



SMEC INTERNAL REF: 30018086

Geotechnical Investigation Report

NSW Ambulance Infrastructure Program

Prepared for: TSA Management
15 September 2023

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Important Notice

This report is confidential and is provided solely for the purposes of providing geotechnical information on the ground conditions at the site, located at 75-79 Oakdale Road, Gateshead, New South Wales. This report is provided pursuant to a Consultancy Agreement between SMEC Australia Pty Limited ("SMEC") and Health Infrastructure NSW ("HINSW"), under which SMEC undertook to perform a specific and limited task for Health Infrastructure NSW. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

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1. Introduction

1.1 Project Background

SMEC Australia Pty Ltd (SMEC) was engaged by TSA Management (TSA), acting on behalf of Health Infrastructure NSW (HINSW) to provide geotechnical investigations for due diligence and acquisition of high priority sites in the NSW Ambulance Infrastructure Program. The site which is the subject of this report is located at 75-79 Oakdale Road, Gateshead NSW.

The investigations were undertaken on 8 June 2023 in general accordance with the following proposal documentation:

- SMEC Fee Proposal: 1046082 _2 Rev1_ NSW Ambulance Infrastructure Program GI Proposal, dated 12 April 2023

The purpose of the investigation was to provide factual surface and subsurface information at each site and provide commentary and recommendations for the design and construction works associated with the establishment of lightly loaded, single or double-storey structures with no basements, constructed on either slab on ground, strip footings or piles.

1.2 Scope of Work

The scope of work was proposed and undertaken by SMEC for the geotechnical investigation. The scope included:

- Desktop review of the site, including:
 - Before You Dig Plans
 - Available geological mapping
 - Preparation of a site-specific Safe Work Method Statement (SWMS)
- A day of intrusive investigation on site, which include:
 - 5 geotechnical boreholes to a maximum depth of 5m
 - Standard Penetration Tests (SPTs) undertaken within soil strength material at 1.5m intervals, commencing at 1.0m below ground level, to assess the intact soil consistency and density.
- Geotechnical laboratory testing
 - Atterberg Limits and Linear Shrinkage
 - Particle Size Distribution
- Preparation of a concise geotechnical investigation report (this report), which includes:
 - Results of the investigation
 - Discussion on the methodology of the fieldwork
 - Engineering logs of the boreholes
 - Photographs of the site conditions and any rock recovered from drilling activities
 - Plan showing locations of completed boreholes, with coordinates to an accuracy of $\pm 5\text{m}$
 - Tabulated Ground model
 - Soil and rock properties
 - Site classification in accordance with AS2870:2011
 - Site subsoil classification in accordance with AS1170.4:2007
 - Foundation design properties for both shallow (allowable bearing capacity) and deep (skin friction and end bearing of piles) foundations (within the depth of investigation)

- Recommendations for the site regarding:
 - Earthworks and material reuse
 - Temporary working platforms
 - Subgrade preparation for pavement construction

2. Project Understanding

2.1 Site Location and Description

The site is located at 75-79 Oakdale Road, Gateshead NSW. The site is currently occupied by several single storey dwellings on the western side and asphalt pavement and containers on the eastern side. The norther portion of the site is vacant grassed area.

The single-story buildings are all demountable structures which are supported by piers. These buildings appear to be staff break rooms and other storage rooms. The paved area covers approximately one third of the site, and is primarily used as a storage area for various pieces of road related equipment and parking of road control vehicles.

The site is located on the northern side of Oakdale Road, and gently slopes to the west. To the north, the site is bordered by dense bushland and Bulls Creek, which flows approximately east to west. The site is adjoined by a vacant block of land to the west, and a garden centre to the east. A two metre high retaining wall is located on the eastern boundary, supporting the adjacent property.

2.2 Regional Geology

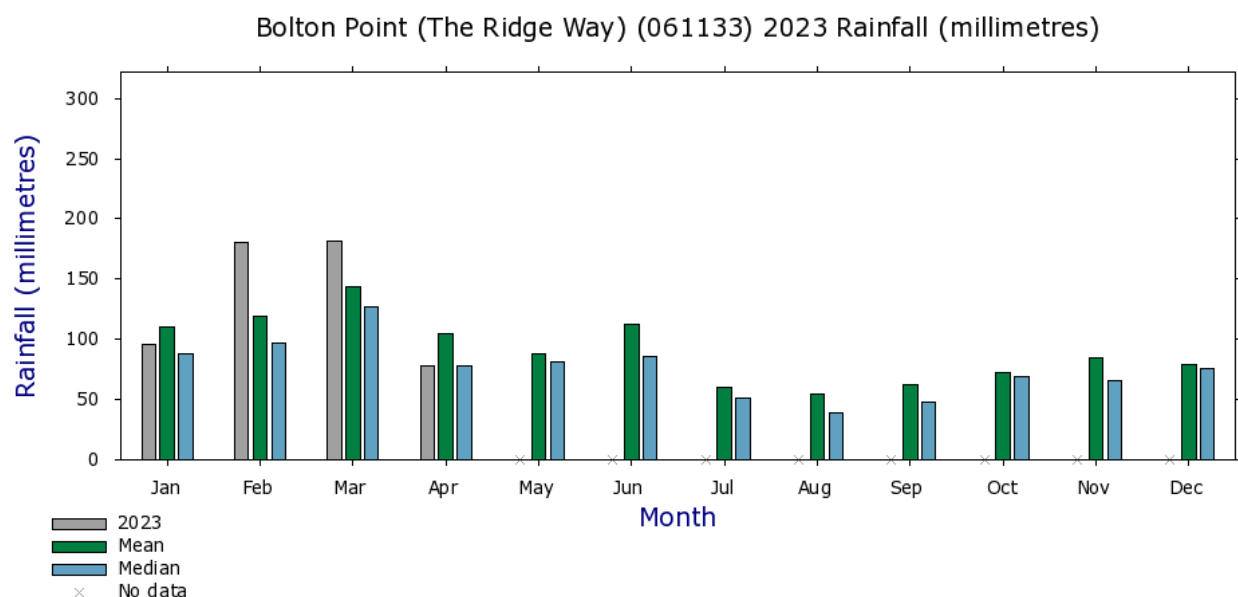
The geology of the site is covered by the Geological Survey of New South Wales (GSNSW) Seamless Geology Project Version 2, dated May 2020.

The geological mapping indicates that the project site is underlain by the Kahibah Formation, which comprises conglomerate, sandstone, shale and tuff. To the north and west of the site, the geological mapping indicates that alluvial deposits are present, following the path of Bulls Creek.

2.3 Climate Data

Rainfall records for 2023 and 2022 have been obtained from the Bureau of Meteorology (BoM) for the Bolton Point weather station (Station Number 061133) which is located approximately 8km from the project site. These records are presented in Figure 2–1 and Figure 2–2.

Records show that rainfall in 2023 has generally been similar to the averages for the months recorded. Rainfall for 2022 however had two months of higher than average rainfall. It is noted that no data was available for the months of April and May for 2022.



Note: Data may not have completed quality control

Climate Data Online, Bureau of Meteorology
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Figure 2–1: 2023 Rainfall Data for Bolton Point

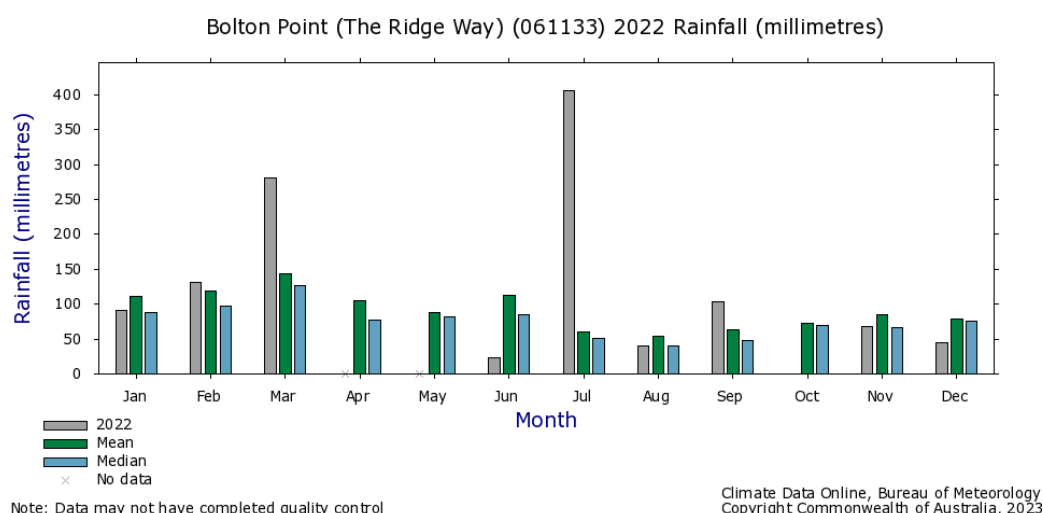


Figure 2–2: 2022 Rainfall Data for Bolton Point

3. Fieldwork

3.1 Project Set up

Prior to commencement of fieldwork, a desktop review of available information relevant to the site was completed. This included reviews of geological maps and online datasets, the previous geotechnical report and Before You Dig Australia (BYDA) service plans. Site- specific Safe Work Method Statements (SWMS) were prepared for the field investigations.

