

GEOTECHNICAL INVESTIGATION AND ACID SULFATE SOILS (ASS) ASSESSMENT

FOR

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16-20 Middle Harbour Road, Lindfield

Report No: 25/1383

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DRAWING NO. 25/1383 – BOREHOLE AND PENETROMETER LOCATIONS

NOTES RELATING TO GEOTECHNICAL REPORTS

APPENDIX A – BOREHOLE LOGS AND EXPLANATION SHEETS, CORE PHOTOGRAPHS

APPENDIX B – LABORATORY TEST RESULTS

DOCUMENT CONTROL

REPORT TITLE: Geotechnical Investigation and Acid Sulfate Soils (ASS) Assessment

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Revision	Details	Date	Amended By
0	Original	13 May 2025	
1	Revision	27 May 2025	LL

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) to assist with addressing the State Significant SSDA requirements for the proposed construction of a new nine level apartment complex at 16-20 Middle Harbour Road, Lindfield. Reference to the Ku-Ring Gai Council LEP, indicates that the site is in a Class 5 area with respect to Acid Sulfate Soils. Therefore, an assessment is included in this report.

The following documents were provided to assist with the preparation of this report:

- Survey drawing, prepared by Hill & Blume Consulting Surveyors, Drawing No. 66013001A, Issue A, dated 20/02/25;
- Architectural drawings, prepared by PTI Architecture, Project No. P774, Stage SK, Drawing No. S01 to 49, Revision P09, dated 13/05/25

Based on the drawings provided, the existing ground surface elevation varies from about RL 86.2 metres AHD (Australian Height Datum), to RL 90.5 metres AHD. The proposed development includes three level basements for car parking with a finished RL of 75.4 metres AHD. Therefore, the basement will require excavations of about 11 to 15 metres below the existing ground level (BEGl). Additional locally deeper excavations may be required for footings, service trenches, or lift pits.

The purpose of the investigation was to provide information on:

- Subsurface conditions including groundwater levels,
- Site Classification to AS2870-2011,
- Site classification for earthquake design in accordance with AS 1170.4,
- Safe batter slopes,
- Excavation conditions and vibration monitoring (if required),
- Temporary and permanent excavation support,
- Retaining wall design parameters,
- Groundwater considerations,
- Foundation design parameters including foundation options,
- Exposure classification/soil aggressivity in accordance with AS2870-2011 & AS2159-2009,
- WALLAP/PLAXIS design parameters for all materials encountered,
- ASS assessment and need for an ASS Management Plan

The investigation was undertaken in accordance with STS proposal ref. P25-168 dated April 15, 2025.

2. NATURE OF THE INVESTIGATION

2.1. Fieldwork

The fieldwork consisted of drilling six (6) boreholes numbered BH1 to BH6, inclusive, at the locations shown on Drawing No. 25/1383 BH1 and BH2 were drilled using a track mounted Mini Track drilling rig owned and operated by STS Geotechnics Pty Ltd. The rig is equipped with Tungsten-Carbide (T-C) bit, Tri Cone bit, and NMLC diamond coring equipment. BH1 and BH2 were initially drilled using a combination of T-C bit and Tri Cone auger until refusal and then continued with NMLC coring. Due to the presence of clay seams, in BH1, Tri Cone auger was used at depths of 5.31 to 8.72m. **Because there was no access for the drilling rig, the remaining boreholes (BH3 to BH6, inclusive) were advanced using a push tube device.** Soil strengths were determined by undertaking a Standard Penetration Test (SPT) at selected depths at BH1 and BH2 and using Dynamic Cone Penetrometer (DCP) in the remaining locations.

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.

2.2. Laboratory Testing

To assess the soil for its aggressiveness, two (2) selected representative soil samples were tested to determine the following:

- pH,
- Sulphate content (SO₄),
- Chloride content (Cl) and
- Electrical Conductivity (EC).

To assist with the Site Classification, two (2) representative soil samples were tested to determine the Atterberg Limits.

To assess the rock strengths, representative rock core samples were tested to determine the Point Load Index.

Detailed test report has been attached in Appendix B.

3. GEOLOGY AND SITE CONDITIONS

The Sydney geological series sheet at a scale of 1:100,000 shows the site is underlain by Triassic Age Ashfield Shale of the Wianamatta Group. Rocks within this formation typically comprise shale and laminite. The Ashfield Shale is underlain by Triassic Age Hawkesbury Sandstone, which comprises medium to coarse grained quartz sandstone, minor shale and laminite lenses.

At the time of the fieldwork, the site was occupied by residential dwellings. Site vegetation comprised grass, shrubs, and trees. The total site area is approximately 3809 m². The existing ground surface falls about 4.5 metres to the north-east across the site.

The site is bound by Middle Harbour Road to the south-east, Lindfield Tennis Club to the north-west, and residential dwellings in the adjoining properties.

4. SUBSURFACE CONDITIONS

4.1. 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 that has been previously developed.

Based on our observations, the stratigraphy has been grouped into five (5) geotechnical units. A summary of the subsurface conditions is presented in Table 4.1. 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 rock classifications, explanatory notes and abbreviations adopted on the borehole logs are also presented in **Appendix A**.

Table 4.1 – Stratigraphy Summary

Unit	Material	Depth to Top of Unit (m BEGL)	Observed Thickness (m)	Comments
1	Concrete/pavers	0.0	0.12 to 0.33	Present in BH1 and BH2 only. 20mm of bedding sand underlying brick pavers in BH2.
2	Fill	0.0 to 0.33	0.17 to 0.9	Clayey Sand, Sandy Clay, Silty Clay, low to medium plasticity
3	Residual Soils	0.2 to 0.9	0.3 to 2.0	Silty Clay, low to medium plasticity. Soft to very stiff.
4	Shale/Sandstone Class V	1.5 to 2.3	2.1 to 8.77	Extremely low to low strength, with abundant residual clay bands.
5	Sandstone Class III	11 to 11.07	5.5 to 8.93	Medium to high strength. Closely spaced to widely spaced defects.

Notes:

- 1 Approximate depths below existing ground level at the time of our assessment, depths may vary across the site.

4.2. Groundwater Observation

No groundwater was observed during this investigation. Following completion of drilling, groundwater monitoring wells were installed in BH1 and BH2 and each were bailed continuously to remove water introduced from drilling. Water circulation used in the boreholes prevented observations of groundwater levels during and immediately following drilling operations. In BH2, perched groundwater seepage was observed at 0.9 metres. In the remaining boreholes, no groundwater was encountered during auger drilling.

5. DISCUSSION

5.1. Site Classification to AS2870-2011

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

The samples collected for shrink swell testing were unsuitable. Experience has shown that at times, the shrink swell index can be estimated by dividing the soil Plasticity Index (PI) by a factor of 10. The soil tested at this site have PI values of 15% and 29% which implies the shrink swell indexes are 1.5% and 2.9% per ΔpF .

Characteristic surface movements of about $s_y = 40 - 60$ mm are applicable to this site.

Because there are trees and existing dwellings present, abnormal moisture conditions (AMC) prevail at the site. (Refer to Section 1.3.3 of AS2870).

Because of the AMC and presence of over 400mm of fill, the site is classified a *problem site (P)*. Because the fill does not appear to be controlled engineered fill, it is not considered appropriate to reclassify this site.

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

We note that AS2870-2011 sets out the criteria for the classification of a site and the design and construction of a footing system for a single dwelling house, townhouse or similar structure which may be detached or separated by a party wall or common wall, but not situated vertically above or below another dwelling, including buildings classified as Class 1 and Class 10a in the Building Code of Australia.

Notwithstanding, AS2870-2011 may also be used for other forms of construction, including some light industrial, commercial and institutional buildings if they are similar in size, loading and superstructure flexibility. The design of ground bearing slab, rafts, shallow footings, including application of deem-to-comply designs, and/or deep footings are to be carried out by a Structural Engineer.

5.2. Earthquake Site Classification to AS1170.4

The classification has been prepared in accordance with the guidelines set out in the “Earthquake actions in Australia” Code, AS1170 Part 4:

- An earthquake subsoil class of Class Ce (Shallow soil)
- The hazard factor (z) for Sydney is 0.09

5.3. Excavation Conditions and Monitoring

Prior to any excavation commencing, we recommend that reference be made to the Safe Work Australia Excavation Work Code of Practice, dated January 2020.

Based on the subsurface conditions observed in boreholes, the proposed basement excavation depth of 11 to 15 metres BEGL is expected to encounter concrete/brick pavers, fill, silty clays, Class V Shale/Sandstone, and Class III Sandstone. Conventional earthmoving excavators without assistance should be able to remove the soils and potentially some of the Class V Shale/Sandstone.

Excavators alone, without assistance, may not be able to remove any significant amount of the Class V Shale/Sandstone, and will not be able to remove Class III Sandstone. Hydraulic breakers mounted on an excavator or jack hammers may be required to break up most of the shale/sandstone before it can be removed using an excavator.

If rock excavation using hydraulic rock breakers is required, 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 5.1.

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 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.

Table 5.1 - 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	100
	or 600 kg rock hammer	50

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

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.

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.

Consideration should be made to the impact of the proposed development upon neighbouring structures, roadways and services. Basement excavation retention systems should be designed so as to limit lateral deflections.

- Contractors should also consider the following limits associated with carrying out excavation and construction activities:
- Limit lateral deflection of temporary or permanent retaining structures;
- Limit vertical settlements of ground surface at common property boundaries and services easement; and
- Limit Peak Particle Velocities (PPV) from vibrations, caused by construction equipment or excavation, experienced by any nearby structures and services.

Monitoring of deflections of retaining structures and surface settlements should be carried out by a registered surveyor at agreed points along the excavation boundaries and along existing building foundations / services / pavements and other structures located within or near the zone of influence of the excavation. Owners of existing services adjacent to the site should be consulted to assess appropriate deflection limits for their infrastructures. Measurements should be taken in the following sequence:

- Before commencing installation of retaining structures where appropriate to determine the baseline readings. Two independent sets of measurements must be taken confirming measurement consistency;
- After installation of the retaining structures, but before commencement of excavation;
- After excavation to the first row of supports or anchors, but prior to installation of these supports or anchors;
- After excavation to any subsequent rows of supports or anchors, but prior to installation of these supports or anchors;
- After excavation to the base of the excavation;
- After de-stressing and removal of any rows of supports or anchors; and
- One month after completion of the permanent retaining structure or after three consecutive measurements not less than a week apart showing no further movements, whichever is the latter.

5.4. Groundwater Conditions

Based on the low permeability of the soils, we expect that some groundwater inflows if any, into the excavation will be along the soil/rock interface and through any defects within the shale bedrock (such as jointing, and bedding planes, etc.) particularly following a period of heavy rainfall.

We expect that any seepage that does occur will be able to 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.

In the long term, drainage should be provided behind all basement retaining walls, around the perimeter of the basement and below the basement slab including relive valves to enable relief of upward hydrostatic pressure if required. The completed excavation 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 discharging 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.

Groundwater seepage monitoring should be carried out during bulk excavation works and prior to finalising the design of a pump out facility. Outlets into the stormwater system will require Council approval.

5.5. Retaining Wall Design Parameters and Excavation Support

From a geotechnical perspective, it is critical to maintain the stability of all adjacent structures and infrastructures during demolition, excavation and construction works.

A suitable retention system may be required for the entire depth of excavation. STS recommends soldier piles with reinforced shotcrete infill panels in between the piles founded into medium strength Class III sandstone are adopted for this site.

Excavations on the subject site should not extend below the zone of influence of any adjacent structure foundations, without first installing temporary support or discussing the works with a geotechnical engineer.

Excavation within Class III sandstone or better should generally be able to be cut vertically and without support, provided an anchor is installed at the toe of the soldier pile wall. Anchors/props and reinforced shotcrete must be installed progressively as excavation proceeds.

For vertical cuts, the excavations must be inspected by a geotechnical engineer from STS at regular intervals to check for any inclined joints or weak seams that require stabilisation

Such geotechnical inspections should be carried out at depth intervals of no more than 1.5m. If adverse defects are encountered, the stabilisation measures may comprise rock bolts, shotcrete and mesh or dental treatment of thin weak seams using non-shrink grout, and this should be allowed for.

The existence of significant horizontal in-situ stresses in bedrock, particularly in the Sydney basin, is well established. The release of such stresses during the basement excavation may cause adverse impact on the stability of the excavation faces and thus increase the movements. Monitoring of several deep excavations within sandstone and shale in the Sydney region indicates that the lateral displacement at the top of the excavation is generally between 0.5mm to 2mm per meter depth of excavation. As the maximum depth of excavation into sandstone is of about 14m, a lateral deflection at the crest of the excavation between 5mm to 30mm can be expected which will reduce in a stepped fashion to zero at the bulk excavation level. Monitoring of the lateral movement as the excavation progresses is recommended. An assessment of such movements and their impact can be carried out using numerical finite element software such as PLAXIS.

The parameters used to proportion any 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 (K_0) should be adopted for the soils. For walls that can be allowed to deflect, an active earth pressure coefficient (K_a) should be adopted for the soils. The recommended earth pressure coefficients have been given in Table 5.2. As with all retaining walls, allowance must be made for ground surface slope, presence of groundwater and surcharge loads.

Table 5.2 – Design Parameters

Material ¹	Unit 2	Unit 3	Unit 4	Unit 5
	Fill	Residual Silty Clay	Shale/Sandstone Class V	Sandstone Class III
Depth to Top of Unit (mB EGL)	0 to 0.33	0.2 to 0.9	1.5 to 2.3	11 to 11.07
Bulk Unit Weight γ (kN/m³)	17	18	22	23
Friction Angle ϕ' (Degrees)	24	26	28	40
Cohesion, c' (kPa)	-	2	30	200
Poisson's ratio, ν'	0.3	0.3	0.25	0.25
Young's Modulus of Elasticity, E' (MPa)	-	8	80	500
Earth Pressure Coefficients	At rest, K_o³	0.6	0.56	0.35
	Active, K_a³	0.4	0.39	0.22
	Passive, K_p³	-	2.56	4.5
Allowable Bearing Pressure⁵ (kPa)	-	-	700	3500
Allowable Shaft Adhesion (kPa)^{4,5}	in Compression	-	-	350
	in Uplift	-	-	175
Allowable Toe Resistance (kPa)	-	-	100	200
Allowable Bond Stress (kPa)	-	-	-	350

Notes:

- 1 More detailed descriptions of subsurface conditions are available on the borehole logs presented in **Appendix A**.
- 2 Approximate depths below existing ground level at the time of our investigation.
- 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;
- 6 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;
- 7 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
- 8 The concrete is poured on the same day as drilling, inspection and cleaning.
- 9 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).

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. Ko should also be used to design the permanent support. It should be noted that some councils do not permit the use of permanent anchors.

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.

In the event a finite element assessment (WALLAP/PLAXIS) is required, the relevant soil and rock parameters are provided in Table 5.2.

5.6 Foundation Design Parameters

The existing topsoil and fill materials are not suitable for foundation support.

After the basement excavation has been completed the exposed material at the basement excavation depth of 11 to 15 mBEGl will likely comprise Class III Sandstone. Footings, Strips or piles founded at the basement excavation level may be proportioned using the allowable bearing pressures given in Table 5.2.

For footings designed for higher bearing capacities of 6000kPa/10000kPa or better, STS recommends additional cored bores after demolition and spoon tests are completed on at least 1/3 / 100% of the footings.

Spoon tests involve the drilling of a small core hole through the base of the footing to a depth of 1.5 times the minimum footing width, and a spoon is used to measure the locations and thicknesses of any seams to confirm the bedrock class.

To ensure that the allowable bearing pressures given can be achieved, the base of the excavations for piles and footings are to be free of all loose material prior to concreting. In addition, the concrete should be poured on the same day as drilling, inspection, and cleaning. It is recommended that all footing excavations be protected with a layer of blinding concrete as soon as possible, preferably immediately after excavating, cleaning, inspection, and approval.

Footings founded at or near a crest of an excavation (such as any building located outside of the basement outline) should be founded below the zone of influence of the lower basement retaining walls, which may be taken as founding below a line drawn at 1 Vertical to 1 Horizontal from the base of the retaining walls. Piles may be required. Specific geotechnical advice should be obtained for such footings taken into consideration the basement excavation and the quality of shale at the particular footing location.

5.7 Basement Floor Slab

Following bulk excavations for the proposed basement, sandstone bedrock is expected to be exposed at the basement floor BEL.

Following the removal of all loose and softened materials, we recommend that underfloor drainage be provided and should comprise a strong, durable, single sized washed aggregate such as ‘blue metal gravel’. Joints in the concrete floor slab should be designed to accommodate shear forces but not bending moments by using dowelled and keyed joints. The basement floor slab should be isolated from columns. The completed excavation should be inspected by the hydraulic engineer to confirm the extent of the drainage required.

In addition, a system of sub-soil drains comprising a durable single sized aggregate with perforated drains/pipes leading to sumps should be provided. The basement floor slab should be isolated from columns.

Permission may need to be obtained from Council and WaterNSW for any permanent discharge of seepage into the drainage system. Given the subsurface conditions, we expect that seepage volumes would be low and within acceptable limits manageable by drainage systems. However, if permission for discharge is not obtained, the basement may need to be designed as a tanked basement.

5.8 Exposure Classification

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 and Tables 5.1 and 5.2 of AS2870-2011 Residential Slabs and Footings.

The test results are summarised in Table 5.3.

Table 5.3 – Soil Aggressiveness Summary

Location	Depth (m)	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Electrical Conductivity (dS/m)	
					EC _{1:5}	EC _e
BH1	1.0 – 1.05	6.5	<10	60	0.043	0.4
BH2	1.5 – 1.95	7.7	100	10	0.092	0.9

The soils consist of low permeability silty clays. Therefore, the soil conditions B are considered appropriate (AS2159 and AS2870).

A review of the durability aspects indicates that:

- pH : minimum value of 6.5
- SO₄ : maximum value of 60 mg/kg (ppm) < 5000 ppm
- Cl : maximum value of 100 mg/kg (ppm) < 5000 ppm
- EC_e : maximum value of 0.9 dS/m

In accordance with AS2159-2009 the exposure classification is non-aggressive for both concrete and steel. In accordance with AS2870-2011 the exposure classification is A1

Reference to DLWC (2002) “Site Investigations for Urban Salinity” indicates that EC_e values of 0.4 and 0.9 dS/m are consistent with the presence of non-saline soils.

6. ACID SULFATE SOIL ASSESSMENT

6.1. Introduction

ASS is the common name given to sediments and soils containing iron sulfides which, when exposed to oxygen generate sulfuric acid. Natural processes formed most acid sulfate sediments when certain conditions existed in the Holocene geological period (the last 10,000 years). Formation conditions require the presence of iron-rich sediments, sulfate (usually from seawater), removal of reaction products such as bicarbonate, the presence of sulfate reducing bacteria. It should be noted that these conditions exist in mangroves, salt marsh vegetation or tidal areas, and at the bottom of coastal rivers and lakes.

The relatively specific conditions under which acid sulfate soils are formed usually limit their occurrence to low lying parts of coastal floodplains, rivers, and creeks. This includes areas with saline or brackish water such as deltas, coastal flats, back swamps and seasonal or permanent freshwater swamps that were formerly brackish. Due to flooding and stormwater erosion, these sulfidic sediments may continue to be re-distributed through the sands and sediments of the estuarine floodplain region. Sulfidic sediment may be found at any depth in suitable coastal sediments – usually beneath the water table.

Any lowering in the water table that uncovers potential ASS will result in their aeration and the exposure of iron sulfide sediments to oxygen. The lowering in the water table can occur naturally due to seasonal fluctuations and drought or any human intervention, when carrying out any excavations during site development. Potential ASS can also be exposed to air during physical disturbance with the material at the disturbance face, as well as the extracted material, both potentially being oxidised. The oxidation of iron sulfide sediments in potential ASS results in ASS soils.

Successful management of areas with ASS is possible but must consider the specific nature of the site and the environmental consequences of development. While it is preferable that sites exhibiting acid sulfate characteristics are not disturbed, management techniques have been devised to minimise and manage impacts in certain circumstances.

When works involving the disturbance of soil or the change of groundwater levels are proposed in coastal areas, a preliminary assessment should be undertaken to determine whether acid sulfate soils are present and if the proposed works are likely to disturb these soils.

6.2. Presence of ASS

The Prospect Parameter ASS Risk Map (9130N3 Edition Two, December 1997) indicates that the property is within an area where there is a low probability of ASS occurring between 1 and 3 metres below the ground surface. It should be noted that maps are a guide only.

The following geomorphic or site criteria are normally used to determine if acid sulfate soils are likely to be present:

- sediments of recent geological age (Holocene epoch)
- soil horizons less than 5 in AHD
- marine or estuarine sediments and tidal lakes
- in coastal wetlands or back swamp areas

Reference to the survey plan provided shows that the existing ground surface has a minimum elevation of approximately RL 86.2 metres AHD. Based on our investigation, the site is underlain by fill, residual silty clays and shale/sandstone bedrock. The observed site conditions are not consistent with the geomorphic criteria necessary for the presence of ASS. It is unlikely that site development will result in the lowering of the groundwater where nearby ASS may be present and will therefore not expose ASS to oxidation. Based on our onsite observations, it is our opinion that the proposed construction will not intercept any ASS nor cause lowering of any groundwater where ASS is present. Therefore, land management activities are unlikely to be affected by ASS materials.

Our assessment is the proposed construction will not require the preparation of an Acid Sulfate Soil Management Plan.

6. FINAL COMMENTS

Below is a summary of the recommended additional work that needs to be carried out:

- Review of the assessment and recommendations presented in this report following availability of further details of the proposed works, and updating as required as a separate engagement;
- Additional Geotechnical investigation at least (3) additional cored boreholes at the centre and north portions of the site, once demolition of the existing structures has been completed and access becomes available for a drilling rig. This will allow for a larger spread of data to be gathered from the site for a more optimised shoring and foundation design.
- Aggressivity testing for buried concrete and steel structures.
- Long term groundwater monitoring and seepage modelling.
- Stability assessment of temporary batters using computer modelling, if required;
- Dilapidation surveys;
- Design of working platforms (if required) for construction plant by an experienced and qualified geotechnical engineer;
- Classification of all excavated material transported off site;
- Witnessing installation of support measures and proof-testing of anchors (if required).
- Numerical Analysis Impact Assessment for nearby Sydney Water/Council Assets.
- Inclometers and instrumentation and monitoring plan (if required).
- Geotechnical inspections of rock faces during excavation by experience geotechnical professional at depth of no greater than 1.5m within medium to high strength bedrock, if vertical cut are adopted;
- Geotechnical inspections of all new footings/piles by an experienced geotechnical professional before concrete or steel are placed to verify their bearing capacity and the in-situ nature of the founding strata; and
- Ongoing monitoring of groundwater inflows into the bulk excavation;

We also recommend a meeting at the commencement of construction to discuss the potential geotechnical issues should the subsurface conditions vary from those inferred above and geotechnical inspection requirements during the construction phase for the proposed development.

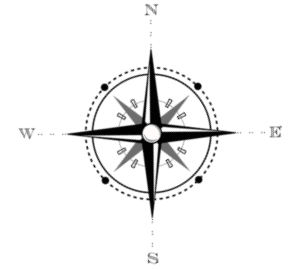
During construction, STS should be contacted to determine if any changes should be made to our recommendations for further advice.



Luky Ly
BE(Hons)(Civil)
Geotechnical Engineer
STS Geotechnics Pty Limited



Mrigesh Tamang
MIE Aust, CPEng, NER, APEC Engineer, IntPE(Aust)
Senior Geotechnical Engineer/ Manager
STS Geotechnics Pty Limited



Legend:

Site Boundary

Borehole +



14/1 Cowpasture Place, Wetherill Park, NSW 2164, Australia
 (PO Box 6989, Wetherill Park, NSW 2164, Australia)
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www.stsgeo.com.au | enquiries@stsgeo.com.au
 ABN 45 636 179 729 | ACN 636 179 729

Borehole Locations

Client:	John Wu & Ming Yang	Project No.	33063/9793D-G	Date:	13/05/2025
Site Address:	16—20 Middle Harbour Road, Lindfield	Drawing No.	25/1383	Scale:	Unknown
Work:	Geotechnical Investigation	Revision No.	0		

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 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,
POINT LOAD TESTING RESULTS AND EXPLANATION SHEETS

Client	Yang & Wu, Ming & John	Date	09 May 2025
Job No.	33063/9793D-G	Logged By	SP
Address	16 - 20 Middle Harbour Road, Lindfield	Review By	LL
Drilling Contractor	STS Geotechnics Pty Ptd	Location #	25/1383
Plant	Christie Mini Track Rig	Surface RL	-
		Drill Bit	AD/T + Tri Cone
		Inclination	90°
		Hole Ø (mm)	100

GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	CLASSIFICATION SYMBOL	CONSISTENCY / REL. DENSITY	MOISTURE CONDITION
		0.0		CONCRETE: 330mm thick		-	-
	BH1_0.60-1.05 SPT 0.60-1.05 2,2,3 N=5 BH1_1.00-1.05	0.5		FILL: Silty CLAY: medium to high plasticity, brown, grey, with fine to medium gravels, trace organics	-	-	M > PL
		1.0		Silty CLAY: medium to high plasticity, red grey, trace gravels, trace organics	Cl-CH	F	
		1.5		SHALE: grey, extremely weathered, extremely low strength, with ironstone bands and residual clay bands			M > PL
		2.0					
		2.5					
		3.0					M > PL
		3.5					
		3.6		Auger Refusal at 3.6m.			
		4.0		Log continued on next page.			
		4.5					
		5.0					
		5.5					
		6.0					
		6.5					
		7.0					
		7.5					
		8.0					
		8.5					
		9.0					
		9.5					

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

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

Client Yang & Wu, Ming & John	Date 09 May 2025
Job No. 33063/9793D-G	Logged By SP Review By LL
Address 16 - 20 Middle Harbour Road, Lindfield	Location # 25/1383
Drilling Contractor STS Geotechnics Pty Ptd	Surface RL - Drill Bit NMLC + Tri Cone
Plant Christie Mini Track Rig	Inclination 90° Hole Ø (mm) 100

METHOD	Flush Return	TCR %	RQD %	DEPTH (m)	GRAPHIC LOG	RL (m AHD)	MATERIAL DESCRIPTION	WEATHERING	ESTIMATED STRENGTH Is(50)						DISCONTINUITIES & ADDITIONAL DATA	FRACTURE SPACING				
									VL ₀₋₁	L ₀₋₃	M ₁	H ₃	VH ₁₀	EH		30	100	300	1000	3000
				0			<i>Log continued from previous page.</i>													
NMLC	90%	100		3.76			SANDSTONE: medium to coarse grained, red grey, iron weathered	DW						3.76-3.79: JT 0-60° CU RO						
				4.09			From 4.5m, becoming indistinctly cross bedded at 10°							4.09: BP PR RO						
				4.17										4.17: 0-10° CU RO						
				4.25										4.25-4.33: JT 60-90° UN						
				4.45										4.45-4.49: CS						
				4.74				DW - XW						4.74-5.12: XWZ						
				5.16										5.16: PR RO						
				5.22										5.22: BP PR RO						
Tri Cone Auger				5.31			SANDSTONE: medium to coarse grained, pale grey brown, with clay bands (from 5.31 to 8.72m, continued as tri cone augering)													
				5.75			From 5.75m, becoming pale grey													
				8.72			SANDSTONE: medium to coarse grained, brown, pale grey	DW - XW						8.80-8.84: XWS						
	90%	100		8.82			From 9.25m, becoming indistinctly cross bedded at 10-15°							8.82-8.85: JT 0-36° ST RO						
				8.88										8.88-9.04: XWZ						
				9.68			From 9.7m, becoming red, iron weathered							9.68-10.45: FZ						

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

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Client	Yang & Wu, Ming & John	Date	09 May 2025
Job No.	33063/9793D-G	Logged By	SP
Address	16 - 20 Middle Harbour Road, Lindfield	Review By	LL
Drilling Contractor	STS Geotechnics Pty Ptd	Location #	25/1383
Plant	Christie Mini Track Rig	Surface RL	-
		Drill Bit	NMLC
		Inclination	90°
		Hole Ø (mm)	100

METHOD	Flush Return	TCR %	RQD %	DEPTH (m)	GRAPHIC LOG	RL (m AHD)	MATERIAL DESCRIPTION	WEATHERING	ESTIMATED STRENGTH Is(50)						DISCONTINUITIES & ADDITIONAL DATA	FRACTURE SPACING			
									VL ₀₋₁	L ₀₋₃	M ₁	H ₃	VH ₁₀	EH		30	100	300	1000
NMLC	90%	100	100	11	[Graphic Log]		SANDSTONE: medium to coarse grained, red, iron weathered	FR - DW							10.56-11.42: FZ				
				From 10.6m, becoming pale grey, indistinctly cross bedded at 10-30°															
				12			From 11.2m, occasional orange brown weathering							11.13: BP					
				13			From 12.1 to 12.8m, becoming distinctly cross bedded at 10°							11.62-11.72: FZ					
				14										12.10: BP 30° PR RO					
				14.00			NO CORE: 240mm thick							12.27: BP 16° PR RO 12.44: BP 12° PR RO 12.71: BP 15° PR RO 12.76: BP PR RO					
				14.24			SANDSTONE: medium to coarse grained, pale grey, cross bedded at 10° to 30°	FR						13.09: BP PR RO					
				15										13.32: BP PR RO 13.44: BP PR RO 13.54-13.64: FZ 13.69-13.73: FS RO 13.81-13.92: FZ RO					
				16										14.29: BP PR RO					
				17			Terminated at 16.50m.							14.58: BP PR RO					
				18										14.80: BP PR RO					
				19										15.09: BP PR RO					
				20										15.14: BP PR RO					
														15.38: BP 20° PR RO					
														15.54: BP 20° PR RO					
														15.69: BP PR RO					
														15.90: BP PR RO					
														16.21-16.33: FZ					

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

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

Project/STS No. 33063/9793D-G

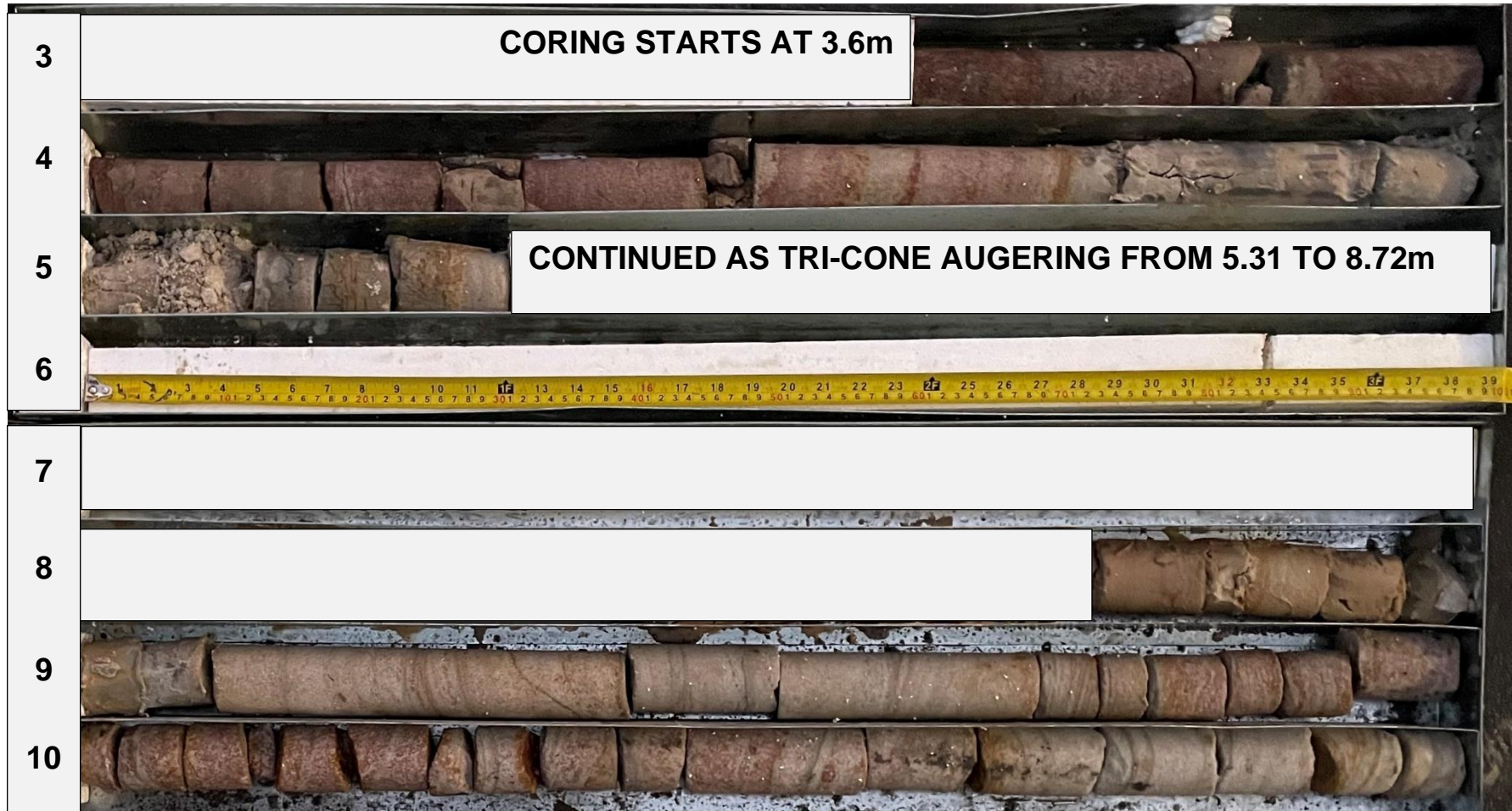
Contractor STS Geotechnics Pty Ltd

Site Address 16-20 Middle Harbour Road, Lindfield

Drill Rig Christie Mini Track Rig

Client John Wu & Ming Yang

Logger SP **Date** 8-9/5/2025



CORE PHOTOGRAPH OF BOREHOLE: BH1

Project/STS No. 33063/9793D-G

Contractor STS Geotechnics Pty Ltd

Site Address 16-20 Middle Harbour Road, Lindfield




















Drill Rig Christie Mini Track Rig

Client John Wu & Ming Yang

Logger SP **Date** 8-9/5/2025



Client	Yang & Wu, Ming & John	Date	12 May 2025
Job No.	33063/9793D-G	Logged By	TB
Address	16 - 20 Middle Harbour Road, Lindfield	Review By	LL
Drilling Contractor	STS Geotechnics Pty Ltd	Location #	25/1383
Plant	Christie Mini Track Rig	Surface RL	-
		Drill Bit	AD/T
		Inclination	90°
		Hole Ø (mm)	100

GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	CLASSIFICATION SYMBOL	CONSISTENCY / REL. DENSITY	MOISTURE CONDITION
		0.5		BRICK: 50mm thick FILL: SAND: fine to coarse grained, grey brown CONCRETE: 50mm thick FILL: Silty CLAY: low to medium plasticity, brown, trace fine to medium gravels Silty CLAY: medium to high plasticity, brown orange, trace fine to medium gravels	-	-	M < PL
	BH2_0.50-0.95 SPT 0.50-0.95 5,8,11 N=19	1.0					M < PL
	BH2_1.50-1.95 SPT 1.50-1.95 2,8,11 N=19	1.5			Cl-CH	VSt	M < PL
		2.0					
		2.5		SHALE: red grey, extremely weathered, extremely low strength			
		3.0					
		3.5					
		4.0					M < PL
		4.5					
		5.0					
		5.5					
		6.0		SHALE: brown-pale grey, extremely weathered to distinctly weathered very low to low strength, with clay bands			
		6.5					
		7.0					
		7.5					
		8.0					M < PL
		8.5					
		9.0					
		9.5					

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

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

Client Yang & Wu, Ming & John	Date 12 May 2025	
Job No. 33063/9793D-G	Logged By TB	Review By LL
Address 16 - 20 Middle Harbour Road, Lindfield	Location # 25/1383	

Drilling Contractor STS Geotechnics Pty Ltd	Surface RL -	Drill Bit AD/T
Plant Christie Mini Track Rig	Inclination 90°	Hole Ø (mm) 100

GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	CLASSIFICATION SYMBOL	CONSISTENCY / REL. DENSITY	MOISTURE CONDITION
GWNE		10.5 11.0		SANDSTONE: fine to coarse grained, brown, extremely weathered, very low to low strength, with clay bands	-	-	D
		11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5 19.0 19.5		At 11.07m, Auger Discontinued. <i>Log continued on next page.</i>			

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

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Project/STS No. 33063/9793D-G

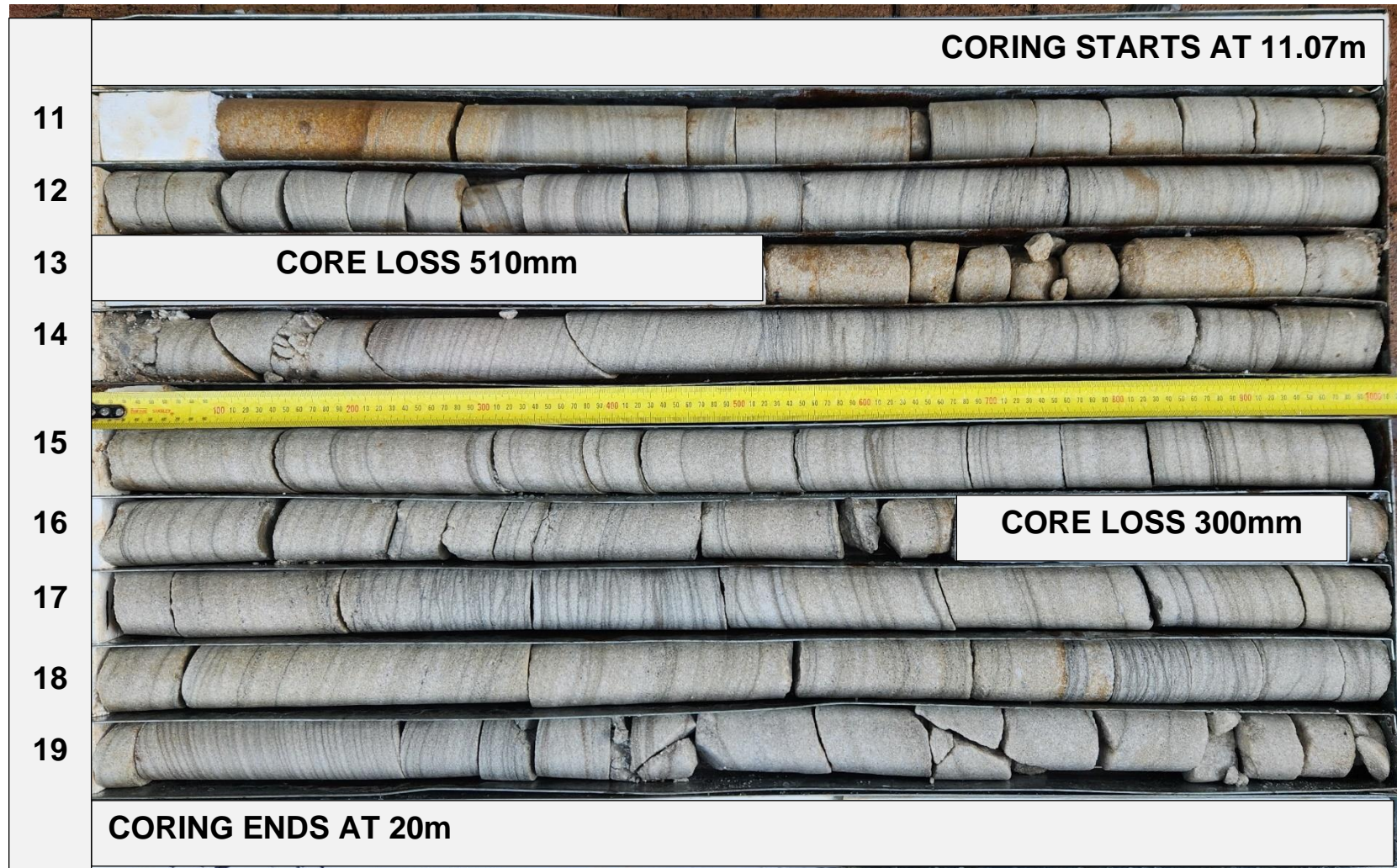
Contractor STS Geotechnics Pty Ltd

Site Address 16-20 Middle Harbour Road, Lindfield

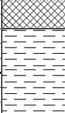
Drill Rig Christie Mini Track Rig

Client John Wu & Ming Yang

Logger TB **Date** 12/5/2025



Client John Wu & Ming Yang	Date 09 May 2025
Job No. 33063/9793D-G	Logged By TB Review By LL
Address 16 - 20 Middle Harbour Road, Lindfield	Location # 25/1383
Drilling Contractor STS Geotechnics Pty Ltd	Surface RL - Drill Bit PT
Plant Push Tube	Inclination 90° Hole Ø (mm) 100

GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	CLASSIFICATION SYMBOL	CONSISTENCY / REL. DENSITY	MOISTURE CONDITION
				FILL: Clayey SAND: fine to medium grained, dark brown, trace fine gravels	-	-	M < PL
GWNE		0.5		Silty CLAY: low to medium plasticity, brown grey	CL-CI	F	M < PL
		1.0		Push Tube Refusal at 0.8m on Silty Clay.			
		1.5					
		2.0					
		2.5					
		3.0					
		3.5					
		4.0					
		4.5					
		5.0					
		5.5					
		6.0					
		6.5					
		7.0					
		7.5					
		8.0					
		8.5					
		9.0					
		9.5					

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

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BOREHOLE LOG

BH ID: BH4




Client John Wu & Ming Yang	Date 09 May 2025
Job No. 33063/9793D-G	Logged By TB Review By LL
Address 16 - 20 Middle Harbour Road, Lindfield	Location # 25/1383
Drilling Contractor STS Geotechnics Pty Ltd	Surface RL - Drill Bit PT
Plant Push Tube	Inclination 90° Hole Ø (mm) 100

GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	CLASSIFICATION SYMBOL	CONSISTENCY / REL. DENSITY	MOISTURE CONDITION
GWNE		0.5		FILL: Clayey SAND: fine to medium grained, dark brown to black brown, trace fine gravels, wood pieces	-	-	M > PL
		1.0		Hand Auger Refusal on Fill.			
		1.5					
		2.0					
		2.5					
		3.0					
		3.5					
		4.0					
		4.5					
		5.0					
		5.5					
		6.0					
		6.5					
		7.0					
		7.5					
		8.0					
		8.5					
		9.0					
		9.5					

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

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

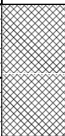

Client John Wu & Ming Yang	Date 09 May 2025
Job No. 33063/9793D-G	Logged By TB Review By LL
Address 16 - 20 Middle Harbour Road, Lindfield	Location # 25/1383
Drilling Contractor STS Geotechnics Pty Ltd	Surface RL - Drill Bit PT
Plant Push Tube	Inclination 90° Hole Ø (mm) 100

GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	CLASSIFICATION SYMBOL	CONSISTENCY / REL. DENSITY	MOISTURE CONDITION
GWNE		0.5		FILL: Sandy CLAY: low to medium plasticity, fine to medium grained, dark brown, trace fine gravels	-	-	M < PL
				FILL: Silty CLAY: low to medium plasticity, brown grey, trace fine gravels	-	-	M < PL
		1.0		Silty CLAY: medium to high plasticity, orange brown	Cl-CH	St VSt	M < PL
		1.5		Push Tube Refusal at 1.2m on Silty Clay.			
		2.0					
		2.5					
		3.0					
		3.5					
		4.0					
		4.5					
		5.0					
		5.5					
		6.0					
		6.5					
		7.0					
		7.5					
		8.0					
		8.5					
		9.0					
		9.5					

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

D - disturbed sample	S - jar sample	WT - level of water table or free water
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Client John Wu & Ming Yang	Date 09 May 2025
Job No. 33063/9793D-G	Logged By TB Review By LL
Address 16 - 20 Middle Harbour Road, Lindfield	Location # 25/1383
Drilling Contractor STS Geotechnics Pty Ltd	Surface RL - Drill Bit PT
Plant Push Tube	Inclination 90° Hole Ø (mm) 100

GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	CLASSIFICATION SYMBOL	CONSISTENCY / REL. DENSITY	MOISTURE CONDITION
GWNE		0.5		FILL: Clayey SAND: fine to medium grained, brown, trace rootlets FILL: Silty CLAY: low plasticity, dark brown	-	-	M < PL
		1.0		Silty CLAY: low to medium plasticity, orange brown grey	CL-CI	VSt	M < PL
		1.2		Push Tube Refusal at 1.2m on Silty Clay.			
		1.5					
		2.0					
		2.5					
		3.0					
		3.5					
		4.0					
		4.5					
		5.0					
		5.5					
		6.0					
		6.5					
		7.0					
		7.5					
		8.0					
		8.5					
		9.0					
		9.5					

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

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

Dynamic Cone Penetrometer Test Report

Project: 16 - 20 Middle Harbour Road, Lindfield

Project No.: 33063/9793D-G

Client: John Wu & Ming Yang

Report No.: 25/1382

Address: 16 - 20 Middle Harbour Road, Lindfield

Report Date: 13/05/2025

Test Method: AS 1289.6.3.2

Page: 1 of 1

Site No.	BH3	BH4	BH5	BH6		
Location	Refer to Drawing No. 25/1382	Refer to Drawing No. 25/1382	Refer to Drawing No. 25/1383	Refer to Drawing No. 25/1383		
Date Tested	09/05/2025	09/05/2025	09/05/2025	09/05/2025		
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level		
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	1	1	1	1		
0.15 - 0.30	3	1	2	2		
0.30 - 0.45	2	2	2	4		
0.45 - 0.60	3	2	5	1		
0.60 - 0.75	2	2	3	2		
0.75 - 0.90	7/50mm/HB	2	8	13		
0.90 - 1.05	Refusal	3	9	21		
1.05 - 1.20		3	9	25+		
1.20 - 1.35		5	18	Discontinued		
1.35 - 1.50		6	24			
1.50 - 1.65		7	Discontinued			
1.65 - 1.80		15				
1.80 - 1.95		24				
1.95 - 2.10		Discontinued				
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: TB

Mrigesh Tamang

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.



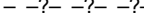
WATER

	 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 (%)

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

RQD = Rock Quality Designation (%)

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



FILL



COUBLES or
BOULDERS



GRAVEL (GP or GW)



ORGANIC SOILS
(OL, OH or Pt)



SILT (ML or MH)

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



CLAY (CL, CI or CH)



SAND (SP or SW)

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.

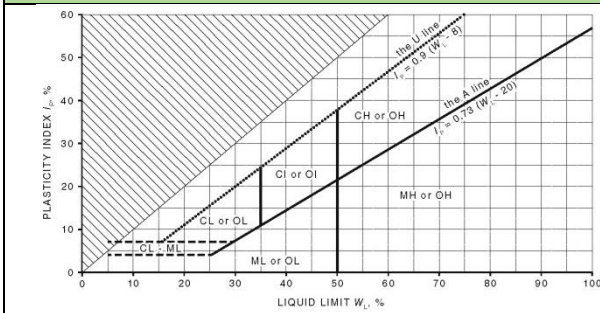
PARTICLE SIZE CHARACTERISTICS

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

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.
Liquid Limit > than 50%	OL		Organic silts and organic silty clays of low plasticity, low to medium dry strength.		
	MH	Inorganic silts of high plasticity, high to very high dry strength.			
	CH	Inorganic clays of high plasticity, high to very high dry strength.			
Highly Organic soil	PT	OH	Organic clays of medium to high plasticity, medium to high dry strength.		
		PT	Peat muck and other highly organic soils.		

PLASTICITY PROPERTIES



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: $\leq 5\%$ Fine grained soil: $\leq 15\%$
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: $>30\%$

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, $I_{s(50)}$ (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, $I_{s(50)}$, Axial test (MPa)

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

Relationship between rock strength test result ($I_{s(50)}$) 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 $I_{s(50)}$.

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	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.

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

Bedding Thickness* (Spacing between bedding partings)	
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

DEFECT APERTURE

Coating	Abbr.	Description	Aperture	Abbr.	Description
Clean	CN	No visible coating or infilling	Closed	CL	Closed.
Stain	SN	No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)	Open	OP	Without any infill material.
Veneer	VNR	A visible coating of soil or mineral substance, usually too thin to measure (< 1 mm); may be patchy	Infilled	-	Soil or rock i.e. clay, silt, talc, pyrite, quartz, etc.

APPENDIX B – LABORATORY TEST RESULTS



STS Geotechnics Pty Ltd

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



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

Atterberg Limits and Linear Shrinkage Report

Project: 16-20 MIDDLE HARBOUR ROAD, LINDFIELD

Project No.: 33063/9793D

Client: JOHN WU & MING YANG

Report No.: 25/1450

Address: 16-20 Middle Harbour Road, Lindfield

Report Date: 22/5/2025


Test Method: AS 1289.3.3.1, 3.2.1, 3.1.2, 3.4.1

Page: 1 of 1

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

STS / Sample No.	9793/1	9793/2				
Sample Location	BH1	BH2				
Material Description	Silty CLAY, red grey, trace gravel (CH)	Silty CLAY; orange grey, trace of sand (CI)				
Depth (m)	0.6-1.05	0.5-0.95				
Sample Date	9/05/2025	9/05/2025				
Sample History	Oven Dried	Oven Dried				
Method of Preparation	Dry Sieve	Dry Sieve				
Liquid Limit (%)	55	35				
Plastic Limit (%)	26	20				
Plasticity Index	29	15				
Linear Shrinkage (%)	13.5	10				
Mould Size (mm)	127	150				
Crumbing	N	N				
Curling	N	N				

Remarks:

Approved Signatory..... 

Technician: SP

Mgrish Tamang - Manager



CERTIFICATE OF ANALYSIS

Work Order	: ES2513836	Page	: 1 of 2
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	: 30060, 33063	Date Samples Received	: 13-May-2025 12:25
Order number	: 2025-173	Date Analysis Commenced	: 14-May-2025
C-O-C number	: ----	Issue Date	: 19-May-2025 14:52
Sampler	: AF, MB		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 3		
No. of samples analysed	: 3		



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.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
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: SOIL
 (Matrix: SOIL)

				Sample ID	30060/2077	30060/2078	33063/S1	----	----
				Sampling date / time	12-May-2025 00:00	12-May-2025 00:00	08-May-2025 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2513836-001	ES2513836-002	ES2513836-003	-----	-----	
				Result	Result	Result	----	----	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	8.9	8.6	6.5	----	----	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	428	483	43	----	----	
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%	4.6	5.8	24.9	----	----	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	310	340	60	----	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg	----	----	<10	----	----	



CERTIFICATE OF ANALYSIS

Work Order : **ES2514066**
Client : **STS Geotechnics**
Contact : ENQUIRES STS
Address : Unit 14/1 Cowpasture Place
Wetherill Park 2164
Telephone : ----
Project : 30055, 33063
Order number : 2025-175
C-O-C number : ----
Sampler : AF, MB
Site : ----
Quote number : EN/222
No. of samples received : 2
No. of samples analysed : 2

Page : 1 of 2
Laboratory : Environmental Division Sydney
Contact : Customer Services ES
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 14-May-2025 12:20
Date Analysis Commenced : 15-May-2025
Issue Date : 20-May-2025 12:13



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

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 ~ = 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: SOIL
 (Matrix: SOIL)

				Sample ID	30055/10176	33063/S2	----	----	----
				Sampling date / time	13-May-2025 00:00	12-May-2025 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2514066-001	ES2514066-002	-----	-----	-----	
				Result	Result	----	----	----	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	5.4	7.7	----	----	----	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	12	92	----	----	----	
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%	16.0	17.1	----	----	----	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	10	----	----	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg	----	100	----	----	----	