

# **GEOTECHNICAL INVESTIGATION**

rebecca & rob northam

69 GRIFFITHS STREET, BALGOWLAH

REPORT GG12068.001A 2 JULY 2025

# Geotechnical Investigation for a proposed dual occupancy residential development at 69 Griffiths Street, Balgowlah, NSW

### **Prepared for**

Rebecca & Rob Northam Apartment 705 46 Wentworth Street Surrey Hills NSW 2010

#### **Prepared by**

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#### 2 July 2025

#### **Document Authorisation**

Our Ref: GG12068.001

For and on behalf of Green Geotechnics



#### **Matthew Green**

Principal Engineering Geologist

#### **Document Control**

Revision	Description	Format	Date	Author	Distributed to
Α	Final	PDF	2/07/2024	MG	Rebecca & Rob Northam (Client)

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## 1. INTRODUCTION

This report presents the results of a geotechnical investigation undertaken by Green Geotechnics for a proposed residential development at 69 Griffiths Street, Balgowlah, NSW. The investigation was commissioned by Rebecca & Rob Northam by return acceptance of Proposal PROP-2025-322, dated 10 June 2025.

We understand that the development will comprise the demolition of existing structures on the site prior to construction of double storey attached dual occupancy type residential dwellings. The dwellings will include a basement garage/medium area together with swimming pools in the rear garden area.

The design finished floor level of the basement is set at Reduced Level (RL) 18.2 metres Australian Height Datum (AHD). Construction of the basement level is expected to require excavating to depths of between 2.0 and 2.5 metres below the existing ground surface. Excavation depths for the swimming pool would be limited to around 1 metre.

We understand that a geotechnical investigation is required to progress the structural design and will also accompany a Development Application (DA) submission to Northern Beaches Council. Further, we understand that it is proposed to dispose of excess stormwater via onsite infiltration.

The purpose of the investigation was to:

- assess the subsurface conditions over the site,
- comment on groundwater levels and their implications to the development,
- provide a Site Classification to AS2870,
- provide recommendations regarding the appropriate foundation system for the site including design parameters,
- comment on excavation conditions for the basement and swimming pool including vibration control during rock excavation, and
- provide recommendations for temporary battering or support for the excavations,
- provide parameters for the design of retaining walls, and
- assess the infiltration rate of the soils for the purposes of hydraulic design.



## 2. FIELDWORK DETAILS

The fieldwork was carried out on 30 June 2025 and comprised a detailed site walkover together with the drilling of three (3) boreholes numbered BH1 to BH3. Due to restricted site access the boreholes were drilled using hand auger equipment.

The site location is shown in the attached Figure A. The borehole locations, as shown on Figure B, were determined by taped measurements from existing surface features overlain on available survey drawings of the site. Photographs of the site are provided on Figure C.

The strength of the soils encountered in the boreholes was assessed by undertaking Dynamic Cone Penetrometer (DCP) tests adjacent to each borehole. The DCP test was also used to "probe" the depth to the underlying sandstone bedrock in BH1 and BH2. The strength of the weathered bedrock in BH1 and BH2 was assessed by observation of the auger penetration resistance together with an examination of the recovered rock cuttings.

Groundwater observations were made in all boreholes during drilling, on completion of drilling and a short time after completion of drilling. No longer term monitoring of groundwater was carried out.

The fieldwork was completed in the full-time presence of our senior field geologist who set out the boreholes, nominated the sampling and testing, and prepared the borehole logs. The logs are attached to this report, together with a glossary of the terms and symbols used in the logs.

For further details of the investigation techniques adopted, reference should be made to the attached explanation notes.

Environmental and contamination testing of the soils was beyond the agreed scope of the works.

## 3. RESULTS OF INVESTIGATION

## 3.1 Site Description

The site is identified as Lot 9 in DP 9860, and is roughly rectangular in shape with an area of approximately 539m<sup>2</sup>. At the time of the fieldwork the site was occupied by a single storey brick rendered residential dwelling with a tile and metal roof.

At the front of the dwelling is a separate flat roof carport with concrete floor slab and concrete block perimeter walls. At the rear of the dwelling is a paved alfresco area which leads to a rear grassed lawn. The rear lawn is elevated around 1.1 to 1.3 metres above the alfresco and is retained by terraced rendered block walls.



Site vegetation comprised grass lawns, shrubs and trees. The ground surface across the site falls approximately 3 metres to the north from RL22 metres AHD to RL19 metres AHD.

To the north of the site is Griffiths Street and to the south are the rear gardens of No.26 Waratah Street. To the east of the site is No.67 Griffiths Street, a two storey brick rendered and clad residential dwelling set back around 1.2 to 3.0 metres from the boundary with the subject site. The dwelling on No.69 is slightly lower than the subject site and includes a separate car port at the front of the dwelling.

To the west of the site is No.71 Griffiths Street, a two storey brick residential unit building set back around 1.5 metres from the boundary with the subject site. The building on No.71 is elevated above the subject site.

## 3.2 Regional Geology & Subsurface Conditions

The 1:100,000 series geological map of Sydney (Geological Survey of NSW, Geological Series Sheet 9130) indicates that the site is underlain by Triassic Age bedrock belonging to the Hawkesbury Sandstone formation. Bedrock within this formation comprises fine to medium grained quartz sandstone. There are outcrops of bedrock in the vicinity of the site which are consistent with this geological setting.

For the development of a site-specific geotechnical model, the observed subsurface conditions from the boreholes have been grouped into four (4) geotechnical units which are summarised as follows:

#### Unit 1 – Topsoil and Fill:

Topsoil and fill materials were encountered across the site in all boreholes extending to depths of 0.3 to 0.5 metres and could not be penetrated in BH3. The topsoil and fill comprise a combination of clayey silty sands and gravelly clayey sands. The topsoil / fill materials appear variably compacted and were assessed to be dry and moist.

#### **Unit 2 – Natural Colluvial Soils:**

Natural colluvial clayey sands were encountered below the topsoil and fill materials in BH1 and BH2 to a depth of 0.9 metres. The natural sands were assessed to be fine to medium grained and loose becoming loose to medium dense. The colluvial soils were assessed to be moist.

