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Perpetual Trustee Limited ATF Axil Pavy c/o ATH Projects

Attention: Andrew Hodges

Project: Proposed Residential Development
Site Location: 11 Oak Street, North Narrabeen NSW 2101
Reference: 13942-GR-1-1
Report Date: 22 October 2021

Geotechnical Investigation Report

1 Introduction

This report presents the findings of a geotechnical investigation carried out by Alliance Geotechnical Pty Ltd (Alliance) for Perpetual Trustee Limited ATF Axil Pavy c/o ATH Projects (the client) for the proposed residential development at 11 Oak Street, North Narrabeen NSW 2101 (the site). The geotechnical investigation was undertaken in accordance with Alliance's fee proposal Estimate No. 05618, dated 08 Oct 2021.

The objectives of the investigation are to assess the subsurface conditions of the site and provide comments and recommendation regarding:

- Existing geotechnical and groundwater conditions;
- Preliminary geotechnical parameters such as allowable bearing capacity, retaining structure options and lateral bearing parameters;
- Comments on footings and retaining structures;
- Comments on excavation conditions and temporary shoring system for the swimming pool;
- Soil Aggressivity to buried concrete and steel structures;
- Site Classification in accordance to AS2870; and
- Acid Sulfate Soils testing.

The following scope of work has been undertaken to achieve the project objectives:

- Review of geological maps;
- Site walkover identifying site features of geotechnical importance;
- Hand Augering three boreholes to a maximum depth of 2.6m;
- Undertake Perth Sand Penetrometer (PSP) tests to aid assessing the soil density;
- Soil sample collection for laboratory testing

This report is prepared to provide geotechnical comments and recommendations regarding the proposed development.

2 Proposed Development

To assist with the geotechnical investigation, the following documents were provided by the Client:

- A set of architectural drawings, prepared by Daniel Siric Architects, Revision: K, dated 31.08.2021; and
- A detailed site survey drawing, prepared by Sydney Surveyors, Ref.: 17105/2A, dated 31/07/2020

Based on the provided documents and previous communication with client, it is understood that the proposed development includes:

- The demolition of the existing double storey dwelling and sheds
- The construction of a new double storey dwelling with the finished floor level at RL3.53m. The ground floor has a 1.0m setback from the site boundary to the south, 2.5m setback from the site boundary to the north, 6.5m setback from the site boundary to the west and 15.6m setback to the site boundary to the east.
- Proposed swimming pool at the rear of the property. It is anticipated that the swimming pool will have a maximum excavation depth of 2m. The pool has a 2.4m setback from the site boundary to the south, 9.4m setback from the site boundary to the north, 1.2m setback to the site boundary to the east and a 7.6m setback from the rear eastern building face of the proposed development.

3 Site Description and Geological Setting

The site is a residential dwelling within the suburb of North Narrabeen, part of the Northern Beaches Council, and comprises a rectangular block of land with an approximate total area of 693m^2. The site is bounded by Oak Street to the west, and residential properties in all other directions as shown in Figure 1.

At the time of the investigation, the site was occupied by an existing occupied double storey dwelling with two sheds. Vegetation on the site was consisted of large to medium sized trees, medium sized shrubs with grass ground cover.

The detailed survey of the site, provided by the client, shows existing ground levels ranging between RL 2.9m AHD (Australian Height Datum) to RL 3.5m AHD. The site was relatively flat with no observable gradient.

Figure 1 - The Site Location

The Sydney 1:100 000 Geological Map (Sheet 9130, Edition 1, 1983, Geological Survey of New South Wales) indicates the site to be underlain by '*Quaternary deposits"* best described as *Silty to peaty quartz sand, silt, and clay. Ferruginous and humic cementation in places. Common shell layers*.

4 Fieldwork

The fieldwork was carried out on 12 October 2021 by a geotechnical engineer. Selected site photographs taken during the fieldwork are presented in Attachment A.

After the site walkover and inspection, the proposed borehole positions located on site were checked against Dial Before You Dig (DBYD) plans for services and utilities. Three boreholes were hand augered to a maximum refusal depth of 2.6m below ground level (BGL) on inferred dense sand within the footprint of the proposed structures.

Perth Sand Penetrometer (PSP) tests were conducted adjacent to each borehole to assess the near surface soil density.

The encountered soil profiles were documented by an experienced geotechnical engineer from Alliance in accordance with AS 1726 - 2017 Geotechnical Site Investigation. The approximate borehole locations and DCP tests are indicated in drawing 13942-GR-1-A (Attachment B). The borehole logs and PSP test results are provided in Attachment C. These results should be read in conjunction with the attached Explanatory Note which explains the terms, abbreviations, and symbols used, together with the interpretation and limitation of the logging procedure.

At completion, the boreholes were backfilled with drilling spoil and made flush with the surrounding surface. The site condition was reinstated to its original condition.

5 Subsurface Conditions

The encountered subsurface conditions are summarised in Table 1. The soil density is based on the results of the PSP tests, which can be found in the logs in attachment C.

The site is underlain by a maximum depth of 0.5m of topsoil fill then underlain by loose to medium dense sand alluvium.

Table 1 - Summary of the Subsurface Profiles

Soil Profile	BH01 (m)	BH02 (m)	BH03 (m)
Ground Surface Level (RL)	**2.9m**	**3.0m**	**3.4m**
Topsoil / Fill – SAND	0.0 – 0.3	0.0 – 0.5	0.0 – 0.5
Alluvium – SAND, loose to medium dense	0.3 – 2.0	0.5 – 1.5	0.5 – 2.6
Terminated depth	2.0	1.5	2.6

All boreholes reached hand auger refusal on inferred dense alluvium sand.

Groundwater seepage was observed in BH03 at a depth of 2.4m. It is noted that groundwater is subject to seasonal, climatic conditions and the groundwater level may fluctuate following extended rain falls.

6 Laboratory Results

Two soil samples were collected for soil aggressivity laboratory testing. Soil aggressivity tests was performed on the soil samples to aid in the durability design of concrete and steel. The test results and exposure classifications are presented in Table 2 below. Detailed results are provided in Attachment D.

