GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

GEOTECHNICAL INVESTIGATION

FOR

NSW LAND AND HOUSING CORPORATION

1-3 Rodd Street, Eden NSW (BH2HF)

Report No: 23/4050

Project No: 32505/8248D-G

December 2023

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Table of Contents

1. INTRODUCTION

This report presents the results of a Geotechnical Investigation carried out by STS Geotechnics Pty Limited (STS) for the proposed new residential development to be constructed at 1-3 Rodd Street, Eden NSW.

Following documents were provided to assist in the preparation of this report:

- Yield Diagram prepared by NSW Planning Industry & Environment for feasibility; '1-3 Rodd Street Eden', dated 06/06/2023, CAD Ref. Eden Rodd 1-3.pln.

At the time of writing this report STS were not provided with detailed architectural drawings for the project. Based on the drawings provided, site development will be limited to two storey residential buildings without basement excavation.

The purpose of the investigation was to assess the subsurface conditions over the site at four borehole locations and provide geotechnical advice and recommendations addressing the following:

- Site conditions and regional geology,
- Subsurface conditions,
- Site Classification according to AS2870,
- Excavation conditions,
- Maximum permissible temporary and permanent batter slopes,
- Retaining wall design parameters,
- Foundation design parameters including foundation options,
- Exposure classification/soil aggressiveness according to AS2870, and
- If required, vibration control during rock excavation.

The investigation was undertaken in accordance with STS proposal P23-532 dated November 16, 2023.

Our scope of work did not include a contamination assessment.

2. NATURE OF THE INVESTIGATION

2.1. Fieldwork

The fieldwork consisted of drilling four (4) boreholes numbered BH1 to BH4 (inclusive), at the locations shown on attached Drawing No. 23/4050**.** Restricted site access dictated the borehole locations. Boreholes were drilled using a utility mounted Christie drilling rig, owned, and operated by STS. Soil strengths were assessed by carrying out a Dynamic Cone Penetrometer (DCP) test adjacent to each borehole location.

Drilling operations were undertaken by one of STS's geotechnical engineers who also logged the subsurface conditions encountered.

Representative soil samples were collected from the boreholes for subsequent laboratory testing.

2.2. Laboratory Testing

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

- pH,
- Sulphate content (SO_4),
- Chloride (Cl)
- Electrical Conductivity (EC), and

To assist with determining the site classification, three (3) Shrink Swell tests were carried out on representative samples retrieved from the site.

Detailed test reports are given in Appendix B.

3. GEOLOGY AND SITE CONDITIONS

The Bega- Mallacoota geological series sheet at a scale of 1:250,000 indicates the site is underlain by Devonian Age Merimbula Group within the Twofold Bay Formation. This formation comprises fluvial sandstone with mud rock and conglomerate.

The site is near rectangular in shape with an approximate area of 1325 m^2. At the time of the fieldwork, there were existing dwellings present. The vegetation comprises grass, shrubs, and trees. The ground surface falls approximately 2m to the east.

The site is bound by Rodd Street to the southeast, and residential dwellings in the adjoining properties.

4. SUBSURFACE CONDITIONS

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 where there has been previous development.

The subsurface conditions consist of topsoil overlying gravelly sandy clays, silty clays, silty sandy clays, sandy clays and weathered rock. The fill is present from the surface to depths of 0.2 metres. In BH 1, BH2 and BH4 soft and firm gravelly sandy clays underlie the fill to depths of 0.4 to 0.6 metres. Firm, stiff and becoming very stiff natural clays underlies fill and gravelly sandy clay to a depth of auger refusal, 2.5 to 3.8 metres. Weathered rock underlies the natural clays at the depth of auger refusal.

No groundwater was observed in the boreholes during the drilling. However, increased moisture was observed in boreholes BH1, BH2 and BH4.

The subsurface conditions observed are recorded on the borehole logs given in Appendix A. An explanation of the terms used on the logs is also given in Appendix A. Notes relating to geotechnical reports are also attached.

5. GEOTECHNICAL DISCUSSION

5.1. Site Classification (AS2870)

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

To assist with determining the site classification, three shrink/swell tests were carried out on the representative sample retrieved from the site. The detailed testing report is attached and summarised in Table 5.1.