#### *Unit 3 – Residual Clayey Soils:*

Natural stiff residual sandy clays were encountered below the Unit 2 materials to depths of 1.0 to 1.2 metres. The residual clays were assessed to be moist becoming moist to dry at the soil rock interface.



#### Unit 4 - Sandstone bedrock:

Weathered sandstone bedrock was encountered at depths of 1.0 to 1.2 metres. The bedrock was assessed to be low strength (Class 5), however is expected to increase to medium and possibly high strength (Class 4/3) within 1 metre of the top of the rock surface.

Groundwater seepage was not observed during auger drilling of the boreholes.

## 4. GEOTECHNICAL RECOMMENDATIONS

## 4.1 Primary Geotechnical Considerations

Based on the results of the assessment, we consider the following to be the primary geotechnical considerations for the development:

- Bulk excavation for the basements and swimming pools, and potential ground loss as a result of excavations, resulting in damage to nearby structures,
- Rock excavation and the generation of ground borne vibrations, and
- Foundation design for structural loads for the additions.

## 4.2 Site Classification to AS2870

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

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

Because of the AMC and loose sands present, the site is classified a **Problem Site (P)**. However, provided the recommendations provided in Section 4.7 of this report are adopted and the footings bear in the underlying natural soils of at least stiff consistency or the underlying sandstone bedrock, the site may be reclassified **Moderately Reactive (M)**.

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



#### 4.3 Excavation Conditions and Vibration Control

All excavation recommendations should be complemented with reference to the NSW Government Code of Practice for Excavation work, dated January 2020.

Based on the subsurface conditions observed in the boreholes and results of the DCP testing, bulk excavation works for the basement and swimming pools are expected to encounter minor fill overlying natural sandy/clayey soils and sandstone bedrock. The bedrock may include bands of medium and high strength rock.

Excavation of the overlying soils and Class 5 bedrock is expected to be achievable using toothed digging buckets attached to medium to large sized excavators. However, excavators alone without assistance are unlikely to be able to remove any significant amount of the rock. Hydraulic breakers mounted on an excavator or jack hammers will likely be required to break up the majority of the rock before it can be removed using an excavator.

During the use of hydraulic impact hammers, precautions must be made to reduce the risk of vibrational damage to adjoining structures and the existing sewer. At the commencement of the use of hydraulic impact hammers we recommend that full time quantitative vibration monitoring be carried out on the adjoining structures, or at the boundaries by an experienced vibration consultant or geotechnical engineer to check that vibrations are within acceptable limits. Further, we strongly recommend that the boundary lines of the excavation be cut first with a rock saw prior to commencing use of rock hammers.

Australian Standard AS 2187: Part 2-2006 recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2" as they "are applicable to Australian conditions". The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where the minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (e.g. compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.



For residential structures, BS 7385 recommends vibration criteria of 7.5 mm/s to 10 mm/s for frequencies between 4 Hz and 15 Hz, and 10 mm/s to 25 mm/s for frequencies between 15 Hz to 40 Hz and above. These values would normally be applicable for new residential structures or residential structures in good condition. Higher values would normally apply to commercial structures, and more conservative criteria would normally apply to heritage structures. However, structures can withstand vibration levels significantly higher than those required to maintain comfort for their occupants. Human comfort is therefore likely to be the critical factor in vibration management.

Excavation methods should be adopted which limit ground vibrations at the adjoining structures to not more than 5mm/sec. Vibration monitoring is recommended to verify that this is achieved.

Table 4.1 – Recommendations for rock breaking equipment

Distance from adjoining	Maximum Peak Particle	Velocity 5mm/sec				
structure (m)	Equipment	Operating Limit (% of maximum capacity)				
1.5 to 2.5	Hand operated hack hammer only	100				
2.5 to 5.0	300 kg rock hammer	50				
5 0 to 10 0	300 kg rock hammer	100				
5.0 to 10.0	600 kg rock hammer	50				

At all times, the excavation equipment must be operated by experienced personnel, per the manufacturer's instructions, and in a manner, consistent with minimising vibration effects.

If during excavation with the hydraulic impact hammers, vibrations are found to be excessive or there is concern, then alternative lower vibration emitting equipment, such as rock saws, rock grinders or smaller hammers may need to be used. The use of a rotary grinder or rock sawing in conjunction with ripping presents an alternative low vibration excavation technique, however, productivity is likely to be slower. When using a rock saw or rotary grinder, the resulting dust must be suppressed by spraying with water.

It should be noted that vibrations that are below threshold levels for building damage may be experienced at adjoining developments. Rock excavation methodology should also consider acceptable noise limits as per the "Interim Construction Noise Guideline" (NSW EPA).



## 4.4 Temporary Batter Slopes

Suggested temporary batter slope angles for slopes not exceeding 3 metres in height are presented in Table 4.2 below. These recommendations are provided based on no surcharge loads, including construction loads and existing footing loads, being placed within H of the top of the batters, where H is the total batter height.

TABLE 4.2 – Recommended Temporary Batter Slopes

Material	Temporary Batter Slope Ratio (H:V)
Unit 1 & 2 Fill and Colluvial Soils	1.5:1
Unit 3 – Residual Clays	1:1
Unit 4A – Class 5 Sandstone bedrock	0.75:1
Unit 4B – Class 3/4 Sandstone bedrock	Vertical*

<sup>\*</sup> Subject to routine geotechnical inspections during construction.

## 4.5 Retaining Wall Design

Depending on the final position and footprint of the basement, there may be insufficient space for temporary batters over sections of the site. Where there is insufficient space to accommodate temporary batters, it will be necessary to install temporary lateral support to ensure that excavation stability is maintained.

Based on the subsurface conditions observed in the boreholes, the shoring / support system considered most suitable to retain future excavations is a bored reinforced pile wall. Depending on the loads and surcharge forces, either solider piles or contiguous piles may be considered.

When considering the design of the support system, it will be necessary to allow for the loading from structures in adjoining properties, any ground surface slope and the water table present.

