Geotechnical Investigation Report

Project

Proposed Land Rezoning
15-17 Mona Street, Mona Vale NSW

Prepared for

Sydney Water Corporation

Date

06 April 2022

Report No

14803-GR-1-1

alliance
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APPENDICES

1 Introduction

This report details the results of a geotechnical investigation carried out for a proposed land rezoning at 15-17 Mona Street, Mona Vale NSW. Sydney Water Corporation (client) requested the investigation which was carried out by Alliance Geotechnical Pty Ltd (Alliance) on 15 March 2022 in accordance with our estimate No. 06322 dated 04 March 2022.

The proposed development for the site comprises of rezoning from its current classification of SP2 (Special Purpose Zone) into R2 (Low Density Residential Zone). The aim of the investigation was to provide information on subsurface and site conditions for assessment of geotechnical risk and to assist with planning and design.

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

- Geotechnical and groundwater conditions.
- Risk assessment in accordance with AGS 2007 Guidelines.
- Geotechnical design parameters to enable footing design.
- Suitable footings and foundation layer.
- Method of excavation, temporary batter slopes, and temporary shoring.
- Earthworks preparation.
- Site classification in accordance with AS2870-2011.

The investigation comprised visual and photographic survey and inspection of exposed strata, drilling of test boreholes, in-situ testing of the subsurface strata and engineering assessment and analysis. Details of the fieldwork are given in the report, together with comments relating to design and construction practice.

2 Site Description and Regional Geology

Figure 1: Site location

2.1 Site Description

The site is situated on a rectangular block of land with an area of approximately 3000 m^2 in Mona Vale, NSW. The site is bounded by residential properties to the southwest, Mona Street to the northwest, Bassett Street to the northeast and an undeveloped vegetated lot located to the southeast as shown in Figure 1. The site was densely vegetated with trees and grass at the time of the geotechnical investigation. The site is bordered by an engineered canal to the northwest, in between the site and Bassett Street. The regional topography of the site is flat, with a negligible slope.

2.2 Regional Geology

Reference to the Sydney 1:100,000 Geological Sheet indicates that Quaternary estuarine sediments underly the site. Quaternary estuarine sediments typically comprise of silty to peaty quartz sand, silt, and clay. Ferruginous and humic cementation in places and common shell layers. The geological units around the site are shown in the extract from the geological map below in Figure 2.

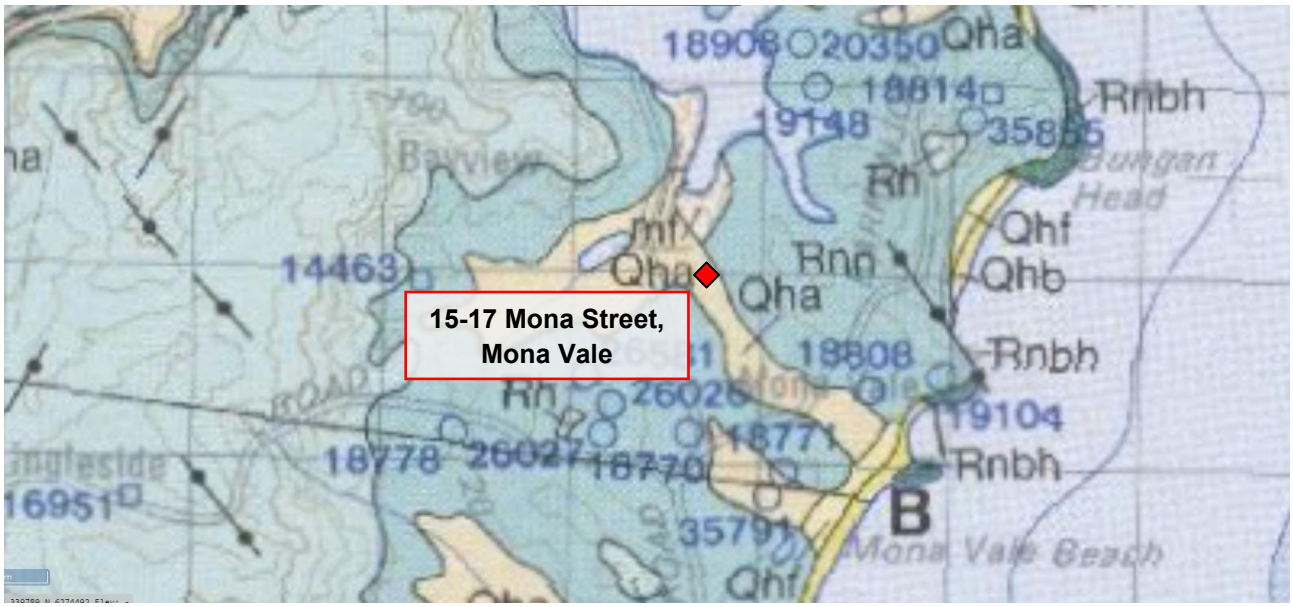

Figure 2 - Extract of Geological Map indicating site location & relevant geological units in the vicinity of the site.

The field observations made during the investigation confirm that the site is consistent with the Geological Map.

3 Proposed Development

To assist with the geotechnical investigation, Alliance was supplied with:

- A proposed lot layout prepared by RJK Architects, Drawing.: 15-17_Mona_Street, Monavale, Option_H.

Based on the supplied drawings and communication with the client, it is understood that the proposed development involves the rezoning of the site from its current classification of SP2 (Special Purpose Zone) into R2 (Low Density Residential Zone). The rezoning will allow for the allotment of the current parcel of land into a 4-lot residential subdivision, and the remainder of the land is to be embellished and potentially dedicated to the Northern Beaches Council as open space.

4 Fieldwork

4.1 Methods

The field work for this investigation comprised the drilling of three boreholes using a ute-mounted drill rig. In-situ testing of the sub-surface strata and a geotechnical site walkover and photographic survey of the site was also performed. Dynamic Cone Penetrometer (DCP) tests were conducted adjacent to each borehole location and two additional locations, testing from the surface to a maximum depth of 2.0m or prior refusal. The DCPs were conducted to determine the consistency of the subsurface material. The DCP's were conducted in accordance with test method AS1289.6.3.2.

4.2 Results

Details of the subsurface conditions encountered in the boreholes are given in the borehole logs in Appendix C and are summarised below. BH01 and BH03 were drilled to a depth of 6.0m while BH02 was drilled to a target depth of 5.0m using a ute-mounted drilling rig with a 100mm auger attachment. The borehole locations are shown on Drawing 14803-GR-1-A in Appendix B.

The sub-surface conditions encountered in the boreholes were relatively similar and are summarised in Table 1. The site is generally underlain by a layer of fill comprising of silty sand / clayey sand / sand. Underlying the fill layer are marine (estuarine) sediments comprising of sand, clay and silt, varying in proportion with depth.

Table 1 - Summary of Subsurface Profiles

Unit	Consistency / Density	Depth to top of unit (mbgl)	Thickness (m)
Fill – Clayey SAND: fine to medium grained	Well Compacted	0	0.6 – 0.8
Marine – Silty/Clayey SAND	Medium Dense to Dense	0.6 – 0.8	1.9 - 2.6
Marine - CLAY	Stiff	2.6 – 3.4	0.15 – 1.4
Marine – SAND with interbedded clay bands	Medium Dense	3.35 – 4.0	Not Penetrated

The borehole logs along with the DCP test results are provided in Appendix C. These results should be read in conjunction with the attached Explanatory Notes which explains the terms, abbreviations, and symbols used, together with the interpretation and limitation of the logging procedure.

4.3 Groundwater

The groundwater table was encountered at 1.2 – 1.3m below ground level within all boreholes during the investigation. No long-term groundwater monitoring was undertaken.

It should be noted that groundwater levels may vary depending on seasonal changes and/or during periods of heavy precipitation.

5 Laboratory Testing

Laboratory tests was carried out on selected soil samples collected from the boreholes during the site investigation. Atterberg Limit and Linear Shrinkage tests were carried out on selected soil samples in Alliance's NATA-accredited soil laboratory and the results are given below.

5.1 Atterberg Limits and Linear Shrinkage

Atterberg limits and linear shrinkage testing was conducted in accordance with AS1289 on clay samples retrieved from the site during the investigation. The results are presented in the table below and the laboratory test certificate and detailed results are provided in Attachment E.

Table 2 - Results of Atterberg Limits and Linear Shrinkage Tests

Test	BH02 & BH03 3.0 – 3.45m
Liquid Limit (%)	34
Plastic Limit (%)	14
Plasticity Index	20
Linear Shrinkage (%)	9.5
Results	Medium to High Plasticity

6 AGS Risk Assessment

The Australian Geomechanics Society (AGS) Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning (2007) has been used to assess the levels of land stability risks associated with a development during and after completion of its construction. The risk assessment process involves the identification of hazards that could potentially affect the stability of the site and surrounding land, as well as identification of "elements at risk" should a landslide occur.

It is assessed that there is negligible risk of slope instability on this site due to the site and its surrounding areas being generally flat.

7 Comments and Recommendations

7.1 Site Classification

A preliminary assessment of the classification of the site in accordance with AS 2870-2011 "Residential Slabs and Footings – Construction" has been carried out. AS 2870-2011 defines the site classification on the basis of a characteristic surface movement associated with the potential movements of foundation strata associated with variation in moisture content. It does not specifically deal with soil settlement. In addition, AS2870-2011 is applicable to simple dwelling houses or structures similar in size to homes. The structural designer should consider this when using the site classification for any ancillary structures with shallow footings.

Based on the encountered subsurface condition, the site is classified as a Class P site due to the uncontrolled fill that is placed over the inferred sandstone bedrock exceeding 0.4m in depth.

7.2 Geotechnical Design Parameters

Based on the borehole logs and the results of laboratory tests, geotechnical design parameters are presented to assist with geotechnical design.

Table 3 – Material Strength Parameters

Description	γ	C_u	C'	$\emptyset'$	E	ϑ
Marine – SAND, Medium Dense	19	0	0	32	35	0.3
Marine – SAND, Dense	20	0	0	34	60	0.3
Marine – CLAY, Stiff	18	50	5	26	15	0.3
Legend: **γ: Unit Weight** **$\emptyset'$: Effective Friction Angle**			C': Drained Cohesion C_u: Undrained Cohesion E: Elasticity Modulus ϑ: Poisson's Ratio			

7.3 Excavation Conditions and Vibrations

Excavation through the natural marine sandy and clayey soil is expected to be readily achievable using conventional earthwork equipment such as a tracked excavator with tiger-tooth bucket. Since the excavation is expected to be only within the soil, construction-related vibrations are expected to be negligible. Generally, the peak particle velocity during any demolition, excavation, and construction should be limited to 5mm.s^{-1}.

If the encountered ground conditions are not in line with the findings of this geotechnical investigation, the project geotechnical engineer should be informed prior to advancing the construction works.

7.4 Excavation Batters

Deep excavation is not expected to be required for residential developments. However, should deep excavations be required, they will not be able to be battered due to shallow groundwater encountered. Should this be required, temporary batters above the groundwater table of 2H: 1V may be considered. The temporary batters should be protected in the short term from erosion caused by heavy rain. This will have to be investigated further during detailed design. Any temporary slopes should be inspected for signs of instability on a regular basis by a geotechnical engineer.

7.5 Site Preparation and Earthworks

It is anticipated that some fill placement and compaction will be necessary to establish ground level for the proposed residential developments. Based on the provided drawings, only minor filling will be required for the

development (less than 1m). Subgrade preparation works will however first need to be undertaken prior to fill placement, as detailed below.

7.5.1 Subgrade Preparation for Ground Slabs and Pavements

The following recommendations are provided for subgrade preparation for earthworks, pavements and slab-on-ground construction:

- Strip existing fill and topsoil. Remove unsuitable materials from the site (e.g., material containing deleterious matter) and stockpile the remainder for re-use as landscaping material or remove from site.
- If natural soils need to be excavated, stockpile for re-use as fill or remove as spoil.
- Areas which show visible heave after a proof roll will need further foundation treatment options as removing the material and replacing it with more suitable material may cause issues due to being so close to the groundwater level. It is unlikely that this will be required and Geofabric along with a layer of engineered fill may be sufficient.
- For the pavement subgrade, after excavation to the design subgrade level, the exposed surface will require inspecting and test rolling in the presence of a geotechnical engineer to identify and delineate any areas of loose, soft or unsuitable subgrade material or where the design CBR value is considered to be not achievable. The test roll should be carried out using a smooth drum roller to pass over the entire subgrade area 4 to 6 times under low speed and in static mode. Following the inspection and test roll, areas of soft or unsuitable subgrade where the design CBR is considered to be not achievable shall be re-evaluated in order to provide a suitable foundation treatment.

If floor slabs are designed to be suspended, subgrade preparation beneath them is considered to be unnecessary. However, root-affected, and organic soils should still be stripped and replaced with surface levelling fill below the footprint of the slab.

Any waste soils being removed from the site must be classified in accordance with current regulatory authority requirements to enable appropriate disposal to an appropriately licensed landfill facility.

7.5.2 Fill Placement and Compaction

All bulk earthworks should be carried out under Level 1 testing and any pavement layers should be carried out under level 2 testing.

Any off-site disposal of excavated materials will require an assessment for re-use or classification of the soils in accordance with EPA guidelines. This includes fill soils and natural soils removed from site. Environmental assessments will need to be undertaken on excavated soils to classify spoil prior to removal from site.
Fill material should be placed and compacted to achieve the density ratio and moisture content as specified in Table 4.

Table 4 - Fill Compaction Criteria

Application	Maximum Loose Layer Thickness	Minimum density ratio (cohesive soils)	Minimum density index (granular soils)	Moisture Content when compacted
General Filling to support pavements and lightly loaded ground slabs	300mm	95%	70	±2% OMC

It is recommended that all compaction control testing in areas that will support slabs and pavements be undertaken under the supervision of a suitable geotechnical testing authority (GTA).

7.6 Foundations

Based on the encountered subsurface conditions highlighted in Table 1, the existing uncontrolled fill is not a suitable foundation material thus it is recommended that preliminary designs should consider the medium dense to dense sand layer or stiff clay layer as the appropriate founding material.

For the proposed structures, screw piles or pad footings maybe a feasible option provided the footings are founded into a natural competent stratum. Due to the unknown loads and footing systems, no specified allowable bearing capacities can be determined at this time. Once specific loadings have been ascertained, Alliance can assist to optimise the footing size and depth to suit the loading on the founding material.

The following parameters are provided for preliminary sizing of shallow footings of ancillary structures. Bearing capacity of footings in soil needs to be subjected to geotechnical checking considering footing size, depth, slope (ground surface and/or footing base) and loadings (i.e. bearing capacity is not a soil property but is dependant of footing size, depth, slope and loadings). A footing subjected to pull out forces should be further assessed in addition to bearing capacity, overturning and sliding.

Table 5 – Allowable Bearing Pressure

Description	Embedment depth (m)	Nominal Footing (m)	Allowable Bearing Pressure (kPa)
Fill – Controlled/ Uncontrolled	N/A	N/A	N/A
Marine – Sand (Medium Dense)	0.5	1m x 1m	70
Marine – Sand (Dense)	0.5	1m x 1m	160
Marine – Clay (Stiff)	0.5	1m x 1m	100

It is recommended that the footings are founded on the same strata to avoid differential settlement.

All footing excavations are required to be cleaned of any loose or disturbed material and any water immediately prior to pouring concrete. If groundwater inflow occurs during footing excavation, pumps may be required to remove the water from the excavation prior to the placement of concrete.

A geotechnical inspection should be undertaken during shallow footing excavations to confirm the design embedment depth and the assumptions made in this report regarding subsoil conditions.

8 Conclusion and Additional Investigation

Based on the above, it is assessed that the site is suitable for residential development. Any recommendations within this report should be implemented prior to and during any future construction.

Due to the limited information on any proposed developments to be constructed on the site, it is recommended that further geotechnical investigations be conducted prior to further developments. Groundwater monitoring should also be undertaken especially if there are any excavations to be carried out.

9 Limitations

This report has been prepared for the Client, Sydney Water Corporation, based on a walkover site inspection, and limited geotechnical testing at locations indicated to address the requirements of the proposed land rezoning at 15 – 17 Mona Street, Mona Vale NSW.

The geotechnical assessment and recommendations provided in this report are based on experience with previous geotechnical investigations and construction review of similar developments in similar geological conditions and have been prepared with the benefit of hand drilled boreholes. To confirm the assessed soil and rock properties in this report, further investigation would be required such as coring and strength testing of rock and should be carried out if the scale of the development warrants, or if any of the properties are critical to the design, construction or performance of the development. Alliance cannot accept responsibility if the advice provided in this report is used for other sites or for preparing structural drawings.

APPENDIX A – Site Photographs

Photo 1 – View of site from Mona St, looking southwest.

Photo 2 – View of site from Mona St, looking south.

APPENDIX B – Investigation Location Plan

Legend

- Indicative Borehole and DCP Location
- Indicative DCP Location

Geotechnical Investigation Plan

Client Name:	Sydney Water Corporation	Figure / Drawing Number:	14803-GR-1-A
Project Name:	Proposed Land Rezoning	Figure / Drawing Date:	16 Mar 2022
Project Location:	15-17 Mona Street, Mona Vale NSW 2103	Report Number:	14803

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APPENDIX C – Borehole Logs and Explanatory Notes

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Job No: 14803

Borehole Log

Client: Sydney Water Corporation
Project: Proposed Land Rezoning
Location: 15-17 Mona Street, Mona Vale

Started: 15/3/2022
Finished: 15/3/2022
Borehole Size 110 mm

Rig Type: TDLR690 **Hole Location:** Refer to drawing 14803-GR-1-A **Driller:** CC **Logged:** SY
RL Surface: 4m **Contractor:** Alliance **Bearing:** --- **Checked:** AS

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	Groundwater Table encountered at 1.2m at 08:45 15/03/22.	3	1		- -	FILL: Silty SAND, fine to medium grained, dark brown, low plasticity, with fine to coarse sub-rounded to angular gravel, trace rootlets. Appears well compacted.		M - W	-	FILL
					SP-SM	Silty SAND, fine to medium grained, brown, trace clay lenses.		M	D - VD	ESTUARINE
		2	2		SP-SM	Silty SAND, fine to coarse grained, brown, trace seashell fragments, trace coarse sub-rounded gravels.	SPT 3, 0, 0 N=0	W	MD - D D MD	
		1	3		CL	Sandy CLAY, low plasticity, dark brown, fine to coarse sand, with silt, trace seashell fragments.		MC ~ LL	St	
					SP	SAND, fine to coarse grained, grey, trace seashell fragments, trace rootlets.	SPT 2, 2, 4 N=6	W	MD	
		0	4		CH	CLAY, high plasticity, grey.		MC > PL	F	
					SP	SAND, fine to coarse grained, pale grey, trace rootlets.	SPT 14, 19, 18 N=37	W	D	
		-1	5		CL	Sandy CLAY, low plasticity, pale grey, fine to coarse sand.		MC > LL	VSt	
		-2	6		CH	CLAY, high plasticity, grey.		MC > PL	VSt	
						Target Depth. Borehole BH01 terminated at 6m				

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Job No: 14803

Borehole Log

Client: Sydney Water Corporation
Project: Proposed Land Rezoning
Location: 15-17 Mona Street, Mona Vale

Started: 15/3/2022
Finished: 15/3/2022
Borehole Size 110 mm

Rig Type: TDLR690 **Hole Location:** Refer to drawing 14803-GR-1-A **Driller:** CC **Logged:** SY
RL Surface: 4m **Contractor:** Alliance **Bearing:** --- **Checked:** AS

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT					- -	FILL: Clayey SAND, fine to medium grained, brown mottled pale grey, low plasticity, trace silt, trace fine to medium angular gravel. Appears well compacted.		D - M	-	FILL
		3	1		SP-SM	Silty SAND, fine to medium grained, dark brown.		M	MD - D	ESTUARINE
	▼ Groundwater Table encountered at 1.2m at 10:30 15/03/22.				SP-SM	Silty SAND, fine to coarse grained, brown, with seashell fragments.		W	D	
		2	2				SPT 3, 2, 3 N=5			
					CH	CLAY, high plasticity, pale grey.		MC > PL	St	
		1	3				SPT 3, 3, 7 N=10			
		0	4		SP-SC	Sandy CLAY, low plasticity, pale grey, fine to coarse sand, trace seashell fragments.		MC > PL	St	
		-1	5				SPT 3, 3, 7 N=10			
						Target Depth. Borehole BH02 terminated at 5m				
		-2	6							

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BH No: BH03
Sheet: 1 of 1
Job No: 14803

Borehole Log

Client: Sydney Water Corporation
Project: Proposed Land Rezoning
Location: 15-17 Mona Street, Mona Vale

Started: 15/3/2022
Finished: 15/3/2022
Borehole Size 110 mm

Rig Type: TDLR690 **Hole Location:** Refer to drawing 14803-GR-1-A **Driller:** CC **Logged:** SY
RL Surface: 4m **Contractor:** Alliance **Bearing:** --- **Checked:** AS

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT					- -	FILL: SAND, fine to medium grained, dark brown, trace rootlets, trace clay lenses. Appears well compacted.		M	-	FILL
					SP-SC	Clayey SAND, fine to medium grained, brown, low plasticity, trace seashell fragments.		M - W	L - MD	ESTUARINE
	▼ Groundwater Table encountered at 1.2m at 12:40 15/03/22	3	1		CL	Sandy CLAY, low plasticity, pale grey, fine to medium sand, trace silt, trace seashell fragments.		MC > PL	St	
					SP	SAND, fine to coarse grained, pale grey, trace seashells fragments.	SPT 1, 0, 0 N=0	W	MD	
		2	2							
		1	3				SPT 4, 8, 11 N=19			
					CH	CLAY, medium to high plasticity, pale grey.		MC > PL	St	
					SP	SAND, fine to coarse grained, brown, trace clay lenses, trace organics (rootlets and seeds), trace shell fragments.		W	MD	
		0	4							
							SPT 9, 5, 15 N=20			
		-1	5		SP-SC	SAND, fine to medium grained, pale grey with interbedded clay bands less than 100mm in thickness.		W	MD	
		-2	6							
						Target Depth. Borehole BH03 terminated at 6m				

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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

Abbreviation	Method
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:

Abbreviation	Description
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

Abbreviation	Test
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. Photos are recommended.

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 Name
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 – 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:

For sedimentary rock:

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

For igneous and metamorphic rock:

Coarse grained	Mainly greater than 2 mm
Medium grained	Mainly 0.6mm to 2mm
Fine grained	Mainly less than 2mm

Colour - Rock colour is described in the moist condition.

Texture and Fabric

Frequently used terms:

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

Bedding and fabric:

Description	Spacing
Very Thickly Bedded	> 2m
Thickly Bedded	0.6m to 2m
Medium Bedded	0.2m to 0.6m
Thinly Bedded	60mm to 200mm
Very Thinly Bedded	20mm to 60mm
Thickly Laminated	6mm to 20mm
Thinly Laminated	< 6mm

Degree of development:

Massive	No layering or fabric. Rock is homogeneous.
Indistinct	Layering or fabric just visible, There is little effect on strength properties.
Distinct	Layering or fabric obvious. The rock may break more easily parallel to the fabric.

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:

Term / Abbreviation		Description	UCS (MPa)	Point Load Strength Index (MPa)
Very Low	**VL**	Crumbles under firm blow with sharp end of pick, can be peeled with a knife; too hard to cut a triaxial by hand; 30mm pieces can be broken by hand.	0.6 – 2	0.03 – 0.1
Low	**L**	Easily scored with a knifed; indentations 1-3mm show with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.	2 – 6	0.1 – 0.3
Medium	**M**	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.	6 – 20	0.3 – 1
High	**H**	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.	20 – 60	1 – 3
Very High	**VH**	Hand specimen breaks with pick after more than one blow; rock rings under hammer.	60 – 200	3 – 10
Extremely High	**EH**	Specimen requires many blows with geological pick to break into intact materials; rock rings under hammer.	> 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
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.
Extremely Weathered	**EW**	Material has soil properties. Mass structure, material texture and fabric of original rock are still visible.
Highly Weathered	**HW**	Material is completely discoloured, significant decrease in strength from fresh rock.
Moderately Weathered	**MW**	Material is `completely discoloured, little or no change of strength from fresh rock.
Slightly Weathered	**SW**	Partly stained or discoloured, little or no change to strength from fresh rock.
Fresh	**FR**	No signs of mineral decomposition or colour change.

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				Description
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		**S**		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	**SSM**	Sheared seam	**DB**	Drilling break
JT	Joint	**CS**	Crushed seam	**HB**	Handling break
SS	Shear surface	**SM**	Infilled seam		
SZ	Sheared zone	**EWS**	Extremely weathered seam		

Sheared surfaces, sheared zones, sheared seams, and crushed seams are generally faults in geological terms.

Defect Orientation

For oriented core: The dip and dip direction are recorded as a two-digit and three-digit number separated by a slash, are collected e.g., 50°/240° 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.

For non-oriented core: The dip is recorded as a two-digit number, e.g., 10°. In vertical boreholes the dip is generally measured relative to the horizontal plan. If the borehole is inclined the dip is generally measured from the core axis.

Surface Roughness – Defect surface roughness is described as follows:

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

Surface Shape – Defect surface roughness is described as follows:

PL	**Planar**	The defect does not vary in orientation.
CU	**Curved**	The defect has a gradual change in orientation
UN	**Undulating**	The defect has a wavy surface.
ST	**Stepped**	The defect has one or more well defined steps
IR	**Irregular**	The defect has many sharp changes of orientation

Defect Infilling – Common abbreviation as follows:

Ca	Calcite	**Fe**	Iron Oxide	**Qz**	Quartz
Cy	Clay	**MS**	Secondary mineral	**X**	Carbonaceous

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

CN	**Clean**	No visible coating.
SN	**Stained**	No visible coating but surfaces are discoloured.
VN	**Veneered**	A visible coating of soil or mineral, too thin to measure; may ne patchy.
CO	**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 is used, e.g. joint spacing typically 100 mm to 300 mm, sheared zones 1m to 3m 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.

Where significant, the nature of the defect end condition is recorded in the context of the scale of the exposure.

Block Shape – Where it is considered significant, block shape should be described using terms given in Table 23, AS 1725:2017.

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.

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.

Total Core Recovery – The percentage of rock recovered excluding core loss per core run.

Defect Spacing – The spacing of successive defects or the mean spacing for relatively broken core.

Fracture Index – Which is the number defects per metre of core.

Rock Quality Designation (RQD) – The percentage of sound core pieces of 100mm or greater per core run and is calculated using Deere et al. (1989) method.

Rock Classification System – For design purpose, Sydney Rock Mass Classification System (Pells et al. 1998, 2019) is adopted.

APPENDIX D – Dynamic Cone Penetrometer Testing Results

alliance

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Website: www.allgeo.com.au

Dynamic Cone Penetrometer (DCP) Test Report

Client	Sydney Water Corporation	**Report Number**	14803-GR-1-1
Project Name	Proposed Land Rezoning	**Project Number**	14803
Project Location	15-17 Mona Street, Mona Vale NSW	**Date Tested**	15/03/2022
Test Method	AS 1289.6.3.2		

Test Number	**DCP01 (BH01)**	**DCP02 (BH02)**	**DCP03 (BH03)**	**DCP04**	**DCP05**
Test Locations	Refer to drawing 14803-GR-1-A				
Surface Material	FILL: Silty SAND	FILL: Clayey SAND	FILL: SAND	FILL: Silty SAND	FILL: SAND
Surface Conditions	M – W	M	D	M	M
RL (m AHD)	4	4	4	4	4
0.00 – 0.15	3	4	4	3	4
0.15 – 0.30	7	7	10	10	12
0.30 – 0.45	22	9	20	9	6
0.45 – 0.60	11	10	24	8	4
0.60 – 0.75	12	8	16	8	5
0.75 – 0.90	16	11	5	9	9
0.90 – 1.05	13	11	5	5	9
1.05 – 1.20	9	5	3	5	6
1.20 – 1.35	6	10	5	9	6
1.35 – 1.50	8	13	5	14	3
1.50 – 1.65	10	19	3 Target Depth	18	2
1.65 – 1.80	10	12		18	3
1.80 – 1.95	11	14		21	2
1.95 – 2.10	5	11 Target Depth		5	4
2.10 – 2.25	5			6	3
2.25 – 2.40	6			9	3
2.40 – 2.55	8			11	3
2.55 – 2.70	9			16	4
2.70 – 2.85	4			22	6
2.85 – 3.00	6			25 for 120mm Refusal	4

3.00 – 3.15	6				11
3.15 – 3.30	7				17
3.30 – 3.45	8 Target Depth				22
3.45 – 3.60					25 for 150mm Refusal

Notes: This test report is intended to be read in conjunction with the geotechnical report by Alliance Geotechnical (ref: 14803-GR-1-1).

APPENDIX E – Laboratory Testing Results

Material Test Report

alliance
geotechnical & environmental solutions
Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
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Phone: 1800 288 188
Email: brett@allgeo.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Report Number: **14803-1**
Issue Number: 1
Date Issued: 29/03/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Roni Marquez
Project Number: 14803
Project Name: Proposed Land Rezoning
Project Location: 15 - 17 Mona Street, Mona Vale
Work Request: 18445
Sample Number: 22-18445A
Date Sampled: 15/03/2022
Dates Tested: 23/03/2022 - 25/03/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **BH02, Depth 3.0-3.45m & BH03, Depth 3.0-3.45m**
Material: Sandy CLAY, low to medium plasticity, grey mottled brown

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	34		
Plastic Limit (%)	14		
Plasticity Index (%)	**20**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	9.5		
Cracking Crumbling Curling	None		