Table 2 - Summary of Soil Aggressivity Tests

Test	Unit	BH01 1.5m Alluvium – Sand	BH03 1.5m Alluvium - Sand
Chloride	$mg.kg^{-1}$	<10	<10
Conductivity(1)	$uS.cm^{-1}$	22	13
pH(1)	pH	8.3	8.3
Resistivity	Ohm.cm	46,000	76,000
Sulfate (SO_4)	$mg.kg^{-1}$	<10	<10
Moisture	%	10	19
Results(2)	In relation to concrete	**Non-Aggressive**	**Non-Aggressive**
	In relation to steel	**Non-Aggressive**	**Non-Aggressive**

(1): Tests were carried out on a 1:5 aqueous extract at 25°C as recorded.
(2): Assessed in accordance with AS 2159 – 2009, Table 6.4.2 (C) and Table 6.5.2 (C)

7 Acid Sulfate Soils Assessment

7.1 Definition and Theoretical Background

Acid Sulfate Soils (ASS) are naturally occurring sediments and soils containing iron sulfides (principally iron sulfide, iron disulfide or their precursors). Oxidation of these soils through exposure to the atmosphere or through lowering of groundwater levels results in the generation of sulfuric acid.

Most ASS are of Holocene age (<10,000 years) and their formation requires the presence of iron-rich sediments, sulfate (usually from sea water), removal of reaction products such as bicarbonate, the presence of sulfate-reducing bacteria and an abundant supply of organic matter. These conditions generally exist in mangroves, salt marshes, inter-tidal areas and on the beds of coastal rivers and lakes.

ASS is further sub-divided into Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soil (PASS). AASS and PASS are generally found in the same soil profile with AASS overlying PASS.

AASS are soils that contain highly acidic soil horizons or layers resulting from the oxidation of iron sulfides. The oxidation produces hydrogen ions in excess of the buffering or neutralising capacity of the soil.

PASS are soils containing iron sulfides or sulfidic material (usually ferrous iron disulfide or pyrite) which are waterlogged soils, rich in pyrite, that have not been exposed to air and oxidised. Any disturbance that admits oxygen (such as excavation works) will lead to the development of actual acid sulfate soil layers, which may pose an environmental risk.

7.2 Indicators of AASS and PASS

The Indicators of PASS materials are as follows:

Screening tests: PASS indicators include significant negative pH shifts during screening tests and pH following oxidation (pH_{Fox}) below pH 3. Samples with pH_F < pH 4.0 indicate that in-situ conditions are already acidic. For pH_F approximately equal to 7 the soil is considered neutral.

Chromium Suite tests: Indicators of PASS materials include significant actual acidity (TAA greater than 18 Mole H^+/t) and Chromium Reducible Sulfur percentages S_{CR} greater than 0.03%. Samples with pH_{KCL} < 6.5 indicate that in-situ conditions are already somewhat acidic, but TAA greater than 18 mole H+/t is required for this to be significant (depending on scale of the job and nature of the soil).

7.3 Assessment Criteria

The ASSMAC (1998) action criteria for treatment of ASS based on the percentage of oxidisable sulfur or equivalent Titratable Actual Acidity (TAA) or Titratable Peroxide Acidity (TPA) for broad soil texture categories are presented in Figure 2. When analysis results exceed the action criteria, a treatment regime and management plan for the materials is triggered. For disturbances of less than 1,000 tonnes, the action criteria vary according to the texture of the material. However if more than 1,000 tonnes is to be disturbed, all action criteria are the same: S% 0.03% and Acid 18 mole H^+/tonne. For the purposes of this assessment the criteria applicable for disturbing less than 1,000 tonnes of soil disturbed has been adopted with a coarse texture.

The action criteria for ASS soil analysis are presented below.

Table 4.4. Action criteria based on ASS soil analysis for three broad texture categories

Type of Material		*Action Criteria 1-1000 tonnes disturbed*		*Action Criteria if more than 1000 tonnes disturbed*	
Texture range.McDonald et al. (1990)	*Approx. clay content (%<0.002 mm)*	*Sulfur trail % S oxidisable (oven-dry basis) eg S_{TOS} or S_{POS}*	*Acid trail mol H^+/tonne (oven-dry basis) eg, TPA or TSA*	*Sulfur trail % S oxidisable (oven-dry basis) eg S_{TOS} or S_{POS}*	*Acid trail mol H^+/tonne (oven-dry basis) eg, TPA or TSA*
Coarse Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium Texture Sandy loams to light clays	5 - 40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≥40	0.1	62	0.03	18

Figure 2 - Extract from Stone, Y, Ahern CR, and Blunden B (1998)

7.4 Laboratory Results

Eight soil samples were collected from BH01 to BH03 to test for pH screening tests to assess the actual and potential acidity of insitu samples. The results are summarized in Table 3 and detailed results can be found in Attachment E.

Table 3 - pH_f / pH_{fox} Screening results

Borehole ID	Depths (m)	pH_f	pH_{fox}	pH Reduction	Reaction Rating
BH01	0.5	8.0	6.2	1.8	2.0
BH01	1.0	8.0	5.7	2.0	2.0
BH01	1.5	8.3	6.3	2.3	2.0
BH01	2.0	7.0	5.2	1.8	1.0
BH02	0.5	8.0	6.1	1.9	2.0
BH02	1.0	8.2	6.0	2.2	2.0
BH02	1.5	7.5	5.7	1.8	2.0
BH03	1.5	8.3	5.9	2.4	1.0

7.5 Discussion

Based on the pH screening test results, the site does not indicate the presence of any Potential or Actual Acid Sulfate Soils, with the exception of unit differences between pH_f and pH_{fox} being >1. The proposed development does not require any further assessment in relation to Acid Sulfate Soils and therefore does not require an Acid Sulfate Soil Management Plan (ASSMP).

8 RECOMMENDATIONS

8.1 Groundwater Seepage

Based on the findings of this investigation, groundwater seepage was encountered in BH03, at a depth of 2.4m. Alliance anticipates that groundwater may be encountered during the excavation works for the swimming pool particularly after heavy rain.

Long-term groundwater monitoring was not conducted. Groundwater seepage may fluctuate, particularly during intense or long duration rainfall events. As such, the construction should be planned to manage seepage and surface runoff during the excavation.

If unexpected groundwater seepage is encountered during construction, dewatering/groundwater control should be undertaken following advice from a geotechnical/hydrogeological engineer.