For the design of temporary structures where some ground movement is acceptable, an active earth pressure coefficient ( $K_a$ ) may be adopted. However, where adjoining structures are within the zone of influence of the excavation, or it is necessary to limit lateral deflections, it will be necessary to adopt at rest ( $K_o$ ) conditions.  $K_o$  conditions should also be used to design the permanent support system.

A triangular lateral earth pressure distribution should be adopted for cantilevered walls, and a rectangular or trapezoidal lateral earth pressure distribution should be adopted for walls that are progressively propped at their top and base, and/or where two or more rows of anchors are used.

Excavations on the subject site are expected to be limited to around 3 metres depth, and therefore a triangular stress distribution is recommended.



The lateral earth pressure for a cantilevered wall should be determined as a proportion of the vertical stress, as given in the following formula:

 $\sigma z = K z \gamma$ , where  $\sigma z = Horizontal pressure at depth z (kPa)$  K = Earth pressure coefficient

z = Depth(m)

 $\gamma$  = Unit weight of soil or rock (kN/m<sup>3</sup>)

Retaining walls may be designed using the parameters provided below in Table 4.3.

TABLE 4.3 – Retaining Wall Design Parameters

No de miel Heit	Unit Weight	Earth	n Pressure Coeffi	cient	
Material Unit	(kN/m³)	Active (K <sub>a</sub> ) <sup>1</sup>	At Rest (K <sub>0</sub> ) <sup>1</sup>	Passive (K <sub>p</sub> ) <sup>2</sup>	
Unit 1 & 2 Fill and Colluvial Soils	18	0.4	0.6	-	
Unit 3 – Residual Clays	19	0.37	0.55	2.8	
Unit 4A – Class 5 Sandstone bedrock	22	0.3	0.5	3.5 <sup>3</sup>	
Unit 4B – Class 3/4 Sandstone bedrock	23	-	-	4.5 <sup>3</sup>	

<sup>1.</sup> These values assume that some wall movement and relaxation of horizontal stress will occur due to the excavation. Actual in-situ K<sub>0</sub> values may be higher, particularly in the rock units.

The embedment of retaining walls can be used to achieve passive support. A triangular passive earth pressure distribution (increasing linearly with depth) may be assumed, starting from 0.5 m below excavation toe/base level.

During the fieldwork no groundwater was encountered on the part of the lot where any future excavation would be carried out. Therefore, based on the observations made during drilling, future basement excavations to a depth of 3 metres are not expected to encounter a regional groundwater table. However, some minor seepage may occur after periods of increased rainfall. Any seepage into the basement is however expected to be minor, and therefore a conventional sump and pump type system should be capable of removing any seepage during construction.



<sup>2.</sup> Includes a reduction factor to the ultimate value of  $K_p$  to consider strain incompatibility between active and passive pressure conditions. Parameters assume horizontal backfill and no back of wall friction.

<sup>3.</sup> The values for rock assume no adversely dipping joints or other defects are present in the bedrock.

## 4.6 Drainage and Basement Floor Slab Construction

Adequate drainage will need to be provided for any subsurface structures and behind retaining walls to prevent the build-up of hydrostatic forces. In this regard, we would recommend that subsoil drains be installed around the perimeter of the basement, together with the installation of underfloor drainage. The underfloor drainage should comprise a strong durable single sized washed aggregate with perforated drains/pipes leading to the basement sump, which is to be fitted with a failsafe pump.

Where very stiff clayey soils or sandstone bedrock are exposed over the excavation footprint, no special treatment is required other than the removal of loose and softened material. Areas, which have to be built-up to infill low points in the excavations should be filled with properly compacted sub-base material.

Slab-on-grade construction is considered appropriate for the basement floor slab provided that it is isolated from the columns. Joints in the on-grade floor slabs should comprise dowels or keys.

## 4.7 Foundation Design

On completion of bulk excavation, sandstone bedrock is expected to be exposed over the floor of the basement. Any slab on ground sections of the ground floor which are outside the basement footprint are likely to encounter fill materials or firm clayey soils / loose sands at founding level.

To limit the potential for differential settlement we recommend that the proposed building be uniformly supported on footings founded in sandstone bedrock.

Foundation design parameters for the various units are provided in Table 4.4 below:

TABLE 4.4 – Foundation Design Parameters

(Unit) Material	Maximu	Typical E <sub>field</sub> MPa			
(Unit) Material	End Bearing Pressure	Shaft Friction in compression#	Shaft Friction in tension*	Typical Effeld IVIPa	
(1) Fill	-	-	-	-	
(2) Loose Sand / Firm Clay	70	-	-	8	
(3) Stiff Clay	150	20	10	15	
(4A) Class 5 Sandstone Bedrock	700	70	35	80	
(4B) Class 4 Sandstone Bedrock	1.000	100	50	120	

<sup>\*</sup> Uplift capacity of piles in tension loading should also be checked for inverted cone pull out mechanism.



<sup>#</sup> clean socket of roughness category R2 or better is assumed

Settlements for footings on rock are anticipated to be about 1% of the minimum footing dimension, based on serviceability parameters as per Table 4.3. Settlements for pad footings in soils are anticipated to be up to about 15mm where loading does not exceed the maximum allowable values.

All shallow footings should be poured with minimal delay (i.e. preferably on the same day of excavation) or the base of the footing should be protected by a concrete blinding layer after cleaning of loose spoil and inspection.

Drilling of rock sockets into the low to medium strength or better sandstone will require the use of large excavators or piling rigs equipped with rock augers. Some limited groundwater inflow should be anticipated into the bored pile excavations. We expect any minor seepage to be controllable by conventional pumping methods. However, some contingency for pouring concrete by tremie methods should be allowed.

Bored pile footings should be drilled, cleaned, inspected and poured with minimal delay, on the same day. Water should be prevented from ponding in the base of footings as this will tend to soften the foundation material, resulting in further excavation and cleaning being required.

The initial stages of footing excavation/drilling, particularly if bored piles are adopted, should be inspected by a geotechnical engineer/engineering geologist to ascertain that the recommended foundation material has been reached and to check initial assumptions about foundation conditions and possible variations that may occur between borehole locations. The need for further inspections can be assessed following the initial visit.

