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BINAH DEVELOPMENT PTY LTD

Acid Sulfate Soil Assessment

26 Elizabeth Street, Liverpool, NSW

Report E23796.E14_Rev0

28 May 2018

REPORT DISTRIBUTION

Acid Sulfate Soils Assessment
26 Elizabeth Street, Liverpool NSW

EI Report No.: E23796.E14_Rev0
Date: 28 May 2018

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SHARON LI Environmental Scientist	**MALCOLM DALE** Senior Principal – Contaminated Land

Revision	Details	Date	Amended By
0	Original	28 May 2018	-

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1. INTRODUCTION

1.1 BACKGROUND AND PROPOSED DEVELOPMENT

EI Australia (EI) was engaged by Mr Ahmad Refaieh, to conduct an Acid Sulfate Soils (ASS) Assessment for the property at 26 Elizabeth Street, Liverpool NSW ('the site').

As shown in **Figure 1**, the site is located in the suburb of Liverpool and comprises Lots 1 in DP 217460 and Lot 10 in DP 621840, covering a total area of approximately 3,144 m^2. The site is situated within the Local Government Area of Liverpool City Council.

Based on proposed development plans provided by the client, it is understood that the site covers an area of approximately 3,144 m^2, is currently occupied by commercial / industrial buildings and car parking at grade. Based on preliminary plans, EI understands that the proposed development involves the demolition of the existing site structures and construction of a multi-level apartment building with five podium levels and four levels of basement car parking. No deep soil planting is proposed.

1.2 PROJECT OBJECTIVES

The objective of this assessment is to evaluate the potential presence of acid sulfate soils at the site, and to provide advice for the management of ASS during proposed site excavation, should it be identified. This assessment also satisfies requirements under Part 7, Clause 7.7(2) of Liverpool Local Environmental Plan 2008.

1.3 SCOPE OF WORKS

In order to achieve the above objectives, the scope of works was as follows:

- A detailed site walkover inspection;
- Review of relevant topographic, geological, hydrogeological and soil landscape maps;
- Intrusive site investigation, soil sampling and laboratory analysis;
- A description of the soil attributes of the site; and
- Data interpretation and reporting.

2. DESKTOP REVIEW

2.1 PROPERTY IDENTIFICATION, LOCATION AND PHYSICAL SETTING

The site identification details and associated information are presented in **Table 2-1**, while the site locality is shown in **Figure 1**.

Table 2-1 Site Identification, Location and Zoning

Attribute	Description
Street Address	26 Elizabeth Street, Liverpool NSW
Location Description	The site is located in the main business are of Liverpool, bounded by Elizabeth Street (north), governmental properties (south), a car parking (east) and a car parking (west).
Site Coordinates	North east corner of the site (GDA94-MGA56): Easting: 308328.476 Northing: 6244709.722 (Source: http://maps.six.nsw.gov.au).
Site Area	3,144 m^2 (Ref. mpa. Drawing title. SK01; drawing no. AP01; project. Proposed subdivision plan)
Lot and Deposited Plan (DP)	Lots 1 in DP 217460 and Lot 10 in DP 621840
State Survey Marks	The Survey Mark in closest proximity to the site is SS3941D located approximately 56 m from the north east corner of the site, on the corner of Elizabeth Street and Bigge Street. (Source: http://maps.six.nsw.gov.au).
Local Government Authority	Liverpool City Council
Parish	St. Luke
County	Cumberland
Current Zoning	B2 – Local centre (Liverpool Local Environmental Plan, 2008)

2.2 REGIONAL SETTING

Local ground topography, geology, soil landscape and hydrogeological information are summarised in **Table 2-2**.

Table 2-2 Topographical, Geological, Soil Landscape and Hydrogeological Information

Attribute	Description
Topography	The site slopes gently to the north, from approximate RL 12.85 mAHD at the north-east corner to approximate RL 13.10 mAHD at the south-east corner. (Ref. Project surveyors, 2018. Job Ref. D4118, dated 26 March 2018).
Site Drainage	As large areas of the site are concrete driveway, stormwater is expected to drain to the council stormwater system.
Regional Geology	With reference to the 1:100 000 scale Geological Series Sheet 9030 (Penrith) the site is likely to be underlain by Bringelly Shale (Rwb). Bringelly Shale is described as *carbonaceous claystone, claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff*.
Soil Landscapes	The Soil Conservation Service of NSW Soil Landscapes of the Sydney 1:100,000 Sheet (Chapman and Murphy, 1989) indicates that the site overlies a Residual Landscape – Blacktown, which typically includes gently undulating rises on Wianamatta Group shales.
Depth to Groundwater	Groundwater inflow was encountered at 4.8 mBGL in BH1M, 6.1 mBGL in BH8M and 8.3 mBGL in BH2M during the detailed site investigation (EI Australia, 2018, Ref. E23796.E02_Rev0).
Nearest Surface Water Feature	Georges River, located approximately 420 m south east of the site. The river flows in a west to east direction into Botany Bay. The Georges River is tidal to Liverpool Weir and is considered to be a marine receptor for assessment purposes.
Anticipated Groundwater Flow Direction	Based on the local topography and the nearest surface water feature, groundwater flow direction is anticipated to be south-easterly towards Georges River located approximately 420 m south-east of the site.

2.3 ACID SULFATE SOIL RISK MAPPING

With reference to the 1:25 000 scale, Liverpool Acid Sulfate Soil (ASS) Risk Map (Murphy, 1997), the subject land lies within the map class description of 'no known occurrence.' As the site is underlain by Bringelly Shale, ASS is not expected to be present.

The Liverpool Local Environmental Plan (2008) Acid Sulfate Soils Map (Sheet ASS_011 shows the site to be within areas mapped as Class 5 Acid Sulfate Soils (ASS). Class 5 areas are likely to locate ASS during works within 500 metres of adjacent Class 1, which are likely to lower the water table below 1 metre AHD on adjacent Class 1 land.

Given that the proposed development is within 500 m from Class 1 land, ASS are likely to be encountered during the works and an ASS Assessment is required.

2.4 GEOMORPHIC AND SITE CHARACTERISTICS

Observations compiled during the site inspection, and via aerial photography interpretation, were compared against various geomorphic and site characteristics outlined in ASSMAC (1998) indicating

likely ASS occurrence. A comparison of site specific and geomorphic features with those indicative of potential ASS presence are presented in **Table 2-3**.

Table 2-3: Summary of Geomorphic and Site Features

Geomorphic Features	**Presence on Site**
Holocene Sediments	Not Present onsite
Soil horizons less than 5 m AHD	Present on site (BH2M)
Marine / estuarine sediments or tidal lakes	Not present onsite
Coastal wetland; backwater swamps; waterlogged or scaled areas; inter-dune swales or coastal sand dunes.	Not present onsite
Dominant vegetation is mangroves, reeds, rushes and other swamp or marine tolerant species	Not present onsite
Geologies containing sulfide-bearing material	Not present onsite
Deep older (Pleistocene) estuarine sediments	Not present onsite

As at least one of the seven geomorphic characteristics listed was positive for this site; hence, there is potential for ASS to be present on the site.

3. FIELD WORK

3.1 SUBSURFACE INSPECTION AND SOIL SAMPLING

A sub-surface inspection and associated soil sampling was conducted at three borehole locations on 20 April 2018. The boreholes were located within the footprint of the base car parking, as presented in **Figure 2.**

Intrusive investigation was performed by a Hanjin Solid Flight Auger. Intrusive investigation extended to a maximum depth of 9.8 m BGL (Refusal on hard rock surface). Soil samples were collected at 0.5 m intervals during drilling advancement, or from each distinctive soil profile.

Soils observed during drilling generally comprised of clayey fill, overlying silty clay (**Table 3-1**). Visual indicators of actual acid sulfate soils (AASS), such as soils containing pale yellow deposits / coatings of jarosite, were not observed. Indicators of potential acid sulfate soils (PASS), including waterlogged and estuarine sands (high moisture content and sulfurous odours) were not observed. Detailed borehole logs pertaining to this ASS investigation are presented in **Appendix A**.