3.2 Underground Service Locating

Prior to any intrusive works, a BYDA search was undertaken for each work site area. Prior to undertaking any intrusive works, each borehole location was scanned and cleared from any underground infrastructure by an accredited service locator.

SMEC engaged the services of Newcastle Locating Services for this task, who used both radio detection and Ground Penetrating Radar (GPR) across the site. Each borehole location was cleared for underground services prior to any ground being broken.

3.3 Setting Out and Surveying

The locations of each borehole were proposed by SMEC and accepted by TSA prior to mobilising to site. Whilst on site, each borehole was located using a handheld GPS unit to an accuracy of $\pm 5\text{m}$. Coordinates are presented to GDA2020 (Map Grid of Australia Zone 56). Reduced Levels (RLs) relative to the Australian Height Datum were not recorded in the field due to the limitations in accuracy of recording RLs with a handheld GPS.

Indicative site location plans are presented in Appendix A with coordinates for each borehole provided on the engineering logs.

3.4 Borehole Investigations

Borehole drilling was undertaken on the 8th of June 2023 under the full-time supervision of a SMEC Geotechnical Engineer. One borehole (BH01) was advanced to a depth of 4.45m and all other boreholes (BH02-BH05) were advanced to 5m.

SMEC engaged the services of Total Drilling to undertake the drilling component of the investigation, using a Hanjin DB8 track mounted drill rig. Boreholes were advanced using solid flight augers equipped with a V-Bit. Rock was not encountered in any of the boreholes. Engineering logs of the boreholes and explanatory notes are presented in Appendix B with summaries of borehole locations and termination depths provided in Table 3–1.

Table 3–1: Summary of BH Locations

ID	Easting	Northing	Termination Depth (m BGL)
BH01	378721	6348892	4.45
BH02	378735	6348878	5.0
BH03	378737	6348854	5.0
BH04	378760	6348874	5.0
BH05	378756	6348861	5.0

3.5 Sampling and Laboratory Testing

Disturbed samples were collected from the auger and SPT split spoon sampler at each location at selected depths. Samples were collected by the onsite SMEC engineer and placed in double lined, zip locked bags for future laboratory testing.

Laboratory testing was scheduled by SMEC and tests were undertaken by a NATA Accredited facility operated by Macquarie Geotech in Lidcombe, NSW (NATA Accreditation No. 22365). Table 3–2 presents the tests which were scheduled by SMEC with Table 3–3 showing the results of the received lab tests.

Table 3–2: Schedule of Laboratory Testing

Laboratory Test	Standard/Test Method	Quantity of Tests Scheduled
Atterberg Limit and Linear Shrinkage	AS1289.3.1.1, 3.4.1, 3.1.2, 3.2.1, 3.3.1	4
Particle Sized Distribution	AS1289.3.6.1	4

Table 3–3: Results of Laboratory Testing

BH no	Depth Range (mbgl)	Liquid Limit (%)	Plastic Limit (%)	Plastic Index	Percentage Gravel	Percentage Sand	Percentage Fines
BH01	1.0-1.45	44	15	29	0	57	43
BH02	1.5-1.95	46	15	31	0	67	33
BH03	1.5-1.95	U*	U*	U*	5	65	30
BH04	1.5-1.95	45	15	30	0	69	31

NOTE: * Values unable to be obtained due to soil material type

4. Discussions and Recommendations

4.1 Summary of Encountered Subsurface Conditions

Table 4–1 presents the interpreted geotechnical units as encountered across the project site. For detailed descriptions of the materials and subsurface conditions encountered at each structure locations, reference should be made to the engineering borehole logs presented in Appendix B.

Subsurface soils have been classified in accordance with Australian Standard AS1726:2017.

Table 4–1: Interpreted geotechnical units

Unit	Depth range (mbgl)	General Description
1a	0-0.2	FILL – Asphalt, pavement wearing course
1b	0.2-0.9	FILL – Gravelly sand, fine to medium grained, pavement basecourse
2a	0.9-Not Penetrated	Alluvial – Sandy clay, stiff
2b	0.9-Not Penetrated	Alluvial – Clayey sand, medium dense

Units 2a and 2b were encountered at varying depths within the boreholes. For three of the locations (BH01, BH04 and BH05), unit 2a was encountered above unit 2b. Unit 2a was not encountered within boreholes BH03 and BH04.

4.2 Groundwater

Groundwater inflows were encountered in BH02 at 4.35m below ground level and at 4.4mbgl in BH01. These strikes were encountered within or below Unit 2b. It is noted that there were no recorded rain events in the week leading up to the fieldwork.

Four registered groundwater wells are located at the corner of Oakdale Road and the Pacific Highway, approximately 1.0km from the project site. Table 4–2 presents the measured groundwater depths in these boreholes. The encountered groundwater levels in these wells typically sits around 6 metres below ground level, however at GW20529 ground water was not encountered until 12 metres below surface level.

Table 4–2: Groundwater Conditions from Registered Monitoring Wells

WaterNSW BH ID	Measured Groundwater Depth	Distance from Project Site	Date
GW201529	12mbgl	0.95km	25/03/2011
GW201528	6mbgl	0.95km	26/03/2011
GW201553	6mbgl	1.0km	25/03/2011
GW201552	6.1mbgl	1.0km	05/10/2011

5. Geotechnical Assessment and Recommendations

Following correspondence from TSA, it is understood that the preferred development at this site is a single-story building with ground level car parking. Based on the proposed development, the following sections provide the recommended geotechnical design parameters and construction considerations.

5.1 Recommended Geotechnical Parameters

Table 5–1 provides the geotechnical parameters relevant to the design of shallow and deep foundations have been based on field test results (SPTs), published data and previous experience.

Table 5–1: Recommended Geotechnical Parameters

Unit	Consistency/ Density	Unit Weight, γ , kN/m ³	Undrained Shear Strength, C_u (kPa)	Effective cohesion, c' (kPa)	Friction angle, Φ' (°)
1a	-	18	-	-	-
1b	-	19	-	-	-
2a	Stiff	18	100	5	28
2b	Medium Dense	18	N/A	2	35

Shallow foundations, subject to geotechnical and structural design, are suitable for the site, and could consist of either strip or pad footings, founded on natural soil material. Shallow foundations must not be founded on fill material. Allowable bearing capacities have been calculated using Meyerhof (1963), using a 1m square footing embedded at 0.5m below ground level and a Factor of Safety of 3. Bearing capacities are presented in Table 5–2.

Shallow foundations based on the allowable bearing capacity values presented in Table 5–2 would be expected to settle by an amount equal to less than 1% of the footing width. Differential settlements between footings would be expected to be less than half of total settlements.

Table 5–2: Recommended Geotechnical Parameters for Shallow Foundations

Unit	Allowable Bearing Capacity (kPa)	Youngs Modulus, E , (MPa)
2a	180	30
2b	270	40

5.2 Site Classification

The project site is underlain by clayey sand/sandy clay, which may be prone to shrink/swell movements when subject to variations in moisture content. These potential movements need to be considered in the design of shallow foundations and pavements.

Shrink swell index values (I_{ss}) have been calculated based on the relationship with the liquid limit, as presented by Beak (1984) and used in the site classification formula presented in AS2870:2011. It is noted that AS2870 is primarily used of slabs and footings for residential buildings, however, may be suited for lightly loaded foundations, which are proposed for this development.

The characteristic surface movement of the soil at the project site has been calculated to be between 20 and 40mm, which classifies the site as being a Moderately Reactive Site.

5.3 Earthquake Classification

Based on the recommendations provided in AS1170.4:2007, the subsoil classification has been assessed as a Class C_E – shallow soil site.

5.4 Earthworks and materials reuse

At the time of writing, it is unknown whether major earthworks are required to either raise or lower the project site. The natural alluvial material is suitable to be used as general fill across the site, however is not suitable for retaining wall backfill, trench backfill or other structural fill. All earthworks shall be constructed in accordance with AS3798:2007 and compacted to 95% maximum dry density and $\pm 3\%$ optimal moisture content.

5.5 Excavation Considerations

Where slopes are required to be constructed across the project site, the following slope ratios are proposed. Further assessment is recommended if larger slopes are required (IE greater than 2.5m vertical height)

- Temporary Slopes 1V:1.5H
- Permanent Slopes 1V:2.5H

Worksafe NSW recommends that any trenches deeper than 1.5m are assessed by an engineer prior to any works being undertaken within the trench. It is not known whether the project is likely to require trenches greater than 1.5m deep. SMEC recommends that all trenches be benched at the ratios presented above, or, if space restricts the excavation of benches, the use of trench boxes to protect workers from any potential collapse. Where excavations are proposed to extend deeper than 2m, further advice shall be sought, and assessment undertaken to determine the size of trench boxes and potential dewatering solutions.

5.6 Subgrade preparation for pavement construction

It is understood that pavements will be constructed across the site, primarily for use as a driveway and carpark.

Pavement for this development will likely be designed as a lightly trafficked pavement in accordance with Figure 12.2 in Austroads Guide to Pavement Technology Part 2. A preliminary CBR value of 4% has been derived from in-situ tests on the natural clayey sand layers. Future investigations will need to include CBR testing for pavement designs.

It is recommended that a geotechnical engineer inspects the subgrade during construction and assesses the CBR and confirms that the subgrade is free from any unsuitable or deleterious material, prior to placement of the first pavement layer. Pavement layers shall be placed so that no layer exceeds 200mm prior to compaction, and compacted to 98% maximum dry density using a modified compaction effort, as described in AS1289.5.2.1:2003.

6. Closure and Recommendations for Further Work

The geotechnical investigation has been carried out to provide preliminary ground information to assist NSW Health Infrastructure in undertaking due diligence for a potential new ambulance facility located at 75-79 Oakdale Road, Gateshead, NSW.

The reader should be aware that there is always geotechnical variability between test locations, and geotechnical testing does not provide the state of the entire site from selected intrusive investigation points.

The investigation has assessed preliminary surface settlements. If surface settlement and movement are considered critical for project, additional investigations should be considered by successful tenderers once the final facility locations have been determined. Likewise, if basements, large retaining structures or additional information on groundwater are required, additional geotechnical investigation should be undertaken.

7. Limitations

7.1 General

We have prepared this report in accordance with the brief. The contents of the report are for the sole use of TSA Management. No responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other purposes without prior review and agreement with SMEC.

The recommendations in this report are based on data collected at specific locations using suitable investigation techniques. Only a finite amount of information has been collected to meet the specific financial and technical requirements of the brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it must be appreciated that actual conditions could vary from the extrapolated model.

Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the provided factual data. They should perform any additional tests as necessary for their own purposes. Subsurface conditions, such as groundwater levels, can change over time and this should be borne in mind, particularly if the findings and/or recommendations contained within this report are used after a protracted delay.

It is strongly recommended that any plans and specifications prepared by others and relating to the content of this report, or any amendments to the original plans and specifications, are reviewed by SMEC to verify that the intent of our recommendations is properly reflected in the design. During construction, we request the opportunity to review our interpretations if the encountered site conditions are significantly different from those inferred in this report.

If this report is reproduced, it must be in full. Should there be any queries concerning this report please do not hesitate to contact the author.

7.2 Notes Relating to Geotechnical Reports

Geotechnical reports are prepared by qualified personnel on the information supplied or obtained and are based on current engineering standards of interpretation and analysis.

Information may be gained from limited subsurface testing, surface observations, and previous work, and is supplemented by knowledge of the local geology and experience of the range of properties that may be exhibited by the materials present. For this reason, geotechnical reports should be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Where the report has been prepared for a specific purpose (e.g., design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (e.g., a twenty-storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by SMEC in the light of the new proposal.

Every care is taken with the report content; however, it is not always possible to anticipate or assume responsibility for the following conditions:

- Unexpected variations in ground conditions. The potential for this depends on the amount of investigative work undertaken.
- Changes in policy or interpretation by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, SMEC would be pleased to resolve the matter through further investigation, analysis or advice.

7.3 Unforeseen Conditions

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, SMEC should be notified immediately. Early identification of site anomalies generally results in any problems being more readily resolved and allows re-interpretation and assessment of the implications for future work.

7.4 Subsurface Information

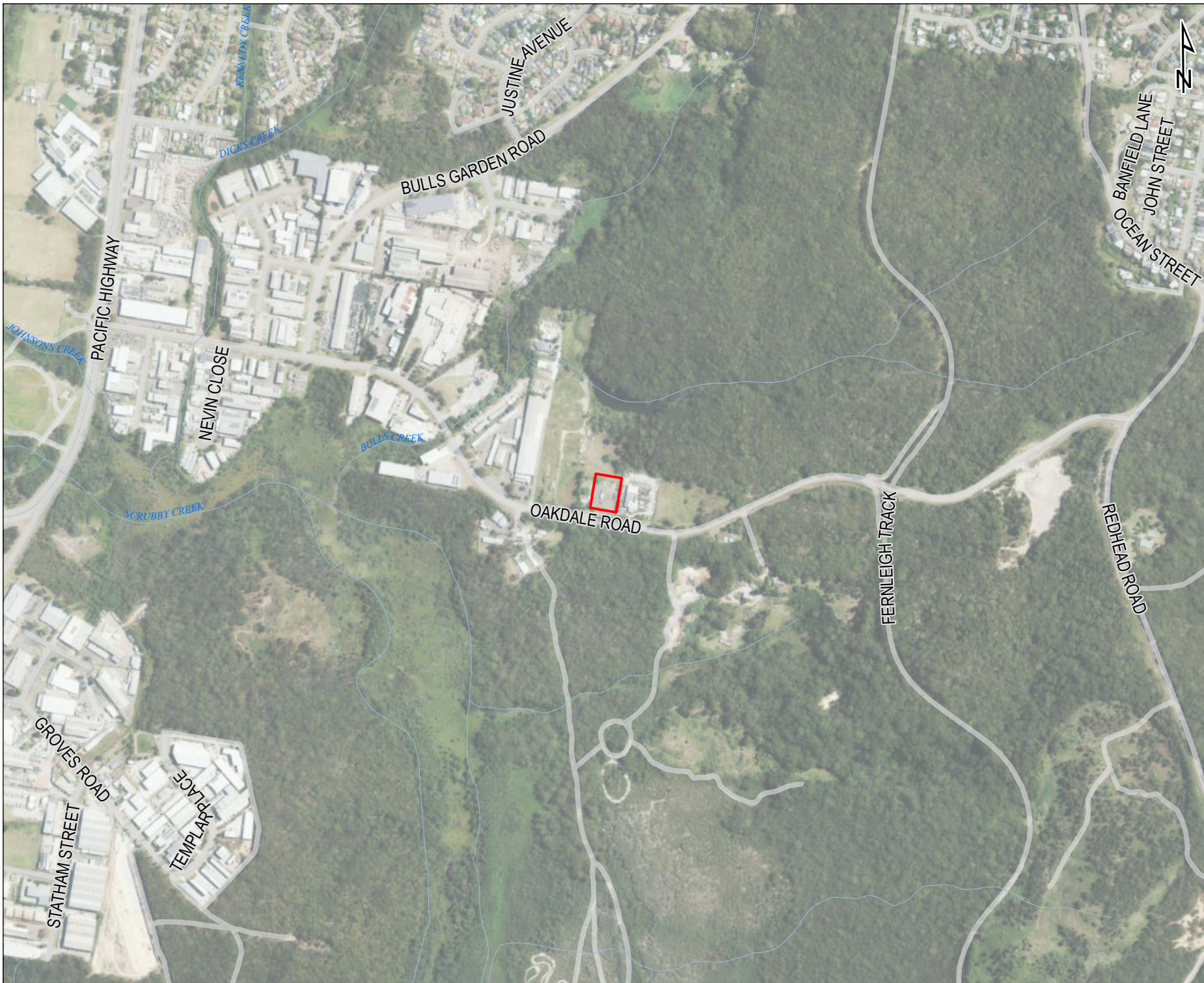
Logs of a borehole, recovered core, test pit, excavated face, or cone penetration test are an engineering and/or geological interpretation of the subsurface conditions. The reliability of the logged information depends on the drilling/testing method, sampling/observation spacing's and the ground conditions. It is not always possible or economic to obtain continuous high quality data. It should also be recognised that the volume of material observed or tested is only a fraction of the total subsurface profile.

Interpretation of subsurface information and application to design and construction must take into consideration the spacing of the test locations, the frequency of observations and testing, and the possibility that geological boundaries may vary between observation points.

Groundwater observations and measurements outside of specially designed and constructed piezometers should be treated with care for the following reasons:

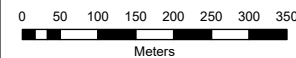
- In low permeability soils groundwater, may not seep into an excavation or bore in the short time it is left open.
- A localised perched water table may not represent the true water table.
- Groundwater levels vary according to rainfall events or season.
- Some drilling and testing procedures mask or prevent groundwater inflow.
- The installation of piezometers and long-term monitoring of groundwater levels may be required to adequately identify groundwater conditions.