## 4.8 Design Infiltration Rate

The infiltration rate of the onsite soils was determined using the falling head test method. The tests were carried out using a PVC pipe installed into a preformed borehole that had been previously drilled. In order to create a saturated bulb in the testing zone, the casing was repeatedly filled with water and the drop in water level measured relative to time. This process was carried out until successive tests gave different readings by less than 5%. The last run has been used to determine the soil infiltration rate.

Results of the testing are as summarised below in Table 4.5:

Table 4.5 – Falling Head Test Results

BH ID	Depth of Test (m)	Design Infiltration Rate (litres/m²/sec)
BH2	0.6m	0.01*

<sup>\*</sup> Drop in water level likely as a result of a poor casing seal between the sands and bedrock.



Due to the presence of shallow sandstone bedrock and residual clays we are of the opinion that the site is not suitable for the on-situ disposal of stormwater. We recommend that all stormwater be discharged to the kerb and gutter system of Griffiths Street via a gravity or charged system.

## FURTHER GEOTECHNICAL INPUT

The following summarises the scope of further geotechnical work recommended within this report. For specific details reference should be made to the relevant sections of this report.

- Complete dilapidation surveys of the adjoining buildings and structures.
- Inspection of the basement and swimming pool excavations as they progress.
- Where required, quantitative monitoring of transmitted vibrations during rock excavation using rock hammers.
- Inspection of footing excavations to ascertain that the recommended foundation has been reached and to check initial assumptions regarding foundation conditions and possible variations that may occur.
- We also recommend that Green Geotechnics view the proposed earthworks and structural drawings in order to confirm they are within the guidelines of this report.

Nevertheless, it will be essential during excavation and construction works that progressive geotechnical inspections be commissioned to check initial assumptions about excavation and foundation conditions and possible variations that may occur between inspected and tested locations and to provide further relevant geotechnical advice.

## GENERAL RECOMMENDATIONS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and Green Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.



This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed.

Copyright in this report is the property of Green Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.



# REPORT INFORMATION



#### Introduction

These notes have been provided to amplify Green Geotechnics report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

Green Geotechnics reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

#### **Borehole and Test Pit Logs**

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

#### **Groundwater**

Where groundwater levels are measured in boreholes there are several limitations, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. The borehole must be flushed, and any water must be extracted from the hole if further water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

#### Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, Green Geotechnics will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, Green Geotechnics cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, Green Geotechnics will be pleased to assist with investigations or advice to resolve the matter.

#### Site Anomalies

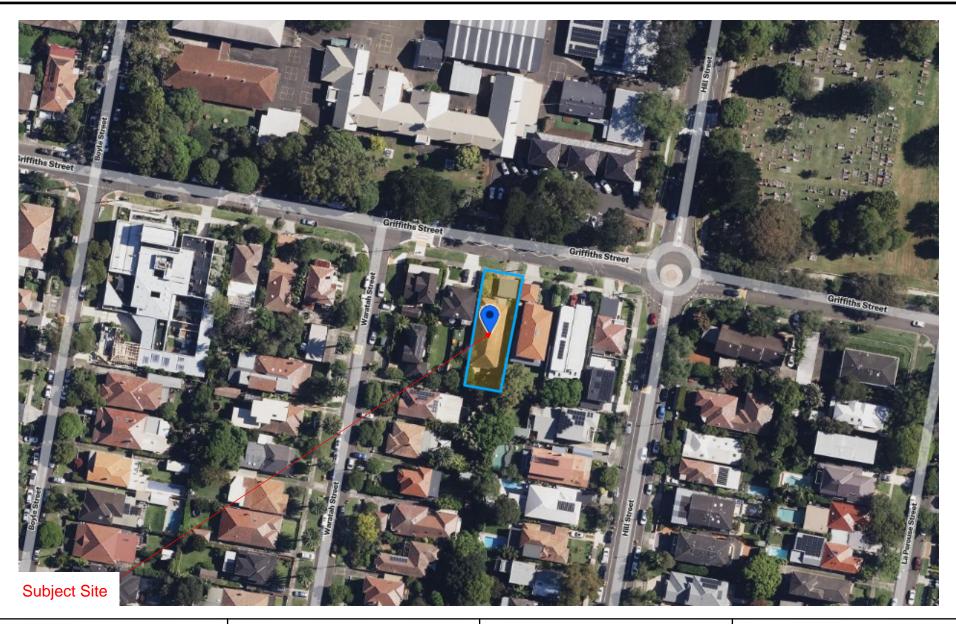
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, Green Geotechnics requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