Table 3-1 Subsurface Soil Profile

Material	Depth+ (mBGL)	General Description
Concrete	0.15	-
Fill	0.15–0.7	Fill – Sandy CLAY; Medium to high plasticity, dark grey, with sub angular to angular gravels, no odour.
Residual Soil	0.7-8.0	Natural – Silty CLAY; Medium to high plasticity, light grey mottled red, dry to moist, no odour.
Bedrock	8.0-9.8+	SHALE; extremely weathered rock, light brown.

Notes:
+ Approximate depth shown as metres below ground level (mBGL). Refer to borehole logs in **Appendix A.**

3.2 SAMPLE HANDLING PROCEDURES

Grab/dry methods (stainless steel knife and dedicated nitrile gloves) were used to transfer soil samples from the auger into laboratory-supplied, glass jars and plastic zip-lock bags. Each jar and zip-lock bag was filled to minimise the headspace air volume and sealed. Upon sealing, the sample was immediately stored in an insulated chest containing freeze packs, before transportation to the designated NATA-accredited laboratory.

All samples were transported under refrigerated conditions to SGS Australia Pty Ltd (SGS), using strict Chain-of-Custody procedures. A copy of the completed Chain-of-Custody certificate is presented in **Appendix B**.

3.3 LABORATORY ANALYSIS

Representative samples from each soil horizon were assigned for laboratory analysis, in accordance with the methodologies prescribed in Section 4.2 of ASSMAC (1998) to confirm the presence or absence of ASSs.

All laboratory analyses were conducted on discrete samples using NATA-registered methods. Laboratory results are summarised in **Tables 4-1** and **4-2**, with laboratory analytical certificates provided in **Appendix C**.

3.4 ADOPTED CRITERIA

The analytical results were interpreted with respect to the criteria presented in Table 4.4 of ASSMAC (1998), for fine textured soil (clay) where less than 1,000 tonnes of soils are to be disturbed.

4. RESULTS

Laboratory analytical results for the discrete soil samples are summarised in **Tables 4-1**. These tables also include the relevant soil criteria.

SPOCAS Analysis

Suspended peroxide oxidation combined acidity and sulfate testing (SPOCAS) was conducted on fourteen samples (BH1M 0.6-0.7, BH1M 1.1-1.2, BH1M 2.1-2.2, BH1M 3.0-3.1, BH1M 3.5-3.6, BH1M 4.4-4.5, BH2M 0.9-1.0, BH2M 1.4-1.5, BH2M 2.4-2.5, BH2M 3.5-3.6, BH2M 4.0-4.1, BH2M 4.5-4.6, BH8M 1.9-2.0, and BH8M 2.4-2.5). Sample peroxide oxidisable sulphur (S_{POS}) results, and acid trail titratable sulfidic acidity (TSA) and titratable peroxide acidity (TPA) results, were below respective action criteria, with the exception of concentrations of titratable peroxide acidity (TPA) (62 moles H+/tonne) exceeded ASSMAC (Fine Textured Soil) Action Criteria at sample BH8M 2.4-2.5 (67 moles H+/tonne).

Table 4-1: Summary of sPOCAS laboratory analytical results

Sample ID	Sampling Depth (m BGL)	Sampling Date	Soil Type	pH KCl	Peroxide pH (pH Ox)	TAA (moles H+/tonne)	TPA (moles H+/tonne)	TSA (moles H+/tonne)	Sulfur (SKCl) %w/w	Sulfur (Sp) %w/w	Peroxide Oxidisable Sulphur (S_{POS}) %w/w	Comment
BH1M 0.6-0.7	0.6-0.7	20/04/18	Clay	6.6	7.5	<5	<5	<5	<0.005	0.007	0.006	ASS/PASS unlikely to be present
BH1M 1.1-1.2	1.1-1.2	20/04/18	Clay	5.7	6.0	12	10	<5	<0.005	0.021	0.018	ASS/PASS unlikely to be present
BH1M 2.1-2.2	2.1-2.2	20/04/18	Clay	4.9	5.5	17	40	22	0.012	0.036	0.024	ASS/PASS unlikely to be present
BH1M 3.0-3.1	3.0-3.1	20/04/18	Clay	6.0	6.5	6	<5	<5	0.009	0.014	<0.005	ASS/PASS unlikely to be present
BH1M 3.5-3.6	3.5-3.6	20/04/18	Clay	6.0	6.9	<5	<5	<5	0.010	0.013	<0.005	ASS/PASS unlikely to be present
BH1M 4.4-4.5	4.4-4.5	20/04/18	Clay	6.6	8.7	<5	<5	<5	0.005	0.005	<0.005	ASS/PASS unlikely to be present
BH2M 0.9-1.0	0.9-1.0	20/04/18	Clay	6.6	7.1	<5	<5	<5	0.006	0.021	0.015	ASS/PASS unlikely to be present
BH2M 1.4-1.5	1.4-1.5	20/04/18	Clay	6.7	6.9	<5	<5	<5	<0.005	<0.005	<0.005	ASS/PASS unlikely to be present
BH2M 2.4-2.5	2.4-2.5	20/04/18	Clay	7.0	7.0	<5	<5	<5	<0.005	0.010	0.006	ASS/PASS unlikely to be present
BH2M 3.5-3.6	3.5-3.6	20/04/18	Clay	6.6	6.7	<5	<5	<5	<0.005	0.007	<0.005	ASS/PASS unlikely to be present
BH2M 4.0-4.1	4.0-4.1	20/04/18	Clay	6.5	6.6	<5	<5	<5	<0.005	0.005	<0.005	ASS/PASS unlikely to be present
BH2M 4.5-4.6	4.5-4.6	20/04/18	Clay	6.7	6.7	<5	<5	<5	0.006	0.010	<0.005	ASS/PASS unlikely to be present
BH8M 1.9-2.0	1.9-2.0	20/04/18	Clay	4.5	5.0	47	60	12	0.037	0.047	0.010	ASS/PASS unlikely to be present
BH8M 2.4-2.5	2.4-2.5	20/04/18	Clay	4.5	5.0	50	67	17	0.048	0.065	0.017	Possible PASS presence
ASSMAC (Fine Textured Soil) Action Criteria				**<4.0[1]**	**<3.5[2]**	**NR**	**62[2]**	**62[2]**	**NR**	**NR**	**0.1[2]**	

Notes:

	Indicates reported result is over the action criterion

ASSMAC (1998) criteria are the *Action Criteria* where between 1 and 1,000 tonnes of fine textured clay soils are to be disturbed
1 Indicator of ASS
2 Indicator of PASS

5. SUMMARY & CONCLUSION

Project Objective

This report has been prepared to evaluate the potential risk of exposure of ASS or PASS during excavations for the proposed multi-level apartment building with a maximum excavation depth of 12 mBGL.

Desktop Study

- The sub-surface layers comprised anthropogenic filling overlying natural clays;
- The nearest surface water feature is Georges River, located approximately 420 m south east of the site;
- The Liverpool Local Environmental Plan (2008) Acid Sulfate Soils Map (Sheet ASS_011 shows the site to be within areas mapped as Class 5 Acid Sulfate Soils (ASS); and
- Geomorphic site features identified from the site walkover included Holocene sediments, soil horizons less than 5 m AHD, marine / estuarine sediments or tidal lakes and coastal wetland; backwater swamps; waterlogged or scaled areas; inter-dune swales or coastal sand dunes. These features indicated a potential for ASS/PASS to be present.

Field Study

- Fill soils were identified from 0.15 mBGL to 0.7 mBGL. These fill soils were characterised by dark grey medium to high plasticity clay with no odour. Natural soils underlying the fill was characterised by light grey mottled red medium to high plasticity clay, no marine or estuarine sediments were observed; and
- The majority of samples did not exceed the action criteria. We note that one soil sample (BH8M 2.4-2.5) exceeded the action criteria for TPA, however, laboratory analytical results indicate that this exceedance is driven by existing soil acidity (TAA). In addition, minor sulfur was reported in soil samples analysed, with S_{POS} laboratory result also reported at low concentrations or below the limit of laboratory reporting.

