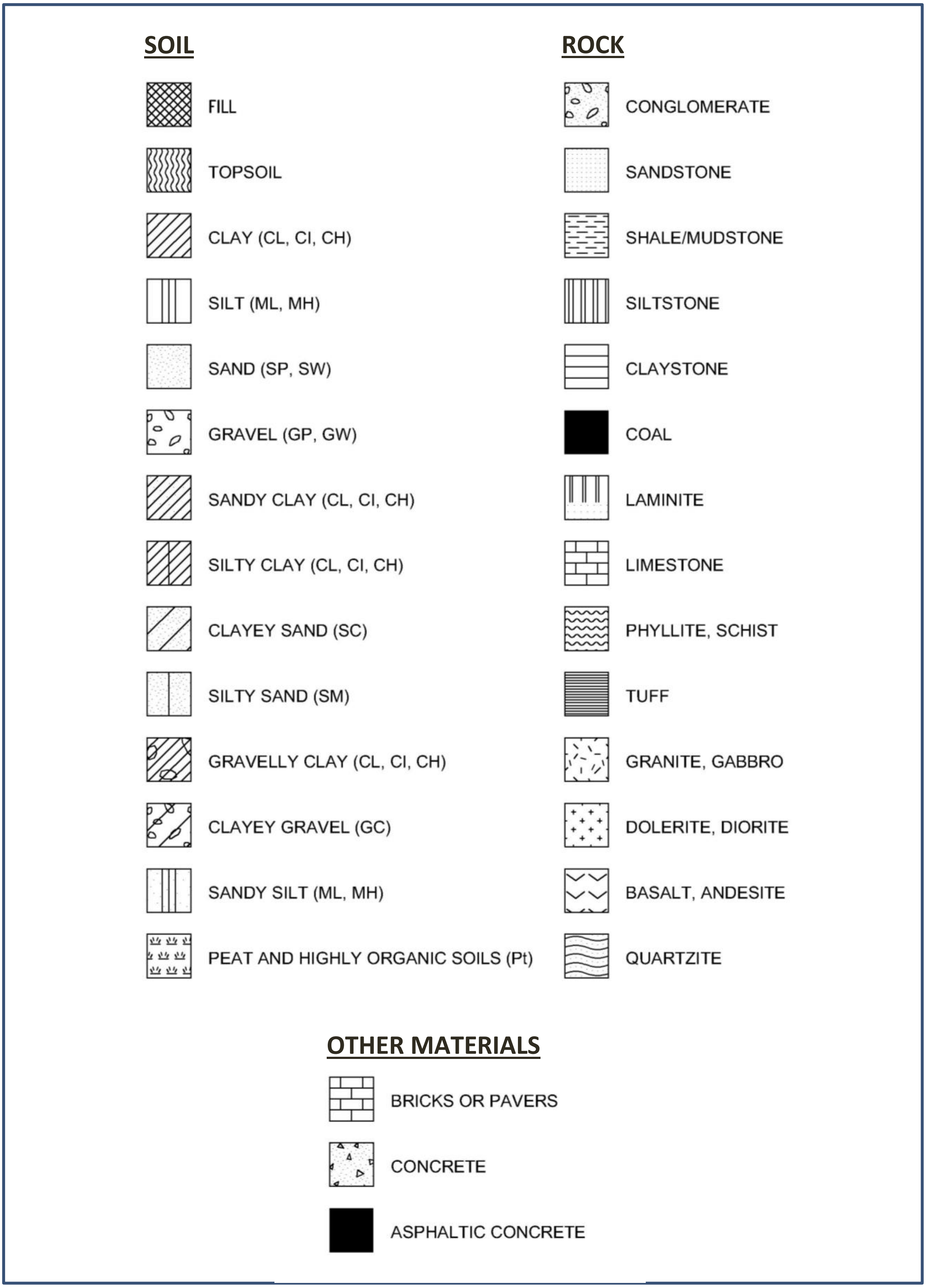
Requirements could range from:

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

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

iii) full time engineering presence on site.

SYMBOL LEGENDS



CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

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

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

Laboratory Classification Criteria

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

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

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

NOTES:

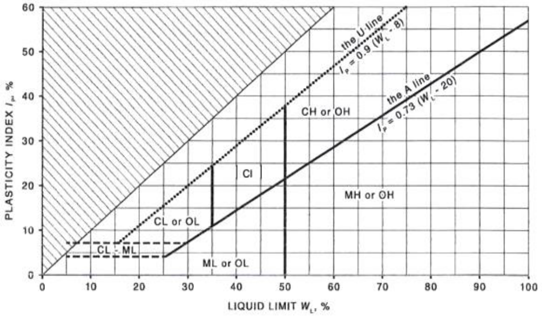
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