In the long term, drainage should be provided behind the swimming pool retaining walls, around the perimeter, and below the swimming pool slab. The completed excavation should be inspected by a hydraulic engineer to confirm that adequate drainage has been allowed for in the design and implemented in the construction of the swimming pool.

8.2 Site Classification

Due to the presence of uncontrolled fill to greater than 0.5m depth, the site is classified as Class P in accordance with *AS2870-2011 Residential Slabs and Footing*.

However, provided that footings are founded on the deeper alluvial sand, deeper footings and slabs may be designed in accordance with AS2870-2011 for a Class A site, described as most sand and rock sites with little or no ground movement from moisture changes.

8.3 Excavation Conditions and Vibrations

Given the encountered alluvium soil profile, the excavation to a maximum depth of 3m is expected to be readily achieved using conventional earthworks excavation equipment (min. 5T excavator). As the excavation is expected to be within loose to medium dense alluvium sand, construction-related vibrations are expected. Generally, the peak particle velocity during any demolition, excavation and construction works should be limited to 5mm/s.

Note should be given that the vibration in the sandy soils, predominantly would cause densification of the sand which may lead to excessive movement of the adjacent footings. Therefore, the vibrations induced by construction machinery should be maintained at a low level.

If the encountered ground conditions are not in line with the findings of this investigation (particularly in the case of encountering medium strength sandstone during the excavation), the project geotechnical engineer should be informed prior to advancing the construction works.

Generally, the ground vibration Peak Particle Velocity (PPV) should be limited to 5mm/s at the site boundary and 2mm/s at the sensitive property boundaries. A dilapidation survey on nearby structures and infrastructure should be carried out by a structural engineer prior to the commencement of any site excavations. The report should include precise measurements of the existing defects and cracks presented with the relevant photos.

8.4 Excavation Support

The proposed excavation can be undertaken by adopting unsupported batter slopes provided that the batter slopes in the soil does not extend below the 'zone of influence' of any adjacent structures and infrastructure (i.e. a 30° line in sand and a 45° line in clay drawn from the foundation level of any adjacent structure and infrastructure).

The recommended maximum temporary batter slopes for excavations presented in Table 4. Surface protection of the batter faces will be needed to prevent erosion and loss of surface materials.

Table 4 - Maximum Excavation Batter Slopes above the Groundwater Level

Material	Maximum Temporary Batter Slope (H: V)
Loose to medium dense sand	2 : 1

If the unsupported batter slopes are not feasible, the excavation should be supported by a properly designed shoring system.

8.5 Lateral Earth Pressures Coefficients

Lateral earth pressures parameters for retaining walls are provided in Table 5. A triangular stress distribution should be used for the design of permanently restrained walls if they are designed as a cantilever. The retaining wall should be designed in accordance with AS4678 - 2002 Earth Retaining Structures. If it is critical to limit the horizontal deformation, an earth pressure coefficient 'at rest' (K_0) should be adopted.

Retaining structures should be designed for any footing surcharge loads that may present within the zone of influence of the side walls. In addition, provisions are to be made for permanent and effective drainage behind the wall.

Table 5 - Geotechnical Design Parameters for Retaining Wall Design

Description	γ	c'	ϕ'	K_0	K_a	K_p	E'	ν
Unit	kN/m^3	kPa	°	–	–	–	MPa	–
Loose to medium dense sand	18	0	30	0.5	0.33	3.0	15	0.3

Legends:
γ Bulk Unit Density
ϕ' Effective Friction Angle
c' Effective Cohesion
K_0 Earth pressure at rest
K_a Active earth pressure
K_p Passive earth pressure
E' Elastic Modulus
ν Poisson's ratio

8.6 Foundations

The existing topsoil material is not a suitable foundation material. The proposed structure and swimming pool may be founded on shallow footings on medium dense alluvial soils

It should be noted that in the case of adopting two different footing system for the proposed building (including shallow pad footings and pier footings) the settlements would be different. As such, it is recommended to found the entire structure on similar foundation layer and on same footing system.

The recommended design parameters for strip and square footings are presented in Table 6. It should be noted that the provided bearing pressure does not apply to raft footing design. If it is proposed to design a raft footing, the allowable bearing pressure should be determined considering the applied loads and tolerable settlement. Additional investigation with deeper boreholes to verify the depth to bedrock would be required.

Table 6 - Geotechnical Design Parameters for Shallow Foundation

Description	Embedment Depth	Allowable Bearing Pressure
	m	kPa
Alluvium medium dense sand	0.5	90
	1.0	110

It is preferred to found the structures on pile footings founded on alluvial soils. Screw piles are recommended to be founded on the alluvial sand layer. An allowable bearing pressure of 150kPa is recommended for 350mm diameter screw pile with 1.0m depth. Screw pile shall be designed for corrosion during design life of the project. If higher bearing capacity is required, deeper machine-formed boreholes would be required. Dense to very dense sands appear to be present at a depth of at least 1.5m bgl.

An inspection should be undertaken during shallow footing excavation. An experienced geotechnical engineer or engineering geologist should be on site to confirm that the assumptions made in this report regarding the subsoil conditions. The base of footing should be free of soft, loose, wet, or disturbed soils.

9 LIMITATIONS

Alliance Geotechnical Pty Ltd (Alliance) has prepared this report for the site located at 11 Oak Street, North Narrabeen NSW in accordance with Alliance's fee proposal and Terms of Engagement. This geotechnical report has been prepared for Perpetual Trustee Limited ATF Axil Pavy c/o ATH Projects for this project and for the purposes outlined in this report. This report cannot be relied upon for other projects, other parties on this site or any other site. The comments and recommendations provided in this report are based on the assumption that the geotechnical recommendations contained in this report will be fully complied with during the design and construction of the proposed site development.

The borehole investigation and laboratory testing results provided in this report are indicative of the subsurface conditions at the site only at the specific sampling and testing locations, and to the depths drilled at the time of the investigation. Subsurface conditions can change significantly due to geological and human processes. Where variations in conditions are encountered further geotechnical advice should be sought from Alliance.

Written by	Reviewed by
	
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Attachment A – Selected Site Photographs

Photo 1 - Site Overview looking West

Photo 2 – Site Overview looking East

Attachment B – Geotechnical Investigation Plan (Drawing 13942-GR-1-A)

Geotechnical Investigation Plan (Not to Scale)

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Client Name:	Perpetual Trustee Ltd. ATF Axil Pavy c/o ATH Projects	Figure / Drawing Number:	13942-GR-1-A
Project Name:	Proposed Residential Development	Figure / Drawing Date:	12 Oct 2021
Project Location:	11 Oak Street, North Narrabeen NSW 2101	Report Number:	13942-GR-1-1

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Attachment C – Explanatory Notes & Borehole Logs

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Explanatory Notes
Drill & Excavation Logs

General

Information obtained from site investigations is recorded on log sheets. Soils and very low strength rock are commonly drilled using a combination of solid-flight augers with a Tungsten-Carbide (TC) bit. Descriptions of these materials presented on the “Borehole Log” are based on a combination of regular sampling and in-situ testing. Rock coring techniques commences once material is encountered that cannot be penetrated using a combination of solid-flight augers and Tungsten-carbide bit. The "Cored Borehole Log" presents data from drilling where a core barrel has been used to recover material - commonly rock.

The "Excavation - Geological Log" presents data and drawings from exposures of soil and rock resulting from excavation of pits or trenches.

The heading of the log sheets contains information on Project Identification, Hole or Test Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The scale is presented in the depth column as metres below ground level.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is included in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures, and geological unit. Material description and classifications are based on Australian Standard Geotechnical Site Investigations: AS 1726 - 2017 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

Drilling

Drilling, Casing and Excavating

Drilling methods deployed are abbreviated as follows

AS	Auger Screwing
ADV	Auger Drilling with V-Bit
ADT	Auger Drilling with TC Bit
BH	Backhoe
E	Excavator
HA	Hand Auger
HQ	HQ core barrel (~63.5 mm diameter core) *
HMLC	HMLC core barrel (~63.5 mm diameter core) *
NMLC	NMLC core barrel (~51.9 mm diameter core) *
NQ	NQ core barrel (~47.6 mm diameter core) *
RR	Rock Roller
WB	Wash-bore drilling

* Core diameters are approximate and vary due to the strength of material being drilled.

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage. It is introduced to assist with the drill process, in particular, when core drilling. The introduction of drill fluid/water does not allow for accurate identification of water seepages.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

VE	Very Easy
E	Easy
F	Firm
H	Hard
VH	Very Hard

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

Groundwater inflow water level

Samples/Tests

Samples collected and testing undertaken are abbreviated as follows

ES	Environmental Sample
DS	Disturbed Sample
BS	Bulk Sample
U50	Undisturbed (50 mm diameter)
C	Core Sample
SPT	Standard Penetration Test
N	Result of SPT (*sample taken)
VS	Vane Shear Test
IMP	Borehole Impression Device
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer Test
HB	Hammer Bouncing

Excavation Logs

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the "Structure and other Observations" column. The depth of the base of excavation (for the logged section) at the appropriate depth in the "Material Description" column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added.

Material Description – Soil

Material Description - In accordance with AS 1726-2017

Classification Symbol - In accordance with the Unified Classification System (AS 1726-2017).

Abbreviation	Typical Names
GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures.
SW	Well graded sands, gravelly sands, little or no fines.
SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
SM	Silty sand, sand-silt mixtures.
SC	Clayey sands, sand-clay mixtures.
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
OL	Organic silts and organic silty clays of low plasticity. *
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts.
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity, organic silts. *
Pt	Peat and other highly organic soils. *

* Additional details may be provided in accordance with the Von Post classification system (1922).

Organic Soils - Identification using laboratory testing:

Material	Organic Content - % of dry mass
Inorganic	<2
Organic Soil	<2 ≤ 25
Peat	> 25

Organic Soils - Descriptive terms for the degree of decomposition of peat:

Term	Decomposition	Remains	Squeeze
Fibrous	Little or none	Clearly recognizable	Only water No solid
Pseudo-fibrous	Moderate	Mixture of fibrous and amorphous	Turbid water < 50% solids
Amorphous	Full	Not recognizable	Paste > 50% solids

Particle Characteristics– Definitions are as follows:

Fraction	Component (& subdivision)		Size (mm)
Oversize	Boulders		> 200
	Cobbles		> 63 ≤ 200
Coarse grained soils	Gravel	Coarse	> 19 ≤ 63
		Medium	> 6.7 ≤ 19
		Fine	> 2.36 ≤ 6.7
	Sand	Coarse	> 0.6 ≤ 2.36
		Medium	> 0.2 ≤ 0.6
		Fine	> 0.075 ≤ 0.21
Fine grained soils	Silt		0.002 ≤ 0.075
	Clay		< 0.002

Secondary and minor soil components

In coarse grained soils – The proportions of secondary and minor components are generally estimated from a visual and tactile assessment of the soils. Descriptions for secondary and minor soil components in coarse grained soils are as follows.

Designation of components	Percentage fines	Terminology (as applicable)	Percentage accessory coarse fraction	Terminology (as applicable)
Minor	≤ 5	Trace clay / silt	≤ 5	Trace sand / gravel
	> 5 ≤12	With clay / silt	> 5 ≤12	With sand / gravel
Secondary	> 12	Silty or clayey	> 30	Sandy or gravelly

Descriptions for secondary and minor soil components in fine grained soils are as follows.

Designation of components	Percentage coarse grained soils	Terminology (as applicable)
Minor	≤ 5	Trace sand / gravel / silt / clay
	> 5 ≤12	With sand / gravel / silt / clay
Secondary	> 30	Sandy / gravelly / silty / clayey

Plasticity Terms – Definitions for fine grained soils are as follows:

Descriptive Term	Range of Liquid Limit for silt	Range of Liquid Limit for clay
Low Plasticity	≤ 50	≤ 35
Medium Plasticity	N/A	> 35 ≤50
High Plasticity	> 50%	> 50

Particle Characteristics

Particle shape and angularity are estimated from a visual assessment of coarse-grained soil particle characteristics. Terminology used includes the following:

Particle shape – spherical, platy, elongated,

Particle angularity –angular, sub-angular, sub-rounded, rounded.

Moisture Condition – Abbreviations are as follows:

D	Dry, looks and feels dry
M	Moist, No free water on remoulding
W	Wet, free water on remoulding

Moisture content of fine-grained soils is based on judgement of the soils moisture content relative to the plastic and liquid limit as follows:

MC < PL	Moist, dry of plastic limit
MC ≈ PL	Moist, near plastic limit
MC > PL	Moist, wet of plastic limit
MC ≈ LL	Wet, near liquid limit
MC > LL	Wet of liquid limit

Consistency - of cohesive soils in accordance with AS 1726-2017, Table 11 are abbreviated as follows:

Consistency Term	Abbreviation	Indicative Undrained Shear Strength Range (kPa)
Very Soft	**VS**	< 12
Soft	**S**	12 ≤ 25
Firm	**F**	25 ≤ 50
Stiff	**St**	50 ≤ 100
Very Stiff	**VSt**	100 ≤ 200
Hard	**H**	≥ 200
Friable	**Fr**	-

Density Index (%) of granular soils is estimated or is based on SPT results. Abbreviations are as follows:

Description	Abbreviation	Relative Density	SPT N
Very Loose	VL	< 15%	0 - 4
Loose	L	15 - 35%	4 - 10
Medium Dense	MD	35 - 65%	10 - 30
Dense	D	65 - 85%	30 - 50
Very Dense	VD	> 85%	> 50

Structures - Fissuring and other defects are described in accordance with AS 1726-2017 using the terminology for rock defects

Origin - Where practicable an assessment is provided of the probable origin of the soil, e.g. fill, topsoil, alluvium, colluvium, residual soil.

MATERIAL DESCRIPTION - ROCK

Material Description

Descriptions of rock for geotechnics and engineering geology in civil engineering

Identification of rock type, composition and texture based on visual features in accordance with AS 1726-2017.

Rock Naming – Where possible conventional geological names are used within the logs. Engineering properties cannot be inferred directly from the rock names in the table, but the use of a particular name provides an indicative range of characteristics to the reader. Lithological identification of rock is provided to appreciate the geology of an area, to correlate geological profiles seen in boreholes or to distinguish boulders from bedrock.

Grain Size – Grain size is done in accordance with AS1726-2017 as follows:

Coarse grained	Mainly 0.6 to 2 mm
Medium grained	0.2 – 0.6 mm
Fine grained	0.06 – 0.2 mm

Colour – Rock colour is described in the moist condition.

Texture and Fabric - Frequently used terms include:

Sedimentary Rock	Metamorphic Rock	Igneous
Bedded	Cleaved	Massive
Interbedded	Foliated	Flow banded
Laminated	Schistose	Folded
Folded	Banded	Lineated
Massive	Lineated	Porphyritic
Graded	Gneissose	Crystalline
Cross-bedded	Folded	Amorphous

Bedding and Laminated – AS 1726 – 2017 bedding and laminated rock descriptions are provided below with additional detail from BS EN ISO 14689-1 as guidance.

Description	Spacing (mm)
Very Thickly Bedded	> 2000
Thickly Bedded	> 600 ≤ 2000
Medium Bedded	> 200 ≤ 600
Thinly Bedded	> 60 ≤ 200
Very Thinly Bedded	> 20 ≤ 60
Thickly Laminated	> 6 ≤ 20
Thinly Laminated	< 6

Features, inclusions and minor components – Features, inclusions and minor components within the rock material shall be described where those features could be significant such as gas bubbles, mineral veins, carbonaceous material, salts, swelling minerals, mineral inclusions, ironstone or carbonate bands, cross-stratification or minerals the readily oxidise upon atmospheric exposure.

Moisture content – Where possible descriptions are made by the feel and appearance of the rock using one according to following terms:

Dry	Looks and feels dry.
Moist	Feels cool, darkened in colour, but no water is visible on the surface
Wet	Feels cool, darkened in colour, water film or droplets visible on the surface

The moisture content of rock cored with water may not be representative of its in-situ condition.

Durability – Descriptions of the materials durability such as tendency to develop cracks, break into smaller pieces or disintegrate upon exposure to air or in contact with water are provided where observed.

Rock Material Strength – The strength of the rock material is based on uniaxial compressive strength (UCS). The following terms are used:

Rock Strength Class	Abbreviation	UCS (MPa)	Point Load Strength Index, $I_{s(50)}$ (MPa)
Very Low	VL	> 0.6 ≤ 2	> 0.03 ≤ 0.1
Low	L	> 2 ≤ 6	> 0.1 ≤ 0.3
Medium	M	> 6 ≤ 20	> 0.3 ≤ 1
High	H	> 20 ≤ 60	> 1 ≤ 3
Very High	VH	> 60 ≤ 200	> 3 ≤ 10
Extremely High	EH	> 200	> 10

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical logs as follows:

D	Diametral Point Load Test
A	Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown. Point Load Strength Index test results are presented as $I_{s(50)}$ values in MPa.

Weathering - Weathering classification assists in identification but does not imply engineering properties. Descriptions are as follows:

Term (Abbreviation)	Description
Fresh (FR)	No signs of mineral decomposition or colour change.
Slightly Weathered (SW)	partly stained or discoloured. Not or little change to strength from fresh rock.
Moderately Weathered (MW)	material is completely discoloured, little or no change of strength from fresh rock.
Highly Weathered (HW)	material is completely discoloured, significant decrease in strength from fresh rock.
Extremely Weathered (EW)	Material has soil properties. Mass structure, material texture and fabric of original rock are still visible.
Residual Soil (RS)	Material has soil properties. Mass structure and material texture and fabric of original rock not visible, but the soil has not been significantly transported.

Alteration – Physical and chemical changes of the rock material due to geological processes by fluids at depth at pressures and temperatures above atmospheric conditions. Unlike weathering, alteration shows no relationship to topography and may occur at any depth. When altered materials are recognized, the following terms are used:

Term		Abbreviation		Definition
Extremely Altered		XA		Material has soil properties. Structure, texture and fabric of original rock are still visible. The rock name is replaced with the name of the parent material, e.g. Extremely Altered basalt. Soil descriptive terms are used.
Highly Altered	Distinctly altered	HA	DA	The whole of the rock material is discoloured. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be higher or lower due to loss of minerals or precipitation of secondary minerals in pores.
Moderately Altered	Distinctly altered	MA	DA	The whole of the rock material is discoloured Little or no change of strength from fresh rock. The term 'Distinctly Altered' is used where it is not practicable to distinguish between 'Highly Altered' and 'Moderately Altered'. Distinctly Altered is defined as follows: The rock may be highly discoloured; Porosity may be higher due to mineral loss; or may be lower due to precipitation of secondary minerals in pores; and Some change of rock strength.
Slightly Altered		SA		Rock is slightly discoloured Little or no change of strength from fresh rock.

Alteration is only described in the context of the project where it has relevance to the civil and structural design.

Defect Descriptions

General and Detailed Descriptions – Defect descriptions are provided to suit project requirements. Generalized descriptions are used for some projects where it is unnecessary to describe each individual defect in a rock mass, or where multiple similar defects are present which are too numerous to log individually. The part of the rock mass to which this applies is delineated.

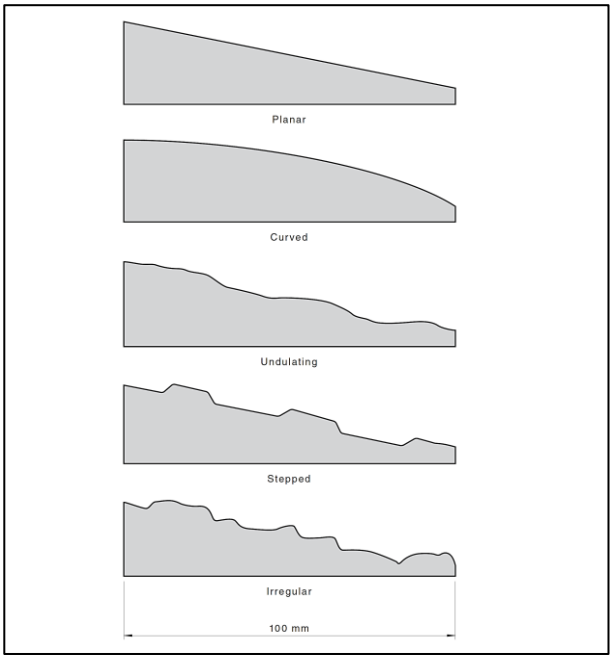
Detailed descriptions are given of defects judged to be particularly significant in the context of the project. For example, crushed seams in an apparently unstable slope. As a minimum, general descriptions outlining the number of defect sets within the rock mass and their broad characteristics are provided where it is possible to do so.

Defect Type – Defect abbreviations are as follows:

BP	Bedding Parting	FL	Foliation	SP	Shear Plane
CL	Cleavage	FZ	Fracture Zone	SZ	Shear Zone
CS	Crushed Seam	HB	Handling break	VN	Vein
DB	Drilling break	JT	Joint		
DL	Drill Lift	SM	Seam		

Defect Orientation – The dip and dip direction are recorded as a two-digit and three-digit number separated by a slash, e.g. 50/240 only when orientated core are collected and there is not core loss that could obscure core orientation. If alternative measurements are made, such as dip and strike or dip direction relative to magnetic north this shall be documented.

Surface Shape –At the medium scale of observation, description of the roughness of the surface shall be enhanced by description of the shape of the defect surface using the following terms, as illustrated below:



Defect Coatings and Seam Composition – Coatings are described using the following terms:

(a) *Clean* No visible coating.
(b) *Stained* No visible coating but surfaces are discoloured.
(c) *Veneer* A visible coating of soil or mineral, too thin to measure; may be patchy.
(d) *Coating* A visible coating up to 1 mm thick. Soil in-fill greater than 1 mm shall be described using defect terms (e.g. infilled seam). Defects greater than 1 mm aperture containing rock material great described as a vein.

Defect Spacing, Length, Openness and Thickness –described directly in millimetres and metres. In general descriptions, half order of magnitude categories are used, e.g. joint spacing typically 100 mm to 300 mm, sheared zones 1 m to 3 m thick.

Depending on project requirements and the scale of observation, spacing may be described as the mean spacing within a set of defects, or as the spacing between all defects within the rock mass. Where spacing is measured within a specific set of defects, measurements shall be made perpendicular to the defect set.

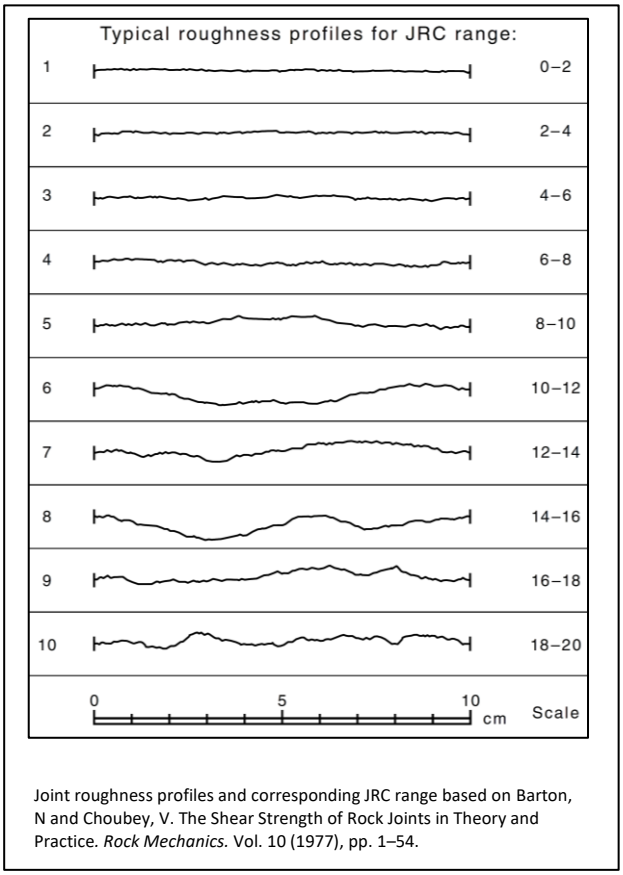
Defect spacing and length (sometimes called persistence), shall be described directly inmillimetres and metres.

Stratigraphic Unit - Geological maps related to the project are used for the designation of lithological formation name and, where possible geological unit name, e.g. Bringelly Shale, Potts Hill Sandstone Member.

Defect Roughness and Shape – Defect surface roughness is described as follows:

Very rough	Many large surface irregularities with amplitude generally more than 1 mm.
Rough	Many small surface irregularities with amplitude generally less than 1 mm.
Smooth	Smooth to touch. Few or no surface irregularities.
Polished	Shiny smooth surface
Slickensided	Grooved or striated surface, usually polished.

Where applicable Joint Roughness Range (JRC) is provided as follows:



Joint roughness profiles and corresponding JRC range based on Barton, N and Choubey, V. The Shear Strength of Rock Joints in Theory and Practice. *Rock Mechanics.* Vol. 10 (1977), pp. 1–54.

Where possible the mineralogy of the coating is identified.

Defect Infilling - abbreviated as follows:

CA	Calcite	KT	Chlorite
CN	Clean	MS	Secondary Mineral
Cy	Clay	MU	Unidentified Mineral
CS	Crushed Seam	Qz	Quartz
Fe	Iron Oxide	X	Carbonaceous

Parameters Related to Core Drilling

Total Core Recovery – T

Defect Spacing or Fracture Index – T

Rock Quality Designation – Y

Core Loss – Core loss occurs when material is lost during the drilling process It is shown at the bottom of the run unless otherwise indicated where core loss is known.

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BH No: BH01
Sheet: 1 of 1
Job No: 13942

Borehole Log

Client: Perpetual Trustee Ltd. ATF Axil Pavy c/o ATH Projects
Project: Proposed Residential Development
Location: 11 Oak St, North Narrabeen NSW 2101

Started: 12/10/2021
Finished: 12/10/2021
Borehole Size: 50 mm

Rig Type: Hand Auger
Hole Location E, N
Driller: NL
Logged: NL
RL Surface: 2.9m
Contractor: Alliance Geotechnical
Bearing: ---
Checked: MAG

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	DCP per 150mm (2 4 9 18)	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
HA	Not Encountered	NIL	2.9	0.0		-	TOPSOIL / FILL: SAND, medium grained, poorly graded, dark grey, with grass roots, trace silt	1		M - W	-	TOPSOIL
			2.5	0.5		SP	SAND, medium grained, brown to dark grey	2 1 2 2 2	ES: 0.5m	M	L	ALLUVIUM
			2.0	1.0			at 1.0m becoming fine to medium grained and pale grey	4 4	ES: 1.0m		MD	
			1.5	1.5			at 1.6m becoming dark grey	5 4 7	ES: 1.5m	M - W		
			1.0	2.0			at 1.7m becoming grey / dark brown	5 10	ES: 2.0m			
			0.5	2.5			Hand auger refusal at 2.0m on inferred medium dense sand Borehole BH01 terminated at 2m	15 13 12 11				
			0.0	3.0								
			-0.5	3.5								

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BH No: BH02
Sheet: 1 of 1
Job No: 13942

Borehole Log

Client: Perpetual Trustee Ltd. ATF Axil Pavy c/o ATH Projects
Project: Proposed Residential Development
Location: 11 Oak St, North Narrabeen NSW 2101

Started: 12/10/2021
Finished: 12/10/2021
Borehole Size: 50 mm

Rig Type: Hand Auger
Hole Location E, N
Driller: NL
Logged: NL
RL Surface: 3.0m
Contractor: Alliance Geotechnical
Bearing: ---
Checked: MAG

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	DCP per 150mm (2 4 9 18)	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
HA	Not Encountered	NIL	2.5	0.5		-	TOPSOIL / FILL: SAND, medium grained, poorly graded, dark grey, with grass roots, trace silt	1 2 1		M	-	TOPSOIL
			2.0	1.0		SP	SAND, fine to medium grained, dark grey to grey	2 1 3 4 4 4	ES: 0.5m ES: 1.0m ES: 1.5m	M	L MD	ALLUVIUM
			1.5	1.5			Hand auger refusal at 1.5m on inferred very dense sand Borehole BH02 terminated at 1.5m	21				
			1.0	2.0								
			0.5	2.5								
			0.0	3.0								
			-0.5	3.5								

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BH No: BH03
Sheet: 1 of 1
Job No: 13942

Borehole Log

Client: Perpetual Trustee Ltd. ATF Axil Pavy c/o ATH Projects
Project: Proposed Residential Development
Location: 11 Oak St, North Narrabeen NSW 2101

Started: 12/10/2021
Finished: 12/10/2021
Borehole Size: 50 mm

Rig Type: Hand Auger | **Hole Location** E, N | **Driller:** NL | **Logged:** NL
RL Surface: 3.4m | **Contractor:** Alliance Geotechnical | **Bearing:** --- | **Checked:** MAG

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	DCP per 150mm (2 4 9 18)	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
HA		NIL	3.0	0.5		-	TOPSOIL / FILL: SAND, medium grained, poorly graded, dark grey, with grass roots, trace silt	2, 3, 4		M - W	-	TOPSOIL
			2.5	1.0		SP	SAND, fine to medium grained, dark grey to grey	2, 2, 2, 4	ES: 0.5m	M	L	ALLUVIUM
									ES: 1.0m		MD	
			2.0	1.5				5, 7, 8	ES: 1.5m			
			1.5	2.0				7, 11, 26	ES: 2.0m		D - VD	
	▼ Water Inflow						at 2.1m becoming dark grey			M - W		
			1.0	2.5			at 2.4m becoming dark grey		ES: 2.5m	W - M		
			0.5	3.0			Hand auger refusal at 2.6m on inferred very dense sand Borehole BH03 terminated at 2.6m					
			0.0	3.5								

Attachment D – Laboratory Results

Alliance Geotechnical
10 Welder Road
Seven Hills
NSW 2147

Attention: **Anurag Sobti**

Report **832158-S**
Project name PROPOSED RESIDENDIAL DEVELOPMENT
Project ID 13942
Received Date Oct 12, 2021

Client Sample ID			**BH01 0.5**	**BH01 1.0m**	**BH01 1.5m**	**BH01 2.0m**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**S21-Oc29754**	**S21-Oc29755**	**S21-Oc29756**	**S21-Oc29757**
Date Sampled			**Oct 12, 2021**	**Oct 12, 2021**	**Oct 12, 2021**	**Oct 12, 2021**
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	8.0	8.0	8.3	7.0
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	6.2	5.7	6.3	5.2
Reaction Ratings*[S05]	0	-	2.0	2.0	2.0	1.0
% Moisture	1	%	26	7.6	10	22
Chloride	10	mg/kg	-	-	< 10	-
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	-	-	22	-
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	-	-	8.3	-
Resistivity*	0.5	ohm.m	-	-	460	-
Sulphate (as SO4)	10	mg/kg	-	-	< 10	-

Client Sample ID			**BH02 0.5m**	**BH02 1.0m**	**BH02 1.5m**	**BH03 1.5m**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**S21-Oc29758**	**S21-Oc29759**	**S21-Oc29760**	**S21-Oc29761**
Date Sampled			**Oct 12, 2021**	**Oct 12, 2021**	**Oct 12, 2021**	**Oct 12, 2021**
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	8.0	8.2	7.5	8.3
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	6.1	6.0	5.7	5.9
Reaction Ratings*[S05]	0	-	2.0	2.0	2.0	1.0
% Moisture	1	%	7.2	19	13	19
Chloride	10	mg/kg	-	-	-	< 10
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	-	-	-	13
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	-	-	-	8.3
Resistivity*	0.5	ohm.m	-	-	-	760
Sulphate (as SO4)	10	mg/kg	-	-	-	< 10

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Acid Sulfate Soils Field pH Test	Sydney	Oct 19, 2021	7 Days
- Method: LTM-GEN-7060 Determination of field pH (pHF) and field pH peroxide (pHFOX) tests			
% Moisture	Sydney	Oct 14, 2021	14 Days
- Method: LTM-GEN-7080 Moisture			
Chloride	Sydney	Oct 19, 2021	28 Days
- Method: In-house method LTM-INO-4270 Anions by Ion Chromatography			
Conductivity (1:5 aqueous extract at 25°C as rec.)	Sydney	Oct 19, 2021	7 Days
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25°C as rec.)	Sydney	Oct 19, 2021	7 Days
- Method: LTM-GEN-7090 pH by ISE			
Sulphate (as SO4)	Sydney	Oct 19, 2021	28 Days
- Method: In-house method LTM-INO-4270 Sulphate by Ion Chromatograph			

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Company Name: Alliance Geotechnical
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Project Name: PROPOSED RESIDENDIAL DEVELOPMENT
Project ID: 13942

Order No.:
Report #: 832158
Phone: 1800 288 188
Fax: 02 9675 1888

Received: Oct 12, 2021 9:04 AM
Due: Oct 19, 2021
Priority: 5 Day
Contact Name: ALL SRAS/RESULTS/INVOICES

Eurofins Analytical Services Manager : Andrew Black

Sample Detail						HOLD	Acid Sulfate Soils Field pH Test	Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA # 1261 Site # 1254									
Sydney Laboratory - NATA # 1261 Site # 18217						X	X	X	X
Brisbane Laboratory - NATA # 1261 Site # 20794									
Mayfield Laboratory - NATA # 1261 Site # 25079									
Perth Laboratory - NATA # 2377 Site # 2370									
External Laboratory									
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**				
1	BH01 0.5	Oct 12, 2021		Soil	S21-Oc29754		X		X
2	BH01 1.0m	Oct 12, 2021		Soil	S21-Oc29755		X		X
3	BH01 1.5m	Oct 12, 2021		Soil	S21-Oc29756		X	X	X
4	BH01 2.0m	Oct 12, 2021		Soil	S21-Oc29757		X		X
5	BH02 0.5m	Oct 12, 2021		Soil	S21-Oc29758		X		X
6	BH02 1.0m	Oct 12, 2021		Soil	S21-Oc29759		X		X
7	BH02 1.5m	Oct 12, 2021		Soil	S21-Oc29760		X		X
8	BH03 1.5m	Oct 12, 2021		Soil	S21-Oc29761		X	X	X
9	BH03 0.5m	Oct 12, 2021		Soil	S21-Oc29854	X			

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Received: Oct 12, 2021 9:04 AM
Due: Oct 19, 2021
Priority: 5 Day
Contact Name: ALL SRAS/RESULTS/INVOICES

Eurofins Analytical Services Manager : Andrew Black

Sample Detail						HOLD	Acid Sulfate Soils Field pH Test	Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA # 1261 Site # 1254									
Sydney Laboratory - NATA # 1261 Site # 18217						X	X	X	X
Brisbane Laboratory - NATA # 1261 Site # 20794									
Mayfield Laboratory - NATA # 1261 Site # 25079									
Perth Laboratory - NATA # 2377 Site # 2370									
External Laboratory									
10	BH03 2.0m	Oct 12, 2021		Soil	S21-Oc29855	X			
11	BH03 2.5m	Oct 12, 2021		Soil	S21-Oc29856	X			
12	BH03 10.0m	Oct 12, 2021		Soil	S21-Oc29857	X			
Test Counts						4	8	2	8

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

Units

mg/kg: milligrams per kilogram
mg/L: milligrams per litre
ug/L: micrograms per litre
ppm: Parts per million
ppb: Parts per billion
%: Percentage
org/100mL: Organisms per 100 millilitres
NTU: Nephelometric Turbidity Units
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs..

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM where no positive PFAS results have been reported have been reviewed and no data was affected.

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QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Chloride	mg/kg	< 10			10	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	uS/cm	< 10			10	Pass	
Sulphate (as SO4)	mg/kg	< 10			10	Pass	
LCS - % Recovery							
Chloride	%	110			70-130	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	%	84			70-130	Pass	
Resistivity*	%	84			70-130	Pass	
Sulphate (as SO4)	%	97			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
				Result 1					
Chloride	N21-Oc19531	NCP	%	97			70-130	Pass	
Sulphate (as SO4)	N21-Oc19531	NCP	%	99			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1	Result 2	RPD	Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Chloride	N21-Oc19531	NCP	mg/kg	110	110	<1	30%	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	S21-Oc30987	NCP	uS/cm	480	530	8.5	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	S21-Oc25894	NCP	pH Units	6.1	6.2	<1	30%	Pass	
Resistivity*	S21-Oc30987	NCP	ohm.m	21	19	8.5	30%	Pass	
Sulphate (as SO4)	N21-Oc19531	NCP	mg/kg	420	420	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	S21-Oc29757	CP	%	22	27	19	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	No
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
S05	Field Screen uses the following fizz rating to classify the rate the samples reacted to the peroxide: 1.0; No reaction to slight. 2.0; Moderate reaction. 3.0; Strong reaction with persistent froth. 4.0; Extreme reaction.

Authorised by:

Emma Beesley	Analytical Services Manager
Charl Du Preez	Senior Analyst-Inorganic (NSW)

Glenn Jackson
General Manager

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.