Conclusions

The maps and documents examined during this assessment established that the site was situated within an area of no known occurrences of Acid Sulfate Soils. The site has been previous mapped as being underlain by residual Bringelly Shale, and this was confirmed during intrusive investigation, with residual sily clay and weathered shale, with no visual indicators of actual and potential ASS observed.

Based on observations obtained during intrusive investigations, the site did not demonstrate indicators for the presence of ASS/PASS.

In view of the above, EI consider the potential for ASS or PASS is unlikely to be present onsite. As such, management planning is not required.

6. STATEMENT OF LIMITATIONS

The findings presented in this report are the result of discrete and specific sampling methodologies used in accordance with best industry practices and standards. Due to the site-specific nature of soil sampling from point locations, it is considered likely that all variations in subsurface conditions across a site cannot be fully defined, no matter how comprehensive the field investigation program.

While normal assessments of data reliability have been made, EI assumes no responsibility or liability for errors in any data obtained from previous assessments conducted on site, regulatory agencies (e.g. Council, EPA), statements from sources outside of EI, or developments resulting from situations outside the scope of works of this project.

Despite all reasonable care and diligence, the ground conditions encountered and concentrations of contaminants measured may not be representative of conditions between the locations sampled and investigated. In addition, site characteristics may change at any time in response to variations in natural conditions, chemical reactions and other events, e.g. groundwater movement and or spillages of contaminating substances. These changes may occur subsequent to EI's investigations and assessment.

EI's assessment is necessarily based upon the result of the site investigation and the restricted program of surface and subsurface sampling, screening and chemical testing which was set out in the proposal. Neither EI, nor any other reputable consultant, can provide unqualified warranties nor does EI assume any liability for site conditions not observed or accessible during the time of the investigations.

This report was prepared for the above named client and no responsibility is accepted for use of any part of this report in any other context or for any other purpose or by other third parties. This report does not purport to provide legal advice.

This report and associated documents remain the property of EI subject to payment of all fees due for this assessment. The report shall not be reproduced except in full and with prior written permission by EI.

REFERENCES

ASSMAC (1998) Acid Sulfate Soils Assessment Guidelines, part of the ASS Manual, Acid Sulfate Soil Management Advisory Committee (ASSMAC), Wollongbar, NSW, Australia, 28 August 1998, 59 p.

DMR (2016) Sydney 1:100,000 Coastal Quaternary Geological Sheet 2179 (Edition 2). Geological Survey of New South Wales, Department of Mineral Resources.

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(2011) Rockdale Local Environmental Plan, New South Wales Government

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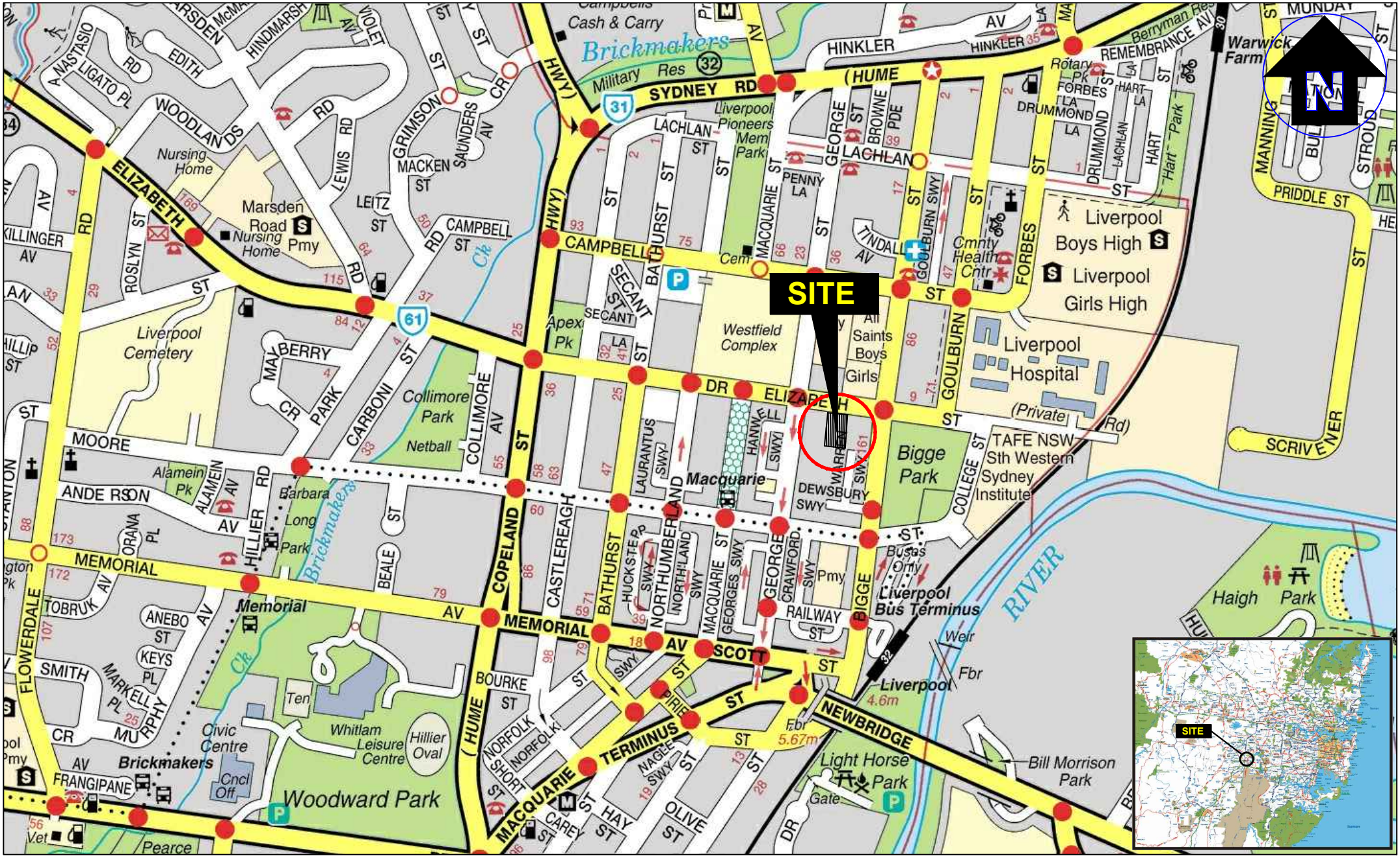
ABBREVIATIONS

AASS	Actual acid sulfate soils
AHD	Australian Height Datum
ASS	Acid sulfate soils
ASRIS	Australian Soil Resource Information System
ASSMAC	Acid Sulfate Soil Management Advisory Committee (ASSMAC)
BGL	Below Ground Level
BH	Borehole
COC	Chain of Custody
DA	Development Application
DP	Deposited Plan
EI	EI Australia
EPA	Environmental Protection Authority
km	Kilometres
m	Metres
mAHD	Metres relative to Australian Height Datum
mBGL	Metres below ground level
NATA	National Association of Testing Authorities, Australia
NSW	New South Wales
OEH	Office of Environment and Heritage, NSW (formerly DEC, DECC, DECCW)
PASS	Potential acid sulfate soils
pH	Measure of the acidity or basicity of an aqueous solution
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance / Quality Control
SRA	Sample receipt advice (document confirming laboratory receipt of samples)

FIGURES



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Drawn:	S.L.
Approved:	C.S.
Date:	23-05-18
Scale:	Not To Scale

Binah Development Pty Ltd
Acid Sulfate Soil Assessment
26 Elizabeth Street, Liverpool NSW

Site Locality Plan

Figure:
1

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LEGEND

- Approximate site boundary
- Approximate monitoring well location
- Approximate basement boundary

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Drawn:	S.L.
Approved:	C.S.
Date:	23-05-18

Binah Development Pty Ltd
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26 Elizabeth Street, Liverpool NSW
Sampling Location Plan

Figure: 2

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APPENDIX A

Borehole Logs

BOREHOLE: BH1M

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Project	Acid Sulfate Soil Assessment
Location	26 Elizabeth Street, Liverpool NSW
Position	Refer to Figure 2
Job No.	E23796
Client	Binah Development Pty Ltd
Contractor	Geosense
Drill Rig	Drill Rig
Inclination	-90°
Sheet	1 OF 1
Date Started	20/4/18
Date Completed	20/4/18
Logged SL	Date: 23/5/18
Checked CS	Date: 23/5/18

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level BH1M
AD/T	-	▽	0	0.10				-	CONCRETE	-		BH1M: Gatic Cover
				0.30	BH1M_0.2-0.3 PID = 3.8 ppm			-	FILL: SANDY CLAY; medium to high plasticity, with subangular to angular gravels, no odour.			
					BH1M_0.6-0.7 PID = 3 ppm			CI-CH	SILTY CLAY; medium to high plasticity, grey mottled red, no odour.			
			1		BH1M_1.1-1.2 PID = 4.2 ppm							
					BH1M_1.6-1.7 PID = 3.2 ppm							Cuttings
			2		BH1M_2.1-2.2 PID = 4.5 ppm							50mm uPVC Casing
					BH1M_2.5-2.6					M		
			3		BH1M_3.0-3.1 PID = 3 ppm						-	
					BH1M_3.5-3.6 PID = 3.4 ppm							
			4		BH1M_3.9-4.0 PID = 4 ppm							Bentonite
					BH1M_4.4-4.5 PID = 1.6 ppm							
		▽		4.80				-	SHALE; extremely weathered, light brown.	-		Sand
			5		BH1M_4.9-5.0 PID = 1.4 ppm							50mm uPVC Screen
					BH1M_5.4-5.5 PID = 1.5 ppm							
				5.70					Hole Terminated at 5.70 m Refusal on Rock. Borehole Converted into Monitoring Well.			
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE: BH2M

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Project	Acid Sulfate Soil Assessment
Location	26 Elizabeth Street, Liverpool NSW
Position	Refer to Figure 2
Job No.	E23796
Client	Binah Development Pty Ltd
Contractor	Geosense
Drill Rig	Drill Rig
Inclination	-90°
Sheet	1 OF 1
Date Started	20/4/18
Date Completed	20/4/18
Logged SL	Date: 23/5/18
Checked CS	Date: 23/5/18

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level BH2M
AD/T	-	▽	0					-	CONCRETE	-		BH2M
					BH2M_0.2-0.3 PID = 0.7 ppm			-	FILL: SANDY CLAY; medium to high plasticity, with subangular to angular gravels, no odour.	D		Gatic Cover
				0.50				CI-CH	SILTY CLAY; medium to high plasticity, grey mottled red, no odour.			
			1		BH2M_0.5-0.6 PID = 2.1 ppm							
					BH2M_0.9-1.0 PID = 2.5 ppm							
			2		BH2M_1.4-1.5 PID = 3.4 ppm							
					BH2M_1.9-2.0 PID = 1.9 ppm							
			3		BH2M_2.4-2.5 PID = 3.2 ppm							
					BH2M_2.9-3.0 PID = 1.8 ppm							
					BH2M_3.5-3.6 PID = 2.6 ppm							Cuttings
			4	4.00				CL-CI	SILTY CLAY; low to medium plasticity, yellow, no odour.	M		50mm uPVC Casing
					BH2M_4.0-4.1 PID = 2 ppm							
			5		BH2M_4.5-4.6 PID = 1.3 ppm						-	
			6									
			7									Bentonite
			8	8.00				-	SHALE; extremely weathered, light brown.			
			9							-		Sand
												50mm uPVC Screen
				9.80	BH2M_9.7-9.8 PID = 1 ppm				Hole Terminated at 9.80 m Refusal on Rock. Borehole Converted into Monitoring Well.			
			10									
			11									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE: BH8M

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Project	Acid Sulfate Soil Assessment
Location	26 Elizabeth Street, Liverpool NSW
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Job No.	E23796
Client	Binah Development Pty Ltd
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Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level BH8M
AD/T	-	▽	0	0.15				-	CONCRETE	-		Concrete Gatic Cover
								-	FILL: SANDY CLAY; medium to high plasticity, with subangular to angular gravels, no odour.			
				0.60	BH8M_0.5-0.6 PID = 6 ppm			CI-CH	SILTY CLAY; medium to high plasticity, grey mottled red, no odour.			
			1									
			2		BH8M_1.9-2.0 PID = 3 ppm							Cuttings
					BH8M_2.4-2.5 PID = 3 ppm							
			3							M		50mm uPVC Casing
			4								-	
			5									Bentonite
				5.80				-	SHALE; extremely weathered, light brown.			
			6									
			7							-		Sand 50mm uPVC Screen
				8.00					Hole Terminated at 8.00 m Refusal on Rock. Borehole Converted into Monitoring Well.			
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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

DRILLING/EXCAVATION METHOD

HA	Hand Auger	RD	Rotary blade or drag bit	NQ	Diamond Core - 47 mm
DTC	Diatube Coring	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
NDD	Non-destructive digging	RAB	Rotary Air Blast	HQ	Diamond Core - 63 mm
AS*	Auger Screwing	RC	Reverse Circulation	HMLC	Diamond Core - 63mm
AD*	Auger Drilling	PT	Push Tube	BH	Tractor Mounted Backhoe
*V	V-Bit	CT	Cable Tool Rig	EX	Tracked Hydraulic Excavator
*T	TC-Bit, e.g. ADT	JET	Jetting	EE	Existing Excavation
ADH	Hollow Auger	WB	Washbore or Bailer	HAND	Excavated by Hand Methods

PENETRATION/EXCAVATION 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

Water level at date shown

Water inflow

Partial water loss

Complete water loss

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.

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 Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm
seating 30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
Sampling	
DS	Disturbed Sample
BDS	Bulk disturbed Sample
GS	Gas Sample
WS	Water Sample
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
Testing	
FP	Field Permeability test over section noted
FVS	Field Vane Shear test expressed as uncorrected shear strength (sv = peak value, sr = residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket Penetrometer test expressed as instrument reading in kPa
WPT	Water Pressure tests
DCP	Dynamic Cone Penetrometer test
CPT	Static Cone Penetration test
CPTu	Static Cone Penetration test with pore pressure (u) measurement

RANKING OF VISUALLY OBSERVABLE CONTAMINATION AND ODOUR (for specific soil contamination assessment

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible contamination	R = B	Slight non-natural odours identified
R = 2	Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

$$= \frac{\text{Length of core recevered}}{\text{Lengh of core run}} \text{ x } 100$$

SCR = Solid Core Recovery (%)

$$= \frac{\Sigma \text{ Length ofcylindrical core recevered}}{\text{Lengh of core run}} \text{ x } 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\Sigma \text{Axial Lenghts of core} > 100\text{mm}}{\text{Lengh of core run}} \text{ x } 100$$

MATERIAL BOUNDARIES

———— = inferred boundary

- - - - - - - - = probable boundary

— ?— ?— ?— ? = possible boundary

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT LOGS

	FILL		ORGANIC SOILS (OL, OH or Pt)		CLAY (CL, CI or CH)
	COUBLES or BOULDERS		SILT (ML or MH)		SAND (SP or SW)
	GRAVEL (GP or GW)	Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay			

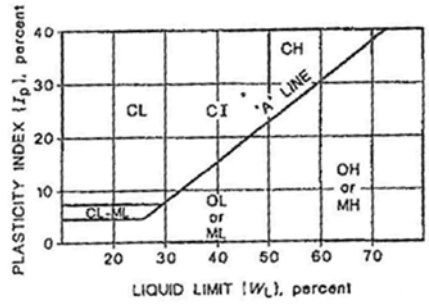
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. Material properties are assessed in the field by visual/tactile methods.