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# **FIGURES**







Project No: GG12068.001

Client: Rebecca and Rob Northham

Date: 2 July 2025

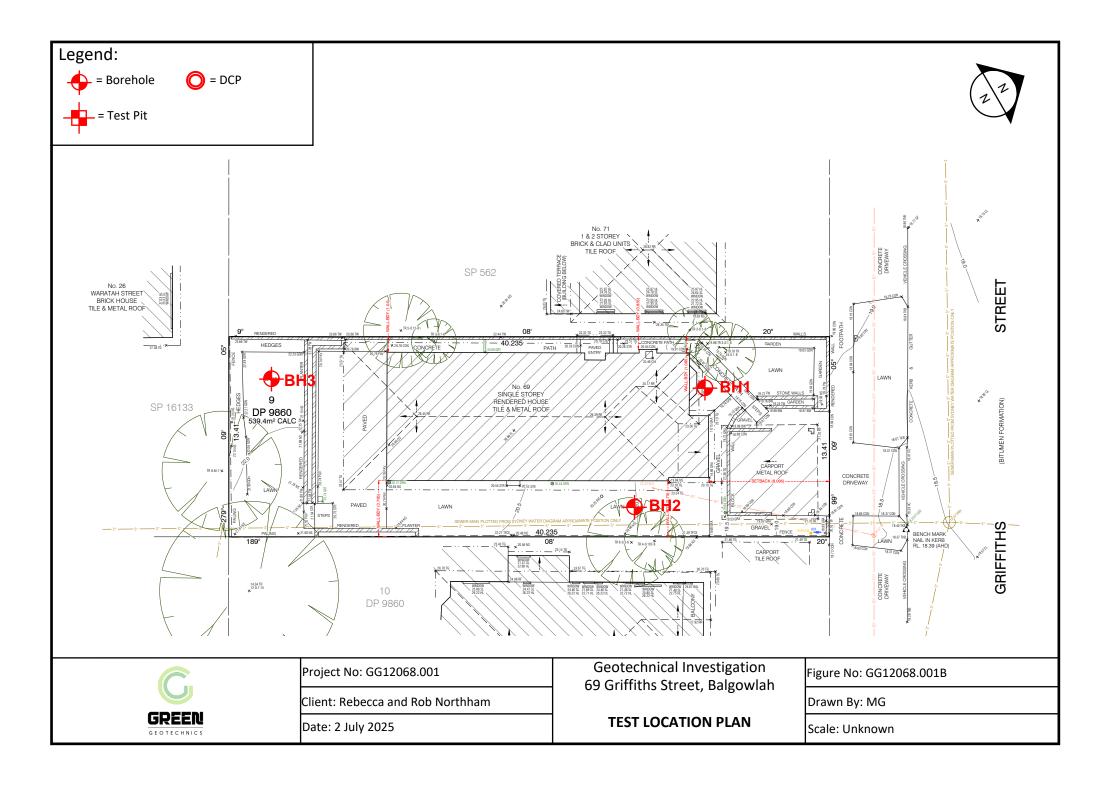
Geotechnical Investigation 69 Griffiths Street, Balgowlah

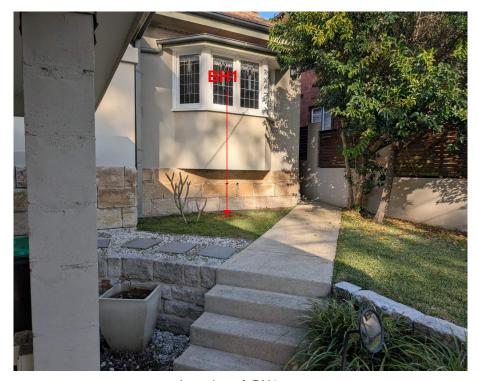
**SITE LOCATION PLAN** 

Figure No: GG12068.001A

Drawn By: MG

Scale: Unknown





Location of BH1



Location of BH2



Project No: GG12068.001

Client: Rebecca and Rob Northham

Date: 2 July 2025

Geotechnical Investigation 69 Griffiths Street, Balgowlah

SITE PHOTOGRAPHS

Page: 1 of 2



Location of BH3



Project No: GG12068.001

Client: Rebecca and Rob Northham

Date: 2 July 2025

Geotechnical Investigation 69 Griffiths Street, Balgowlah

SITE PHOTOGRAPHS

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APPENDIX	A – BOREH	OLE LOGS 8	& DCP TEST	RESULTS







BH1

Page 1 of 1

## **Engineering Log - Borehole**

Commenced: Client: Rebecca and Rob Northham 30/6/2025 Project Name: Geotechnical Investigation: 69 Griffiths Street, Balgowlah Completed: 30/6/2025 Logged By: Hole Location: 69 Griffiths Street, Balgowlah JK

Hole Position: See Plan Checked By: MG

Drill Model and Mounting: Hand Auger Inclination: RL Surface: 19.80 m

Project No.:

GG12068.001

H	Hole Diameter: 65 mm  Prilling Information					mm			Bearing: Datum: AHD Oper  Soil Description						oerator: JK  Observations
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Des Fraction, Colour, Stru Plasticity, Sensitiv	cription ucture, Bedding,		Moisture Condition	Consistency Relative Density	
							-	×	SM	TOPSOIL Clayey Silty SANI dark brown.  0.30m  Clayey SAND: fine to mediu		rained,	М		TOPSOIL  COLLUVIAL SOIL
						19.3	0.5			orayoy of the time to moda	m gramou, orango	DIOWII.	M	L	
						 18.8	1.0—		CL	0.90m Sandy CLAY: orange brown brown, sand is fine to mediu weathered sandstone).	with pale grey and im grained; (comple	yellow etely	М	L to MD	RESIDUAL SOIL
							_			1.20m 1.21m SANDSTONE: fine to mediu	ım grained, pale gre		M / D		\ROCK
					-	18.3	1.5—			orange brown and red brown Hole Terminated at 1.21 m Refusal on weathered sands					
						 17.8	2.0-								
						17.3	2.5—								
_	\S -	Metho Auger Auger	Screv	<u>Pene</u> ving ⊠ No	o res	rion sistanding to		_	<u>Vater</u> vel (Dat	Samples and T  U - Undisturbed San D - Disturbed Sample SPT - Standard Penetr	nple I	Moisture ( D - Dry M - Mois		ition	Consistency/Relative Den  VS - Very Soft S - Soft F - Firm

Carbide Bit RR - Rock Roller WB- Washbore

Support С

- Casing

GREEN GEO 1.01.5 LIB.GLB

Partial Loss

Graphic Log/Core Loss

Core recovered (hatching indicates material)
Core loss

Complete Loss

PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions Based on Unified Soil Classification System

w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense





BH2

Page 1 of 1

## **Engineering Log - Borehole**

Client: Rebecca and Rob Northham Commenced: 30/6/2025 30/6/2025 Project Name: Geotechnical Investigation: 69 Griffiths Street, Balgowlah Completed: Hole Location: 69 Griffiths Street, Balgowlah Logged By: JK

Hole Position: See Plan Checked By: MG

Drill Model and Mounting: Hand Auger Inclination: RL Surface: 20.00 m

Project No.:

