Acid Sulphate Assessment

Prepared For:

Webber Architects

Site Address:

Warringah Recreation Centre – Cnr Pittwater & Kentwell Road, North Manly

Ref No:

71113-IDF

Date:

July 2024

Accredited for compliance
With ISO/IEC 17025
NATA Accreditation No.
19226

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Contents

1.0 INTRODUCTION

Ideal Geotech has undertaken a Preliminary Acid Sulphate Soils Assessment for the proposed proposed commercial development Warringah Recreation Centre; corner of Pittwater and Kentwell Road, North Manly.

The proposed development indicated on the plans provided by the client comprises construction of a proposed squash club. It is understood minimal cut and fill will be undertaken to accommodate construction of the proposed works.

2.0 OBJECTIVES AND SCOPE OF WORK

The objectives of the work are outlined below:

- Summarise the relevant environmental characteristics of the site that may impact Actual Acid Sulphate Soils (AASS) and result in the release of acidity and the potential leaching and transport of contaminants.
- Outline potential environmental impacts associated with the proposed works.
- Summarise the presence or the absence of AASS and Potential Acid Sulphate Soils (PASS).
- Summarise soil aggressiveness to steel and concrete.

The scope of work includes the following:

- Review of soils and geological maps.
- A Preliminary soil sampling and analysis program to investigate the presence and distribution of AASS and PASS within the site.
- Analysis (SPOCAS suite) by a NATA accredited laboratory.
- Assessment of the results of the chemical analysis against the appropriate guidelines to assess if management is required so as to minimise potential environmental impacts caused by the disturbance of ASS.

Provide recommendations for the need to undertake an ASS Management Plan.

3.0 SITE DETAILS

Site Address	Warringah Recreation Centre – Cnr Pittwater and Kentwell Road, North Manly
Client	Webber Architects
Council Area	Northern Beaches Council

3.1 Geology

Reference to the Sydney 1:100,000 geological map (Geological Series Sheet 9130) indicates that the site is underlain by Quaternary deposits consisting of silty to peaty quartz sand, silt and clay. Ferruginous and humic cementation in places and common shell layers.

Image 1: Geological Series Map

3.2 Site Description

The subject site is roughly rectangular in shape and approximately 10,000m^2 in area and is bound by Pittwater Road to the north east, Kentwell Road to the south, Brookvale Creek to the west and by Warringah Golf Course on all remaining sides.

The site is currently occupied by tennis courts and sports facilities. The site is relatively flat with no notable slopes that will impact construction with a line of large mature trees along the western, northern and eastern boundaries.

4.0 Subsurface Conditions

Fieldwork was undertaken on 3rd July 2024 and included drilling six boreholes (BH1-BH6) using a 4wd mounted drill rig using solid flight spiral augers to a maximum depth of 3.0m at the locations shown on Figure 1, attached in Appendix A.

Borehole logs and field observations are presented in Appendix B.

4.1 Soil Profile

A general summary of the subsurface conditions encountered across the site is presented in Table 2 below.

Table 1: Summary of Subsurface Conditions

Borehole	Depth of fill/topsoil (m)	Depth to Water table (m)	Termination depth (m)	Summary of sub-surface profiles
BH1	0.4 (Topsoil)	2.6	3.0	Topsoil- Silty SAND / Natural- Silty Clayey SAND
BH2	0.8 (Topsoil)	2.7	3.0	Topsoil- Silty SAND / Natural- Silty Clayey SAND
BH3	1.1 (Topsoil)	2.8	3.0	Topsoil- Silty SAND / Natural- Silty Clayey SAND
BH4	0.6 (Topsoil)	0.6*	3.0	Topsoil- Silty SAND / Natural- Silty Clayey SAND
BH5	0.4 (Topsoil)	0.6*	3.0	Topsoil- Silty SAND / Natural- Silty Clayey SAND
BH6	0.5 (Topsoil)	0.9*	3.0	Topsoil- Silty SAND / Natural- Silty Clayey SAND

* *Water Seepage (Not standing water table)*
NE *Not Encountered*

Groundwater was observed at the time of investigation at the depths outlined in Table 2. BH4-BH6 had evidence of water seepage and BH1-BH3 showed a standing water table. It should be noted that groundwater levels are likely to fluctuate with variations in climatic and site conditions.

4.2 Acid Sulphate Soils

Acid Sulphate Soils (ASS) are naturally occurring and usually form in low lying coastal areas, creeks, rivers and flood plains. The sulphates present in the soil are stable when in the saturated/waterlogged state, but react to form sulphuric acid when disturbed and exposed to oxygen.

Maps showing the areas identified as being affected by ASS have been prepared by the Department of Land and Water Conservation. These maps identify the probability of acid sulphate soils occurring in these areas and as such any areas should be specifically investigated before a particular site is classified.

Disturbance of these soil materials will result in an environmental risk that will vary with elevation and depth of disturbance. Any works below natural ground surface or affecting the water table has a risk of being contaminated with acid sulphate soils.