PARTICLE SIZE CHARACTERISTICS

Major Division	Sub Division	Particle Size
BOULDERS		>200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	20 to 63 mm
	Medium	6 to 20 mm
	Fine	2 to 6 mm
SAND	Coarse	0.6 to 2 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2mm
SILT		0.002 to 0.075 mm
CLAY		<0.002 mm

PLASTICITY PROPERTIES



USCS SYMBOLS

Major Divisions		Symbol	Description
COARSE GRAINED SOILS More than 50% by dry mass less than 63mm is greater than 0.075mm	More than 50% of coarse grains are >2.mm	GW	Well graded gravel and gravel-sand mixtures, little or no fines.
		GP	Poorly graded gravel and gravel-sand mixtures, little or no fines.
		GM	Silty gravel, gravel-sand-silt mixtures.
		GC	Clayey gravel, gravel-sand-clay mixtures.
	More than 50% of coarse grains are <2 mm	SW	Well graded sand and gravelly sand, little or no fines.
		SP	Poorly graded sand and gravelly sand, little or no fines.
		SM	Silty sand, sand-silt mixtures.
		SC	Clayey sand, sandy-clay mixtures.
FINE GRAINED SOILS More than 50% by dry mass less than 63mm 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.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
		OL	Organic silts and organic silty clays of low plasticity.
	Liquid Limit > than 50%	MH	Inorganic silts of high plasticity.
		CH	Inorganic clays of high plasticity.
		OH	Organic clays of medium to high plasticity.
		PT	Peat muck and other highly organic soils.

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays & Silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition & may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

Moisture content of cohesive soils may also be described in relation to plastic limit (WP) or liquid limit (WL) [» much greater than, > greater than, < less than, « much less than].

CONSISTENCY

Symbol	Term	Undrained Shear Strength
VS	Very Soft	0. to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa
H	Hard	Above 200 kPa

DENSITY

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	< 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Density	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 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 – 1993, and may be subject to corrections for overburden pressure and equipment type.

MINOR COMPONENTS

Term	Assessment Guide	Proportion by Mass
Trace	Presence just detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: ≤ 5% Fine grained soil: ≤15%
Some	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%

TERMS FOR ROCK MATERIAL STRENGTH AND WEATHERING

CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. Material properties are assessed in the field by visual/ tactile methods.

STRENGTH

Symbol	Term	Point Load Index, $Is_{(50)}$ (MPa) #	Field Guide
EL	Extremely Low	< 0.03	Easily remoulded by hand to a material with soil properties.
VL	Very Low	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

 # Rock Strength Test Results

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

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

Relationship between rock strength test result ($Is_{(50)}$) and unconfined compressive strength (UCS) will vary with rock type and strength, and should be determined on a site-specific basis. UCS is typically 10 to 30 x $Is_{(50)}$, but can be as low as 5 MPa.

ROCK MATERIAL WEATHERING

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.
EW		Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW	Distinctly Weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
	MW		
SW		Slightly Weathered	Rock slightly discoloured but shows little or no change of strength relative to fresh rock.
FR		Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole Logs using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. Material properties are assessed in the field by visual/ tactile methods.

ROCK MATERIAL DESCRIPTION

Layering

Term	Description
Massive	No layering apparent
Poorly Developed	Layering just visible; little effect on properties
Well Developed	Layering (bedding, foliation, cleavage) distinct; rock breaks more easily parallel to layering

Structure

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.
Foliation	FL	Repetitive planar structure parallel to the shear direction or perpendicular to the direction of higher pressure, especially in metamorphic rock, e.g. Schistosity (SH) and Gneissosity.
Contact	CO	The surface between two types or ages of rock.
Cleavage	CL	Cleavage planes appear as parallel, closely spaced and planar surfaces resulting from mechanical fracturing of rock through deformation or metamorphism, independent of bedding.
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.
Decomposed Seam/ Zone	DS/DZ	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.
Schistocity	SH	The foliation in schist or other coarse grained crystalline rock due to the parallel arrangement of platy or prismatic mineral grains, such as mica.
Vein	VN	Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

Shape	Abbr.	Description	Roughness	Abbr.	Description
Planar	Pl	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	S	Smooth to touch. Few or no surface irregularities
Stepped	St	One or more well defined steps	Rough	RF	Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper
Irregular	Ir	Many sharp changes in orientation	Very Rough	VR	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper

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

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

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

DEFECT APERTURE

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

APPENDIX B

Chain of Custody Certificate and Sample Receipt Form

CE133191

CHAIN OF CUSTODY & ANALYSIS REQUEST
(FOR INTERLAB WORK)

Receiving Laboratory: **SGS Cairns**

Initiating Laboratory: SGS Sydney - Alexandria
Initiating Contact: Emily Yin (au.samplereceipt.sydney@sgs.com)
Send Results to:- **AU.Environmental.Sydney@sgs.com**

Final Report Required:	**Yes** / No / NATA	Prelim Report Due:	01/05/2018	Special Prices Apply:	Yes / No
Send To:	**Us** / Client	Final Report Due:	01/05/2018	Quote No:	Client:**Environmental Investigation
Address To:	Us / **Client*** (Address As Below)	Matrix	Preservation Method	Analysis Required	Remarks

SGS Job No: SE178319	Client Job No: E23796 - 26 Elizabeth St, Liverpool NSW	Water	Soil	Date Sampled	Ice	Acid	Other	None	SPOCAS
Sample No.	Sample No.								
SE178319.002	BH1M 0.6-0.7		X	20/04/18					X
SE178319.003	BH1M 1.1-1.2		X	20/04/18					X
SE178319.004	BH1M 2.1-2.2		X	20/04/18					X
SE178319.005	BH1M 3.0-3.1		X	20/04/18					X
SE178319.006	BH1M 3.5-3.6		X	20/04/18					X
SE178319.007	BH1M 4.4-4.5		X	20/04/18					X
SE178319.010	BH2M 0.9-1.0		X	20/04/18					X
SE178319.011	BH2M 1.4-1.5		X	20/04/18					X
SE178319.012	BH2M 2.4-2.5		X	20/04/18					X
SE178319.013	BH2M 3.5-3.6		X	20/04/18					X

SGS Cairns Environmental
CE133191 COC
Received: 26 – Apr – 2018

SGS Alexandria Environmental
SE178319 SUBCON
Received: 23 – Apr – 2018

Client Contacts for AUENVSE:
INVOICE = Invoice
SGS_SYD_REPORTS_PM = REPORTS
SGS_SYD_SRA_PM = Sample Receipt Advice

SPOCAS

4 x soil

COURIER SERVICE: STARTRACK

CONSIGNMENT No:

Relinquished By: Emily Yin	Date/Time: 24/04/2018	Received By:	Date/Time 26/4/18 12:30pm

NOTES:* Client Address: Attention: SHARON_LI
Environmental Investigations
Suite 6.01, 55 Miller Street
Pyrmont NSW 2009

*** Special Prices, Quotes, Clients **MUST BE** Referred To.

SLIM CLIENT CODE: EI AUSTRALIA 12269923_11762409

CHAIN OF CUSTODY & ANALYSIS REQUEST
(FOR INTERLAB WORK)

Receiving Laboratory: **SGS Cairns**

Initiating Laboratory: SGS Sydney - Alexandria
Initiating Contact: Emily Yin (au.samplereceipt.sydney@sgs.com)
Send Results to:- **AU.Environmental.Sydney@sgs.com**

Final Report Required: **Yes** / No / NATA	Prelim Report Due: 01/05/2018	Special Prices Apply: Yes / No
Send To: **Us** / Client	Final Report Due: 01/05/2018	Quote No: Client:**Environmental Investigation

Address To:	Us / **Client*** (Address As Below)	Matrix				Preservation Method				Analysis Required										Remarks
SGS Job No: SE178319	Client Job No: E23796 - 26 Elizabeth St, Liverpool NSW	Water	Soil	Date Sampled		Ice	Acid	Other	None	SPOCAS										Client Contacts for AUENVSE: **INVOICE** = Invoice **SGS_SYD_REPORTS_PM** = REPORTS **SGS_SYD_SRA_PM** = Sample Receipt Advice
Sample No.	Sample No.																			
SE178319.014	BH2M 4.0-4.1		X	20/04/18						X										**SPOCAS**
SE178319.015	BH2M 4.5-4.6		X	20/04/18						X										
SE178319.023	BH8M 1.9-2.0		X	20/04/18						X										
SE178319.024	BH8M 2.4-2.5		X	20/04/18						X										
																				COURIER SERVICE: STARTRACK
																				CONSIGNMENT No:

Relinquished By: Emily Yin	Date/Time: 24/04/2018	Received By:	Date/Time

NOTES:* Client Address: Attention: SHARON_LI
Environmental Investigations
Suite 6.01, 55 Miller Street
Pyrmont NSW 2009

*** Special Prices, Quotes, Clients **MUST BE** Referred To.

SLIM CLIENT CODE: EI AUSTRALIA 12269923_11762409

SAMPLE RECEIPT ADVICE

CE133191

CLIENT DETAILS

Contact	Sharon Li
Client	SGS EHS SYDNEY
Address	5258 201 EHS SYDNEY UNIT 16 33 MADDOX STREET ALEXANDRIA NSW 2015
Telephone	61 2 95160722
Facsimile	02 8594 0499
Email	au.environmental.sydney@sgs.com
Project	**E23796-26 Elizabeth St Liverpool NSW**
Order Number	**SE178319**
Samples	14

LABORATORY DETAILS

Manager	Jon Dicker
Laboratory	SGS Cairns Environmental
Address	Unit 2, 58 Comport St Portsmith QLD 4870
Telephone	+61 07 4035 5111
Facsimile	+61 07 4035 5122
Email	AU.Environmental.Cairns@sgs.com
Samples Received	Thu 26/4/2018
Report Due	Tue 1/5/2018
SGS Reference	**CE133191**

SUBMISSION DETAILS

This is to confirm that 14 samples were received on Thursday 26/4/2018. Results are expected to be ready by COB Tuesday 1/5/2018. Please quote SGS reference CE133191 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	Ice Bricks
Samples received in correct containers	Yes	Sample counts by matrix	14 X SOIL
Date documentation received	26/4/2018	Type of documentation received	COC
Number of eskies/boxes received	1	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	Chilled
Sufficient sample for analysis	Yes	Turnaround time requested	3 DAY TAT

Unless otherwise instructed, water and bulk samples will be held for one month from date of report, and soil samples will be held for two months.

COMMENTS

3 day tat

SAMPLE RECEIPT ADVICE

CE133191

CLIENT DETAILS

Client SGS EHS SYDNEY

Project E23796-26 Elizabeth St Liverpool NSW

SUMMARY OF ANALYSIS

No.	Sample ID	Moisture Content	SPOCAS Net Acidity Calculations	TAA (Titratable Actual Acidity)	TPA (Titratable Peroxide Acidity)
001	BH1M 0.6-0.7	1	6	7	21
002	BH1M 1.1-1.2	1	6	7	21
003	BH1M 2.1-2.2	1	6	7	21
004	BH1M 3.0-3.1	1	6	7	21
005	BH1M 3.5-3.6	1	6	7	21
006	BH1M 4.4-4.5	1	6	7	21
007	BH2M 0.9-1.0	1	6	7	21
008	BH2M 1.4-1.5	1	6	7	21
009	BH2M 2.4-2.5	1	6	7	21
010	BH2M 3.5-3.6	1	6	7	21
011	BH2M 4.0-4.1	1	6	7	21
012	BH2M 4.5-4.6	1	6	7	21
013	BH8M 1.9-2.0	1	6	7	21
014	BH8M 2.4-2.5	1	6	7	21

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

APPENDIX C

Laboratory Analytical Reports

eiaustralia

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Sharon Li	Manager	Jon Dicker
Client	EI AUSTRALIA	Laboratory	SGS Cairns Environmental
Address	SUITE 6.01 55 MILLER STREET PYRMONT NSW 2009	Address	Unit 2, 58 Comport St Portsmith QLD 4870
Telephone	61 2 95160722	Telephone	+61 07 4035 5111
Facsimile	02 8594 0499	Facsimile	+61 07 4035 5122
Email	au.environmental.sydney@sgs.com	Email	AU.Environmental.Cairns@sgs.com
Project	**E23796-26 Elizabeth St Liverpool NSW**	SGS Reference	**CE133191 R0**
Order Number	**SE178319**	Date Received	26 Apr 2018
Samples	14	Date Reported	01 May 2018

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(3146).

SIGNATORIES

Anthony Nilsson
Operations Manager

Jon Dicker
Manager Northern QLD

Parameter	Units	LOR	Sample Number: CE133191.001 Sample Matrix: Soil Sample Date: 20 Apr 2018 Sample Name: BH1M 0.6-0.7	CE133191.002 Soil 20 Apr 2018 BH1M 1.1-1.2	CE133191.003 Soil 20 Apr 2018 BH1M 2.1-2.2	CE133191.004 Soil 20 Apr 2018 BH1M 3.0-3.1
Moisture Content Method: AN002 Tested: 26/4/2018						
% Moisture	%w/w	0.5	**17**	**20**	**20**	**13**
TAA (Titratable Actual Acidity) Method: AN219 Tested: 30/4/2018						
pH KCl	pH Units	-	**6.6**	**5.7**	**4.9**	**6.0**
Titratable Actual Acidity	kg H2SO4/T	0.25	<0.25	**0.61**	**0.86**	**0.31**
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5	<5	**12**	**17**	**6**
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01	<0.01	**0.02**	**0.03**	**0.01**
Sulphur (SKCl)	%w/w	0.005	<0.005	<0.005	**0.012**	**0.009**
Calcium (CaKCl)	%w/w	0.005	**0.14**	**0.11**	**0.018**	**0.013**
Magnesium (MgKCl)	%w/w	0.005	**0.020**	**0.088**	**0.059**	**0.082**
TPA (Titratable Peroxide Acidity) Method: AN218 Tested: 30/4/2018						
Peroxide pH (pH Ox)	pH Units	-	**7.5**	**6.0**	**5.5**	**6.5**
TPA as kg H_2SO_4/tonne	kg H2SO4/T	0.25	<0.25	**0.49**	**2.0**	<0.25
TPA as moles H+/tonne	moles H+/T	5	<5	**10**	**40**	<5
TPA as S % W/W	%w/w S	0.01	<0.01	**0.02**	**0.06**	<0.01
Titratable Sulfidic Acidity as moles H+/tonne	moles H+/T	5	<5	<5	**22**	<5
Titratable Sulfidic Acidity as kg H_2SO_4/tonne	kg H2SO4/T	0.25	<0.25	<0.25	**1.1**	<0.25
Titratable Sulfidic Acidity as S % W/W	%w/w S	0.01	<0.01	<0.01	**0.04**	<0.01
ANCE as % $CaCO_3$	% CaCO3	0.01	**0.40**	<0.01	<0.01	**0.25**
ANCE as moles H+/tonne	moles H+/T	5	**80**	<5	<5	**50**
ANCE as S % W/W	%w/w S	0.01	**0.13**	<0.01	<0.01	**0.08**
Peroxide Oxidisable Sulphur (Spos)	%w/w	0.005	**0.006**	**0.018**	**0.024**	<0.005
Peroxide Oxidisable Sulphur as moles H+/tonne	moles H+/T	5	<5	**11**	**15**	<5
Sulphur (Sp)	%w/w	0.005	**0.007**	**0.021**	**0.036**	**0.014**
Calcium (Cap)	%w/w	0.005	**0.17**	**0.12**	**0.038**	**0.015**
Reacted Calcium (CaA)	%w/w	0.005	**0.031**	**0.007**	**0.020**	<0.005
Reacted Calcium (CaA)	moles H+/T	5	**16**	<5	**10**	<5
Magnesium (Mgp)	%w/w	0.005	**0.023**	**0.090**	**0.12**	**0.083**
Reacted Magnesium (MgA)	%w/w	0.005	<0.005	<0.005	**0.060**	<0.005
Reacted Magnesium (MgA)	moles H+/T	5	<5	<5	**50**	<5
Net Acid Soluble Sulphur as % w/w	%w/w	0.005	-	-	-	-
Net Acid Soluble Sulphur as moles H+/tonne	moles H+/T	5	-	-	-	-
SPOCAS Net Acidity Calculations Method: AN220 Tested: 1/5/2018						
s-Net Acidity	%w/w S	0.01	<0.01	**0.04**	**0.05**	<0.01
a-Net Acidity	moles H+/T	5	<5	**24**	**32**	<5
Liming Rate	kg CaCO3/T	0.1	<0.1	**1.8**	**2.4**	<0.1
Verification s-Net Acidity	%w/w S	-20	**-0.08**	**0.01**	**0.01**	**-0.05**
a-Net Acidity without ANCE	moles H+/T	5	<5	**24**	**32**	**9**
Liming Rate without ANCE	kg CaCO3/T	0.1	<0.1	**1.8**	**2.4**	NA