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

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

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

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



LOG SYMBOLS

<table>
<tr><th>Log Column</th><th colspan="2">Symbol</th><th colspan="3">Definition</th></tr>
<tr><td>Groundwater Record</td><td colspan="2">▼</td><td colspan="3">Standing water level. Time delay following completion of drilling/excavation may be shown.</td></tr>
<tr><td></td><td colspan="2">C</td><td colspan="3">Extent of borehole/test pit collapse shortly after drilling/excavation.</td></tr>
<tr><td></td><td colspan="2">►</td><td colspan="3">Groundwater seepage into borehole or test pit noted during drilling or excavation.</td></tr>
<tr><td>Samples</td><td colspan="2">ES</td><td colspan="3">Sample taken over depth indicated, for environmental analysis.</td></tr>
<tr><td></td><td colspan="2">U50</td><td colspan="3">Undisturbed 50mm diameter tube sample taken over depth indicated.</td></tr>
<tr><td></td><td colspan="2">DB</td><td colspan="3">Bulk disturbed sample taken over depth indicated.</td></tr>
<tr><td></td><td colspan="2">DS</td><td colspan="3">Small disturbed bag sample taken over depth indicated.</td></tr>
<tr><td></td><td colspan="2">ASB</td><td colspan="3">Soil sample taken over depth indicated, for asbestos analysis.</td></tr>
<tr><td></td><td colspan="2">ASS</td><td colspan="3">Soil sample taken over depth indicated, for acid sulfate soil analysis.</td></tr>
<tr><td></td><td colspan="2">SAL</td><td colspan="3">Soil sample taken over depth indicated, for salinity analysis.</td></tr>
<tr><td>Field Tests</td><td colspan="2">N = 17
4, 7, 10</td><td colspan="3">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.</td></tr>
<tr><td></td><td>N_c =</td><td>5
7
3R</td><td colspan="3">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.</td></tr>
<tr><td></td><td colspan="2">VNS = 25</td><td colspan="3">Vane shear reading in kPa of undrained shear strength.</td></tr>
<tr><td></td><td colspan="2">PID = 100</td><td colspan="3">Photoionisation detector reading in ppm (soil sample headspace test).</td></tr>
<tr><td>Moisture Condition
(Fine Grained Soils)</td><td colspan="2">w > PL</td><td colspan="3">Moisture content estimated to be greater than plastic limit.</td></tr>
<tr><td></td><td colspan="2">w ≈ PL</td><td colspan="3">Moisture content estimated to be approximately equal to plastic limit.</td></tr>
<tr><td></td><td colspan="2">w < PL</td><td colspan="3">Moisture content estimated to be less than plastic limit.</td></tr>
<tr><td></td><td colspan="2">w ≈ LL</td><td colspan="3">Moisture content estimated to be near liquid limit.</td></tr>
<tr><td></td><td colspan="2">w > LL</td><td colspan="3">Moisture content estimated to be wet of liquid limit.</td></tr>
<tr><td>(Coarse Grained Soils)</td><td colspan="2">D</td><td colspan="3">DRY – runs freely through fingers.</td></tr>
<tr><td></td><td colspan="2">M</td><td colspan="3">MOIST – does not run freely but no free water visible on soil surface.</td></tr>
<tr><td></td><td colspan="2">W</td><td colspan="3">WET – free water visible on soil surface.</td></tr>
<tr><td>Strength (Consistency)
Cohesive Soils</td><td colspan="2">VS</td><td colspan="3">VERY SOFT – unconfined compressive strength ≤ 25kPa.</td></tr>
<tr><td></td><td colspan="2">S</td><td colspan="3">SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.</td></tr>
<tr><td></td><td colspan="2">F</td><td colspan="3">FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.</td></tr>
<tr><td></td><td colspan="2">St</td><td colspan="3">STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.</td></tr>
<tr><td></td><td colspan="2">VSt</td><td colspan="3">VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.</td></tr>
<tr><td></td><td colspan="2">Hd</td><td colspan="3">HARD – unconfined compressive strength > 400kPa.</td></tr>
<tr><td></td><td colspan="2">Fr</td><td colspan="3">FRIABLE – strength not attainable, soil crumbles.</td></tr>
<tr><td></td><td colspan="2">( )</td><td colspan="3">Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.</td></tr>
<tr><td>Density Index/
Relative Density
(Cohesionless Soils)</td><td colspan="2"></td><td></td><td>Density Index (I_D) Range (%)</td><td>SPT ‘N’ Value Range (Blows/300mm)</td></tr>
<tr><td></td><td colspan="2">VL</td><td>VERY LOOSE</td><td>≤ 15</td><td>0 – 4</td></tr>
<tr><td></td><td colspan="2">L</td><td>LOOSE</td><td>> 15 and ≤ 35</td><td>4 – 10</td></tr>
<tr><td></td><td colspan="2">MD</td><td>MEDIUM DENSE</td><td>> 35 and ≤ 65</td><td>10 – 30</td></tr>
<tr><td></td><td colspan="2">D</td><td>DENSE</td><td>> 65 and ≤ 85</td><td>30 – 50</td></tr>
<tr><td></td><td colspan="2">VD</td><td>VERY DENSE</td><td>> 85</td><td>> 50</td></tr>
<tr><td></td><td colspan="2">( )</td><td colspan="3">Bracketed symbol indicates estimated density based on ease of drilling or other assessment.</td></tr>
<tr><td>Hand Penetrometer Readings</td><td colspan="2">300
250</td><td colspan="3">Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.</td></tr>
</table>

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

Classification of Material Weathering

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

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

Rock Material Strength Classification

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

Abbreviations Used in Defect Description

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