Reference to the Acid Sulphate Soils Map of Sydney Heads indicates that the site is located on the border between disturbed terrain and no known occurrence of acid sulphate soil materials.

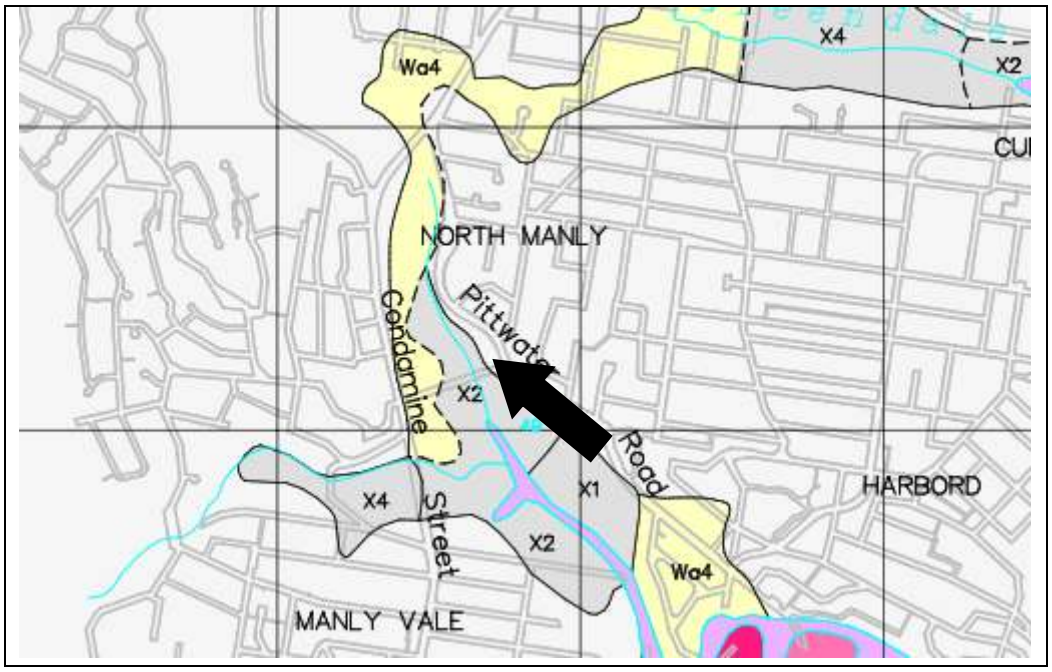


Image 2: Acid Sulphate Soils Risk Map

**Site marked with arrow*

5.0 SAMPLING & ANALYSIS PLAN

Sampling and analysis were undertaken in order to assess the presence or absence, location and likely distribution of any AASS or PASS present at the subject site in the area of the proposed development.

5.1 Sampling

Soil sampling was undertaken in general accordance with the Acid Sulphate Soil Guidelines (Refer to Figure 1 for the borehole locations). Test results were compared to the relevant New South Wales Environment Protection Authority (NSW EPA) criteria.

BH1-BH6 were all terminated at a depth of approx. 3.0m below ground surface with samples collected at the depths as listed; BH1- 0.5m & 1.5m, BH2- 1.0m & 2.0m, BH3- 1.0m & 3.0m, BH4- 0.5m & 1.5m, BH5- 1.0m & 2.0m, BH6- 1.5m & 3.0m. The samples were placed directly into labelled clean zip lock bags and placed on ice until delivery to the laboratory for testing. All analyses were performed by a NATA registered laboratory using NATA accredited methods.

6.0 ACID SULPHATE SOILS ASSESSMENT

6.1 Field Screening

The field screening involved the testing of samples for field pH and peroxide pH, using 30% hydrogen peroxide to oxidise the soil, and comparing both results.

A positive peroxide test, indicating the potential presence of acid sulphate soil, may include one or more of the following.

1. Change in colour from grey tones to brown tones.
2. Effervescence.
3. Release of sulphurous odours.
4. pH following oxidation with H_2O_2 ($_{pHfox}$) <3.
5. Lowering of the pH (pH_f - pH_{fox}) by 1 or greater.
6. Field pH (pH_f) <4.

The results of the field and peroxide tests are provided in Table 1 below.

Table 2: Results of Field Screening Tests

Location/Depth	Field pH	Peroxide pH	Reaction to 30% h_2O_2
BH1/0.5m	6.9	3.5	Slight
BH1/1.5m	5.6	2.7	Strong
BH2/1.0m	8.0	5.3	Moderate
BH2/2.0m	6.0	2.6	Slight
BH3/1.0m	5.1	2.6	Slight
BH3/3.0m	6.0	2.7	Slight
BH4/0.5m	5.0	2.7	Slight
BH4/1.5m	6.2	3.2	Strong
BH5/1.0m	6.3	2.9	Slight
BH5/2.0m	5.9	2.1	Strong
BH6/1.5m	5.6	2.5	Strong
BH6/3.0m	5.7	2.0	Strong

Based on findings of the field screenings, indications of PASS were observed. The samples were tested by quantitative laboratory analysis to confirm the presence or absence of acid sulphate soil.

6.2 Laboratory Test Results

The samples were analysed for SPOCAS to confirm the presence or absence of ASS or PASS in the soil. The samples were dispatched to ALS Environmental services for the quantitative analysis for Suspension Peroxide Oxidation Combined Acidity & Sulphate (SPOCAS).

6.3 Assessment Criteria for Acid Sulphate Soils (Laboratory)

The results of analysis for the soils are compared to the below ASSMAC assessment criteria. It is assumed that <1000 tonnes of material would be disturbed hence the action criteria for less than 1000 tonnes have been applied.

6.4 NSW ASSMAC Action Criteria

The NSW ASSMAC action criteria is detailed in Table 2 below for less than 1000 tonnes of disturbance.

Table 3: NSW ASSMAC Action Criteria

Type of Material Texture	Approx Clay Content (% <0.002mm)	Action Criteria <1000 tonnes Sulfur Trail Spos or Stos%	Action Criteria <1000 tonnes Acid Trail TPA or TSA mole H+/t
Coarse e.g. sands	< 5	0.03	18
Loams/light clays	**5 – 40**	**0.06**	**36**
Fine clays/silts	≥ 40	0.1	62

Note: The assessment values chosen are based on loams/light clays which are in bold

6.5 SPOCAS Test Results

The SPOCAS testing identified no exceedances of the threshold criteria in nine of the samples which suggests there is a presence of acid sulphate soils. Refer to Table 3 below.

Table 4: Results of SPOCAS Testing

Sample	pH_{ox}	TAA pH 6.5 moles H+/tonne	TPA pH 6.5 moles H+/tonne	TSA pH 6.5 moles H+/tonne	Spos %w/w
BH1/0.5m	5.9	<2	<2	<2	<0.020
BH1/1.5m	3.0	**177**	**392**	**216**	**0.255**
BH2/1.0m	6.9	<2	<2	<2	<0.020
BH2/2.0m	3.0	11	**96**	**85**	0.124
BH3/1.0m	3.4	25	**74**	**49**	0.028
BH3/3.0m	3.4	13	**65**	**52**	0.043
BH4/0.5m	3.9	5	**44**	**38**	<0.020
BH4/1.5m	4.1	**61**	**313**	**252**	**0.098**
BH5/1.0m	4.2	5	6	<2	<0.020
BH5/2.0m	2.2	**118**	**1810**	**1700**	**0.188**
BH6/1.5m	2.4	**170**	**1160**	**987**	**0.364**
BH6/3.0m	2.1	**97**	**888**	**791**	**0.288**

6.6 Aggressiveness to Steel and Concrete

The aggressiveness or erosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of pH and types of salts present. In order 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 Piling - Design and Installation and tables 5.1 to 5.4 in AS2870-2011 "Residential Slabs and Footings". The following testing suite was undertaken with results summarised within table 4 below;

- pH
- Electrical Conductivity (EC µS/cm)
- Chloride (Cl)
- Resistivity (ohm.cm)
- Sulphate

Table 5: Results of Aggressivity Testing

Location/Depth	pH	EC_e dS/m	Resistivity Ohm.cm	Cl mg/kg	Sulphate mg/kg
BH1/0.5m	7.1	0.210	31200	<10	<10
BH2/1.0m	8.2	1.260	6370	<10	20
BH3/3.0m	6.2	0.196	18200	<10	<10
BH4/1.5m	6.4	0.238	12300	<10	70
BH5/2.0m	6.1	0.42	8930	60	20

Based on test results detailed in Table 4 the soil conditions are considered to be mildly aggressive to concrete and non-aggressive to steel in soils in groundwater. An exposure classification of A2 for concrete has been determined.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Ideal Geotech has undertaken a Preliminary Acid Sulphate Soils Assessment for the proposed residential development at Warringah Recreation Centre, Corner of Pittwater Road and Kentwell Road, North Manly. Our preliminary site investigation included site observation of the soil retrieved from the borehole and sampling of soil for laboratory testing. Upon completion of our onsite investigation and laboratory analysis the following conclusions are made:

- An exposure classification of A2 for concrete with the soil mildly aggressive to concrete and non-aggressive to steel structures.

- Laboratory sample analysis indicates that test levels exceeded the action criteria in SPOCAS testing and it has been determined that an acid sulphate management plan will be required for excavation activities on the site.

This report is based on a limited sampling and testing regime. It is possible that acid sulphate soils and differing ground conditions may be present between sampling locations, or in the remainder of the site not intrusively investigated.

Should you have any queries, please do not hesitate to contact the undersigned.

For and on behalf of Ideal Geotech

D. Dwyer

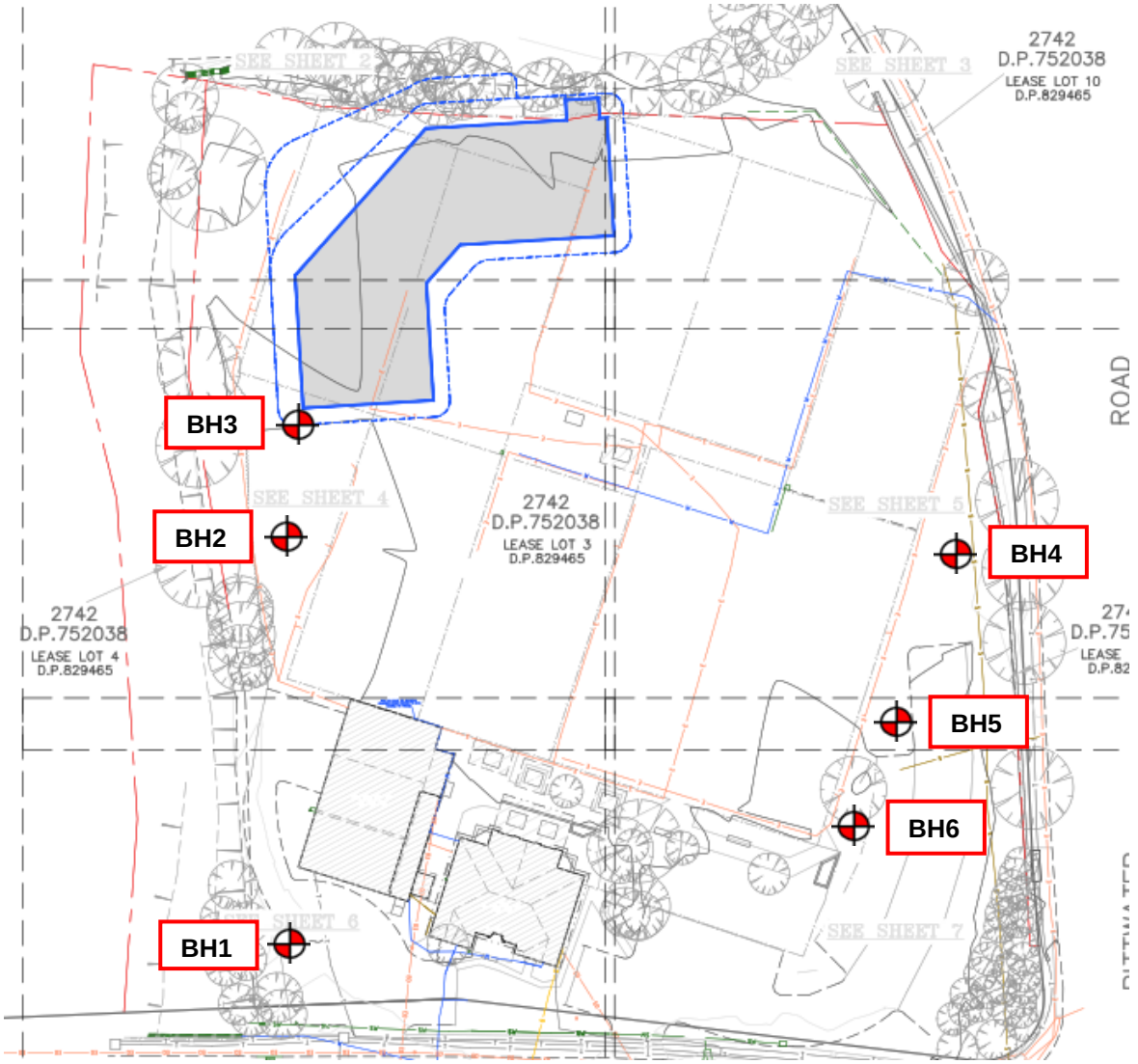
Dane Dwyer
Geotechnical Engineer

8.0 REFERENCES

- *Geological Series Sheet 9130, Map of Sydney, scale 1:100,000*
- *Acid Sulphate Soil Risk Map – Edition 2, Botany Bay*
- *Stone, Y, and Hopkins G (1998). Acid Sulphate Soils Planning Guidelines.* Published by the Acid Sulphate Soil Management Advisory Committee, Wollongbar, NSW, Australia.
- Ahern C R, Stone, Y, and Blunden B (1998). *Acid Sulphate Soils Assessment Guidelines* Published by the Acid Sulphate Soil Management Advisory Committee, Wollongbar, NSW, Australia

9.0 APPENDICES

9.1 Appendix A – Borehole Location Plan



Title	Borehole Location Plan	**Council**	Northern Beaches Council	**Drawn By**	Ben
Project	Acid Sulphate Soil Assessment	**Job Number**	71113-IDF	**Checked By**	Dane
Site Address	Warringah Recreation Centre – North Manly	**Figure Number**	Figure 1	**Date**	Jul-24