GG12068.001

Hole Diameter: 65 mm							Bearing: Datum: AHD C					Op	perator: JK		
	Drilling Information						Soil I	Description				Observations			
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Fraction, Cold	rial Description pur, Structure, Bedding, Sensitivity, Additional		Moisture Condition	Consistency Relative Density	Structure and Additional Observations
						.5	- - -	*	SM	FILL Clayey Silty SA brown, trace of grave	ND: fine to medium grained		M / D		FILL
HA						— 19.3	0.5 —		SC		o medium grained, yellow b	rown	М	L to MD	COLLUVIAL SOIL
-6202 2023						19.0	1.0-		CL	Sandy CLAY: low pla	asticity, orange brown with predium grained.		M D	St	RESIDUAL SOIL
77.2025 10:17 10.05.00.09 Darget Lab and in Situ Tod - DGD   Ltd: Green Geo 1,01.5 2022-07-45 PT; Green Geo 1,01.5 2023-47-45							-			SANDSTONE: fine to orange brown.  Hole Terminated at 1 Refusal on weathere		y with	ט		ROCK
5  U   1001   1200						18.5	1.5—								
						18.0	2.0								
The state of the s						17.5	2.5— - -								
5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5												• • •		-,-	
GIB Log	ADV ADT RR -	Metho Auger Auger Carbio Rock I Washl	Screv V Bit Tung: le Bit Roller	ving sten	rang rei	sistand ling to fusal	-	∠ Lev > Infl ⊲ Pa	rtial Los mplete	e) U - Undisturb D - Disturbed SPT - Standard SPP - Pocket Poly Loss	ped Sample Disample Menetration Test Venetrometer F	Ioisture D - Dry D - Moi D - Wet D - Moi D - Plas L - Liqu	st t sture (	Conte	\( \frac{\text{Consistency/Relative Density}}{\text{VS}} \ \ \text{VS} \ \ \text{Very Soft} \\ \text{S} \ \ \ \text{Soft} \\ \ \ \ \ \ \ \ \text{Firm} \\ \text{vot} \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \

<u>Support</u> - Casing

GREEN GEO 1.01.5 LIB.GLB 1

Graphic Log/Core Loss Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions Based on Unified Soil Classification System

VS - Very Stiff
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense





**BH3** Page 1 of 1

## **Engineering Log - Borehole**

Project No.: GG12068.001

Client: Rebecca and Rob Northham Commenced: 30/6/2025 Project Name: Geotechnical Investigation: 69 Griffiths Street, Balgowlah Completed: 30/6/2025 Hole Location: 69 Griffiths Street, Balgowlah JK

Logged By: Hole Position: See Plan Checked By: MG

Drill Model and Mounting: Hand Auger Inclination: RL Surface: 22.20 m

Drill Model and Mou	nting: Hand Auger 65 mm		Inclination: -90° RL Surface: 22.20 m  Bearing: Datum: AHD Operator: JK						
Drilling Ir	nformation		Soil Description Observations						
Method Support Penetration Groundwater Levels eige	nples & 2-1 ld Tests 8 RL Depth	Graphic Log Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations			
Ŧ		sc	FILL Gravelly Clayey SAND: fine to medium grained, dark brown and grey, with some gravel.	D		FILL			
2023-07-06			Hole Terminated at 0.50 m Refusal in fill						
eo 1.01.5 2022-07-45 Pri; Green Geo 1.01.5	-\frac{\text{\tinx{\tint{\text{\tin}\text{\tinit}\xi\\\ \text{\text{\text{\text{\text{\text{\text{\text{\ti}\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\tett{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\tin}\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\tin}\tint{\text{\text{\text{\text{\text{\text{\text{\text{\ti}}}\tint{\text{\text{\text{\text{\text{\text{\text{\texi}\tint{\text{\ti}\tint{\text{\texi}}\tint{\tint{\ti}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}								
Lab and in Situ Tod - DGD  Lib: Green Ge									
ile> 27/2025 10:17 10.03 00.09 Datget La	- S 2.0								
OREEN 020 BOXENOTE GOT 12088 001 GPJ <-CD-awmg-file> 20772025 10:17 10.03 00.09 Datget Lab and In Star Tool - DGD   Lib.: Green Geo 1 OI 5 2023-07-05 Prj. Green Geo 1 OI 5 2023-07-07-07 Prj. Green Geo 1 OI 5 2023-07-07-07 Prj. Green Geo 1 OI 5 2023-07-07-07 Prj. Green Geo 1 OI 5 2023-07-07-07-07-07-07-07-07-07-07-07-07-07-	- 10 2.5								
Method  AS - Auger Screwing ADV Auger V Bit		<u>Water</u> ✓ Level (Date	Samples and Tests   Moisture   D - Undisturbed Sample   D - Dr.		lition	Consistency/Relative Density  VS - Very Soft S - Soft			

ADV Auger V Bit
ADT Auger Tungsten
Carbide Bit
RR - Rock Roller
WB- Washbore

ranging to refusal

Partial Loss

Complete Loss

D - Disturbed SampleSPT- Standard Penetration TestPP - Pocket Penetrometer

M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

VS - Very Stiff
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

<u>Support</u>

- Casing

Graphic Log/Core Loss Core recovered (hatching indicates material)
Core loss Classification Symbols and Soil Descriptions Based on Unified Soil Classification System

# **Dynamic Cone Penetrometer Test Report**



Project Number: GG12068.001

Site Address: 69 Griffiths Street, Balgowlah

Remarks: \* Pre drilled prior to testing

Test Date: 30/06/2025

Page: 1 of 1

Test Method:	AS1289.6.3.2				Technician: JK				
Test No	BH1	BH2	BH3						
Starting Level	Surface Level	Surface Level	Surface Level						
Depth (m)		Pe	Penetration Resistance (blows / 150mm)						
0.00 - 0.15	1	1	1						
0.15 - 0.30	1	1	8						
0.30 - 0.45	2	2	12						
0.45 - 0.60	2	2	22						
0.60 - 0.75	3	3	Refusal						
0.75 - 0.90	3	3							
0.90 - 1.05	10	22							
1.05 - 1.20	22	Refusal							
1.20 - 1.35	Refusal								
1.35 - 1.50									
1.50 - 1.65									
1.65 - 1.80									
1.80 - 1.95									
1.95 - 2.10									
2.10 - 2.25									
2.25 - 2.40									
2.40 - 2.55									
2.55 - 2.70									
2.70 - 2.85									
2.85 - 3.00									
		i	1						

# SAMPLING & IN-SITU TESTING



#### Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock. Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure. Undisturbed samples are taken by pushing a thin walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility.

#### **Test Pits**

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator.

#### Large Diameter Augers

Boreholes can be drilled using a large diameter auger, typically up to 300 mm or larger in diameter mounted on a standard drilling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content.

#### **Continuous Spiral Flight Augers**

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole.

#### **Non-core Rotary Drilling**

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration.

#### **Diamond Core Rock Drilling**

A continuous core sample of can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter (NMLC). The borehole is advanced using a water or mud flush to lubricate the bit and removed cuttings.

#### **Standard Penetration Tests**

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1. The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable, and the test is discontinued.

The test results are reported in the following form.

 In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

> 4,6,7 N=13

 In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as: 15, 30/40 mm.

The results of the SPT tests can be related empirically to the engineering properties of the soils.

# Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Two types of penetrometer are commonly used.

- Perth sand penetrometer a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

# SOIL DESCRIPTIONS



#### **Description and Classification Methods**

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

#### Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Туре	Particle Size (mm)			
Boulder >200	Boulder >200			
Cobble 63 - 200	Cobble 63 - 200			
Gravel 2.36 - 63	Gravel 2.36 - 63			
Sand 0.075 - 2.36	Sand 0.075 - 2.36			
Silt 0.002 - 0.075	Silt 0.002 - 0.075			
Clay < 0.002	Clay < 0.002			

The sand and gravel sizes can be further subdivided as follows:

Туре	Particle Size (mm)			
Coarse Gravel	20 – 63			
Medium Gravel	6 – 20			
Fine Sand	2.36 – 6			
Coarse Sand	0.6 – 2.36			
Medium Sand	0.2 - 0.6			
Fine Sand	0.075 – 0.2			

The proportions of secondary constituents of soils are described as:

Term	Proportion				
And	Specify				
Adjective	20 - 35%				
Slightly	12 - 20%				
With some	5 - 12%				
With a trace of	0 - 5%				

Definitions of grading terms used are:

- Well graded a good representation of all particle sizes
- Poorly graded an excess or deficiency of particular sizes within the specified range
- Uniformly graded an excess of a particular particle size
- Gap graded a deficiency of a particular particle size with the range

#### **Cohesive Soils**

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained Shear Strength (kPa)			
Very soft	VS	<12			
Soft	S	12 - 25 25 - 50			
Firm	F				
Stiff	ST	50 - 100			
Very stiff	VST	100 - 200			
Hard	Н	200			

#### Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (DCP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N Value	CPT qc value (MPa)	
Very loose	VL	<4	<2	
Loose	L	4 - 10	2 -5	
Medium Dense	MD	10-30	5-15	
Dense	D	30-50	15-25	
Very Dense	VD	>50	>25	

#### Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil derived from in-situ weathering of the underlying rock;
- Transported soils formed somewhere else and transported by nature to the site; or
- Fill moved by man.

Transported soils may be further subdivided into:

- Alluvium river deposits
- Lacustrine lake deposits
- Aeolian wind deposits
- Littoral beach deposits
- Estuarine tidal river deposits
- Talus scree or coarse colluvium
- Slopewash or Colluvium transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

# **ROCK DESCRIPTIONS**



#### Rock Strength

The Rock strength is defined by the Point Load Strength Index ( $Is_{(50)}$ ) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index IS <sub>(50)</sub> MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	Н	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200

<sup>\*</sup> Assumes a ration of 20:1 for UCS to IS<sub>(50)</sub>

#### Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description			
Residual Soil	RS	Soil developed on extremely weathered rock, the mass structure and			
		substance fabric are no longer evident.			
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.			
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable.			
Distinctly Weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured usually by iron staining.			
Moderately weathered	MW	Staining and discolouration of rock substance has taken place.			
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock.			
Fresh	FR	No signs of decomposition or staining.			

#### **Degree of Fracturing**

The following classification applies to the spacing of natural fractures in core samples (bedding plane partings, joints and other defects, excluding drilling breaks

Term	Description					
Fragmented	Fragments of <20 mm					
Highly Fractured	Core lengths of 20-40 mm with some fragments					
Fractured Core	Core lengths of 40-200 mm with some shorter and longer sections					
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections					
Unbroken	Unbroken Core lengths mostly > 1000 mm					

#### Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	2 m

#### **Rock Quality Designation**

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

RQD % = <u>cumulative length of 'sound' core sections ≥ 100 mm long</u> total drilled length of section being assessed

'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling/handling, then the broken pieces are fitted back together and are not included in the calculation of RQD.

# **ABBREVIATIONS**



#### Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

#### **Drilling or Excavation Methods**

С Core Drilling R Rotary drilling ADT Auger Drill TC Bit ADV Auger Drill V Brit

**NMLC** Diamond core - 52 mm dia NQ Diamond core - 47 mm dia Diamond core - 63 mm dia HQ PQ Diamond core - 81 mm dia

#### Water

Ζ Water seep Water level

#### Sampling and Testing

Α Auger sample В **Bulk sample** D Disturbed sample S Chemical sample

U50 Undisturbed tube sample (50mm)

W Water sample

PΡ Pocket Penetrometer (kPa) PLPoint load strength Is(50) MPa S **Standard Penetration Test** Shear vane (kPa) ٧

#### Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

#### Defect Type

С **Crushed Seam** DB **Drilling Break** DL **Drilling Lift** 

EW **Extremely Weathered Seam** 

**Handling Break** ΗВ IS **Infilled Seam** 

J Joint

Mechanical Break MB

Р **Parting** 

S **Sheared Surface** SS **Sheared Seam** SZ Sheared Zone

#### **Orientation**

The inclination of defects is always measured from the perpendicular to the core axis.

horizontal vertical

sub-horizontal sh sub-vertical sv

#### **Coating or Infilling Term**

cn clean ct coating stained sn veneer

#### **Coating Descriptor**

ca calcite cbs carbonaceous

cly clay

iron oxide fe manganese mn silty slt

#### Shape

cu curved ir irregular planar pr st stepped undulating un

#### Roughness

polished ро rf rough sl slickensided smooth sm very rough vr

#### Other

fg fragmented bnd band qtz quartz

# **SYMBOLS**



## **Graphic Symbols for Soil and Rock**

G	eı	٦e	r	а

p. ~i. Y. Y. o. ~

Asphalt



Road base



Concrete



Filling

#### Soils



Topsoil



Peat



Clay



Silty clay



Sandy clay



Gravelly clay



Shaly clay



Silt



Clayey silt



Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

## **Sedimentary Rocks**

Boulder conglomerate



Conglomerate



Conglomeratic sandstone



Sandstone



Laminite

Siltstone



Mudstone, claystone, shale



Coal



Limestone

#### **Metamorphic Rocks**



Slate, phyllite, schist



Gneiss



Quartzite

## Igneous Rocks



Granite



Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry

# GREEN GEOLECHNICS

# **UNIFIED SOIL CLASSIFICATION TABLE**

Field Identification Procedures (Excluding particles larger than 75um and basing fractions on estimated weights)					Group Symbols	Typical Names	Information Required for Describing Soils		Laboratory Classification Criteria			
ą		Gravels than half of the coarse s larger than a 4mm sieve	Clean gravels (little or no fines)		Wide range in grain size and substantial amounts of all intermediate particle sizes		GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name: indicative approximate percentages of sand		e size)	$C_u = \underline{D_{50}}$ Greater than 4 $D_{10}$ $C_c = \underline{(D_{30})^2}$ Between 1 and 3 $D_{10} \times D_{60}$
sieve size			Clean (little fin		one size or range of ermediate sizes miss		GP	Poorly graded gravels, grave-sand mixtures, little or no fines	and gravel; maximum size; angularity; surface condition, and hardness of the coarse grains; local of geologic name and other		curve Sum sieve /mbol	Not meeting all graduation requirements for <i>GW</i>
hat 75um			s with es ciable int of	Nonplastic fines	(for identification pr below)	ocedures see ML	GM	Silty gravels, poorly graded gravel- sand-silt mixtures	pertinent descriptive information; and symbols in parentheses		from grain size curve smaller than 75um sieve size) s g use of dual symbol	Atterberg limits below "A" line or PI less than 4  Above "A" line with PI between 4 and 7
ained soils I is large tl		More th fraction is	Gravels with fines (appreciable amount of fines)	Plastic fines (for ic	dentification procedu	ures see CL below)	GC	Clayey gravels, poorly graded gravel- sand-clay mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation,		and sand from s (fraction smal as follows P C	Atterberg limits above "A" line with PI greater than 7  Are borderline cases of requiring use of dual symbols
Coarse-grained soils More than half of the material is large that 75um sieve size <sup>b</sup>	aked eye	coarse a 4mm	Clean sands (little or no fines)		ain size and substant ermediate particle si		SW	Well graded sands, gravelly sands, little or no fines	1		gravel a gravel a of fines of Ssified a SW, SP SM, SC	$C_u = \underline{D_{60}}$ Greater than 6 $D_{10}$ $C_c = \underline{(D_{30})^2}$ Between 1 and 3 $\underline{D_{10} \times D_{60}}$
an half of	to the na	Sands n half of the coarse smaller than a 4mm sieve	Clear (littl: fi		one size or range of ermediate sizes miss		SP	Poorly graded sands, gravelly sands, little or no fines	Silty Sand, gravelly; about 20% hard, angular gravel particles 12mm maximum size; rounded and	ler field id	eld in tage of the class of the	Not meeting all graduation requirements for SW
More th	icle visible	tha	Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see <i>ML</i> below)		SM	Silty sands, poorly graded sand-silt mixtures	subangular sand grains, coarse to fine, about 15% non-plastic fines low dry strength; well compacted	given und	Determine percentage Depending on percer Coarse grained soils a Less than 5% GV More than 12% G S to 12% Boo	Atterberg limits below "A" line or PI less than 5  Above "A" line with PI between 4 and 7	
	is about the particle visible to the naked eye	More	Sands fin (appre amou	Plastic fines (for identification procedures see CL below)		SC	Clayey sands, poorly graded sand- clay mixtures	and moist in place; alluvial sand; (SM)		Determine Depending coarse grai Less than 5 More than	Atterberg limits above "A" line with PI greater than 7	
	abou	Identification Procedures of Fractions Smaller than 380 um Sieve Size								ne fra		
n sieve size	size		ess than	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				curve in identifying the fractions as		PLASTICITY CHART
Find-grained soils material is smaller than 75um	The 75um sieve		and clays liquid limit less 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slit plasticity	Give typical name: indicative degree and character of plasticity, amount and maximum size of coarse	curve in i	(%) (Id)	
ined soils is smaller	Т		nd clays lic	Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and	grain size	40 40 (A)	CH A LINE: PI = 0,73(LL-20)
			Silts ar	Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity	symbol in parentheses		20 La 10	CL MH&OH
than half of the			Slig me 20	Slight to medium	Slow to none	Slight to medium	МН	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and		ML&OL 20 30 40 50 60 70 80 90 100	
ore than k	re than he		s and clays liquid t greater than 50	High to very high	None	High	СН	Inorganic clays of high plasticity, fat clays	drainage conditions			LIQUID LIMIT (LL) (%)
δ	More Silts and		Silts a limit g		None to very slow	Slight to medium	ОН	Organic clays of medium to high plasticity	Example: Clayey Silt, brown; slightly plastic; small percentage of fine sand;			
	Highly Organic Soils  Readily identified by colour, odour, spongy feel and frequently by fibrous texture			Pt	Peat and other highly organic soils	numerous vertical root holes; firm and dry in place; loess; (ML)		For labo	Plasticity Chart ratory classification of fine-grained soils			

1 Soils possessing characteristics of two groups are designated by combinations of group symbols (eg. GW-GC, well graded gravel-sand mixture with clay fines

2 Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity