GEOTECHNICAL INVESTIGATION

FOR

NSW LAND AND HOUSING CORPORATION

46 Chester Avenue, Maroubra, NSW (BGZ93)

Report No: 22/2860

Project No: 31864/6656D-G

August 2022

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Document Control

Report Title: Geotechnical Investigation

Report No: 22/2860

Revision	Details	Date	Amended By
0	Original	August 22, 2022	

Following advice from the Building Commissioner, the advice, recommendations and design parameters provided in this report are only valid and to be relied upon if geotechnical inspections of footings and support/shoring systems are conducted by STS Geotechnics during construction.

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1. INTRODUCTION

This report presents the results of a Geotechnical Investigation carried out by STS Geotechnics Pty Limited (STS) for the proposed new construction at 46 Chester Avenue, Maroubra. At the time of writing this report STS were not provided with architectural drawings for the project. It is understood, the proposed development comprises 3 or 4 above ground levels and a basement that will require excavating to a depth of 3 metres below the existing ground surface. The purpose of the investigation was to provide information on:

- Site conditions and regional geology,
- Subsurface conditions,
- Site Classification according to AS2870,
- Excavation conditions and support, including vibration control during rock excavation,
- Maximum permissible temporary and permanent batter slopes and retaining wall design parameters,
- WALLAP design parameters for all materials encountered,
- Foundation design parameters including foundation options, and
- Soil aggressiveness to buried steel and concrete in accordance with AS2870 and AS2159.

The investigation was undertaken in accordance with STS proposal P22-385 dated July 5, 2022.

Our scope of work did not include a contamination assessment.

2. FIELDWORK DETAILS

The fieldwork consisted of drilling two (2) boreholes numbered BH1 and BH2, at the locations shown on Drawing No. 22/2860. Restricted site access dictated the borehole locations. The boreholes were drilled using a track mounted Commachio Geo205 drilling rig equipped with Tungsten-Carbide (T-C) bit and NMLC diamond coring equipment. The drilling rig is owned and operated by GeoSense Drilling.

Soils were drilled using rotary solid flight augers. Soil strengths were determined by undertaking Standard Penetration Tests (SPT) and visual observation of the recovered rock cuttings at each borehole location. The recovered cores were boxed on site and brought back to the STS laboratory where cores were logged, photographed, and point load tests were carried out. To measure the groundwater levels, a monitoring well was installed in BH1.

The subsurface conditions observed are recorded on the borehole logs given in Appendix A together with photographs of the recovered rock core and results of the point load testing. An explanation of the terms used on the logs is also given in Appendix A. Notes relating to geotechnical reports are also given in Appendix A.

3. LABORATORY TESTING

To assess the soils for their aggressiveness, representative soil samples were tested to determine the following:

- Electrical Conductivity,
- pH,
- Sulfate content as $S0_4$,
- Chloride content as CL.

To assist in in the assessment of rock strength, Point Load Strength Index was determined. Tests were carried out on the core samples from the boreholes.

Detailed test reports are given in Appendix B.

4. GEOLOGY AND SITE CONDITIONS

The Sydney geological series sheet at a scale of 1:100,000 shows the site is underlain by Quaternary Age depositions. Materials typically comprise medium to fine grained marine sand with podsols. The site is located close to the geological boundary with Triassic Age Hawkesbury Sandstone. Rocks within this formation comprise mainly medium to coarse grained quartz sandstone.

The site is rectangular in shape and at the time of the fieldwork, the site was occupied by an existing single-storey house. Site vegetation comprises grasses, trees, and shrubs. The ground surface falls approximately 1 metre to the east.

The site is bound by Chester Avenue to the east and residential dwellings in the adjoining properties.

5. SUBSURFACE CONDITIONS

5.1. Stratigraphy

When assessing the subsurface conditions across a site from a limited number of boreholes, there is the possibility that variations may occur between test locations. The data derived from the site investigation programme are extrapolated across the site to form a geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour regarding the proposed development. The actual condition at the site may differ from those inferred, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies, particularly on a site such as this that has been previously developed.

The stratigraphy observed in the geotechnical Investigation has been grouped into four geotechnical units. A summary of the subsurface conditions across the site, interpreted from the assessment results, is presented in Table 5.1. More detailed descriptions of subsurface conditions at each borehole location are available on the borehole logs presented in **Appendix A**. The details of the methods of soil and rock classifications, explanatory notes and abbreviations adopted on the borehole logs are also presented in **Appendix A**.

Table 5.1 – Stratigraphy Summary

Unit	Material	Depth to Top of Unit (m)[1]	Observed Thickness (m)	Comments
1	Topsoil	Surface	0.4 to 0.7	Brown to light brown, grey and orange, silty sand, fine to medium grained, with some roots.
2	Very Loose to Loose Silty Sand and Sand	0.4 to 0.7	3.3 to 3.7	Orange-brown, silty sand, fine to medium grained overlying light grey to grey to light brown clean sands fine to medium grained.
3	Sandstone (Class IV/V)	4.0 to 4.1	1.9 to 2.8	Pale grey to grey and grey - brown, very low to low strength, extremely to distinctly weathered sandstone with clay seams.
4	Sandstone (Class III)[2]	6.8	0.45	Pale grey, generally medium strength, distinctly weathered to fresh.

Notes:

1. Approximate depth at the time of our assessment. Depths and levels may vary across the site.
2. Based on our experience, the medium strength rock in BH1 and BH2 and high strength rock at the bottom of BH1 are assumed as a higher strength band in a low strength rock.

5.2. Groundwater Observation

Following completion of drilling, a groundwater monitoring well was installed in BH1. Water circulation due to coring within the borehole prevented further observation of groundwater level within BH1. A secondary site visit was conducted on 16 August 2022, to measure the monitoring well. The groundwater level was measured at 2.5 metres below the existing ground level.

6. DISCUSSION

6.1. Site Classification

A site classification to AS2870 is not technically relevant for a development involving basement construction such as this, however it does provide a useful indication of the potential shrink/swell movements onsite due to soil reactivity.

The classification has been prepared in accordance with the guidelines set out in the "Residential Slabs and Footings" Code, AS2870 – 2011.

Because of the topsoil thickness greater than 400mm and underlying very loose sands to a depth greater than the proposed depth of excavation, 3.0metres, the site is classified as a *Problem Site (P).* Because of the presence of low strength very loose sands, it is not appropriate to reclassify the site.

6.2. Excavation Conditions

Based on the subsurface conditions observed in boreholes, the proposed basement excavation is expected to encounter topsoil, silty sands, and sands. Excavators without assistance should be able to remove the soils.

In the unlikely event sandstone requires excavation, care will be required to ensure that the structures on the subject site and buildings or other developments on adjacent properties are not damaged when excavating the rock. Excavation methods should be adopted which limit ground vibrations at the adjoining structures to not more than 5 mm/sec. Vibration monitoring may be required to verify that this is achieved.

The limits of 5 mm/sec are expected to be achievable if rock breaker equipment or other excavation methods are restricted as indicated in Table 6.1.

Table 6.1 - Recommendations for Rock Breaking Equipment

Distance from adjoining structure (m)	**Maximum Peak Particle Velocity 5 mm/sec**	
	Equipment	Operating Limit (% of Maximum Capacity)
1.5 to 2.5	Hand operated jackhammer only	100
2.5 to 5.0	300 kg rock hammer	50
5.0 to 10.0	300 kg rock hammer or 600 kg rock hammer	100 50

Use of other techniques (e.g., grinding, rock sawing), although less productive, would reduce or possibly eliminate risks of damage to property through vibration effects transmitted via the ground. Such techniques may be considered if an alternative to rock breaking is required.

If rock sawing is carried out around excavation boundaries in not less than 1-metre-deep lifts, a 900 kg rock hammer could be used at up to 100% maximum operating capacity with an assessed peak particle velocity not exceeding 5 mm/sec, subject to observation and confirmation by a geotechnical engineer at the commencement of excavation.

It should be noted that vibrations that are below threshold levels for building damage may be experienced at adjoining developments.

It would be appropriate before commencing excavation to undertake a dilapidation survey of any adjacent structures that may potentially be damaged. This will provide a reasonable basis for assessing any future claims of damage.

It should be noted that medium and high strength sandstone may be encountered during excavations/drilling for piled foundations at depths of approximately 4.1 to 5.6 metres. These materials will likely require large, say 30 tonnes, piling rig, to penetrate at a reasonable rate.

6.3. Temporary and Permanent Batter Slopes

Temporary slopes in the dry sand soils above the water table may be constructed at a maximum angle of 2H:1V. Where the basement is insufficiently setback from the site boundaries to allow for the use of temporary batters, a suitable retention system must be installed to support Units 1 and 2 prior to excavation commencing. Because of the groundwater present, the use of temporary batters should only be used after careful consideration and consultation with an experienced geotechnical engineer.

When considering the design of the supports, it will be necessary to allow for the loading from structures in adjoining properties, any ground surface slope, and the water table present. Where the structures in adjoining properties are within the zone of influence of the excavation, it will be necessary to adopt K_o conditions when designing the temporary support. Anchors or props can be used to provide the required support. If anchors extend into adjoining property, it will be necessary to obtain the permission of the property owners. When props or anchors are used for support, a rectangular earth pressure distribution should be adopted on the active side of the support. K_o should also be used to design the permanent support.

It is of course important that the onsite excavations do not endanger the adjacent properties. Excavations on the subject site should not extend below the zone of influence of any adjacent structure footings, without first installing temporary support or discussing the works with a geotechnical engineer.

6.4. Retaining Wall Design and Foundation Design Parameters

We do not recommend founding any structural loads in topsoil and very loose and loose sands. Upon completion of bulk excavation, the exposed material will likely comprise very loose to loose sands. The site is not considered suitable for slab on ground construction. Piles will be required to suspend the basement slab. Piles founded into weathered sandstone and better, may be designed for this purpose. The slab should be designed for movements consistent with a *stable site (A)* classification.

Table 6.2 – Design Parameters

Material[1]		Unit 1 Topsoil	Unit 2 Very Loose to Loose Silty Sand and Sand	Unit 3 Sandstone (Class IV/V)	Unit 4 Sandstone (Class III)
Depth to Top of Unit (m)[2]		Surface	0.5 - 1.0	3.2-4.1	4.4-5.1
Bulk Unit Weight ϒ (kN/m^3)		17	17	22	23
Friction Angle ϕ’ (°)		25	25	30	40
Cohesion, c’ (kPa)		0	0	100	200
Poisson’s ratio, v’		0.3	0.3	0.25	0.25
Young’s Modulus of Elasticity, E’ (MPa)		35	35	200	500
Earth Pressure Coefficients	At rest K_o[3]	0.6	0.6	0.5	0.35
	Active K_a[3]	0.4	0.4	0.3	0.22
	Passive K_p[3]	-	-	3.0	4.5
Allowable Bearing Pressure (kPa)[5]		-	-	800	3,500
Allowable Shaft Adhesion (kPa)[4,5]	In Compression	-	-	80	350
	In Uplift	-	-	40	175
Allowable Toe Resistance (kPa)		-	-	-	200
Allowable Bond Stress (kPa)		-	-	50	175

Notes:

1. More detailed descriptions of subsurface conditions are available on the borehole logs presented in **Appendix A.**
2. Approximate levels of top of unit at the time of our investigation. Levels may vary across the site.
3. Earth pressures are provided on the assumption that the ground behind the retaining walls is horizontal.
4. Side adhesion values given assume there is intimate contact between the pile and foundation material and should achieve a clean socket roughness category R2 or better. Design engineer to check both ‘piston pull-out’ and ‘cone lift out’ mechanics in accordance with AS4678-2002 Earth Retaining Structures.
5. To adopt these parameters, we have assumed that:
   - Footings have a nominal socket of at least 0.3m, into the relevant founding material;
   - For piles, there is intimate contact between the pile and foundation material (a clean socket roughness category of R2 or better);
   - Potential soil and groundwater aggressivity will be considered in the design of piles and footings;
   - Piles should be drilled in the presence of a Geotechnical Engineer prior to pile construction to verify that ground conditions meet design assumptions. Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremmie system could be used;
   - The bases of all pile, pad and strip footing excavations are cleaned of loose and softened material and water is pumped out prior to placement of concrete;
   - The concrete is poured on the same day as drilling, inspection, and cleaning.
   - The allowable bearing pressures given above are based on serviceability criteria of settlements at the footing base/pile toe of less than or equal to 1% of the minimum footing dimension (or pile diameter).

Geotechnical inspections of foundations are recommended to determine that the required bearing capacity has been achieved and to determine any variations that may occur between the boreholes and inspected locations.

In the event a finite element assessment (WALLAP) is required, the relevant soil and rock parameters are provided in Table 6.2.

6.5. Groundwater Conditions

Reference to Section 5.2 above, indicates that groundwater was observed at a depth of 2.5 metres in BH1. No long-term groundwater monitoring was carried out as part of this investigation.

Based on our observations, the basement excavation is expected to extend below the water table. We recommend that seepage monitoring be carried out during the excavation works to help determine the capacity of the drainage system.

It will be necessary to ensure the perimeter support is watertight to prevent water flow into the excavation. In this regard, a secant pile wall is considered the appropriate method of support. A contiguous pile wall will not be suitable because of the difficulty of sealing off the zone between the piles. Sheet pile walls are normally too permeable to use for this purpose, however, when combined with shotcrete they can be suitable. When installing sheet piles, the effects of vibrations during installation need to be considered.

An appropriately and sufficiently designed secant wall with a functioning cut off wall ensures there is minimal drawdown and negligible resultant ground settlement below adjoining sites with minimum dewatering requirements during construction within the basement excavation.

In the long-term removal of seepage may be required at the basement level. We expect that any seepage that does occur can be controlled by a conventional sump and pump system. We recommend that a sump-and-pump system be used both during construction and for permanent groundwater control below the basement floor slab.

The completed excavation and water inflows should be inspected by the hydraulic engineer to confirm that adequate drainage has been allowed for. Drainage should be connected to the sump-and-pump system and discharged into the stormwater system. The permanent groundwater control system should consider any possible soluble substances in the groundwater which may dictate whether groundwater can be pumped into the stormwater system.

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

6.6. Soil Aggressiveness

The aggressiveness or erosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of soil pH and the types of salts present, generally sulfates and chlorides. To determine the degree of aggressiveness, the test values obtained are compared to Tables 6.4.2 (C) and 6.5.2 (C) in AS2159 – 2009 Piling – Design and Installation.

The test results are summarised in Table 6.3.

Table 6.3 – Soil Aggressiveness Summary Table

Sample No.	Location	Depth (m)	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Electrical Conductivity (dS/m)	
						$EC_{1:5}$	EC_e
S1	BH1	0.4	5.9	<10	<10	0.008	0.1
S2	BH2	0.4	6.5	<10	<10	0.014	0.2

The soils on the site consist of high permeability soils constituting of silty sands and sands which are in groundwater. Therefore, the soil conditions A are considered appropriate (AS2159).

A review of the durability aspects indicates that:

- pH : minimum value of 5.9
- SO_4 : maximum value of <10 mg/kg (ppm) < 5000 ppm
- Cl : maximum value of <10 mg/kg (ppm) < 5000 ppm
- EC_e : maximum value of 0.2 dS/m

In accordance with AS2159-2009 the exposure classification for the onsite soils is non-aggressive for concrete as well as steel. In accordance with AS2870-2011 the soils are classified as A2.

Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that ECe values of 0.1 and 0.2 dS/m are consistent with the presence of non-saline soils.

7. FINAL COMMENTS

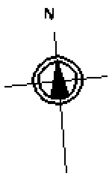
During construction, should the subsurface conditions vary from those inferred above, we would be contacted to determine if any changes should be made to our recommendations.

The exposed bearing surfaces should be inspected by a geotechnical engineer to ensure the allowable pressure given has been achieved.

Yours faithfully,

Krishna Shakya
Geotechnical Engineer
STS Geotechnics Pty Limited

Laurie Ihnativ
Principal Geotechnical Engineer
STS Geotechnics Pty Limited



STS Geotechnics Pty. Ltd.	Scale: Unknown	Date: August2022
Client: NSW LAND & HOUSING CORPORATION		
GEOTECHNICAL INVESTIGATION 46 CHESTER AVENUE, MAROUBRA BOREHOLE LOCATIONS		Project No. 31864/6656D-G Drawing No: 22/2860

NOTES RELATING TO GEOTECHNICAL REPORTS

Introduction

These notes have been provided to outline the methodology and limitations inherent in geotechnical reporting. The issues discussed are not relevant to all reports and further advice should be sought if there are any queries regarding any advice or report.

When copies of reports are made, they should be reproduced in full.

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, 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 (eg. design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (eg. a twenty storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by STS Geotechnics Pty Limited 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, STS Geotechnics Pty Limited would be pleased to resolve the matter through further investigation, analysis or advice.

Unforeseen Conditions

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, STS Geotechnics Pty Limited 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.

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 and/or observation spacings 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 or 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.

Supply of Geotechnical Information or Tendering Purposes

It is recommended tenderers are provided with as much geological and geotechnical information that is available and that where there are uncertainties regarding the ground conditions, prospective tenders should be provided with comments discussing the range of likely conditions in addition to the investigation data.

APPENDIX A – BOREHOLE LOGS, CORE PHOTOGRAPHS AND EXPLANATION SHEETS

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project / STS No. 31864/6656D-G	**BOREHOLE NO.: BH 1**
Project: 46 Chester Avenue, Maroubra	Date: July 28, 2022	
Location: Refer to Drawing No. 22/2860	Logged: KS Checked By: IW	Sheet 1 of 3

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S1 @0.4m		TOPSOIL: SILTY SAND: brown to light brown, fine to medium grained, plant roots	SM	-	M
	SPT 0.5-0.95 m 1, 1, 2 N = 3	1.0	SILTY SAND: orange brown, fine to medium grained	SM	VERY LOOSE	M
			grading to dark/orange/light brown		VERY LOOSE	
	SPT 1.5-1.95 m 2, 2, 2 N = 4		grading to light grey, grey brown			
WT@**2.5m**	SPT 3.0-3.45 m 2, 3, 5 N = 8	2.0, 3.0	SAND: light grey to grey brown (clean) fine to medium grained grading towards yellow brown At 3.3m, clay seams	SP	VERY LOOSE	W
		4.0, 5.0	AUGERING DISCONTINUED AT 4.0 M For core details, refer to core log sheets			

D - disturbed sample
U - undisturbed tube sample
B - bulk sample
WT - level of water table or free water
N - Standard Penetration Test (SPT)
S - jar sample

Contractor: Geosense
Equipment: Commachio Geo205
Hole Diameter (mm): 100
Angle from Vertical (^{o}): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS Geotechnics Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: NSW Land & Housing Corporation
Project: 46 Chester Avenue, Maroubra
Location: Refer to Drawing No. 22/2860

Project / STS No. 31864/6656D-G
Date: July 28, 2022
Logged: KS
Checked By: IW

BOREHOLE NO.: BH 1
Sheet 2 of 3

Method	Water	RQD (SCR)	Recovery / TCR	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
				1.0			
				2.0			
				3.0			
					For non core details, refer to non core log sheets		
				4.0	START CORING AT 4.0 M		
NMLC CORING	100%	25%	100%		SANDSTONE: grey brown, fine to medium grained, thinly to medium bedded, very low and low strength, distinctly weathered.	DW	4.0m, XWZ clay 600 mm
							4.6m, BP, 2 deg. PR, Ro, XWS, clay 2 mm
							4.83m, BP, 5 deg. PR, Ro, VNR, clay
				5.0			5.0m, BP, 5 deg. PR, Ro, VNR, clay
							5.1-5.5m, XWZ clay, sand 400 mm
							5.54, BP, 2 deg. PR, Ro, VNR, clay
	100%	79.4%	100%		5.6 - 5.9 metres, medium to coarse grained, grading to pale grey and medium strength		5.80m, BP, 2 deg. PR, Ro, VNR, clay
							5.92m, BP, 2 deg. PR, Ro, VNR, clay
							5.94m, BP, 2 deg. PR, Ro, VNR, clay
				6.0	5.9 - 6.7 metres, fine to medium grained, grading back to low strength		5.95-6.15m, XWZ, clay 200 mm

Estimated Rock Strength: Extremely Low, Very Low, Low, Medium, High, Very High, Extremely High
Average Defect Spacing (mm): 20, 40, 100, 300, 1000
Visual

Notes:

Contractor: Geosense Drilling
Equipment: Commachio Geo205
Hole Diameter (mm): 50 mm
Angle from Vertical (°): 0

See explanation sheets for meaning of all descriptive terms and symbols

STS Geotechnics Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: NSW Land & Housing Corporation
Project / STS No. 31864/6656D-G
BOREHOLE NO.: BH 1
Project: 46 Chester Avenue, Maroubra
Date: July 28, 2022
Location: Refer to Drawing No. 22/2860
Logged: KS
Checked By: IW

Method	Water	RQD (SCR)	Recovery / TCR	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength	Average Defect Spacing (mm) (20 / 40 / 100 / 300 / 1000)	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
NMLC CORING	100%	79.4%	100%		SANDSTONE: grey brown, fine to medium grained, thinly to medium bedded, low to medium strength, distinctly weathered	DW	Low	100–300		6.25m, XWS clay, 5mm
								40–100		6.66m, XWS, clay, 10 mm 6.70m, XWS, clay, 50 mm 6.76m, Jt, 60 deg. PP, Ro
				7.0	From 6.8metres grading to medium to high strebgth, fresh rock	Fr	High	100–300		6.83m, BP, 2 deg. PR, Ro, VNR clay 7.09m, BP, 2 deg. PR, Ro, VNR clay 7.2m, BP, 2 deg. PR, Ro, VNR clay
					CORING DISCONTINUED AT 7.25 M STANDPIPE PIEZOMETER INSTALLED					
				8.0						
				9.0						
				10.0						
				11.0						
				12.0						

Notes:

Contractor: Geosense Drilling
Equipment: Commachio Geo205
Hole Diameter (mm): 50 mm
Angle from Vertical (°): 0

See explanation sheets for meaning of all descriptive terms and symbols

GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

PROJECT: 46 CHESTER AVENUE, MAROUBRA
PROJECT NO. 31864/6656D-G
CLIENT: NSW LAND & HOUSING CORPORATION
BOREHOLE NUMBER: BH1
DEPTH (m) START 4.0m - 7.25m END

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project / STS No. 31864/6656D-G	**BOREHOLE NO.: BH 2**
Project: 46 Chester Avenue, Maroubra	Date: July 28, 2022	
Location: Refer to Drawing No. 22/2860	Logged: KS Checked By: IW	Sheet 1 of 2

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: SILTY SAND: grey, orange, light brown, fine to medium grained	SM	-	M
	S2 @0.4m SPT 0.5-0.95 m SW, SW, 1 N = 1		SILTY SAND: orange brown, fine to medium grained	SM	VERY LOOSE	M
		1.0	SAND: light brown (clean), fine to medium grained grading towards grey brown and wet	SP	VERY LOOSE	W
	SPT 1.5-1.95 m 1, 1, 2 N = 3					
		2.0	grading towards yellow brown pungent sewer odour			
	SPT 3.0-3.45 m SW, 4, 1 N = 5	3.0			LOOSE	
		4.0				
			AUGERING DISCONTINUED AT 4.1 M For core details, refer to core log sheets			
		5.0				

D - disturbed sample U - undisturbed tube sample B - bulk sample
WT - level of water table or free water N - Standard Penetration Test (SPT)
S - jar sample

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Geosense
Equipment: Commachio Geo205
Hole Diameter (mm): 100
Angle from Vertical (^{o}): 0
Drill Bit: Spiral

STS Geotechnics Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: NSW Land & Housing Corporation
Project / STS No. 31864/6656D-G
Project: 46 Chester Avenue, Maroubra
Date: July 28, 2022
Location: Refer to Drawing No. 22/2860
Logged: KS
Checked By: IW

BOREHOLE NO.: BH 2

DRILLING: Method	Water	RQD (SCR)	Recovery / TCR	Depth (m)	MATERIAL STRENGTH: Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength (Extremely Low / Very Low / Low / Medium / High / Very High / Extremely High)	DISCONTINUITIES: Average Defect Spacing (mm) (20 / 40 / 100 / 300 / 1000)	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
				1.0						
				2.0						
				3.0						
					For non core details, refer to non core log sheets					
				4.0	START CORING AT 4.1 M					
NMLC CORING	100%	66.3%	100%		SANDSTONE: pink-yellow-grey brown, medium to coarse grained, medium bedded, low to medium strength distinctly weathered.	DW	Medium	300–1000		4.1m, BP, 2 deg. PR, Ro
										4.5m, BP, 2 deg. Jt, 45 deg. PR, Ro, VNR clay
				5.0						
					From 5.3m grading to fine grained and low strength		Low	100–300		5.23m, BP, 5 deg. PR, Ro, XWS, clay 5 mm
										5.27-5.784m, XWZ, clay 470 mm
										5.90m, BP, 5 deg. PR, Ro, VNR clay
										5.98m, BP, 5 deg. PR, Ro, VNR clay
				6.0	BOREHOLE DISCONTINUED AT 6.0 M					6.0m, BP, 5 deg. PR, Ro, VNR clay

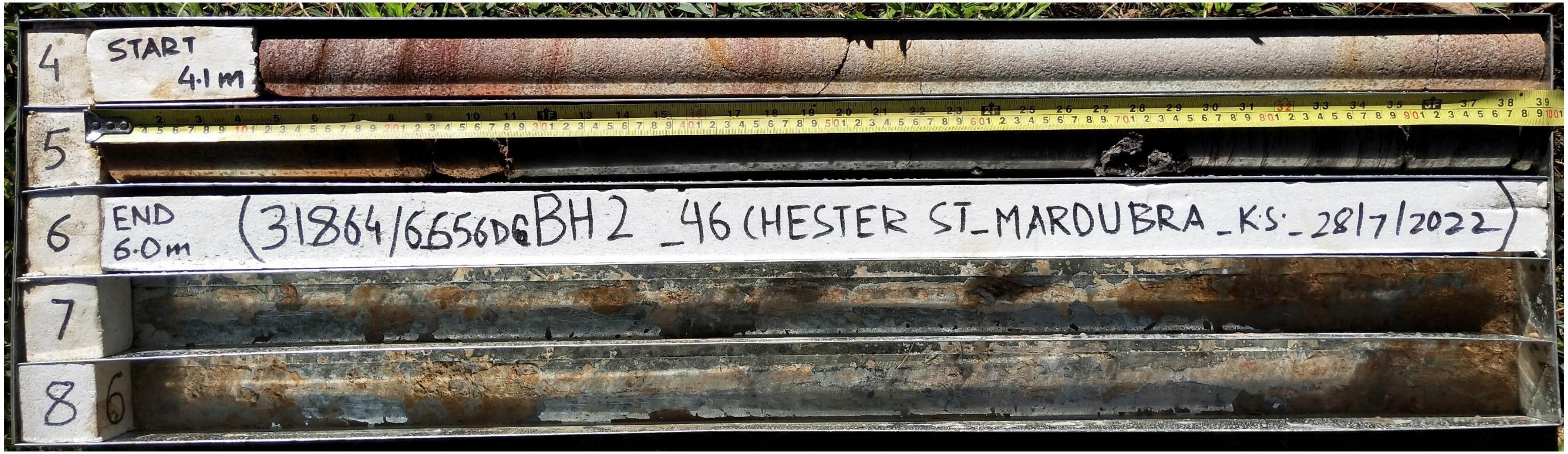
Notes:

Contractor: Geosense Drilling
Equipment: Commachio Geo205
Hole Diameter (mm): 50 mm
Angle from Vertical (°): 0

See explanation sheets for meaning of all descriptive terms and symbols

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

PROJECT: 46 CHESTER AVENUE, MAROUBRA
PROJECT NO. 31864/6656D-G
CLIENT: NSW LAND & HOUSING CORPORATION
BOREHOLE NUMBER: BH2
DEPTH (m) START 4.1m - 6.0m END



E1. CLASSIFICATION OF SOILS

E1.1 Soil Classification and the Unified System

An assessment of the site conditions usually includes an appraisal of the data available by combining values of engineering properties obtained by the site investigation with descriptions, from visual observation of the materials present on site.

The system used by STS Geotechnics Pty Ltd (STS) in the identification of soil is the Unified Soil Classification system (USC) which was developed by the US Army Corps of Engineers during World War II and has since gained international acceptance and has been adopted in its metricated form by the Standards Association of Australia.

The Australian Site Investigation Code (AS1726-2017, Appendix D) recommends that the description of a soil includes the USC group symbols which are an integral component of the system.

The soil description should contain the following information in order:

Soil composition

- SOIL NAME and USC classification symbol (IN BLOCK LETTERS)
- plasticity or particle characteristics
- colour
- secondary and minor constituents (name estimated proportion, plasticity or particle characteristics, colour

Soil condition

- moisture condition
- consistency or density index

Soil structure

- structure (zoning, defects, cementing)

Soil origin

interpretation based on observation eg FILL, TOPSOIL, RESIDUAL, ALLUVIUM.

E1.2 Soil Composition

(a) Soil Name and Classification Symbol

The USC system is summarised in Figure E1.2.1. The primary division separates soil types on the basis of particle size into:

- Coarse grained soils - more than 50% of the material less than 60 mm is larger than 0.06 mm (60 µm).
- Fine grained soils - more than 50% of the material less than 60 mm is smaller than 0.06 mm (60 µm).

Initial classification is by particle size as shown in Table E1.2.1. Further classification of fine grained soils is based on plasticity.

TABLE E1.2.1 - CLASSIFICATION BY PARTICLE SIZE

NAME	SUB-DIVISION	SIZE
Clay (1)		< 2 µm
Silt (2)		2 µm to 60 µm
Sand	Fine Medium Coarse	60 µm to 200 µm 200 µm to 600 µm 600 µm to 2 mm
Gravel (3)	Fine Medium Coarse	2 mm to 6 mm 6 mm to 20 mm 20 mm to 60 mm
Cobbles (3)		60 mm to 200 mm
Boulders (3)		> 200 mm

Where a soil contains an appropriate amount of secondary material, the name includes each of the secondary components (greater than 12%) in increasing order of significance, eg sandy silty clay.

Minor components of a soil are included in the description by means of the terms “some” and “trace” as defined in Table E1.2.2.

TABLE E1.2.2 - MINOR SOIL COMPONENTS

TERM	DESCRIPTION	APPROXIMATE PROPORTION (%)
Trace	presence just detectable, little or no influence on soil properties	0-5
Some	presence easily detectable, little influence on soil properties	5-12

The USC group symbols should be included with each soil description as shown in Table E1.2.3

TABLE E1.2.3 - SOIL GROUP SYMBOLS

SOIL TYPE	PREFIX
Gravel	G
Sand	S
Silt	M
Clay	C
Organic	O
Peat	Pt

The group symbols are combined with qualifiers which indicate grading, plasticity or secondary components as shown on Table E1.2.4

TABLE E1.2.4 - SOIL GROUP QUALIFIERS

SUBGROUP	SUFFIX
Well graded	W
Poorly Graded	P
Silty	M
Clayey	C
Liquid Limit <50% - low to medium plasticity	L
Liquid Limit >50% - medium to high plasticity	H

(b) Grading

"Well graded"	Good representation of all particle sizes from the largest to the smallest.
"Poorly graded"	One or more intermediate sizes poorly represented
"Gap graded"	One or more intermediate sizes absent
"Uniformly graded"	Essentially single size material.

(c) Particle shape and texture

The shape and surface texture of the coarse grained particles should be described.

Angularity may be expressed as "rounded", "sub-rounded", "sub-angular" or "angular".

Particle **form** can be "equidimensional", "flat" or elongate".

Surface texture can be "glassy", "smooth", "rough", pitted" or striated".

(d) Colour

The colour of the soil should be described in the moist condition using simple terms such as:

Black	White	Grey	Red
Brown	Orange	Yellow	Green
Blue			

These may be modified as necessary by "light" or "dark". Borderline colours may be described as a combination of two colours, eg red-brown.

For soils that contain more than one colour terms such as:

- Speckled Very small (<10 mm dia) patches
- Mottled Irregular
- Blotched Large irregular (>75 mm dia)
- Streaked Randomly oriented streaks

(e) Minor Components

Secondary and minor components should be individually described in a similar manner to the dominant component.

E1.3 ***S****oil Condition*

(a) Moisture

Soil moisture condition is described as "dry", "moist" or "wet".

The moisture categories are defined as:
Dry (D) - Little or no moisture evident. Soils are running.
Moist (M) - Darkened in colour with cool feel. Granular soil particles tend to adhere. No free water evident upon remoulding of cohesive soils.

In addition the moisture content of cohesive soils can be estimated in relation to their liquid or plastic limit.

(b) Consistency

Estimates of the consistency of a clay or silt soil may be made from manual examination, hand penetrometer test, SPT results or from laboratory tests to determine undrained shear or unconfined compressive strengths. The classification of consistency is defined in Table E1.3.1.

TABLE E1.3.1 - CONSISTENCY OF FINE-GRAINED SOILS

TERM	UNCONFINED STRENGTH (kPa)	FIELD IDENTIFICATION
Very Soft	<25	Easily penetrated by fist. Sample exudes between fingers when squeezed in the fist.
Soft	25 - 50	Easily moulded in fingers. Easily penetrated 50 mm by thumb.
Firm	50 - 100	Can be moulded by strong pressure in the fingers. Penetrated only with great effort.
Stiff	100 - 200	Cannot be moulded in fingers. Indented by thumb but penetrated only with great effort.
Very Stiff	200 - 400	Very tough. Difficult to cut with knife. Readily indented with thumb nail.
Hard	>400	Brittle, can just be scratched with thumb nail. Tends to break into fragments.

Unconfined compressive strength as derived by a hand penetrometer can be taken as approximately double the undrained shear strength ($q_u = 2\ c_u$).

(c) Density Index

The insitu density index of granular soils can be assessed from the results of SPT or cone penetrometer tests. Density index should not be estimated visually.

TABLE E1.3.2 - DENSITY OF GRANULAR SOILS

TERM	SPT N VALUE	STATIC CONE VALUE q_c (MPa)	DENSITY INDEX (%)
Very Loose	0 - 3	0 - 2	0 - 15
Loose	3 - 8	2 - 5	15 - 35
Medium Dense	8 - 25	5 - 15	35 - 65
Dense	25 - 42	15 - 20	65 - 85
Very Dense	>42	>20	>85

E1.4 Soil Structure

(a) Zoning

A sample may consist of several zones differing in colour, grain size or other properties. Terms to classify these zones are:

Layer - continuous across exposure or sample
Lens - discontinuous with lenticular shape
Pocket - irregular inclusion
Each zone should be described, their distinguishing features, and the nature of the interzone boundaries.

(b) Defects

Defects which are present in the sample can include:

- fissures
- roots (containing organic matter)
- tubes (hollow)
- casts (infilled)

Defects should be described giving details of dimensions and frequency. Fissure orientation, planarity, surface condition and infilling should be noted. If there is a tendency to break into blocks, block dimensions should be recorded

E1.5 Soil Origin

Information which may be interpretative but which may contribute to the usefulness of the material description should be included. The most common interpreted feature is the origin of the soil. The assessment of the probable origin is based on the soil material description, soil structure and its relationship to other soil and rock materials.

Common terms used are:

"Residual Soil" - Material which appears to have been derived by weathering from the underlying rock. There is no evidence of transport.

"Colluvium" - Material which appears to have been transported from its original location. The method of movement is usually the combination of gravity and erosion.

"Landslide Debris" - An extreme form of colluvium where the soil has been transported by mass movement. The material is obviously distributed and contains distinct defects related to the slope failure.

"Alluvium" - Material which has been transported essentially by water. usually associated with former stream activity.

"Fill" - Material which has been transported and placed by man. This can range from natural soils which have been placed in a controlled manner in engineering construction to dumped waste material. A description of the constituents should include an assessment of the method of placement.

E1.6 Fine Grained Soils

The physical properties of fine grained soils are dominated by silts and clays.

The definition of clay and silt soils is governed by their Atterberg Limits. Clay soils are characterised by the properties of cohesion and plasticity with cohesion defines as the ability to deform without rupture. Silts exhibit cohesion but have low plasticity or are non-plastic.

The field characteristics of clay soils include:

- dry lumps have appreciable dry strength and cannot be powdered
- volume changes occur with moisture content variation
- feels smooth when moist with a greasy appearance when cut.

The field characteristics of silt soils include:

- dry lumps have negligible dry strength and can be powdered easily
- dilatancy - an increase in volume due to shearing - is indicted by the presence of a shiny film of water after a hand sample is shaken. The water disappears upon remoulding. Very fine grained sands may also exhibit dilatancy.
- low plasticity index
- feels gritty to the teeth

E1.7 Organic Soils

Organic soils are distinguished from other soils by their appreciable content of vegetable matter, usually derived from plant remains.

The soil usually has a distinctive smell and low bulk density.

The USC system uses the symbol Pt for partly decomposed organic material. The O symbol is combined with suffixes "O" or "H" depending on plasticity.

Where roots or root fibres are present their frequency and the depth to which they are encountered should be recorded. The presence of roots or root fibres does not necessarily mean the material is an "organic material" by classification.

Coal and lignite should be described as such and not simply as organic matter.

E2 CLASSIFICATION OF ROCKS

E2.1 Uniform Rock Description

The aim of a rock description for engineering purposes is to give an indication of the expected engineering properties of the material.

In a similar manner to soil materials, the assessment of site conditions where rock is encountered has to be based on the use of a descriptive method which is uniform and repeatable. Description has to:

- provide a clear identification of the rock substance and its engineering properties, and
- include details of the features which affect the engineering properties of the rock mass.

There is no internationally accepted system for rock description but STS Geotechnics Pty Ltd has adopted a method which incorporates terminology defined by common usage in the engineering geological profession. Most feature definitions are as recommended by the International Society of Rock Mechanics and by the Standards Association of Australia.

For uniform presentation the different features are described in order:

Rock Substance

- NAME (in block letters)
- Mineralogy
- Grain Size
- Colour
- Fabric
- Strength
- Weathering/Alteration

Rock Mass

- Defect type
- Defect orientation
- Defect features
- Defect spacing

E2.2 Rock Substance

(a) Rock name

Each rock type has a specific name which is based on:

- mineralogy
- grain size
- fabric
- origin

The only method of determining the precise rock name is by thin section petrography.

Field identification of rocks for engineering purposes should be based on the use of common, easily understood, simple, geological names. In many cases knowledge of the precise name is of little consequence in the assessment of site conditions. If required the "field name" can be qualified by reference to a petrographic report. Reference to local geological reports often provides information on the rock types which may be expected.

(b) Mineralogy

The rock description should include the identification of the prominent minerals. This identification is usually restricted to the more common minerals in medium and coarse grained rocks.

(c) Grain Size

Rock material descriptions should include general grouping of the size of the predominant mineral grains as defined in Table E2.2.1. The maximum size, or size range, of the larger mineral grains or rock fragments should be recorded.

TABLE E2.2.1. - GRAIN SIZE GROUPS

TERM	GRAIN SIZE (mm)
Very Coarse	>60
Coarse	2 – 60
Medium	0.06 – 2
Fine	0.002 - 0.06
Very Fine	<0.002
Glassy	

(d) Colour

The colour of the rock should be described in the moist condition using simple terms such as:

Black	White	Grey	Red
Brown	Orange	Yellow	Green
Blue			

These may be modified as necessary by "light" or "dark". Borderline colours may be described by a combination of two colours, eg: grey-blue.

(e) Fabric

The fabric of a rock includes all the features of texture and structure, though the term refers specifically to the arrangement of the constituent grains or crystals in a rock. The fabric can provide an indication of the mode of formation of the rock:

- in sedimentary rocks bedding indicates depositional conditions,
- in igneous rocks the texture indicates the rate of cooling, and
- in metamorphic rocks the foliation indicates the stress conditions

Descriptions of fabric should include structure orientation, either with reference to North and horizontal, or to a plane normal to the core axis.

Tables E2.2.2, E2.2.3 and E2.2.4 list common textural features of sedimentary, igneous and metamorphic rocks with the subdivision of stratification spacing in Table E2.2.5.

TABLE E2.2.2 - COMMON STRUCTURES IN IGNEOUS ROCKS

STRATIFICATION (Planar)	STRATIFICATION (Irregular)
Bedding	Washout
Cross Bedding	Slump Structure
Graded Bedding	Shale Breccia
Lamination	

TABLE E2.2.3 - COMMON STRUCTURES IN IGNEOUS ROCKS

	FINE GRAINED ROCKS	COARSE GRAINED ROCKS
Uniform Grain Size	Massive	Massive
	Flow Banded	Granitic
	Vesicular	Pegmatitic
Different Grain Size	Porphyritic	Porphyritic

TABLE E.2.2.4 - COMMON STRUCTURES IN METAMORPHIC ROCKS

FINE GRAINED ROCKS	COARSE GRAINED ROCKS
Slatey Cleavage	Granoblastic
Spotted	Porphyroblastic
Hornsfelsic	Lincated
Foliated	Gneissic
Mylonitic	Mylonitic

TABLE E2.2.5 - STRATIFICATION SPACING

TERM	SEPARATION (mm)
Very Thickly Bedded	>2000
Thickly Bedded	600 - 2000
Medium Bedded	200 - 600
Thinly Bedded	60 - 200
Very Thinly Bedded	20 - 60
Laminated	6 - 20
Thinly Laminated	<6

(f) Strength

Substance strength is one of the most important engineering features of a rock and every description should include at least an estimate of the rock strength class of the material. This estimate can be calibrated by test results, either by Point Loan Strength Index or by Unconfined Compressive Strength.

The rock strength class in As 1726-2017 is defined by Point Loan Strength Index $I_s(50)$. The relationship between Point Loan and Unconfined Strength is commonly assumed to be about 20, but can range from 4 (in some carbonate rocks) to 40 (in some igneous rocks). It is necessary to confirm the relationship for each rock type and project. classification should be based on material at field moisture content, as some rocks give a significantly higher strength when tested dry.

Table E2.2.6 defines the rock strength classes, with indicative field tests listed in Table E2.2.7 which assist in classification when testing equipment is not available.

TABLE E2.2.6 - CLASSIFICATION OF ROCK STRENGTH

SYMBOL	TERM	POINT LOAD STRENGTH (MPa)	APPROX Qu (MPa)
EL	Extremely low	<0.03	<1
VL	very low	0.03 - 0.1	1 - 3
L	Low	0.1 - 0.3	3 - 10
M	Medium	0.3 - 1	10 - 30
H	High	1 - 3	30 - 70
VH	very high	3 - 10	70 - 200
EH	Extremely high	>10	>200

TABLE E2.2.7 - FIELD TESTS FOR ROCK STRENGTH CLASSIFICATION

STRENGTH CLASS	FIELD TEST
Extremely Low	Indented by thumb nail with difficulty
Very Low	Scratched by thumb nail
Low	Easily broken by hand or pared with a knife
Medium	Broken by hand or scraped with a knife
High	Broken in hand by firm hammer blows
Very High	Broken against solid object with several hammer blow
Extremely High	Difficult to break against solid object with several hammer blows

(g) Weathering/Alteration

In addition to the description of rock substance as examined, an assessment is required of the extent to which the original rock material has been affected by subsequent events. The usual processes are:

- Weathering - Decomposition due to the effect of surface or near surface activities
- Alteration - Chemical modification by the action of materials originating from within the mantle below.

The classification of weathering/alteration presented in Table E2.2.8 is based on the extent/degree to which the original rock substance has been affected. This classification has little engineering significance, as the properties of the rock as examined may bear no relationship to the properties of the fresh rock.

TABLE E2.2.8 - CLASSIFICATION OR ROCK WEATHERING/ALTERATION

TERMS	DEFINITION
Fresh (Fr)	Rock substance unaffected.
Fresh Stained (FR St)	Rock substance unaffected. Staining of defect surfaces.
Slightly (SW)	Partial staining or discolouration of rock substance.
Moderately (MW)	Staining or discolouration extends throughout the whole rock substance.
Highly (HW)	Rock substance partly decomposed.
Completely (CW)	Rock substance entirely decomposed.

E2.3 Rock Mass

The engineering properties of rock mass reflect the effect which the presence of defects has on the properties of the rock substance. Description of the rock mass properties consists of supplementing the description covered by Section E2.2 with data on the defects which are present.

(a) Defect type

The different defect types are described in Table E2.3.1.

(b) Defect orientation

Descriptions of defects should include orientation, either of individual fractures or of groups of fractures. Orientation should be with reference to North and horizontal, or to a plane normal to the core axis.

TABLE E2.3.1 - ROCK DEFECT TYPES

TYPE	SYMBOL	DESCRIPTION
Parting	Pt	A defect parallel or subparallel to a layered arrangement of mineral grains or micro-fractures which has caused planar anistrophy in the rock substance.
Joint	Jt	A defect across which the rock substance has little tensile strength and is not related to textural or structural features with the rock substance.
Sheared Zone	SZ	A zone with roughly parallel planar boundaries or rock substance containing closely spaced, often slickensided, joints.
Crushed Zone	CZ	A zone with roughly parallel planar boundaries of rock substance composed of disoriented, usually angular, fragments of rock.
Seam	Sm	A zone with roughly parallel boundaries infilled by soil or decomposed rock.
Drilling Break	DB	Break in core due to drilling
Handling Break	HB	Break in core during handling

(c) Defect features

The character of a defect is described by its continuity, planarity, surface roughness, width, and infilling.

Continuity In outcrop the extent of a joint, bedding plane or similar defect both along and across the strike can be measured. In core, continuity measurement is restricted to defects nearly parallel to the core axis.

Planarity Described as “Planar”, “Irregular”, “Curved” or “Undulose”.

Roughness Described as “Rough”, “Smooth”, “Polished” or “Slickensided”.

Width Measured in millimetres normal to the plane of the defect

Infilling Described as “Clean”, “Stained”, “Veneer” (<1 mm) or “Infill” (>1 mm). The coating or infilling material should be identified.

(d) Defect spacing

The spacing of defects, particularly where they occur in parallel groups or sets, provides an indication of the rock block sizes which:

- have to be supported in the face or roof of an excavation
- will be produced by the excavation operation.

It is preferable to provide measured data but discontinuity spacing is grouped as shown in Table E2.3.2.

TABLE E2.3.2 - DISCONTINUITY SPACING

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

E3. DESCRIPTION OF WELL CONSTRUCTION, PID AND GROUNDWATER SYMBOLS

TABLE E3.1 – BORE CONSTRUCTION DETAILS

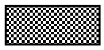
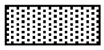
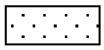
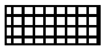
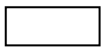
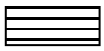
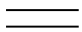
SHADING / SYMBOL	DESCRIPTION
	Cement-Based Grout
	Bentonite Seal
	Sand Filter
	Borehole Cuttings
	Class 18 PVC casing
	Class 18 PVC Slotted Screen
	End Caps
	Vapour Probe Tip
	Teflon Tubing

TABLE E3.2 – PID SYMBOLS

SYMBOL	MEANING
I	Insitu
A	Above Soil
H	Headspace

TABLE E3.3 – WATERTABLE SYMBOLS

SYMBOL	DESCRIPTION
	Standing Water Level
	Inflow
	Outflow

APPENDIX B – LABORATORY TEST RESULTS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Accredited for Compliance with ISO/IEC 17025 - Testing No. 2750

Point Load Strength Index Report

Project: 46 CHESTER AVENUE, MAROUBRA

Client: NSW LAND & HOUSING CORPORATION

Address: 4 Parramatta Square, 12 Darcy Street, Parramatta

Test Method: AS4133.4.1

Sampling Procedure: AS 1289.1.2.1 Clause 6.5.3 - Power Auger Drilling (Not covered under NATA Scope of Accreditation)

Project No.: 31864/6656D-G
Report No.: 22/2781
Report Date: 01/08/2022
Page: 1 OF 1

Borehole / Sample No.	Depth (m)	Date Sampled	Date Tested	Test Type	Is (MPa)	$Is_{(50)}$ (MPa)	Rock Type	Failure Type	Moisture
BH1	4.70	28/07/2022	01/08/2022	A	**0.21**	**0.21**	SS/SH	3	M
BH1	5.05	28/07/2022	01/08/2022	A	**0.071**	**0.069**	SS	3	M
BH1	5.70	28/07/2022	01/08/2022	A	**0.59**	**0.59**	SS	3	M
BH1	6.34	28/07/2022	01/08/2022	A	**0.13**	**0.13**	SS/SH	3	M
BH1	6.86	28/07/2022	01/08/2022	A	**2.4**	**2.4**	SS	3	D
BH1	7.06	28/07/2022	01/08/2022	A	**2.1**	**2.1**	SS	3	D
BH2	4.13	28/07/2022	01/08/2022	A	**0.48**	**0.46**	SS	3/4.	M
BH2	4.63	28/07/2022	01/08/2022	A	**0.42**	**0.44**	SS	3	M
BH2	4.94	28/07/2022	01/08/2022	A	**0.42**	**0.41**	SS	3	M
BH2	5.18	28/07/2022	01/08/2022	A	**0.31**	**0.3**	SS	3	M
BH2	5.81	28/07/2022	01/08/2022	A	**0.18**	**0.17**	SS/SH	3	M

Failure Type
1 = Fracture through bedding or weak plane
2 = Fracture along bedding
3 = Fracture through rock mass
4 = Fracture influenced by natural defect or drilling
5 = Partial fracture or chip (invalid result)

Test Type
A = Axial
D = Diametrial
I = Irregular
C = Cube

Moisture Condition
W = Wet
M = Moist
D = Dry

Rock Type
SS = Sandstone
ST = Siltstone
SH = Shale
YS = Claystoane
IG = Igneous

Remarks:

Approved Signatory..

Technician: LL

Orlando Mendoza - Laboratory Manager

CERTIFICATE OF ANALYSIS

Work Order	: **ES2227105**	Page	: 1 of 4
Client	: **STS Geotechnics**	Laboratory	: Environmental Division Sydney
Contact	: ENQUIRES STS	Contact	: Customer Services ES
Address	: Unit 14/1 Cowpasture Place Wetherill Park 2164	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 3055/30060/31354/31864/31865	Date Samples Received	: 01-Aug-2022 15:10
Order number	: 2022-245	Date Analysis Commenced	: 02-Aug-2022
C-O-C number	: ----	Issue Date	: 04-Aug-2022 14:34
Sampler	: EJ, KS, MB		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 10		
No. of samples analysed	: 10		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

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

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

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

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	30055/8517	30055/8519	30055/8520	30055/8521	30060/1688
			Sampling date / time	29-Jul-2022 00:00	29-Jul-2022 00:00	29-Jul-2022 00:00	29-Jul-2022 00:00	29-Jul-2022 00:00
Compound	CAS Number	LOR	Unit	ES2227105-001	ES2227105-002	ES2227105-003	ES2227105-004	ES2227105-005
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**5.4**	**5.9**	**6.8**	**5.4**	**7.1**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**27**	**31**	**93**	**36**	**33**
EA055: Moisture Content								
Moisture Content	----	1.0	%	**22.3**	**19.8**	**19.4**	**21.7**	**16.9**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**10**	<10	**20**	**50**	<10

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	31354/084	31864/S1	31864/S2	31865/S1	31865/S2
			Sampling date / time	29-Jul-2022 00:00	28-Jul-2022 00:00	28-Jul-2022 00:00	29-Jul-2022 00:00	29-Jul-2022 00:00
Compound	CAS Number	LOR	Unit	ES2227105-006	ES2227105-007	ES2227105-008	ES2227105-009	ES2227105-010
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.5	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	----	5.9	6.5	6.7	6.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	116	----	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	----	8	14	10	9
EA055: Moisture Content								
Moisture Content	----	1.0	%	21.7	----	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	----	4.5	5.4	4.3	4.3
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	140	<10	<10	<10	<10
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	<10	<10	<10	<10