NORTH POINT

9.2 Appendix B – Borehole Logs

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5.1 FIELD LOG

Date: {maxWorklogDate}
Customer Job: -
Ideal Job: 3041-71113
Site Address: Warringah Golf Club Corner of Pittwater and Kingsway Road, NORTH MANLY, NSW, 2100

Borehole: BH1
Surface RL:
Easting:
Northing:

Water		Samples	Depth	Material Origin	FILL Depth	Classification Code	Material Description	Moisture	Density / Consistency
				TOPSOIL		SM	Silty SAND Black Grey	Slightly Moist	Loose
			0.5	NATURAL		SM	Silty Clayey SAND Black Grey	Slightly Wet	Loose
			1.0						
			1.5						
			2.0						
▼			2.5				End Bore 3m		

▼ Water Table **UTP** - Unable to penetrate **DCP** - 9kg Dynamic Cone Penetrometer **PP** - Pocket Penetrometer

SAND – Density Index vs Approx. Penetrometer results

DENSITY		Density Index	DCP Blow Count (blows/100mm)
VL	Very Loose	< 15 %	< 1
L	Loose	15 – 35 %	1 – 3
MD	Medium Dense	35 – 65 %	3 – 9
D	Dense	65 – 85 %	9 – 15
VD	Very Dense	> 85 %	> 15

SILTS & CLAY – Cu vs Approx. Penetrometer results

CONSISTENCY		Undrained Shear Strength (kPa)	DCP Blow Count (blows/100mm)
VS	Very Soft	0 – 12	< 1
S	Soft	12 – 25	1 – 2
F	Firm	25 – 50	2 – 3
St	Stiff	50 – 100	3 – 5
VSt	Very Stiff	100 – 200	5 – 8
H	Hard	> 200	> 8

MOISTURE

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit
m	Moisture

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5.2 FIELD LOG

Date: {maxWorklogDate}
Customer Job: -
Ideal Job: 3041-71113
Site Address: Warringah Golf Club Corner of Pittwater and Kingwell Road, NORTH MANLY, NSW, 2100

Borehole: BH2
Surface RL:
Easting:
Northing:

Water		Samples	Depth	Material Origin	FILL Depth	Classification Code	Material Description	Moisture	Density / Consistency
			0.5	TOPSOIL		SM	Silty SAND Black Grey	Slightly Moist	Loose
			1.0	NATURAL		SM	Silty Clayey SAND Black Grey	Slightly Wet	Loose
			1.5						
			2.0						
			2.5				End Bore 3m		

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VSt	Very Stiff	100 – 200	5 – 8
H	Hard	> 200	> 8

MOISTURE

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit
m	Moisture

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5.3 FIELD LOG

Date: {maxWorklogDate}
Customer Job: -
Ideal Job: 3041-71113
Site Address: Warringah Golf Club Corner of Pittwater and Kingsway Road, NORTH MANLY, NSW, 2100

Borehole: BH3
Surface RL:
Easting:
Northing:

Water		Samples	Depth	Material Origin	FILL Depth	Classification Code	Material Description	Moisture	Density / Consistency
			0.5	TOPSOIL		SM	Silty SAND Black Grey	Slightly Moist	Loose
			1.0						
			1.5	NATURAL		SM	Silty Clayey SAND Black Grey	Slightly Wet	Loose
			2.0						
			2.5				End Bore 3m		

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H	Hard	> 200	> 8

MOISTURE

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit
m	Moisture

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5.4 FIELD LOG

Date: {maxWorklogDate}
Customer Job: -
Ideal Job: 3041-71113
Site Address: Warringah Golf Club Corner of Pittwater and Kingsway Road, NORTH MANLY, NSW, 2100

Borehole: BH4
Surface RL:
Easting:
Northing:

Water		Samples	Depth	Material Origin	FILL Depth	Classification Code	Material Description	Moisture	Density / Consistency
			0.5	TOPSOIL		SM	Silty SAND Black Grey	Slightly Moist	Loose
▼			1.0	NATURAL		SM	Silty Clayey SAND Black Grey	Slightly Wet	Loose
			1.5						
			2.0						
▼			2.5				End Bore 3m		

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MOISTURE

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit
m	Moisture

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5.5 FIELD LOG

Date: {maxWorklogDate}
Customer Job: -
Ideal Job: 3041-71113
Site Address: Warringah Golf Club Corner of Pittwater and Kingsway Road, NORTH MANLY, NSW, 2100

Borehole: BH5
Surface RL:
Easting:
Northing:

Water		Samples	Depth	Material Origin	FILL Depth	Classification Code	Material Description	Moisture	Density / Consistency
				TOPSOIL		SM	Silty SAND Black Grey	Slightly Moist	Loose
▼			0.5	NATURAL		SM	Silty Clayey SAND Black Grey	Slightly Wet	Loose
			1.0						
			1.5						
			2.0						
▼			2.5				End Bore 3m		

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MOISTURE

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit
m	Moisture

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5.6 FIELD LOG

Date: {maxWorklogDate}
Customer Job: -
Ideal Job: 3041-71113
Site Address: Warringah Golf Club Corner of Pittwater and Kingwell Road, NORTH MANLY, NSW, 2100

Borehole: BH6
Surface RL:
Easting:
Northing:

Water		Samples	Depth	Material Origin	FILL Depth	Classification Code	Material Description	Moisture	Density / Consistency
			0.5	TOPSOIL		SM	Silty SAND Black Grey	Slightly Moist	Loose
▼			1.0	NATURAL		SM	Silty Clayey SAND Black Grey	Slightly Wet	Loose
			1.5						
			2.0						
▼			2.5				End Bore 3m		

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St	Stiff	50 – 100	3 – 5
VSt	Very Stiff	100 – 200	5 – 8
H	Hard	> 200	> 8

MOISTURE

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit
m	Moisture

9.3 Appendix C – Laboratory Test Results

CERTIFICATE OF ANALYSIS

Work Order	: **ES2422257**	Page	: 1 of 9
Client	: **IdealCorp Pty Ltd**	Laboratory	: Environmental Division Sydney
Contact	: DANE DWYER	Contact	: Customer Services ES
Address	: 16-18 Sammut Street SMITHFIELD NSW, AUSTRALIA 2164	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 71113	Date Samples Received	: 04-Jul-2024 11:00
Order number	: ----	Date Analysis Commenced	: 10-Jul-2024
C-O-C number	: ----	Issue Date	: 15-Jul-2024 14:52
Sampler	: BA		
Site	: ----		
Quote number	: SY/386/19 V8		
No. of samples received	: 12		
No. of samples analysed	: 12		

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
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

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.

- EA032 (Saturated Paste EC): NATA accreditation does not cover the performance of this service.
- ASS: EA029 (SPOCAS): Analysis is performed as per the Acid Sulfate Soils Laboratory Methods Guidelines (2004) and the updated National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT (2018)
- ASS: EA029 (SPOCAS): Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA029 (SPOCAS): Laboratory determinations of ANC needs to be corroborated by effectiveness of the measured ANC in relation to incubation ANC. Unless corroborated, the results of ANC testing should be discounted when determining Net Acidity for comparison with action criteria, or for the determination of the acidity hazard and required liming amounts.
- ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in t/m3.
- ASS: EA003 (NATA Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- ALS is not NATA accredited for the calculation of saturated resistivity in a soil.
- 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	BH1 - 0.5m	BH1 - 1.5m	BH2 - 1.0m	BH2 - 2.0m	BH3 - 1.0m
			Sampling date / time	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00
Compound	CAS Number	LOR	Unit	ES2422257-001	ES2422257-002	ES2422257-003	ES2422257-004	ES2422257-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.1	----	8.2	----	----
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.9	5.6	8.0	6.0	5.1
pH (Fox)	----	0.1	pH Unit	3.5	2.7	5.3	2.6	2.6
Reaction Rate	----	1	Reaction Unit	1	3	2	1	1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	15	----	90	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	6.3	4.6	8.6	6.0	5.2
pH OX (23B)	----	0.1	pH Unit	5.9	3.0	6.9	3.0	3.4
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	177	<2	11	25
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	392	<2	96	74
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	216	<2	85	49
sulfidic - Titratable Actual Acidity (s-23F)	----	0.020	% pyrite S	<0.020	0.283	<0.020	<0.020	0.040
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.020	% pyrite S	<0.020	0.629	<0.020	0.154	0.119
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.020	% pyrite S	<0.020	0.346	<0.020	0.136	0.079
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.020	% S	<0.020	<0.020	<0.020	<0.020	<0.020
Peroxide Sulfur (23De)	----	0.020	% S	<0.020	0.255	<0.020	0.124	0.028
Peroxide Oxidisable Sulfur (23E)	----	0.020	% S	<0.020	0.255	<0.020	0.124	0.028
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	159	<10	78	18
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.020	% Ca	0.058	0.122	0.241	<0.020	<0.020
Peroxide Calcium (23Wh)	----	0.020	% Ca	0.070	0.129	0.416	<0.020	<0.020
Acid Reacted Calcium (23X)	----	0.020	% Ca	<0.020	<0.020	0.176	<0.020	<0.020

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	BH1 - 0.5m	BH1 - 1.5m	BH2 - 1.0m	BH2 - 2.0m	BH3 - 1.0m
				Sampling date / time	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00
Compound	CAS Number	LOR	Unit		ES2422257-001	ES2422257-002	ES2422257-003	ES2422257-004	ES2422257-005
					Result	Result	Result	Result	Result
EA029-D: Calcium Values - Continued									
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t		<10	<10	**88**	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.020	% S		<0.020	<0.020	**0.140**	<0.020	<0.020
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.020	% Mg		<0.020	<0.020	<0.020	<0.020	<0.020
Peroxide Magnesium (23Tm)	----	0.020	% Mg		<0.020	<0.020	<0.020	<0.020	<0.020
Acid Reacted Magnesium (23U)	----	0.020	% Mg		<0.020	<0.020	<0.020	<0.020	<0.020
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.020	% S		<0.020	<0.020	<0.020	<0.020	<0.020
EA029-F: Excess Acid Neutralising Capacity									
Excess Acid Neutralising Capacity (23Q)	----	0.020	% CaCO3		----	----	**0.911**	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t		----	----	**182**	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.020	% S		----	----	**0.292**	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		<0.02	**0.54**	<0.02	**0.14**	**0.07**
Net Acidity (acidity units)	----	10	mole H+ / t		<10	**336**	<10	**88**	**43**
Liming Rate	----	1	kg CaCO3/t		<1	**25**	<1	**7**	**3**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	**0.54**	<0.02	**0.14**	**0.07**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		<10	**336**	<10	**88**	**43**
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	**25**	<1	**7**	**3**
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		**12.4**	----	**13.9**	----	----
EA084: Saturated Resistivity									
Resistivity at 25°C	----	10	ohm cm		**31200**	----	**6370**	----	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		<10	----	**20**	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	BH1 - 0.5m	BH1 - 1.5m	BH2 - 1.0m	BH2 - 2.0m	BH3 - 1.0m
				Sampling date / time	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00
Compound	CAS Number	LOR	Unit		ES2422257-001	ES2422257-002	ES2422257-003	ES2422257-004	ES2422257-005
					Result	Result	Result	Result	Result
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		<10	---	<10	---	---

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	BH3 - 3.0m	BH4 - 0.5m	BH4 - 1.5m	BH5 - 1.0m	BH5 - 2.0m
			Sampling date / time	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00
Compound	CAS Number	LOR	Unit	ES2422257-006	ES2422257-007	ES2422257-008	ES2422257-009	ES2422257-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.2	----	6.4	----	6.1
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.0	5.0	6.2	6.3	5.9
pH (Fox)	----	0.1	pH Unit	2.7	2.7	3.2	2.9	2.1
Reaction Rate	----	1	Reaction Unit	1	1	3	1	3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	14	----	17	----	30
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	5.7	6.1	5.1	5.9	4.6
pH OX (23B)	----	0.1	pH Unit	3.4	3.9	4.1	4.2	2.2
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	13	5	61	5	118
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	65	44	313	6	1810
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	52	38	252	<2	1700
sulfidic - Titratable Actual Acidity (s-23F)	----	0.020	% pyrite S	0.020	<0.020	0.098	<0.020	0.188
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.020	% pyrite S	0.105	0.070	0.501	<0.020	2.91
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.020	% pyrite S	0.084	0.062	0.403	<0.020	2.72
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.020	% S	<0.020	<0.020	<0.020	<0.020	<0.020
Peroxide Sulfur (23De)	----	0.020	% S	0.043	<0.020	0.107	<0.020	0.514
Peroxide Oxidisable Sulfur (23E)	----	0.020	% S	0.043	<0.020	0.107	<0.020	0.514
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	27	<10	67	<10	320
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.020	% Ca	0.034	0.076	0.213	0.039	0.132
Peroxide Calcium (23Wh)	----	0.020	% Ca	0.058	0.080	0.242	0.042	0.180
Acid Reacted Calcium (23X)	----	0.020	% Ca	0.023	<0.020	0.029	<0.020	0.048

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	BH3 - 3.0m	BH4 - 0.5m	BH4 - 1.5m	BH5 - 1.0m	BH5 - 2.0m
				Sampling date / time	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00	03-Jul-2024 09:00
Compound	CAS Number	LOR	Unit		ES2422257-006	ES2422257-007	ES2422257-008	ES2422257-009	ES2422257-010
					Result	Result	Result	Result	Result
EA029-D: Calcium Values - Continued									
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t		12	<10	14	<10	24
sulfidic - Acid Reacted Calcium (s-23X)	----	0.020	% S		<0.020	<0.020	0.023	<0.020	0.038
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.020	% Mg		<0.020	<0.020	<0.020	<0.020	0.035
Peroxide Magnesium (23Tm)	----	0.020	% Mg		<0.020	<0.020	<0.020	<0.020	0.046
Acid Reacted Magnesium (23U)	----	0.020	% Mg		<0.020	<0.020	<0.020	<0.020	<0.020
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.020	% S		<0.020	<0.020	<0.020	<0.020	<0.020
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S		0.06	<0.02	0.20	<0.02	0.70
Net Acidity (acidity units)	----	10	mole H+ / t		40	<10	128	<10	438
Liming Rate	----	1	kg CaCO3/t		3	<1	10	<1	33
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		0.06	<0.02	0.20	<0.02	0.70
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		40	<10	128	<10	438
Liming Rate excluding ANC	----	1	kg CaCO3/t		3	<1	10	<1	33
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		23.3	----	50.0	----	63.3
EA084: Saturated Resistivity									
Resistivity at 25°C	----	10	ohm cm		18200	----	12300	----	8930
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		<10	----	70	----	20
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		<10	----	<10	----	60

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	BH6 - 1.5m	BH6 - 3.0m	---	---	---
				Sampling date / time	03-Jul-2024 09:00	03-Jul-2024 09:00	---	---	---
Compound	CAS Number	LOR	Unit		ES2422257-011	ES2422257-012	-------	-------	------
					Result	Result	---	---	---
EA003 :pH (field/fox)									
pH (F)	---	0.1	pH Unit		5.6	5.7	---	---	---
pH (Fox)	---	0.1	pH Unit		2.5	2.0	---	---	---
Reaction Rate	---	1	Reaction Unit		3	3	---	---	---
EA029-A: pH Measurements									
pH KCl (23A)	---	0.1	pH Unit		4.7	4.8	---	---	---
pH OX (23B)	---	0.1	pH Unit		2.4	2.1	---	---	---
EA029-B: Acidity Trail									
Titratable Actual Acidity (23F)	---	2	mole H+ / t		170	97	---	---	---
Titratable Peroxide Acidity (23G)	---	2	mole H+ / t		1160	888	---	---	---
Titratable Sulfidic Acidity (23H)	---	2	mole H+ / t		987	791	---	---	---
sulfidic - Titratable Actual Acidity (s-23F)	---	0.020	% pyrite S		0.273	0.155	---	---	---
sulfidic - Titratable Peroxide Acidity (s-23G)	---	0.020	% pyrite S		1.86	1.42	---	---	---
sulfidic - Titratable Sulfidic Acidity (s-23H)	---	0.020	% pyrite S		1.58	1.27	---	---	---
EA029-C: Sulfur Trail									
KCl Extractable Sulfur (23Ce)	---	0.020	% S		<0.020	<0.020	---	---	---
Peroxide Sulfur (23De)	---	0.020	% S		0.364	0.288	---	---	---
Peroxide Oxidisable Sulfur (23E)	---	0.020	% S		0.364	0.288	---	---	---
acidity - Peroxide Oxidisable Sulfur (a-23E)	---	10	mole H+ / t		227	180	---	---	---
EA029-D: Calcium Values									
KCl Extractable Calcium (23Vh)	---	0.020	% Ca		0.141	<0.020	---	---	---
Peroxide Calcium (23Wh)	---	0.020	% Ca		0.159	0.020	---	---	---
Acid Reacted Calcium (23X)	---	0.020	% Ca		<0.020	0.020	---	---	---
acidity - Acid Reacted Calcium (a-23X)	---	10	mole H+ / t		<10	10	---	---	---
sulfidic - Acid Reacted Calcium (s-23X)	---	0.020	% S		<0.020	<0.020	---	---	---
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	---	0.020	% Mg		0.035	<0.020	---	---	---

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	BH6 - 1.5m	BH6 - 3.0m	---	---	---
				Sampling date / time	03-Jul-2024 09:00	03-Jul-2024 09:00	---	---	---
Compound	CAS Number	LOR	Unit		ES2422257-011	ES2422257-012	-------	-------	------
					Result	Result	---	---	---
EA029-E: Magnesium Values - Continued									
Peroxide Magnesium (23Tm)	---	0.020	% Mg		**0.040**	<0.020	---	---	---
Acid Reacted Magnesium (23U)	---	0.020	% Mg		<0.020	<0.020	---	---	---
Acidity - Acid Reacted Magnesium (a-23U)	---	10	mole H+ / t		<10	<10	---	---	---
sulfidic - Acid Reacted Magnesium (s-23U)	---	0.020	% S		<0.020	<0.020	---	---	---
EA029-H: Acid Base Accounting									
ANC Fineness Factor	---	0.5	-		**1.5**	**1.5**	---	---	---
Net Acidity (sulfur units)	---	0.02	% S		**0.64**	**0.44**	---	---	---
Net Acidity (acidity units)	---	10	mole H+ / t		**397**	**276**	---	---	---
Liming Rate	---	1	kg CaCO3/t		**30**	**21**	---	---	---
Net Acidity excluding ANC (sulfur units)	---	0.02	% S		**0.64**	**0.44**	---	---	---
Net Acidity excluding ANC (acidity units)	---	10	mole H+ / t		**397**	**276**	---	---	---
Liming Rate excluding ANC	---	1	kg CaCO3/t		**30**	**21**	---	---	---

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry / Biology).

(SOIL) EA029-D: Calcium Values
(SOIL) EA029-G: Retained Acidity
(SOIL) EA029-B: Acidity Trail
(SOIL) EA029-C: Sulfur Trail
(SOIL) EA029-E: Magnesium Values
(SOIL) EA029-H: Acid Base Accounting
(SOIL) EA003 :pH (field/fox)
(SOIL) EA029-F: Excess Acid Neutralising Capacity
(SOIL) EA029-A: pH Measurements