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	CE133191.005 Soil 20 Apr 2018 BH1M 3.5-3.6	CE133191.006 Soil 20 Apr 2018 BH1M 4.4-4.5	CE133191.007 Soil 20 Apr 2018 BH2M 0.9-1.0	CE133191.008 Soil 20 Apr 2018 BH2M 1.4-1.5
Moisture Content Method: AN002 Tested: 26/4/2018							
% Moisture	%w/w	0.5		**16**	**9.3**	**19**	**17**
TAA (Titratable Actual Acidity) Method: AN219 Tested: 30/4/2018							
pH KCl	pH Units	-		**6.0**	**6.6**	**6.6**	**6.7**
Titratable Actual Acidity	kg H2SO4/T	0.25		<0.25	<0.25	<0.25	<0.25
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5		<5	<5	<5	<5
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01		<0.01	<0.01	<0.01	<0.01
Sulphur (SKCl)	%w/w	0.005		**0.010**	**0.005**	**0.006**	<0.005
Calcium (CaKCl)	%w/w	0.005		**0.010**	**0.014**	**0.17**	**0.10**
Magnesium (MgKCl)	%w/w	0.005		**0.086**	**0.054**	**0.073**	**0.052**
TPA (Titratable Peroxide Acidity) Method: AN218 Tested: 30/4/2018							
Peroxide pH (pH Ox)	pH Units	-		**6.9**	**8.7**	**7.1**	**6.9**
TPA as kg H_2SO_4/tonne	kg H2SO4/T	0.25		<0.25	<0.25	<0.25	<0.25
TPA as moles H+/tonne	moles H+/T	5		<5	<5	<5	<5
TPA as S % W/W	%w/w S	0.01		<0.01	<0.01	<0.01	<0.01
Titratable Sulfidic Acidity as moles H+/tonne	moles H+/T	5		<5	<5	<5	<5
Titratable Sulfidic Acidity as kg H_2SO_4/tonne	kg H2SO4/T	0.25		<0.25	<0.25	<0.25	<0.25
Titratable Sulfidic Acidity as S % W/W	%w/w S	0.01		<0.01	<0.01	<0.01	<0.01
ANCE as % $CaCO_3$	% CaCO3	0.01		**0.25**	**0.25**	**0.45**	**0.30**
ANCE as moles H+/tonne	moles H+/T	5		**50**	**50**	**90**	**60**
ANCE as S % W/W	%w/w S	0.01		**0.08**	**0.08**	**0.14**	**0.10**
Peroxide Oxidisable Sulphur (Spos)	%w/w	0.005		<0.005	<0.005	**0.015**	<0.005
Peroxide Oxidisable Sulphur as moles H+/tonne	moles H+/T	5		<5	<5	**9**	<5
Sulphur (Sp)	%w/w	0.005		**0.013**	**0.005**	**0.021**	<0.005
Calcium (Cap)	%w/w	0.005		**0.012**	**0.020**	**0.20**	**0.11**
Reacted Calcium (CaA)	%w/w	0.005		<0.005	**0.006**	**0.021**	**0.006**
Reacted Calcium (CaA)	moles H+/T	5		<5	<5	**10**	<5
Magnesium (Mgp)	%w/w	0.005		**0.091**	**0.059**	**0.083**	**0.059**
Reacted Magnesium (MgA)	%w/w	0.005		**0.005**	<0.005	**0.010**	**0.007**
Reacted Magnesium (MgA)	moles H+/T	5		<5	<5	**8**	**6**
Net Acid Soluble Sulphur as % w/w	%w/w	0.005		-	-	-	-
Net Acid Soluble Sulphur as moles H+/tonne	moles H+/T	5		-	-	-	-
SPOCAS Net Acidity Calculations Method: AN220 Tested: 1/5/2018							
s-Net Acidity	%w/w S	0.01		<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H+/T	5		<5	<5	<5	<5
Liming Rate	kg CaCO3/T	0.1		<0.1	<0.1	<0.1	<0.1
Verification s-Net Acidity	%w/w S	-20		**-0.05**	**-0.05**	**-0.09**	**-0.06**
a-Net Acidity without ANCE	moles H+/T	5		**7**	<5	**9**	<5
Liming Rate without ANCE	kg CaCO3/T	0.1		NA	<0.1	NA	<0.1

Parameter	Units	LOR	Sample Number: CE133191.009 Sample Matrix: Soil Sample Date: 20 Apr 2018 Sample Name: BH2M 2.4-2.5	CE133191.010 Soil 20 Apr 2018 BH2M 3.5-3.6	CE133191.011 Soil 20 Apr 2018 BH2M 4.0-4.1	CE133191.012 Soil 20 Apr 2018 BH2M 4.5-4.6
Moisture Content Method: AN002 Tested: 26/4/2018						
% Moisture	%w/w	0.5	**14**	**15**	**16**	**14**
TAA (Titratable Actual Acidity) Method: AN219 Tested: 30/4/2018						
pH KCl	pH Units	-	**7.0**	**6.6**	**6.5**	**6.7**
Titratable Actual Acidity	kg H2SO4/T	0.25	<0.25	<0.25	<0.25	<0.25
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5	<5	<5	<5	<5
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01	<0.01	<0.01	<0.01	<0.01
Sulphur (SKCl)	%w/w	0.005	<0.005	<0.005	<0.005	**0.006**
Calcium (CaKCl)	%w/w	0.005	**0.11**	**0.011**	**0.009**	**0.018**
Magnesium (MgKCl)	%w/w	0.005	**0.073**	**0.067**	**0.063**	**0.059**
TPA (Titratable Peroxide Acidity) Method: AN218 Tested: 30/4/2018						
Peroxide pH (pH Ox)	pH Units	-	**7.0**	**6.7**	**6.6**	**6.7**
TPA as kg H_2SO_4/tonne	kg H2SO4/T	0.25	<0.25	<0.25	<0.25	<0.25
TPA as moles H+/tonne	moles H+/T	5	<5	<5	<5	<5
TPA as S % W/W	%w/w S	0.01	<0.01	<0.01	<0.01	<0.01
Titratable Sulfidic Acidity as moles H+/tonne	moles H+/T	5	<5	<5	<5	<5
Titratable Sulfidic Acidity as kg H_2SO_4/tonne	kg H2SO4/T	0.25	<0.25	<0.25	<0.25	<0.25
Titratable Sulfidic Acidity as S % W/W	%w/w S	0.01	<0.01	<0.01	<0.01	<0.01
ANCE as % $CaCO_3$	% CaCO3	0.01	**0.40**	**0.25**	**0.25**	**0.25**
ANCE as moles H+/tonne	moles H+/T	5	**80**	**50**	**50**	**50**
ANCE as S % W/W	%w/w S	0.01	**0.13**	**0.08**	**0.08**	**0.08**
Peroxide Oxidisable Sulphur (Spos)	%w/w	0.005	**0.006**	<0.005	<0.005	<0.005
Peroxide Oxidisable Sulphur as moles H+/tonne	moles H+/T	5	<5	<5	<5	<5
Sulphur (Sp)	%w/w	0.005	**0.010**	**0.007**	**0.005**	**0.010**
Calcium (Cap)	%w/w	0.005	**0.12**	**0.012**	**0.010**	**0.021**
Reacted Calcium (CaA)	%w/w	0.005	**0.019**	<0.005	<0.005	<0.005
Reacted Calcium (CaA)	moles H+/T	5	**10**	<5	<5	<5
Magnesium (Mgp)	%w/w	0.005	**0.082**	**0.071**	**0.069**	**0.070**
Reacted Magnesium (MgA)	%w/w	0.005	**0.010**	<0.005	**0.007**	**0.010**
Reacted Magnesium (MgA)	moles H+/T	5	**8**	<5	**5**	**8**
Net Acid Soluble Sulphur as % w/w	%w/w	0.005	-	-	-	-
Net Acid Soluble Sulphur as moles H+/tonne	moles H+/T	5	-	-	-	-
SPOCAS Net Acidity Calculations Method: AN220 Tested: 1/5/2018						
s-Net Acidity	%w/w S	0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H+/T	5	<5	<5	<5	<5
Liming Rate	kg CaCO3/T	0.1	<0.1	<0.1	<0.1	<0.1
Verification s-Net Acidity	%w/w S	-20	**-0.08**	**-0.05**	**-0.05**	**-0.05**
a-Net Acidity without ANCE	moles H+/T	5	<5	<5	<5	<5
Liming Rate without ANCE	kg CaCO3/T	0.1	<0.1	<0.1	<0.1	<0.1