Appendix A – Site Plan



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Scale: 1:10,000 @ A4
GDA 1994 MGA Zone 56

LEGEND

-  Site Location
-  Watercourse



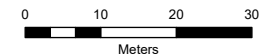
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PROJECT: Gateshead DSI
PROJECT NO: 30018086
FIGURE NO: 1
FIGURE TITLE: Site Locality
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DATE: 24/07/2023
VERSION: 1



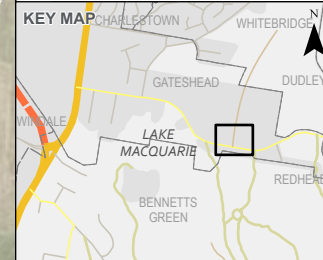
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Scale: 1:1,000 @ A4
GDA 1994 MGA Zone 56

LEGEND

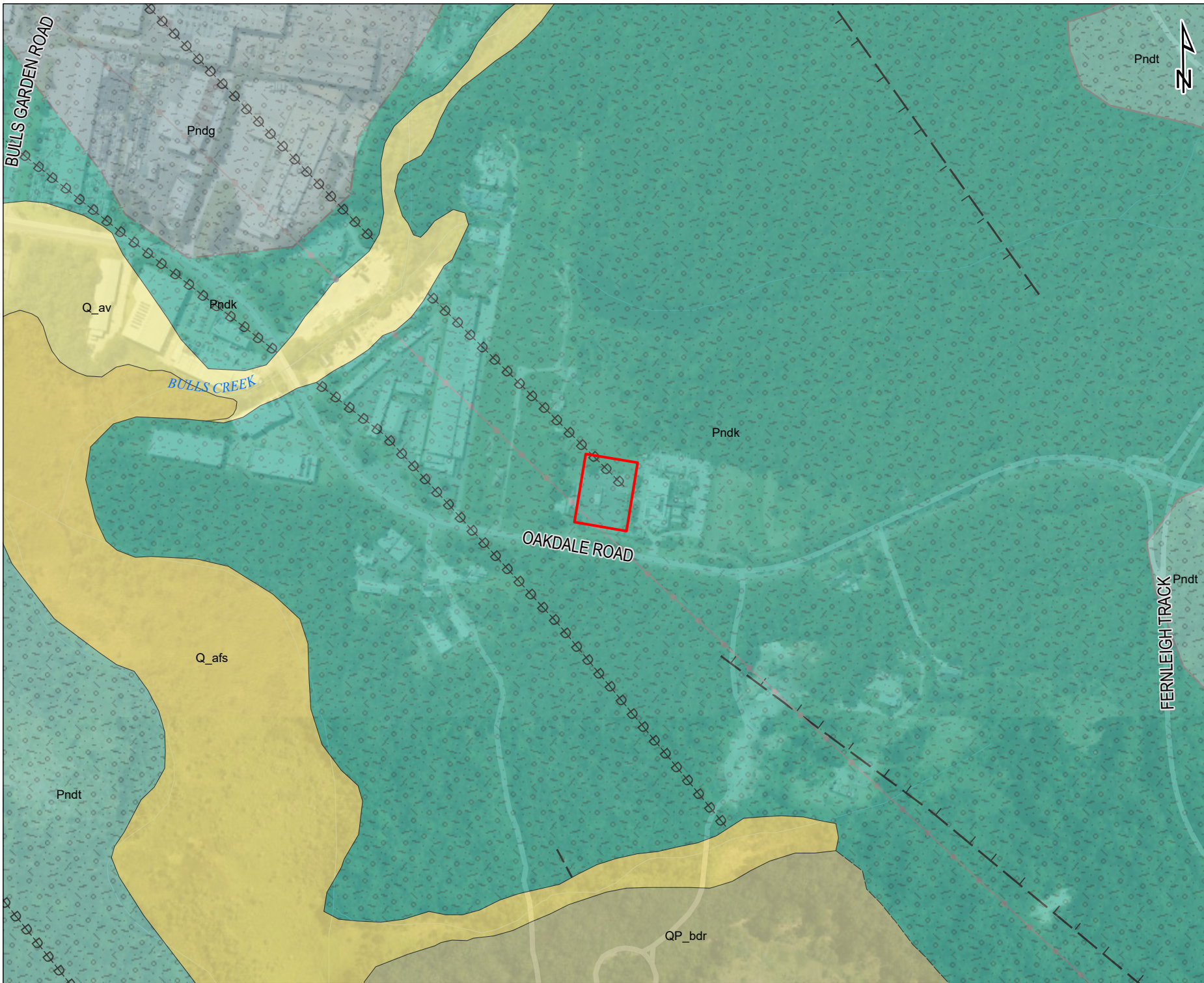
- Site Location
- Cadastre
- Proposed Borehole
- Proposed Test Pit
- Shallow Surface Sample



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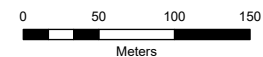
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PROJECT: Gateshead DSI
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FIGURE NO: 2
FIGURE TITLE: Sample Plan
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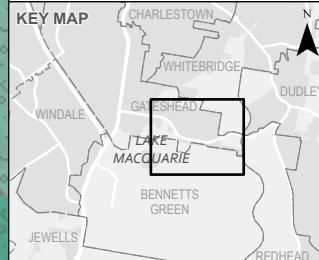
SMEC AUSTRALIA PTY LTD
ABN 47 065 475 149



Scale:1:5,000 @ A4
GDA 1994 MGA Zone 56

LEGEND

- Site Location
- Dyke or Vein
- Dyke, approximate
- Coal seam outcrop
- Coal seam outcrop, inferred
- Geological boundary, position accurate
- Geological boundary, position approximate
- Normal fault, approximate
- Fault, position approximate
- Conglomerate
- Rock Units - colours**
- QP_bdr - Coastal deposits - bedrock-mantling dune facies
- Q_afs - Alluvial floodplain deposits - swamp facies
- Q_av - Alluvial valley deposits
- Pndg - Glebe Formation
- Pndk - Kahibah Formation
- Pndt - Tickhole Formation



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3. Colquhoun GP, Hughes KS, Dyeasing L, Ballard JC, Folkes CB, Phillips G, Treadwell AJ, and Fritzscheit JA (2023). New South Wales Seamless Geology dataset (Single Layer), version 2.3 [dataset]. Geological Survey of New South Wales, Department of Regional NSW, Maitland.

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PROJECT: Gateshead DSI
PROJECT NO: 30018086
FIGURE NO: 3
FIGURE TITLE: Regional Geology
CREATED BY: FA13847
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Appendix B – Geotechnical Logs and Test Results

Explanatory Notes of Abbreviations and Terms

Used on Borehole and Excavation Logs

General

The “Geological and Engineering Log” presents data from drilling or excavation operations where material recovery is soil and or rock. Data presented is a combination of material recovered, regular sampling and insitu testing. Excavations may present data obtained on the subsurface profile from observations of natural or man-made excavations. Logs may contain scaled graphical presentations, photography, or downhole imagery results. Logs may not contain all data types presented in these notes.

The “Non Core Drill Hole Engineering Log” presents data from drilling operations where a core barrel has not been used. The material is penetrated using methods other than those designed to recover core and is commonly soil or extremely to highly weathered. The “Cored Drill Hole Engineering Log” presents data from drilling operations where a core barrel has been used. The “Excavation - Geological Log” presents data obtained on the subsurface profile from observations of excavations, either natural or anthropogenic. As far as is practicable, the data contained on the log sheet is factual. Some interpretation is inevitable with respect to the:

- a.** location of areas of core loss,
- b.** description and classification of material,
- c.** estimate of field strength, and
- d.** identification of drilling induced fractures.

Material description and classification is generally based on AS1726-2017 (as amended).

Drilling Method

Code	Description
ADT	Auger drilling with TC-bit
ADV	Auger drilling V-bit
AS	Auger screwing
AT	Air track
CA	Casing advancer
CC	Concrete core
CTR	Cable tool rig
DB	Wash bore drag bit
HA	Hand auger
HAND	Hand methods
HF	Hollow flight auger
HMLC	Diamond core 62mm diameter
HQ	Wire line core barrel 64mm diameter
HQ3	Wire line core barrel 62mm diameter
NDD	Non destructive drilling
NMLC	Diamond core 52mm diameter
NQ	Wire line core barrel 47mm diameter
NQ3	Wire line core barrel 45mm diameter
PT	Continuous push tube
PQ	Wire line core barrel 85mm diameter
RAB	Rotary air blast
RC	Reverse circulation
RD	Rotary blade or drag bit
RR	Rock roller
RT	Rotary tricone bit
SD	Sonic drilling
TBX	Tube-X
VC	Vibro-core drilling
WB	Wash bore drilling

Drilling Penetration

Ease of penetration in non-core drilling

VE	Very easy
E	Easy
F	Firm
H	Hard
VH	Very hard

Support and Casing

Code	Description	Code	Description
C	Casing	Hw	114.3 mm
M	Mud	Nw	88.9 mm
W	Water	PVC	150 mm

Core Run

Core lifts are identified by a line and depth with core loss per run as a percentage. Core loss is shown in the core run unless otherwise indicated.

2 Revision 3, February 2021 SMEC Soil and Rock Logging Explanatory Notes.

Defect Spacing

The average distance between defects is measured parallel to the core axis in mm and may be expressed as a range or average.

Angle / Orientation

Angle from horizontal and orientation to magnetic north.

For inclined cored boreholes the Alpha and Beta angles are presented for orientated core. Alpha (α) is measured relative to the core axis, whilst Beta (β) is measured clockwise from the reference line looking down the core axis in the direction of drilling.

Excavation Method

N	Natural exposure
X	Existing excavation
BB	Tractor mounted backhoe bucket
EX	Hydraulic excavator
EH	Hydraulic excavator with hammer
B	Bulldozer blade
R	Ripper

Water / Drilling Fluid

The drilling fluid used is identified and loss of return to the surface is estimated as a percentage, generally of each core lift.

Symbol	Description
	Water inflow
	Water outflow
	Water level: during drilling or immediately after completion of drilling
	Groundwater level with date observed prior to introduction of fluids or after standpipe construction
Not observed	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole / test pit.
Not encountered	The borehole / test pit was dry soon after excavation, however groundwater could be present in less permeable strata. Inflow may have been observed had the borehole / test pit been left open for a longer period.

Colour

The colour of a soil or rock is described in a moist/wet condition using simple terms, such as black, white, grey, red, brown, orange, yellow green or blue. These are modified as necessary by 'pale', 'dark' or 'mottled'. Borderline colours are described as a combination of these colours (e.g. orange-brown). Where a soil or rock consists of a primary colour with a secondary mottling it is described as (primary colour) mottled (first colour) and (secondary colour).

Black						
White						
			Grey			
			Brown			
			Red			
			Orange			
			Yellow			
			Green			
			Blue			
< Darker				Paler >		

Description of Soil

- v. Soil name (BLOCK LETTERS)
- vi. Plasticity or particle size of soil
- vii. Colour
- viii. Secondary soil components names & estimated proportions, including their plasticity / particle characteristics, colour
- ix. Minor soil components name, estimated proportions, including their plasticity / particle characteristics, colour
- x. Other minor soil components
- xi. Moisture condition
- xii. Consistency / density
- xiii. Structure of soil, geological origin
- xiv. Additional observations

Particle Size

Term		Grain Size
Clay		< 2 μm
Silt		2 – 75 μm
Sand	Fine	0.075 – 0.21 mm
	Medium	0.21 – 0.6 mm
	Coarse	0.6 – 2.36 mm
Gravel	Fine	2.36 – 6.7 mm
	Medium	6.7 – 19 mm
	Coarse	19 – 63 mm
Cobbles		63 – 200 mm
Boulders		> 200 mm

Fine Grained and Coarse Grained Soils

Term	Description
Fine Grained Soil (cohesive)	More than 35% of the material less than 63 mm is smaller than 0.075 mm (silts and clays)
Coarse Grained Soil	More than 65% of the material less than 63 mm is larger than 0.075 mm (sands, gravels and cobbles)

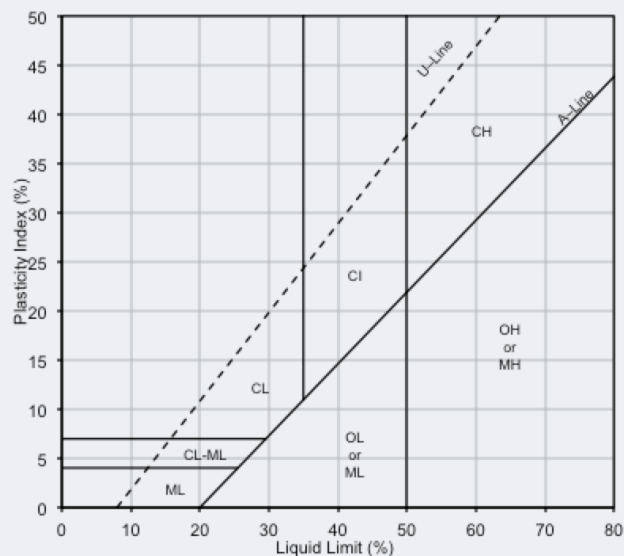
Descriptive Terms for Secondary and Minor Components

Designation of Components	In coarse grained soils				In fine grained soils	
	% Fines	Terminology	% Accessory coarse fraction	Terminology	% Sand / Gravel	Terminology
Minor	≤5	trace	≤15	trace	≤15	trace
	>5, ≤12	with	>15, ≤30	with	>15, ≤30	with
Secondary	>12	prefix	>30	prefix	>30	prefix

Plasticity – Fine Grained Soils

Liquid Limit (LL) %	Description
≤ 35	Low plasticity (L)
>35 to ≤ 50	Medium plasticity (I)
> 50	High plasticity (H)

Plasticity Chart– Fine Grained Soils



Consistency Terms – Fine Grained Soils

Term	Undrained shear strength (kPa)	Indicative SPT (N) Blow Count	Field Guide to Consistency
Very Soft (VS)	<12	0 – 2	Easily penetrated several centimetres by fist, exudes between fingers when squeezed in fist
Soft (S)	12 – 25	2 – 4	Easily penetrated several centimetres by thumb, easily moulded by light finger pressure
Firm (F)	25 – 50	4 – 8	Can be penetrated several centimetres by thumb with moderate effort, and moulded between the fingers by strong pressure
Stiff (St)	50 – 100	8 – 15	Readily indented by thumb but penetrated only with difficulty. Cannot be moulded by fingers
Very Stiff (VSt)	100 – 200	15 – 30	Readily indented by thumb nail, still very tough
Hard (H)	>200	>30	Indented with difficulty by thumb nail, brittle
Friable (Fr)	-		Can be easily crumbled or broken into small pieces

Density Terms – Coarse Grained Soils

Term	Density Index (%)	SPT (N) Blow Count
Very Loose (VL)	< 15	0 – 4
Loose (L)	15 – 35	4 – 10
Medium Dense (MD)	35 – 65	10 – 30
Dense (D)	65 – 85	30 – 50
Very Dense (VD)	> 85	>50

Particle Characteristics – Coarse Grained Soils

Term	Description
Well Graded	Having good representation of all particle sizes
Poorly graded	With one or more intermediate size poorly represented
Gap graded	With one or more intermediate sizes absent
Uniform	Essentially of one size

Angularity – Coarse Grained Soils

	Rounded
	Sub-rounded
	Angular
	Sub-angular

Origin of Soil

Fill	Formed by humans
Aeolian	Formed by wind
Alluvial	Formed by streams and rivers
Colluvial	Formed on slopes (talus)
Estuarine	Formed in marine environments
Lacustrine	Formed in lakes
Residual	Formed by weathering insitu

Soil Moisture

	Term	Code	Description
Coarse Grained	Dry	D	Looks and feels dry and free running
	Moist	M	Soil feels cool, darkened in colour, soils tend to stick together, soil grains do not run freely through fingers and no visible free water
	Wet	W	Soil feels cool, darkened in colour, soils tend to stick together, free water on remoulding
Fine Grained	Moist, Less than Plastic Limit	W < PL	Hard and friable or powdery, moisture content well below Plastic Limit
	Moist, Near Plastic Limit	W ≈ PL	Soil feels cool, darkened in colour, can be moulded, near Plastic Limit
	Moist, Wet of Plastic Limit	W > PL	Soil feels cool, dark, usually weakened, free water, moisture content well above Plastic Limit
	Wet, Near Liquid Limit	W ≈ LL	Soil exudes easily
	Wet, Wet of Liquid Limit	W > LL	Soil behaves as a liquid

Boundary Classifications

Soils possessing characteristics of two groups are designated by combinations of group symbols. For example, GW-GC, well graded gravel-sand mixture with clay binder.

Graphic Symbols

	Asphalt		MH
	CH		ML
	CI		OH
	CL		OL
	Concrete		PT
	Fill		SC
	GC		SM
	GM		SP
	GP		SW
	GW		

Soil Classification

Soils are described in general accordance with AS1726-2017 as shown below.

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)					GROUP SYMBOL	PRIMARY NAME		
COARSE GRAINED SOILS More than 65% of the material is less than 63 mm and is larger than 0.075 mm	A particle size of 0.075 is about the smallest size distinguishable to the naked eye	GRAVELS More than half of coarse fraction is larger than 2.36 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes, not enough fines to bind coarse grains, no dry strength; ≤ 5% fines	GW	GRAVEL		
				Predominantly one size or a range of sizes with more intermediate sizes missing, not enough fines to bind coarse grains, no dry strength; ≤ 5% fines	GP	GRAVEL		
			GRAVELS w/ FINES (Appreciable amount of fines)	'Dirty' materials with excess of non-plastic fines, none to medium dry strength; ≥ 12% silty fines	GM	SILTY GRAVEL		
				'Dirty' materials with excess of plastic fines, medium to high dry strength; ≥ 12% clayey fines	GC	CLAYEY GRAVEL		
		SANDS More than half of coarse fraction is smaller than 2.36 mm	CLEAN SANDS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes, not enough fines to bind coarse grains, no dry strength; ≤ 5% fines	SW	SAND		
				Predominantly one size or a range of sizes with more intermediate sizes missing, not enough fines to bind coarse grains, no dry strength; ≤ 5% fines	SP	SAND		
			SANDS w/ FINES (Appreciable amount of fines)	'Dirty' materials with excess of non-plastic fines, none to medium dry strength; ≥ 12% silty fines	SM	SILTY SAND		
				'Dirty' materials with excess of plastic fines, medium to high dry strength; ≥ 12% clayey fines	SC	CLAYEY SAND		
		FINE GRAINED SOILS More than 35% of the material less than 63 mm is less than 0.075 mm	A particle size of 0.075 is about the smallest size distinguishable to the naked eye	IDENTIFICATION PROCEDURES ON FRACTIONS < 0.075 mm				
				SILTS AND CLAYS Liquid Limit < 50%	DRY STRENGTH	DILATANCY	TOUGHNESS	GROUP SYMBOL
None to low	Slow to rapid				Low	ML	SILT	
Medium to high	≥ 12% clayey fines				Medium	CL, CI*	CLAY	
Low to medium	Slow				Low	OL	ORGANIC SILT	
SILTS AND CLAYS Liquid Limit > 50%	Low to medium			None to slow	Low to medium	MH	SILT	
	High to very high			None	High	CH	CLAY	
	Medium to high			None to very slow	Low to medium	OH	ORGANIC CLAY	
HIGHLY ORGANIC SOILS: readily identified by colour, odour, spongy feel and frequently fibrous texture					PT	PEAT		

* CL is low plasticity clay, CI is medium plasticity clay

Description of Rock

- i. Rock name (BLOCK LETTERS)
- ii. Grain size and mineralogy
- iii. Colour
- iv. Fabric and texture
- v. Features, inclusions, minor components, moisture content and durability
- vi. Strength
- vii. Weathering and/or alteration
- viii. Rock mass properties – discontinuities and structure of rock
- ix. Interpreted stratigraphic unit
- x. Additional observations including geological structure

Simple rock names are used to provide a reasonable engineering description, rather than a precise geological classification. The rock name is chosen by considering the nature and shape of the grains or crystals, the texture and fabric of the rock material, the geological structure and setting, and information from the geological map of the area. Further guidance on the naming of rocks can be found in AS1726-2017, Tables 15, 16, 17 and 18. Typical rock types are described below, though subject to site specific variations.

Rock Type	Description	Example of Rock Name
Sedimentary	Formed by deposited beds of sediments, have grains that are cemented together and often rounded. Significant porosity	COMMON: Conglomerate, Breccia, Sandstone, Mudstone, Siltstone, Claystone ≥90% CARBONATE: Limestone, Dolomite, Calcirudite, Calcarene, Calcisiltite, Calcilutite PYROCLASTIC: Agglomerate, Volcanic Breccia, Tuff
Igneous	Formed from molten rock and have a crystalline texture. Typically massive and low porosity. Rock types are from coarse to fine grained.	HIGH QUARTZ CONTENT: Granite, Microgranite, Rhyolite MODERATE QUARTZ CONTENT: Diorite, Microdiorite, Andesite LOW QUARTZ CONTENT: Gabbro, Dolerite, Basalt
Metamorphic	Formed when rocks are subject to heat and/or pressure and have typically have directional fabric. Typically have low porosity and crystalline structure. Rock types are from coarse to fine grained	FOLIATED: Gneiss, Schist, Phyllite, Slate NON-FOLIATED: Marble, Quartzite, Serpentinite, Hornfels
Duricrust	Formed as part of a weathering profile and show evidence of being cemented in situ. Cementation is typically irregular and exhibits replacement textures.	Ferricrete (Iron oxides and hydroxides) Silicrete (Silica) Calcrete (Calcium carbonate) Gypcrete (Gypsum)

Note: () denotes dominant cementing mineralogy

Grain Size

Terms describing dominate grain size in sedimentary rocks.

Term	Grain size
Coarse	Mainly 0.6 mm to 2 mm
Medium	Mainly 0.2 mm to 0.6 mm
Fine	Mainly 0.06 mm (just visible)

Terms describing dominate grain size in igneous and metamorphic rocks

Term	Grain size
Coarse	Mainly greater than 2 mm
Medium	0.06 mm to 2 mm
Fine	Mainly less than 0.06 mm (just visible)

Texture and Fabric

Sedimentary rocks

Thickness	Bedding Term
< 6 mm	Thinly laminated
6 – 20 mm	Laminated
20 – 60 mm	Very thinly bedded
60 – 200 mm	Thinly bedded
0.2 – 0.6 m	Medium bedding
0.6 – 2 m	Thickly bedded
> 2 m	Very thickly bedded

Igneous rocks

Term	Definition
Amorphous	Indicates that the rock has no obvious crystalline structure
Crystalline	A regular molecular structure, showing crystal structure and symmetry.
Cryptocrystalline	The texture comprises crystals that are too small to recognise under an ordinary microscope. Indistinctly crystalline.
Porphyritic	Indicates the presence of phenocrysts (relatively large crystals in a fine grained ground mass) in igneous rocks.
Flow banded	Indicates visible flow lines in volcanic rocks and some intrusive rocks
Glassy	Entirely glass like. No crystalline units and without crystalline structure.
Vesicular	A texture of volcanic rocks that indicates the presence of vesicles (small gas bubbles). Where the vesicles are filled with a mineral substance they are termed Amygdales and the texture is Amygdaloidal.

Metamorphic

Term	Definition
Foliation	The parallel arrangement of minerals due to metamorphic process, which shall be defined by the terms in weak, moderate and strongly foliated.
Porphyroblastic	A texture indicating the presence of porphyroblasts (larger crystals formed by recrystallization during metamorphism, such as garnet or staurolite in a mica schist).
Cleavage	A type of foliation developed in fine grained metamorphic rocks such as slates.

Bedding and Fabric Development

Type	Definition
Massive	No obvious development of bedding – rock appears homogeneous
Poorly Developed	Bedding is barely obvious as faint mineralogical layering or grain size banding, but bedding planes are poorly defined.
Well Developed	Bedding is apparent in outcrops or drill core as distinct layers or lines marked by mineralogical or grain size layering.
Very Well Developed	Bedding is often marked by a distinct colour banding as well as by mineralogical or grain size layering.
Indistinct fabric	There is little effect on strength properties
Distinct Fabric	The rock may break more easily parallel to the fabric

Rock Strength

Term (Code)	UCS (MPa)	Is ₍₅₀₎ (MPa)	Field Guide to Strength
Soil Strength (SS)	<0.6	<0.03	Soil strength materials, formerly classified as Extremely Low Strength rock, as to be assigned a soil strength based on the soil characteristics: granular or cohesive. Where strength ranges between soil and Very Low Strength rock, Soil Strength may be used for transitional strengths.
Very Low (VL)	0.6 – 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 3 cm thick can be broken by finger pressure.
Low (L)	2 – 6	> 0.1 to ≤ 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blow of the pick point; has dull sound under hammer. A piece of core 150 mm long 50 mm in diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium (M)	6 – 20	> 0.3 to ≤ 1.0	Readily scored with a knife; a piece of core 150 mm long by 50 mm in diameter can be broken by hand with difficulty.
High (H)	20 – 60	> 1 to ≤ 3	A piece of core 150 mm long by 50 mm in diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High (VH)	60 – 200	> 3 to ≤ 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High (EH)	>200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Rock strength is assessed by laboratory Uniaxial Compressive Strength (UCS) testing and/or Point Load Strength Index (PLT) testing to obtain the Is₍₅₀₎ the strength table implies a 20 times correlation between Is₍₅₀₎ and UCS used for classification. Note however, multiplier may range from 4 (e.g. some carbonated and low strength rocks) to 40 (e.g. some igneous rocks and/or some high strength rocks). A site specific correlation based on testing, previous investigation or literature may be used where available. These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considered weaker due to the effect of rock defects. Material with strength less than Very Low are described using soil characteristics including consistency / density as detailed on page 4.

Visual Log

A detailed core photo or diagrammatic plot of defects showing type, spacing and orientation in relation to the core axis.

	Defects open in-situ or clay sealed
	Defects closed in-situ
	Drill induced fractures or handling breaks
	Infilled seam

Rock Weathering and or Alteration Classification

Term (Code)	Definition		
Residual soil (RS)	Soil developed on extremely weathered rock. The rock mass structure and substance fabric are no longer evident but the soil has not been significantly transported.		
Extremely weathered (XW)	Rock is weathered to such an extent that it has 'soil' properties, i.e, it either disintegrates or can be remoulded in water, but the texture of original rock is still evident.		
Extremely altered (XA)			
Highly weathered (HW)	Distinctly weathered (DW)*	Whole rock material is discoloured usually by extent that iron staining or bleaching and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original rock substance is no longer recognisable	*Where is it not practical to distinguish between 'HW' and MW'. 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
Highly Altered (HA)		Distinctly Altered (DA)	
Moderately weathered (MW)		Whole rock material is discoloured usually by staining that original colour of the fresh rock is no longer recognisable	
Moderately Altered (MA)			
Slightly weathered (SW)	Rock is slightly discoloured but shows little or no change of strength from fresh rock		
Slightly altered (SA)			
Fresh rock (F)	Rock shows no sign of decomposition or staining.		

Rock Core Recovery

TCR = Total Core Recovery (%)

$$\frac{\text{Length of Core Recovered}}{\text{Length of Core run}} \times 100$$

SCR = Solid Core Recovery (%)

$$\frac{\text{Sum Length of Cylindrical Core Recovered}}{\text{Length of Core run}} \times 100$$

RQD = Rock Quality Designation (%)

$$\frac{\text{Sum Length of Sound Core Pieces > 100mm in length}}{\text{Length of Core run}} \times 100$$

Types of Defects

Term		Code	Description
Parting		PT	A surface or crack across which the rock has little or no tensile strength. Parallel or sub-parallel to layering (e.g. bedding) or a planar anisotropy in the rock material (i.e. cleavage). May be opened or closed.
Joint		JT	A surface or crack with no apparent shear displacement and across which the rock has little or no tensile strength, but which is not parallel or sub-parallel to layering or to planar anisotropy in the rock material. May be open or closed.
Sheared Surface		SR	A near planar, curved or undulating surface which is usually smooth, polished or slickensided and which shows evidence of shear displacement.
Sheared Zone		SZ	Zone of rock material with roughly parallel, near planar, curved, or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.
Crushed Zone ^a		CZ	A zone of broken and disturbed ground containing more than one identifiable Crushed Seam.
Fracture Zone ^a		FZ	A zone of broken ground with parallel to opposing boundaries dominated by abundant, extremely closely to closely spaced defects, which may be intact or open, and planar, curved, undulating, irregular, or stepped, resulting in a dissected rock mass of angular trapezoidal, triangular or rectangular fragments.
Seam (SE)	Sheared Seam	SS	Seam of soil material with roughly parallel almost planar boundaries, composed of soil materials with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.
	Crushed Seam	CS	Seam of soil material with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock material which may be more weathered than the host rock. The seam has soil properties.
	Infilled Seam	IS	Seam of soil material usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1 mm thick may be described as a veneer or coating on a joint surface.
	Extremely Weathered Seam	XS	Seam of soil material, often with gradational boundaries. Formed by weathering of the rock material in place.
Fault ^b		FT	A fracture (defect) or fracture zone along which there has been an observable amount of displacement.
Vein ^c		VE	Any fracture that contains mineralized material. Veins can display either crack-normal extension or shear displacement coupled with crack-normal extension.
Vugh ^a		VG	An open void with secondary crystallisation which may be coated, partly or nearly completely filled.
Void ^a		VO	An open space created through natural or anthropogenic processes, including, but not limited to, caves, kettles, tunnels, mines, pipes, piping, landslides, faulting, shearing, dissolution, & erosion.
Mechanical Break		MB	A fracture or break induced or created by the sampling process (i.e. drilling (DB) handling (HB), drill lift (DL), excavation, or blasting).

All definitions as per AS1726-2017 except: ^a SMEC Field Manual, ^b British Standard BS 5930:2015, and ^c Glossary of Geology (Fifth Edition - revised) 2011) American Geosciences Institute.

Discontinuity Planarity

Code	Description
CR	Curved – A defect with a gradual change in orientation
IR	Irregular – A defect with many sharp changes in orientation
PL	Planar – Defect forms a continuous plane without variation in orientation
ST	Stepped – A defect with distinct sharp steps or step
UN	Undulose – A defect with undulations
VG	Vuggy – An open void with crystallisation
WV	Wavy – A wavy defect surface

Discontinuity Roughness

Abbreviation	Description
RO	Rough – Many small surface irregularities generally related to the grain size of the parent rock
SM	Smooth – Few or no surface irregularities related to the grain size of the parent rock
PO	Polished – Planes have a distinct sheen or a smoothness
SL	Slickensided – Planes have a polished, grooved or striated surface consistent with differential movement of the parent rocks along the plane
VR	Very rough – many large surface irregularities, amplitude generally more than 1mm

Type of Structures

Term	Code	Description
Bedding	BD	A layered arrangement of minerals parallel to the surface of deposition which has caused planar anisotropy in the rock substance.
Cleavage	CV	An alignment of fine grained minerals caused by deformation.
Schistosity	SH	A layered arrangement of minerals to each other
Foliation	FO	A planar alignment of minerals caused by deformation.
Void	VO	A completely empty space
Dyke	DK	Sheet-like bodies of igneous rock that cut across sedimentary bedding or foliations in rocks. They may be single or multiple in nature
Sill	SL	A sill is an intrusion of magma that spreads underground between the layers of another kind of rock
Contact	CX	A contact between intrusive and stratigraphic units.
Boundary	BN	A distinct boundary between two stratigraphic units

Note: Drill breaks (DB) and handling breaks (HB) are not included as natural discontinuity.

Discontinuity Spacing

Spacing (mm)	Description
>6000	Extremely Widely Spaced
2000 - 6000	Very Widely Spaced
600 - 2000	Widely Spaced
200 - 600	Medium Spaced
60 - 200	Closely Spaced
20 - 60	Very Closely Spaced
<20	Extremely Closely Spaced

Relative Strength Index

A diagrammatical representation of soil and rock strength level. Rock is to the right of center line, increasing in strength and soil to the left is decreasing in strength.

Infill Material

Code	Name	Code	Name
AM	Azurite / Malachite	Ga	Galena
Ap	Apatite	Gp	Gypsum
Ca	Calcite	He	Hematite
Co	Coal	Is	Ironstone
Ch	Chlorite	Mn	Manganese
Cl	Clay	Pl	Pyrolusite
Cp	Chalcopyrite	Py	Pyrite
Cy	Chalcedony	Sd	Siderite
Ep	Epidote	Se	Serpentine minerals
Fe	Limonite/Goethite	Sp	Sphalerite
FeO	Iron oxide	Um	Unidentified mineral
Fs	Feldspar (K)	Qz	Quartz
FsC	Feldspar (Ca/Na)	X	Carbonaceous
		Ze	Zeolite

Discontinuity Observation

Term	Code	Description
Clean	CN	No visible coating or infill
Stain	SN	No visible coating or infill but surfaces are discoloured by mineral staining
Veneer <1 mm	VN	A visible coating or soil or mineral substance but usually unable to be measured. If discontinuous over the plane, patchy veneer.
Coating >1 mm to <10 mm	CT	A visible coating or infilling of soil or mineral substance. Describe composition and thickness.
Filling (Filled) >10 mm	FD	A visible filling of soil or mineral substance. Describe composition and thickness.

Discontinuity Orientation

Code	Description
VT	Vertical
HO	Horizontal
RL	Top right to bottom left
LR	Top left to bottom right

Discontinuity Nature

Code	Description
C	Crushed
DL	Dilated
DS	Displaced
HL	Hairline
HE	Healed
IF	Infilled
IT	Intact

Samples and Field Tests

Code	Description
B	Bulk disturbed sample
BLK	Block sample
C	Core sample
DS	Small disturbed sample
ES	Soil sample for environmental testing
EW	Water sample for environmental testing
FP	Pressuremeter
G	Gas sample
H	Hydraulic fracturing
HP	Hand penetrometer test
I	Impression device
IS ₍₅₀₎	Point Load Index
K	Permeability
LB	Large bulk disturbed sample
N	Standard penetration test result (N* denotes SPT sample recovery)
O	Core orientation
P	Piston sample
PID	Photoionisation detector reading in ppm
R	Hammer bouncing / refusal
SPT	Standard Penetration Test
U	Undisturbed push in sample
UCS	Uniaxial Compressive Strength
U50	Undisturbed tube sample (50 mm diameter)
U75	Undisturbed tube sample (75 mm diameter)
VS	Vane shear test
● (A)	Axial Test
○ (D)	Diametral Test
□	Irregular Lump test

Completion Details

Type	Description
Collapse	Exploratory hole collapsed before reaching planned depth
Equipment Failure	Boring or excavator equipment operational failure
Flooding	Flooding of excavation
Machine Limit	Limit of machine capability reached
Obstruction	Obstruction preventing further advancement
Possible services	Indication of possible services below
Services present	Services encountered during exploratory hole
Squeezing	Hole squeezing boring equipment
Target Depth	Depth reached as planned
Target Depth Instrumentation Installed	Depth reached as planned instrumentation installed
Target Depth Standpipe Installed	Depth reached as planned open standpipe constructed
Material Refusal	Material preventing further advancement

Laboratory Tests

Code	Description
ACM	Asbestos Containing Material
CD	Consolidated Drained
CU	Consolidated Undrained
LL	Liquid Limit
LS	Linear Shrinkage
MC	Moisture Content
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
PBT	Plate Bearing Test
PI	Plasticity Index
PL	Plastic Limit
PSD	Particle Size Distribution
ρ_b	Bulk Density
ρ_p	Particle Density
ρ_d	Dry Density
UU	Undrained Unconsolidated

Backfill / Standpipe Detail

Symbol	Description	Symbol	Description
	Cement seal		Filter pack: sand filter
	Grout backfill		Filter pack: gravel filter
	Blank pipe		Bentonite seal
	Slotted pipe		Cutting – excavated material backfill
	Surface Completion: Monument Above Ground		Surface Completion: Gatic Ground Monument

Status

Code	Description
-2	Historic
-1	For information
0	Preliminary
1	Checked
2	Draft
3	Final

Project NSW Ambulance Infrastructure Program - Contam

Location Gateshead

East 378721.00 m

Sheet

1 OF 1

Position

North 6348892.00 m MGA2020 Zone 56

Job No. 30018086

Contractor Total Drilling

Date Started 08/06/2023

Client Health Infrastructure NSW

Drill Rig D & B 8D

Date Completed 08/06/2023

Inclination -90° Direction: 000° Hole Dia. 125 mm Logged

YE

BOREHOLE: BH01

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE & SPT	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE, FIELD TEST & Other Observations
Auger - Solid Flight (125 mm)			0.0	0.05					ASPHALT. FILL Gravelly SAND: fine to medium grained, poorly graded, dark grey, fine to medium grained angular gravel.			ASPHALT FILL
							SP		M			
	F		0.70					Sandy CLAY: medium plasticity, yellow-brown mottled red, fine to medium grained sub-angular sand.	w>PL		ALLUVIAL SOIL 0.70-4.45: Interbedded between clay and sand.	
			1.00m SPT 5, 4, 4 N=8		CI		St					
	F		1.50	1.45m				Clayey SAND: fine to medium grained, poorly graded, yellow-brown mottled red-brown, high plasticity clay.	w<PL			
								2.00: becoming red-brown mottled orange-brown				
			2.50m SPT 9, 9, 11 N=20		SC		MD					
	VH			2.95m					M			
			4.00	4.00m SPT 9, 19, 16 N=35					D			
			4.45	4.45m					W	4.40: Possible groundwater level at around 4.4m.		
			4.5					BH Terminated at 4.45 m				

Comments

Checked

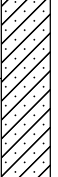
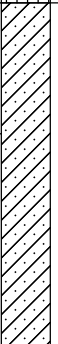
Date

Project NSW Ambulance Infrastructure Program - Contam
Location Gateshead
Position
Job No. 30018086
Client Health Infrastructure NSW

East 378735.00 m
North 6348878.00 m MGA2020 Zone 56
Contractor Total Drilling
Drill Rig D & B 8D
Inclination -90° Direction: 000° Hole Dia. 125 mm

BOREHOLE: BH02

Sheet 1 OF 1
Date Started 08/06/2023
Date Completed 08/06/2023
Logged YE

Drilling				Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE & SPT	RECOVERED GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE, FIELD TEST & Other Observations
Auger - Solid Flight (125 mm)			0.0					ASPHALT.			ASPHALT FILL
							SP	FILL Gravelly SAND: fine to medium grained, poorly graded, dark grey, fine to medium grained angular gravel.			
			0.50m		SPT 12, 5, 3 N=8						
			0.67				SC	Clayey SAND: fine to medium grained, poorly graded, yellow-brown, high plasticity clay, trace gravel.	M		0.65-5.00: Interbedded between sand and clay.
	VE				0.95m					L	ALLUVIAL SOIL
			1.30				CH	Sandy CLAY: high plasticity, yellow-brown mottled red, fine to medium grained sub-angular sand.			
			1.50m		SPT 4, 4, 5 N=9						
			1.95m								
	F								w<PL	St	
			3.00		3.00m	SPT 5, 6, 8 N=14		SC	Clayey SAND: fine to medium grained, red-brown mottled yellow-brown, low plasticity clay, moderately cemented. 3.10: becoming pale brown mottled pale grey and yellow-brown		
		3.45m									
								3.80: becoming yellow-brown mottled pale brown	M	MD	
		4.20					CH	Sandy CLAY: high plasticity, pale grey mottled pale brown, fine to medium grained sand.			
F										St	
		4.50m		SPT 10, 10, 13 N=23					w<PL	VSt	
		4.90					SC	Clayey SAND: fine to medium grained, poorly graded, pale brown mottled pale grey.	W	L	
VE			5.00	4.95m				BH Terminated at 5.00 m Target depth			

Comments

Checked
Date



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Project NSW Ambulance Infrastructure Program - Contam

Location Gateshead

East 378737.00 m

Sheet 1 OF 1

Position

North 6348854.00 m MGA2020 Zone 56

Job No. 30018086

Contractor Total Drilling

Date Started 08/06/2023

Client Health Infrastructure NSW

Drill Rig D & B 8D

Date Completed 08/06/2023

Inclination -90° Direction: 000° Hole Dia. 125 mm Logged YE

BOREHOLE: BH03

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE & SPT	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE, FIELD TEST & Other Observations
Auger - Solid Flight (125 mm)	VE	Not Encountered	0.0	0.05					ASPHALT.			ASPHALT
								FILL Gravelly SAND: fine to medium grained, poorly graded, dark grey, fine to medium grained angular gravel.			FILL	
			0.5	0.65	0.50m SPT 4, 4, 2 N=6		SP					
								Silty SAND: fine to medium grained, sub-angular, yellow-brown, non plastic silt, trace fine grained sub-angular gravel.			ALLUVIAL SOIL	
			1.0	0.95m								
			1.5	1.50m SPT 8, 4, 3 N=7		SM	1.60-1.70: pale brown, colour band, cemented	M	L			
			2.0	1.95m								
			2.5	2.50				Sandy CLAY: medium plasticity, yellow-brown, fine grained sand.		F		
			3.0	3.00m SPT 4, 5, 7 N=12		CI	3.00: becoming yellow-brown mottled red-brown, with sand, iron stained	w<PL				
			3.5	3.45m			3.40: becoming pale grey 3.60: becoming red-brown		St			
	F		4.0	4.00				Clayey SAND: fine to medium grained, poorly graded, yellow-brown mottled pale grey, high plasticity clay.		MD		
			4.5	4.50m SPT 16, 15, 20 N=35		SC	4.50: becoming yellow-brown mottled red-brown	M				
									D			
			5.00	4.95m				BH Terminated at 5.00 m Target depth				

Comments

Checked

Date



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Project NSW Ambulance Infrastructure Program - Contam

Location Gateshead

East 378760.00 m

Sheet

1 OF 1

Position

North 6348874.00 m MGA2020 Zone 56

Job No. 30018086

Contractor Total Drilling

Date Started 07/06/2023

Client Health Infrastructure NSW

Drill Rig D & B 8D

Date Completed 08/06/2023

Inclination -90° Direction: 000° Hole Dia. 125 mm

Logged YE

BOREHOLE: BH04

Drilling			Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE & SPT	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE, FIELD TEST & Other Observations
Auger - Solid Flight (125 mm)	F	Not Encountered	0.0	0.05				GP	ASPHALT. FILL Sandy GRAVEL: fine to medium grained, dark grey, fine to medium grained sand.	M		ASPHALT FILL
			0.40									
			0.5	0.50m SPT 4, 6, 7 N=13		SC	FILL Clayey SAND: fine to medium grained, poorly graded, brown, high plasticity clay.					
			0.90	0.95m			0.80-0.87: colour band, dark brown	w<PL	St	ALLUVIAL SOIL 0.90-5.00: Interbedded between sand and clay.		
			1.0			CH	Sandy CLAY: high plasticity, yellow-brown, fine grained sand.					
			1.5	1.50m SPT 6, 5, 10 N=15								
			1.95m				2.00: becoming yellow-brown mottled red-brown					
			2.30			SC	Clayey SAND: fine to medium grained, poorly graded, yellow-brown mottled red-brown, high plasticity clay.		MD			
			3.0	3.00m SPT 10, 14, 15 N=29		SP	SAND: fine to medium grained, poorly graded, yellow-brown mottled red-brown, with low plasticity clay.	M	D			
			3.5	3.45m			SAND: fine to medium grained, poorly graded, yellow-brown. 3.70-4.00: colour band, yellow					
			4.0			SP						
4.5	4.50m SPT 10, 17, 18 N=35											
5.0	4.95m			BH Terminated at 5.00 m Target depth								

Comments

Checked

Date

Project NSW Ambulance Infrastructure Program - Contam

Location Gateshead

Position

Job No. 30018086

Client Health Infrastructure NSW

East 378756.00 m

North 6348861.00 m MGA2020 Zone 56

Contractor Total Drilling

Drill Rig D & B 8D

Inclination -90° Direction: 000° Hole Dia. 125 mm

Sheet 1 OF 1

Date Started 08/06/2023

Date Completed 08/06/2023

Logged YE

BOREHOLE: BH05

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE & SPT	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE, FIELD TEST & Other Observations
Auger - Solid Flight (125 mm)	VE	F	0.0	0.05					ASPHALT.			ASPHALT FILL
			0.20				SP	FILL Gravelly SAND: fine to medium grained, poorly graded, dark grey, fine to medium grained angular gravel.				
								FILL Clayey SAND: fine to medium grained, poorly graded, yellow-brown, high plasticity clay.	M			
			0.50	0.50m SPT 6, 4, 4 N=8		SC			L			
			0.70					CLAY: high plasticity, yellow-brown, trace sand.			ALLUVIAL SOIL 0.70-5.00: Interbedded between sand and clay.	
			0.95									
			1.50	1.50m SPT 5, 6, 9 N=15		CH		w<PL	St			
			1.95									
			2.00					Clayey SAND: fine to medium grained, poorly graded, yellow-brown, low plasticity clay.				
			2.50							MD		
VH		F	3.00	3.00m SPT 7, 14, 17 N=31				3.10-3.20: colour band, pale grey				
			3.45				SC		M			
			4.50	4.50m SPT 14, 16, 20 N=36				4.50: becoming orange-brown mottled yellow-brown		D		
			4.95					BH Terminated at 5.00 m Target depth				
Auger - Solid Flight (125 mm)			Not Encountered									

Comments

Checked

Date



Member of the Surbana Jurong Group

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