Table 5.1 – Shrink Swell Test Summary

Location	Depth (m)	Material Description	Shrink/Swell Index (% per ΔpF)
BH2	0.6 – 0.9	Silty Sandy Clay, grey brown	1.0
BH3	0.5 – 0.8	Silty Clay, orange brown	1.3
BH4	0.7 – 1.0	Silty Clay, brown	1.3

Because there is a residential dwelling and trees present, abnormal moisture conditions (AMC) prevail at the site (Refer to Section 1.3.3 of AS2870).

Because of the AMC present, the site is classified a *Problem Site (P).* Provided the recommendations given below are adopted the site may be reclassified *Moderately Reactive (M).*

Foundation design and construction consistent with this classification shall be adopted as specified in the above referenced standard and in accordance with the following design parameters provided below.

5.2. Excavation Conditions

We have not been informed of any proposed excavations. However, to achieve the proposed building levels some cutting may be required. Assuming any proposed cut is less than 2 metres, it is expected that the proposed excavation will encounter topsoil/fill overlying natural soils. Excavators should be able to remove these materials.

5.3. Temporary and Permanent Batter Slopes

In the short term, dry cut soil slopes should remain stable at an angle of 1(H) to 1(V). In the long-term dry cut slopes formed at an angle of 2(H) to 1(V) should remain stable. Slopes cut at this angle would be subject to erosion unless protected by topsoil and diversion drains at the crest of the slopes. The above temporary batters should remain stable provided that all surcharge loads, including construction loads, are kept at a distance of at least 2h (where 'h' is the height of the batter in metres) from the crest of the batter. If steeper batters are to be used, then these must be supported by shotcrete and soil nail system designed by a suitable experienced structural or geotechnical engineer.

Where space for temporary batters is not available, a suitable retention system will be required for the 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.

5.4. Retaining Wall Design Parameters

The parameters used to proportion retaining wall support depends on whether the walls can be permitted to deflect. For walls, which cannot be permitted to deflect, an at rest earth pressure coefficient (Ko) of 0.6 should be adopted for the clays. For walls that can be allowed to deflect, an active earth pressure coefficient (Ka) of 0.4 should be adopted for the clays. A passive earth pressure coefficient (Kp) of 2.5 may be used for the natural clays and 4.5 for the weathered rock. A bulk density of 19 kN/m^3 may be used for the natural clays and 22 kN/m^3 for the weathered rock. If anchors or props are used for additional support, a rectangular pressure distribution should be used.

As with all retaining walls, the earth pressure coefficients must be adjusted for ground surface slope, presence of groundwater and surcharge loads.

5.5. Foundation Design Parameters

We do not recommend founding any structural loads within the topsoil or soft soils.

Pad and/or strip footings founded in stiff natural clays may be proportioned using an allowable bearing pressure of 100 kPa. The minimum depth of founding must comply with the requirements of AS2870.

Piles founded in very stiff natural clays may be proportioned using an allowable end bearing pressure of 300 kPa, provided their depth to diameter ratio exceeds a value of 4. An allowable adhesion value of 20 kPa may be adopted for the portion of the shaft below a depth of 0.5 metres.

If a higher load carrying capacity is required, piles founded in rock may be proportioned using an allowable end bearing pressure of 700 kPa. An allowable adhesion value of 70 kPa may be adopted for the portion of the shaft in weathered rock. When piles are founded in weathered rock the adhesion within the overlying soils must be ignored.

To ensure the bearing values given can be achieved, care should be taken to ensure the base of the excavations is free of all loose material prior to concreting. To this end, it is recommended that all excavations be concreted as soon as possible, preferably immediately after excavating, cleaning, inspecting and approval. Pier excavations should not be left open overnight. The

possibility of groundwater inflow needs to be considered when drilling the piers and pouring concrete.

During foundation construction, should the subsurface conditions vary to those inferred in this report, a suitably experienced geotechnical engineer should review the design and recommendations given above to determine if any alterations are required.

5.6. Site Preparation and Re-grading

Subgrade Preparation

Earthworks recommendations provided in this report should be complemented by reference to AS3798.

1. Any topsoils excavated should be stockpiled separately since these materials may not be suitable for re-use as engineered fill. Any excavations carried should be no steeper than 1 Vertical to 1 Horizontal. Any new fill required must be 'keyed-in' the sides of these batters.
2. The base of the excavation should be proof rolled with a smooth drum roller (say 12 tonne) used in static or non-vibratory mode of operation. Caution is required when proof rolling near existing infrastructures and utilities (where present). The purpose of the proof rolling is to detect any soft or heaving areas and to allow for some further improvement in strength or compaction.
3. The final pass should be undertaken in the presence of an experienced geotechnician or geotechnical engineer, to detect any unstable or soft subgrade areas, and to allow for some further improvement in strength/compaction.
4. If dry conditions prevail at the time of construction, then any exposed residual clay subgrade may become desiccated or have shrinkage cracks prior to pouring any concrete slabs. If this occurs, the subgrade must be scarified and reconditioned with watered prior recompacting.
5. Unstable subgrade detected during proof rolling should be locally excavated down to a sound base and replaced with engineered fill or further advice should be sought. Any fill placed to raise site levels should also be engineered fill, as per the specifications below.

Engineered Fill Specifications

Any fill placed for structural purposes should be engineered fill. Fill should be compacted in layers not greater than 200 mm loose thickness, to a minimum density ratio of 95% of SMDD.

The existing clayey soils excavated from cut areas may be reused as engineered fill, provided any unsuitable ('over wet' and 'oversized') and deleterious materials that may be present are removed.

Density tests should be regularly carried out on any filling required to confirm the above specifications are achieved in accordance with AS3798-2007 Table 8.1. We recommend that at least Level 1 inspection and testing, as defined in AS3798-2007, be adopted for the placement of any fill material. Level 2 testing can be carried out on the pavement layers.

We recommend that the engineered fill layers required extend a horizontal distance of at least 1m beyond the design geometry. The roller must extend over the edge of each placed layer to seal the batter surface. On completion of filling, the excess under-compacted edge fill should be trimmed back to the design geometry.

The 'tying in' of engineered fill to temporary cut batter slopes can be achieved by locally benching the cut slopes in no greater than 0.4m high steps. This can be carried out progressively as the height of engineered fill increases.

For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness.

During construction of the fill, platform runoff should be enhanced by providing suitable falls to reduce ponding of water on the surface of the fill. Ponding of water may lead to softening of the fill and subsequent delays in the earthworks program. A poorly drained subgrade may become un-trafficable when wet. We recommend that if soil softening occurs, the exposed surface be over-excavated to below the affected soil, and then replaced with engineered fill as specified above.

5.7. 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 sulphates 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 5.2.

Table 5.2 – Soil Aggressiveness Summary

Sample No.	Location	Depth (m)	pH	Sulfate (mg/kg)	Chloride (mg/kg)	Electrical Conductivity (dS/m)	
						$EC_{1:5}$	EC_e
S1	BH1	0.2	6.8	<10	20	0.042	0.4
S2	BH3	0.3	6.3	30	180	0.019	0.2

The soils on the site are cohesive and above groundwater. Therefore, soil conditions B are considered appropriate (AS2159).

A review of the durability aspects indicates that:

- pH : minimum value of 6.3
- SO_4 : maximum value of 30 mg/kg (ppm) < 5000 ppm
- Cl : maximum value of 180 mg/kg (ppm) < 5000 ppm
- EC_e : maximum value of 0.4 dS/m

In accordance with AS2159-2009 the exposure classification for the onsite soils is non-aggressive to both steel and concrete. In accordance with AS2870-2011 the soils are classified as A1.

Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that ECe values of 0.2 and 0.4 dS/m are consistent with the presence of non-saline soils.

6. FINAL COMMENTS

We recommend the following additional geotechnical work:

- Geotechnical Inspections of the exposed bearing surfaces for footings by an experienced geotechnical professional to verify the founding material and ensure the allowable pressure given has been achieved.
- Level 1 testing of the fill material as defined in AS3798-2007.

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 above classification has been made assuming that all footings will bear in either natural ground or in controlled filling. Prior to the placement of any filling the existing surface should be stripped of all vegetation and topsoil.

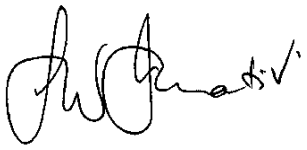
If excavations for rainwater or detention tanks are to be made within 6 metres of the building foundations, advice should be sought regarding their effect on the foundations.

Placing absorption trenches on the high side of the property may create abnormal moisture conditions for the foundations (Refer to Section 1.3.3 of AS2870). This could have a negative effect on the foundation performance and more than likely alter the site classification provided above.

This report has been prepared assuming that no trees other than those noted will be present on the site. If future tree planting is planned, eg. there is a landscaping plan, their effect on the foundation performance must be considered.

This report has been prepared assuming the site development will be limited to three storey residential buildings. The information and interpretation may not be relevant if the design proposal changes (e.g. to a five-storey building involving major cuts during the site preparation). If changes occur, we would be pleased to review the report and advise on the adequacy of the investigation.

Manoj Shrestha
Geotechnical Engineer
STS Geotechnics Pty Limited



Laurie Ihnativ
Principal Geotechnical Engineer
STS Geotechnics Pty Limited

STS Geotechnics Pty. Ltd.	Scale: Unknown	Date: December 2023
Client: NSW LAND & HOSUING CORPORATION		
GEOTECHNICAL INVESTIGATION **1-3 RODD STREET, EDEN** **BOREHOLE AND PENETROMETER LOCATIONS**		Project No. 32505/8248D-G Drawing No: 23/4050

Important Information

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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.

UNFORSEEN 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 CONDITIONS

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 GETEOECHNICAL 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.

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APPENDIX A – BOREHOLE LOGS AND EXPLANATION SHEETS

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project: 32505/8248D-G	**BOREHOLE NO.:**	**BH 1**
Project: 1-3 Rodd Street, Eden	Date : December 4, 2023	Sheet 1 of 1	
Location: Refer to Drawing No. 23/4050	Logged: PS Checked By: MT		

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S1 @ 0.2 m		TOPSOIL: SANDY CLAY: low plasticity, dark grey, black, fine to medium grained sand, rootlets	CL		> PL
			GRAVELLY SANDY CLAY: low plasticity, grey brown	CL/CI	SOFT	> PL
			SANDY CLAY: low to medium plasticity, light grey red brown	CL/CI	FIRM	≥ PL
					BECOMING STIFF	
		1.0			VERY STIFF	
		2.0				
			SILTY CLAY: medium plasticity, grey, trace gravel	CI		<PL
		3.0				
			AUGER REFUSAL AT 3.8 M ON WEATHERED ROCK			
		4.0				
		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: STS

Equipment: Christie

Hole Diameter (mm): 100

Angle from Vertical (^{o}): 0

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project: 32505/8248D-G	**BOREHOLE NO.:**	**BH 2**
Project: 1-3 Rodd Street, Eden	Date : December 4, 2023	Sheet 1 of 1	
Location: Refer to Drawing No. 23/4050	Logged: PS Checked By: MT		

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: CLAYEY SAND: medium to coarse grained, dark grey, black, rootlets, some gravel	SC		M
			GRAVELLY SANDY CLAY: low plasticity, grey brown	CL	FIRM	> PL
	U50	1.0	SILTY SANDY CLAY: low to medium plasticity, grey brown trace sand	CL/CI	STIFF BECOMING VERY STIFF	<PL
		2.0	SANDY CLAY: medium to coarse grained, yellow brown, some gravel	SC		
		3.0	SILTY CLAY: medium plasticity, grey, trace sand and gravel	CI		
		4.0	AUGER REFUSAL AT 3.7M ON WEATHERED ROCK			
		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: STS
Equipment: Christie
Hole Diameter (mm): 100
Angle from Vertical (^{o}): 0
Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project: 32505/8248D-G	**BOREHOLE NO.:**	**BH 3**
Project: 1-3 Rodd Street, Eden	Date : December 4, 2023	Sheet 1 of 1	
Location: Refer to Drawing No. 23/4050	Logged: PS Checked By: MT		

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S2 @ 0.3 m		TOPSOIL: CLAYEY SAND: fine to medium to coarse grained, rootlets, some gravel	SC		W
			SILTY CLAY: low to medium plasticity, light grey red brown, trace sand	CL/CI	STIFF BECOMING VERY STIFF	<PL
	U50	1.0				
			SANDY CLAY: low plasticity, brown grey, trace gravel	CL		
		2.0				
			AUGER REFUSAL AT 2.5M ON WEATHERED ROCK			
		3.0				
		4.0				
		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

Contractor: STS
Equipment: Christie
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 - NON CORE BOREHOLE

Client: NSW Land & Housing Corporation	Project: 32505/8248D-G	**BOREHOLE NO.: BH 4**
Project: 1-3 Rodd Street, Eden	Date : December 4, 2023	Sheet 1 of 1
Location: Refer to Drawing No. 23/4050	Logged: PS Checked By: MT	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: SANDY CLAY: low plasticity, dark brown with rootlets	CL		≥PL
			GRAVELLY SANDY CLAY: low plasticity, grey brown	CL	FIRM	> PL
			SILTY CLAY: low to medium plasticity, brown, trace sand and gravel	CL/CI		≥PL
	U50	1.0			STIFF BECOMING VERY STIFF	
		2.0				
		3.0	AUGER REFUSAL AT 3.0M ON WEATHERED ROCK			
		4.0				
		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: STS
Equipment: Christie
Hole Diameter (mm): 100
Angle from Vertical (^{o}): 0
Drill Bit: Spiral

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

Dynamic Cone Penetrometer Test Report

Project: 1-3 RODD STREET, EDEN
Client: NSW LAND & HOUSING CORPORATION
Address: Level G, 4 Parramatta Square, 12 Darcy Street, Parramatta
Test Method: AS 1289.6.3.2

Project No.: 32505/8248D
Report No.: 23/4049
Report Date: 7/12/2023
Page: 1 of 1

Site No.	P1	P2	P3	P4		
Location	Refer to Drawing No. 23/4050	Refer to Drawing No. 23/4050	Refer to Drawing No. 23/4050	Refer to Drawing No. 23/4050		
Date Tested	5/12/2023	5/12/2023	5/12/2023	5/12/2023		
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level		
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	*	1	1	1		
0.15 - 0.30	1	1	3	2		
0.30 - 0.45	1	3	4	4		
0.45 - 0.60	3	1	8	3		
0.60 - 0.75	4	2	11	4		
0.75 - 0.90	5	3	11	5		
0.90 - 1.05	11	5	12	7		
1.05 - 1.20	16	12	14	10		
1.20 - 1.35	16	3	5	10		
1.35 - 1.50	7	Refusal	Refusal	10		
1.50 - 1.65	Refusal			11		
1.65 - 1.80				19		
1.80 - 1.95				23		
1.95 - 2.10				Refusal		
2.10 - 2.25						
2.25 - 2.40						
2.40 - 2.55						
2.55 - 2.70						
2.70 - 2.85						
2.85 - 3.00						
3.00 - 3.15						
3.15 - 3.30						
3.30 - 3.45						
3.45 - 3.60						
3.60 - 3.75						

Remarks: * Pre drilled prior to testing

Approved Signatory..... .....

Technician: PS

Orlando Mendoza - Laboratory Manager

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EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT LOGS

DRILLING/EXCAVATION METHOD

HA	Hand Auger	**ADH**	Hollow Auger	**NQ**	Diamond Core - 47 mm
DT	Diatube Coring	**RT**	Rotary Tricone bit	**NMLC**	Diamond Core - 52 mm
NDD	Non-destructive digging	**RAB**	Rotary Air Blast	**HQ**	Diamond Core - 63 mm
AD*	Auger Drilling	**RC**	Reverse Circulation	**HMLC**	Diamond Core - 63 mm
***V**	V-Bit	**PT**	Push Tube	**EX**	Tracked Hydraulic Excavator
***T**	TC-Bit, e.g. AD/T	**WB**	Washbore	**HAND**	Excavated by Hand Methods

PENETRATION RESISTANCE

L	**Low Resistance**	Rapid penetration/ excavation possible with little effort from equipment used.
M	**Medium Resistance**	Penetration/ excavation possible at an acceptable rate with moderate effort from equipment used.
H	**High Resistance**	Penetration/ excavation is possible but at a slow rate and requires significant effort from equipment used.
R	**Refusal/Practical Refusal**	No further progress possible without risk of damage or unacceptable wear to equipment used.

These assessments are subjective and are dependent on many factors, including equipment power and weight, condition of excavation or drilling tools and experience of the operator.

WATER

Standing Water Level **Partial water loss**

Water Seepage **Complete Water Loss**

GWNO	GROUNDWATER NOT OBSERVED - Observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave-in of the borehole/ test pit.
GWNE	GROUNDWATER NOT ENCOUNTERED - 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.

SAMPLING AND TESTING

SPT	Standard Penetration Testing to AS1289.6.3.3 2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following a 150mm seating drive
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported, N is not reported
RW	Penetration occurred under the rod weight only, N<1
HW	Penetration occurred under the hammer and rod weight only, N<1
HB	Hammer double bouncing on anvil, N is not reported
Sampling	
S1	Jar sample – number indicates sample number
D	Disturbed Sample
B	Bulk disturbed Sample
U50	Thin walled tube sample - number indicates nominal sample diameter in millimetres
Testing	
PP	Pocket Penetrometer test expressed as instrument reading in kPa
DCP	Dynamic Cone Penetrometer (AS1289.6.3.1 1997)
PSP	Perth Sand Penetrometer (AS1289.6.3.2 1997)

GEOLOGICAL BOUNDARIES

———— = Observed Boundary (Position known)

– – – – – – – – – – = Observed Boundary (Position approximate)

– –?– –?– –?– – = Boundary (Interpreted or inferred)

ROCK CORE RECOVERY

TCR =Total Core Recovery (%)

$$= \frac{Length\ of\ core\ recovered}{Length\ of\ core\ run} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum Axial\ lengths\ of\ core > 100mm}{Length\ of\ core\ run} \times 100$$

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT LOGS

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FILL

COUBLES or BOULDERS

GRAVEL (GP or GW)

ORGANIC SOILS (OL, OH or Pt)

SILT (ML or MH)

CLAY (CL, CI or CH)

SAND (SP or SW)

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay

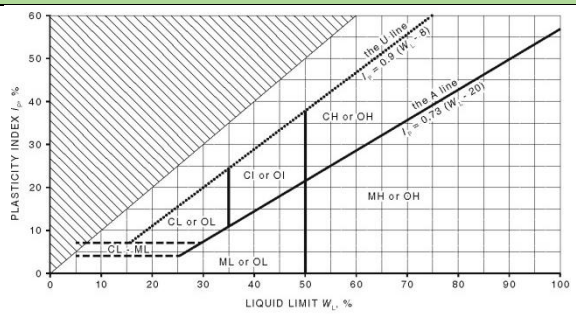
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS 1726:2017, Section 6.1 – Soil description and classification.

PARTICLE SIZE CHARACTERISTICS

Fraction	Components	Sub Division	Size mm
Oversize	BOULDERS		>200
	COBBLES		63 to 200
Coarse grained soil	GRAVEL	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	SAND	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine grained soil	SILT		0.002 to 0.075
	CLAY		<0.002

PLASTICITY PROPERTIES



GROUP SYMBOLS

Major Divisions		Symbol	Description
COARSE GRAINED SOILS More than 65% of soil excluding oversize fraction is greater than 0.075mm	GRAVEL More than 50% of coarse fraction is >2.36mm	GW	Well graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GP	Poorly graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GM	Silty gravel, gravel-sand-silt mixtures, zero to medium dry strength.
		GC	Clayey gravel, gravel-sand-clay mixtures, medium to high dry strength.
	SAND More than 50% of coarse fraction is <2.36 mm	SW	Well graded sand and gravelly sand, little or no fines, no dry strength.
		SP	Poorly graded sand and gravelly sand, little or no fines, no dry strength.
		SM	Silty sand, sand-silt mixtures, zero to medium dry strength.
		SC	Clayey sand, sandy-clay mixtures, medium to high dry strength.
FINE GRAINED SOILS More than 35% of soil excluding oversized fraction is less than 0.075mm	Liquid Limit less < 50%	ML	Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands, zero to medium dry strength.
		CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, medium to high dry strength.
		OL	Organic silts and organic silty clays of low plasticity, low to medium dry strength.
	Liquid Limit > than 50%	MH	Inorganic silts of high plasticity, high to very high dry strength.
		CH	Inorganic clays of high plasticity, high to very high dry strength.
		OH	Organic clays of medium to high plasticity, medium to high dry strength.
Highly Organic soil		PT	Peat muck and other highly organic soils.

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Non- cohesive and free running.
M	Moist	Soils feel cool, darkened in colour. Soil tends to stick together.
W	Wet	Soils feel cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture content of cohesive soils shall be described in relation to plastic limit (PL) or liquid limit (LL) for soils with higher moisture content as follows: Moist, dry of plastic limit (w < PL); Moist, near plastic limit ($w \approx$ PL); Moist, wet of plastic limit (w < PL); Wet, near liquid limit ($w \approx$ LL), Wet, wet of liquid limit (w > LL),

CONSISTENCY

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N" #
VS	Very Soft	≤ 12	≤ 2
S	Soft	>12 to ≤ 25	>2 to ≤ 4
F	Firm	>25 to ≤ 50	>4 to 8
St	Stiff	>50 to ≤ 100	>8 to 15
VSt	Very Stiff	>100 to ≤ 200	>15 to 30
H	Hard	>200	>30
Fr	Friable	-	

DENSITY

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	≤ 15	0 to 4
L	Loose	>15 to ≤ 35	4 to 10
MD	Medium Dense	>35 to ≤ 65	10 to 30
D	Dense	>65 to ≤ 85	30 to 50
VD	Very Dense	>85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material. # SPT correlations are not stated in AS1726:2017, and may be subject to corrections for overburden pressure, moisture content of the soil, and equipment type.

MINOR COMPONENTS

Term	Assessment Guide	Proportion by Mass
Add 'Trace'	Presence just detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: ≤ 5% Fine grained soil: ≤ 15%
Add 'With'	Presence easily detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: 5 - 12% Fine grained soil: 15 - 30%
Prefix soil name	Presence easily detectable by feel or eye in conjunction with the general properties of primary component	Coarse grained soils: >12% Fine grained soil: >30%

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TERMS FOR ROCK MATERIAL STRENGTH AND WEATHERING

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

ROCK MATERIAL STRENGTH CLASSIFICATION

Symbol	Term	Point Load Index, $Is_{(50)}$ (MPa) #	Field Guide
VL	Very Low	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 30 mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

 # Rock Strength Test Results

▼ Point Load Strength Index, $Is_{(50)}$, Axial test (MPa)

● Point Load Strength Index, $Is_{(50)}$, Diametral test (MPa)

Relationship between rock strength test result ($Is_{(50)}$) and unconfined compressive strength (UCS) will vary with rock type and strength, and should be determined on a site-specific basis. However UCS is typically 20 x $Is_{(50)}$.

ROCK MATERIAL WEATHERING CLASSIFICATION

Symbol		Term	Field Guide
RS		Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
XW		Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW	Distinctly Weathered	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. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
	MW		
SW		Slightly Weathered	Rock slightly discoloured but shows little or no change of strength relative to fresh rock.
FR		Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

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CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

DETAILED ROCK DEFECT SPACING

Defect Spacing

Spacing/width (mm)	Descriptor	Symbol
<20	Extremely Close	EC
20-60	Very Close	VC
60-200	Close	C
200-600	Medium	M
600-2000	Wide	W
2000-6000	Very Wide	VW

Bedding Thickness (Stratification)

Term	Spacing (mm)
Thinly laminated	<6
Laminated	6 – 20
Very thinly bedded	20 – 60
Thinly bedded	60 – 200
Medium bedded	200 – 600
Thickly bedded	600 – 2,000
Very thickly bedded	> 2,000

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT TYPES

Defect Type	Abbr.	Description
Joint	JT	Surface of a fracture or parting, formed without displacement, across which the rock has little or no tensile strength. May be closed or filled by air, water or soil or rock substance, which acts as cement.
Bedding Parting	BP	Surface of fracture or parting, across which the rock has little or no tensile strength, parallel or sub-parallel to layering/ bedding. Bedding refers to the layering or stratification of a rock, indicating orientation during deposition, resulting in planar anisotropy in the rock material.
Contact	CO	The surface between two types or ages of rock.
Sheared Surface	SSU	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.
Sheared Seam/ Zone (Fault)	SS/SZ	Seam or zone with roughly parallel almost planar boundaries of rock substance cut by closely spaced (often <50 mm) parallel and usually smooth or slickensided joints or cleavage planes.
Crushed Seam/ Zone (Fault)	CS/CZ	Seam or zone composed of disoriented usually angular fragments of the host rock substance, with roughly parallel near-planar boundaries. The brecciated fragments may be of clay, silt, sand or gravel sizes or mixtures of these.
Extremely Weathered Seam/ Zone	XWS/XWZ	Seam of soil substance, often with gradational boundaries, formed by weathering of the rock material in places.
Infilled Seam	IS	Seam of soil substance, usually clay or clayey, with very distinct roughly parallel boundaries, formed by soil migrating into joint or open cavity.
Vein	VN	Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.

NOTE: Defects size of <100mm SS, CS and XWS. Defects size of >100mm SZ, CZ and XWZ.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

Shape	Abbr.	Description	Roughness	Abbr.	Description
Planar	PR	Consistent orientation	Polished	POL	Shiny smooth surface
Curved	CU	Gradual change in orientation	Slickensided	SL	Grooved or striated surface, usually polished
Undulating	UN	Wavy surface	Smooth	SM	Smooth to touch. Few or no surface irregularities
Stepped	ST	One or more well defined steps	Rough	RO	Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper
Irregular	IR	Many sharp changes in orientation	Very Rough	VR	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper

Orientation: **Vertical Boreholes –** The dip (inclination from horizontal) of the defect.
Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

Coating	Abbr.	Description
Clean	CN	No visible coating or infilling
Stain	SN	No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)
Veneer	VNR	A visible coating of soil or mineral substance, usually too thin to measure (< 1 mm); may be patchy

DEFECT APERTURE

Aperture	Abbr.	Description
Closed	CL	Closed.
Open	OP	Without any infill material.
Infilled	-	Soil or rock i.e. clay, silt, talc, pyrite, quartz, etc.

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APPENDIX B – LABORATORY TEST RESULTS

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

Shrink Swell Index Report

Project: 1 - 3 RODD STREET, EDEN
Client: NSW LAND & HOUSING CORPORATION
Address: Level G, 4 Parramatta Square, 12 Darcy Street, Parramatta
Test Method: AS 1289.7.1.1

Project No.: 32505
Report No.: 23/4074
Report Date: 8/12/2023
Page: 1 of 1

Sampling Procedure: AS 1289.1.3.1 Clause 3.1.3.2 - Thin Walled Sampler

STS / Sample No.		8248D-L/1	8248D-L/2	8248D-L/3			
Sample Location		Borehole 2 Refer to Drawing No. 23/4050	Borehole 3 Refer to Drawing No. 23/4050	Borehole 4 Refer to Drawing No. 23/4050			
Material Description		Silty Sandy Clay, grey brown (CI)	Silty Clay, orange brown (CI)	Silty Clay, brown (CI)			
Depth (m)		0.6 - 0.9	0.5 - 0.8	0.7 - 1.0			
Sample Date		4/12/2023	4/12/2023	4/12/2023			
Shrink	Moisture Content (%)	19.8	19.4	22.5			
	Soil Crumbling	Nil	Nil	Nil			
	Extent of Cracking	Fine Cracks	Fine Cracks	Fine Cracks			
	Strain (%)	1.9	1.6	2.4			
Swell	Moisture Content Initial (%)	12.0	16.1	21.9			
	Moisture Content Final (%)	14.1	19.6	25.8			
	Strain (%)	0.0	1.4	0.0			
Inert Inclusions (%)		<5	<10	<10			
Shrink Swell Index (%)		**1.0**	**1.3**	**1.3**			

Remarks:

Approved Signatory.....

Technician: AW/AO

Orlando Mendoza - Laboratory Manager

CERTIFICATE OF ANALYSIS

Work Order	: **ES2342610**	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	: 30055/30060	Date Samples Received	: 06-Dec-2023 12:05
Order number	: 2023-441	Date Analysis Commenced	: 11-Dec-2023
C-O-C number	: ----	Issue Date	: 13-Dec-2023 11:27
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

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.

- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: SLAG (Matrix: SOIL)			Sample ID	30055/9299	30055/9305	30060/1879	32505/S1	32505/S2
			Sampling date / time	05-Dec-2023 00:00	05-Dec-2023 00:00	05-Dec-2023 00:00	05-Dec-2023 00:00	05-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	ES2342610-001	ES2342610-002	ES2342610-003	ES2342610-004	ES2342610-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.3	7.2	5.8	6.8	6.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	43	199	396	42	19
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	9.8	9.6	16.3	13.6	11.4
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	140	410	<10	30
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	----	----	20	180

Analytical Results

Sub-Matrix: SLAG (Matrix: SOIL)			Sample ID	32512/S1	32512/S2	----	----	----
			Sampling date / time	05-Dec-2023 00:00	05-Dec-2023 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2342610-006	ES2342610-007	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.8**	**5.2**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**88**	**82**	**----**	**----**	**----**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**16.6**	**10.2**	**----**	**----**	**----**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**90**	**110**	**----**	**----**	**----**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**120**	**10**	**----**	**----**	**----**