Parameter	Units	LOR	Sample Number: CE133191.013 Sample Matrix: Soil Sample Date: 20 Apr 2018 Sample Name: BH8M 1.9-2.0	Sample Number: CE133191.014 Sample Matrix: Soil Sample Date: 20 Apr 2018 Sample Name: BH8M 2.4-2.5
Moisture Content Method: AN002 Tested: 26/4/2018				
% Moisture	%w/w	0.5	**18**	**17**
TAA (Titratable Actual Acidity) Method: AN219 Tested: 30/4/2018				
pH KCl	pH Units	-	**4.5**	**4.5**
Titratable Actual Acidity	kg H2SO4/T	0.25	**2.3**	**2.5**
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5	**47**	**50**
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01	**0.08**	**0.08**
Sulphur (SKCl)	%w/w	0.005	**0.037**	**0.048**
Calcium (CaKCl)	%w/w	0.005	**0.026**	**0.021**
Magnesium (MgKCl)	%w/w	0.005	**0.099**	**0.11**
TPA (Titratable Peroxide Acidity) Method: AN218 Tested: 30/4/2018				
Peroxide pH (pH Ox)	pH Units	-	**5.0**	**5.0**
TPA as kg H_2SO_4/tonne	kg H2SO4/T	0.25	**2.9**	**3.3**
TPA as moles H+/tonne	moles H+/T	5	**60**	**67**
TPA as S % W/W	%w/w S	0.01	**0.10**	**0.11**
Titratable Sulfidic Acidity as moles H+/tonne	moles H+/T	5	**12**	**17**
Titratable Sulfidic Acidity as kg H_2SO_4/tonne	kg H2SO4/T	0.25	**0.61**	**0.86**
Titratable Sulfidic Acidity as S % W/W	%w/w S	0.01	**0.02**	**0.03**
ANCE as % $CaCO_3$	% CaCO3	0.01	<0.01	<0.01
ANCE as moles H+/tonne	moles H+/T	5	<5	<5
ANCE as S % W/W	%w/w S	0.01	<0.01	<0.01
Peroxide Oxidisable Sulphur (Spos)	%w/w	0.005	**0.010**	**0.017**
Peroxide Oxidisable Sulphur as moles H+/tonne	moles H+/T	5	**6**	**10**
Sulphur (Sp)	%w/w	0.005	**0.047**	**0.065**
Calcium (Cap)	%w/w	0.005	**0.029**	**0.025**
Reacted Calcium (CaA)	%w/w	0.005	<0.005	<0.005
Reacted Calcium (CaA)	moles H+/T	5	<5	<5
Magnesium (Mgp)	%w/w	0.005	**0.10**	**0.11**
Reacted Magnesium (MgA)	%w/w	0.005	<0.005	**0.008**
Reacted Magnesium (MgA)	moles H+/T	5	<5	**6**
Net Acid Soluble Sulphur as % w/w	%w/w	0.005	-	-
Net Acid Soluble Sulphur as moles H+/tonne	moles H+/T	5	-	-
SPOCAS Net Acidity Calculations Method: AN220 Tested: 1/5/2018				
s-Net Acidity	%w/w S	0.01	**0.09**	**0.10**
a-Net Acidity	moles H+/T	5	**53**	**60**
Liming Rate	kg CaCO3/T	0.1	**4.0**	**4.5**
Verification s-Net Acidity	%w/w S	-20	**0.00**	**0.01**
a-Net Acidity without ANCE	moles H+/T	5	**53**	**60**
Liming Rate without ANCE	kg CaCO3/T	0.1	**4.0**	**4.5**

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

TAA (Titratable Actual Acidity) **Method: ME-(AU)-[ENV]AN219**

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH KCl	LB055913	pH Units	-	5.8	0 - 2%	101%
Titratable Actual Acidity	LB055913	kg H2SO4/T	0.25	<0.25	0%	NA
Titratable Actual Acidity (TAA) moles H+/tonne	LB055913	moles H+/T	5	<5	0%	92%
Titratable Actual Acidity (TAA) S%w/w	LB055913	%w/w S	0.01	<0.01	0%	92%
Sulphur (SKCl)	LB055913	%w/w	0.005	<0.005	0%	96%
Calcium (CaKCl)	LB055913	%w/w	0.005	<0.005	2%	92%
Magnesium (MgKCl)	LB055913	%w/w	0.005	<0.005	1 - 2%	87%

TPA (Titratable Peroxide Acidity) **Method: ME-(AU)-[ENV]AN218**

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Peroxide pH (pH Ox)	LB055910	pH Units	-	6.1	0 - 10%	105%
TPA as kg H_2SO_4/tonne	LB055910	kg H2SO4/T	0.25	<0.25	0%	99%
TPA as moles H+/tonne	LB055910	moles H+/T	5	<5	0%	99%
TPA as S % W/W	LB055910	%w/w S	0.01	<0.01	0%	99%
ANCE as % $CaCO_3$	LB055910	% CaCO3	0.01	<0.01	0 - 13%	
ANCE as moles H+/tonne	LB055910	moles H+/T	5	<5	0 - 13%	
ANCE as S % W/W	LB055910	%w/w S	0.01	<0.01	0 - 13%	
Sulphur (Sp)	LB055910	%w/w	0.005	<0.005	3 - 6%	86%
Calcium (Cap)	LB055910	%w/w	0.005	<0.005	2 - 3%	108%
Magnesium (Mgp)	LB055910	%w/w	0.005	<0.005	1 - 4%	91%

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN218	Soil samples are subjected to extreme oxidising conditions using hydrogen peroxide. Continuous application of heat and peroxide ensure all sulfide is converted to sulfuric acid. Excess peroxide is broken down by a copper catalyst prior to titration for acidity. Calcium, magnesium, and sulfur are determined by ICP-OES. Also included is a carbonate modification step which, depending on pH after the initial oxidation, gives a measure of ANC.
AN219	Dried pulped sample is extracted for 4 hours in a 1 M KCl solution. The ratio of sample to solution is 1:40. The extract is titrated for acidity. Calcium, magnesium, and sulfur are determined by ICP-AES.
AN220	SPOCAS Suite: Scheme for the calculation of net acidities and liming rates using a Fineness Factor of 1.5.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf