REPORT ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED COMMERCIAL DEVELOPMENT AT NO.1-7 ALDER CIRCUIT, YARRABILBA DESCRIBED AS LOT 10 ON SP 296372

PREPARED FOR

RADIANCE SPACES PTY LTD

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

Approval no: DEV2023/1442

Date: 19 December 2024

Queensland Government

PROJECT REF: GI 6735-A

18 SEPTEMBER 2023

DRILLING ENVIRONMENTAL GEOTECHNICAL

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Document Details

Project Number	GI 6735-b
Report Title	Report on Geotechnical Investigation Proposed Commercial Development
Site Address	No.1-7 Alder Circuit, Yarrabilba Lot 10 on SP 296372
Prepared for	Radiance Spaces Pty Ltd

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This document was prepared in accordance with the scope of services described in Geotech Investigations Pty Ltd proposal and trading conditions as agreed with the client. This report is issued for the specific client, project and purpose(s) as described in the report, and should not be used or relied upon for other projects or purposes on the site or other sites.

The undersigned, for and on behalf of Geotechnical Investigations Pty Ltd, confirm that this document and all attached drawings, logs, and test results prepared by Geotech Investigations Pty Ltd have been checked and reviewed for errors, omissions and inaccuracies.

Yours faithfully
For and on behalf of
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1. INTRODUCTION

At the request of Radiance Spaces Pty Ltd (client), Geotech Investigations Pty Ltd (GI) has undertaken a geotechnical investigation for the proposed commercial development at No.1-7 Alder Circuit, Yarrabilba, described as Lot 10 on SP 296372.

At the time of preparing this report, limited plans of the development had been provided to GI within the 'Engineering Service Report' by Ven der Meer, referenced: Job No.: BR222157 dated 25/07/2023. The plans have been prepared by Reddog Architects, referenced: Project No.: 2789-427 issue 4 and indicate the development is to include:-

- Construction of a four (4)-storey mixed use structure including commercial and residential occupancy;
- Basement level and at grade car parking;
- It is anticipated that construction will comprise of reinforced concrete frame construction, suspended concrete flooring and a concrete slab-on-ground including a lift well;
- Internal concrete footpaths, gardens and associated services.

Figure 1: Proposed Development 3D Views by Reddog Architects

2. SCOPE OF WORKS

The scope of the geotechnical services provided by GI was directed towards evaluating the following items. The geotechnical report was to detail information regarding the project, site, and investigation, and provide comments on:-

- Subsurface conditions, including groundwater;
- Earthworks and site preparation;
- Geotechnical retaining wall design parameters for the sub-basement level;
- Short and long term batter angles;

- Site Classification in accordance with AS 2870 – 2011[1];
- Shallow footing recommendations and shallow bored pier recommendations (if available);
- Potential geotechnical constraints to the development;
- Indicative footing types, allowable bearing pressure for high level footings, estimated settlements; and
- Indicative pavement parameters (design by others).

3. SITE DESCRIPTION

The site is near rectangular shaped covering an approximate plan area of 3950 m^2 and bounded by Yarrabila Drive to the north, Wongawallen Drive to the east and Alder Circuit to the south.

The subject site gently slopes down from RL 55.8m AHD in the south west corner towards the north east, which lies at RL 52.5 AHD, typically. Three prominent swale type drains also grade in this direction across the site. A small gently sloping filled batter located on the eastern side of the site grades down to the eastern boundary.

The site was vacant and sparsely grassed with scattered trees along the boundaries (excluding the western boundary).

Figures 2 to 3 below show some of the site features described.

Figure 2: Looking east across subject site

[1] Australian Standard AS2870-2011 *'Residential footings and slabs - Construction'*, Standards Australia

Figure 3: Looking north across subject site

4. FIELD WORK METHODOLOGY

Fieldwork was initially undertaken on the 7th of November 2022 and comprised the drilling and sampling of five (5) boreholes, designated BH 1 to BH 5 using a vehicle mounted drill rig. Additional fieldwork was completed on the 14th and 28th of August 2023 comprising drilling and sampling of (7) boreholes, designated BH 6 to BH 12. The boreholes were undertaken at accessible locations spread over the site employing spiral flight auguring techniques to the termination depths between 1.0 m and 8.1 m.

Dynamic cone penetrometer test/s (DCPs) were carried out adjacent to selected borehole/s to provide an estimate of the strength consistency or relative density of the subsurface soils. The approximate locations of the boreholes shown on Site Plan S01 attached in Appendix A.

This investigation has been carried out generally in accordance with AS 1726 – 2017[2] in terms of soil description. The fieldwork was carried out by an experienced geo-technician with a logging undertaken by a senior geotechnical engineer. At the completion of drilling, the boreholes were backfilled loosely with drill spoil.

5. GEOTECHNICAL CONDITIONS

5.1 Regional Geology

Reference to detailed mapping by the Geological Survey of Queensland and New South Wales 1:500,000 series 'Moreton Geology' show that the 'Ipswich Coal Measures' are the predominant Triassic aged strata over the subject site, with sedimentary residual material consisting '*Shale, conglomerate, sandstone, coal, siltstone, basalt and tuff*'.

[2] Australian Standard AS 1726-2017 *'Geotechnical site investigations'*, Standards Australia

5.2 Field Work Results

The results of the fieldwork are detailed on the Engineering Log attached in Appendix B, along with explanatory notes. Table 1 below provide a summary of the subsurface conditions encountered.

Table 1: Summary of Subsurface Conditions *(depth metres below existing surface level)*

BH I.D.	Fill	Residual (Soils)		Residual (Rock)	
		CLAY	SAND	EW (Soil Properties)	HW (Very Low Strength)
BH 1	0 to 3.8	NE	3.8 to 5.0	5.0 to 5.5	NE
BH 2	0 to 2.0	NE	NE	NE	2.0 to 2.4(1)
BH 3	0 to 1.0	NE	NE	NE	1.0 to 1.2(1)
BH 4	0 to 2.3	2.3 to 3.2	NE	NE	3.2 to 4.0(1)
BH 5	0 to 1.0	NE	NE	NE	NE
BH 6	0 to 3.7	3.7 to 5.0 5.8 to 7.7	NE	5.0 to 5.8	7.7 to 8.1
BH 7	0 to 2.4	2.4 to 3.4	NE	NE	3.4 to 3.8(1)
BH 8	0 to 3.5	3.5 to 6.0	NE	6.0 to 7.2	7.2 to 7.5
BH 9	0 to 1.5	NE	1.5 to 2.0	NE	NE
BH 10	0 to 0.5	NE	0.5 to 1.5	NE	NE
BH 11	0 to 0.5	NE	0.5 to 1.8	NE	NE
BH 12	0 to 0.2	NE	0.2 to 1.5	NE	NE

Note: NE – Not Encountered
(HW) Highly Weathered Rock
(EW) Extremely Weathered Rock - soil like properties
(1) – Tungsten carbide auger bit refusal

Borehole BH 5 was undertaken in the location of the proposed pavement to acquire a bulk sample for laboratory testing.

This fill material has been placed recently during the construction of the estate with 'Level 1 Observation and Testing' undertaken by SGS Pty Ltd, referenced Project No: SGSL/17/091 dated 30th October 2017, and the fill material can be considered '**controlled'** in accordance with AS 2870 – 2011.

5.3 Historical Satellite Imagery

Following a review of previous satellite imagery, the following observations were made:-

- The image captured in 2015 shows a sediment pond present within the eastern lower portion of the allotment, refer to Figure 4.
- The image captured in 2017 shows a sediment pond / diversion drain present within the central portion of the allotment, with subsequent rock drainage downslope, refer to Figure 5.
- The bulk earthworks (current levels) were completed around October 2018.

Figures 4 and 5: Courtesy of Google Earth and (Left Image taken 2015 and Right Image taken 2017) of Subject Site (red polygon indicating previous sediment pond/ drainage system)

5.4 Groundwater

Groundwater or groundwater seepage was not observed during the investigation, while the boreholes remained open. It should be noted that groundwater is affected by climatic conditions, varying soil permeability, and possibly tidal influences, and will therefore vary over time.

5.5 Laboratory Results

A disturbed sample of the underlying residual clay was collected from BH 5 during the fieldwork and was subjected to California Bearing Ratio (CBR) testing by Spec Geotechnical Testing Pty Ltd.

Table 2: Summary of Laboratory Testing— California Bearing Ratio

Test I.D.	Layer	Depth (m)	MDD	OMC	CBR
BH 5	"Controlled" FILL	0.2 to 0.6	1.89	12.0	19

Notes: MDD – Maximum Dry Density (t/m^3) OMC – Optimum Moisture Content (%)
CBR – California Bearing Ratio (%)

6. RESULTS AND RECOMMENDATIONS

6.1 Appreciation of Ground Conditions

The results of the field investigation of the site indicate the subsurface profile comprised varying depths of fill material, residual soils and underlain by extremely weathered sandstone (with soil like properties) and very low to low strength highly weathered sandstone.

The ground conditions encountered at the test location indicate geotechnical design for the proposed development will need to consider the following:-

- **Due to the previous sediment basins and various earthworks as highlighted in Section 5.3, the depth of filled material is expected to vary within relatively short distances.**
- Comments on excavation support measures, including consideration to supporting the adjacent structures (if present at the time of construction);
- Consideration to limit ground vibrations during excavations and construction operations to reduce potential settlement and lateral ground movements on the adjacent neighbouring structures and services;
- Suitability for shallow footing; and
- Suitable pile type and construction.

6.2 Sub-Basement Construction

6.2.1 General

The basement floor level is proposed at RL 51.8m AHD indicating excavations of between 1 m and 2.5 m depth. Excavations will extend to within 2 to 3 m of the northern, eastern and southern boundaries and well set back from the western boundary. The remaining area primarily encompassed the western portion of the allotment will comprise pavement (car parking, access and turnaround area).

6.2.2 Temporary Excavations

Stable batter angles in soils and rock is strongly dependent upon fill type and compaction, soil type and strength, strength of underlying soils, slope angle / height and surcharge loadings. For the purpose of preliminary design, the batter slopes presented in Table 3 are considered to be suitable for the different soil and rock conditions encountered on the site for temporary conditions only.

Where soil / rock conditions vary from those presented in Table 3, GI may provide guidance and alternative slope angles on site during construction. At these batter slopes, some movement at and behind the slope crest, as well as some localised slumping of batter faces may occur.

The batter slopes assume that no surcharge loadings will be applied to the crest of the slope, and that no seepage out of the batter is present. If seepage is encountered or present at any stage, site specific geotechnical advice on batter stability should be obtained, and likely positive support options considered.

Table 3: Slopes Angles for Batter Heights < 2 m (Unsurcharged, Horizontal Ground Behind Crest) [(1)]

Material Description	Short Term (Maximum)
"Controlled" Clayey Sand FILL	1V:1.5H (33°)
"Controlled" Clay FILL	1V:1H (45°)
(EW) ROCK / Residual Soils	1V:1H (45°)
Very Low Strength (or better) ROCK[(2)]	1V:0.5H (63°)

Notes:

[(1)] A geotechnical engineer from GI is required to be on site during excavations of embankments to confirm safe batter slopes. These slopes assume the batters are not underlain by lower bearing strata.

[(2)] The stability of excavations in rock is often governed by the presence of geological structures such as bedding planes, joints and faults. A suitably experienced Engineering Geologist/Geotechnical Engineer must inspect the excavations at the time of construction to assess whether the slope angles recommended in the table are appropriate.

6.2.3 Geotechnical Design Parameters

For design of walls that are rigid and unable to rotate or tilt (i.e. basement wall that is tied to an upper level concrete floor), the 'at-rest' earth pressure coefficient (K_O) should be adopted for design. The rigid type wall will be required for the basement construction.

The values provided in Table 4 are ultimate values, and appropriate safety factors or strength reduction factors should be included.

Table 4: Geotechnical Design Parameters (Unfactored)

Soil Stratum	Unit weight[(1)] (kN/m^3)	Effective Friction Angle (ϕ')	Effective Cohesion (kPa) (c')	Rigid Wall (k_o)	Poisson's Ratio (long term)	Elastic Modulus E (MPa)
"Controlled" FILL	17	26	2	0.56	0.3	20
Very Stiff Residual CLAY / SILT	18	26	2	0.56	0.3	20
Dense (EW) Weathered ROCK	19	35	-	0.43	0.3	50
Very Low strength (HW) Weathered ROCK	21	38	5	0.38	0.3	100

The design of all retaining walls (sub-basement retention) will need to take into account any surcharge loading behind the walls / existing neighbouring structures at the time of construction and is to be confirmed by a structural engineer and / or a specialist geotechnical contractor.

6.3 Footing Options

6.3.1 High Level Footings

The proposed structure will require all constructions loads to be found within underlying uniform very low strength (or better) highly weathered rock. Based on the variation of depths of the semi-basement / ground floor level and depth to the very low strength weathered rock, the foundation could use a combination of a shallow pad and strip footings and piled footings, depending on final loads.

Strip and Pad footings found into the very low strength weathered rock may be designed for an allowable bearing pressure of 400 kPa. Due to the high likelihood of variability of exposed soils at the underside of the basement level, additional testing / inspections during construction by GI representatives to confirm these design parameters are recommended.

6.3.2 Minor Slab Loads

Minor slab loads in between the main wall loads and column loads could be found into the existing controlled fill where it is expected an allowable bearing pressure of 100 kPa could be achieved. Where this is designed for, additional testing / inspections during construction by GI representatives to confirm these design parameters are recommended.

6.3.3 Piled Footings

Typical pile types conducive for the structure, site and geology include, bored or continuous flight auger (CFA) piles cast insitu piles (non-displacement piles).

The upper 1.8 m of pile shaft should be ignored to allow for pile load development loads and soil shrinkage.

Given the limited amount of investigation undertaken, it is recommended that a geotechnical strength reduction factor (ϕg) of 0.50 be adopted for the design. The assessment of the recommended geotechnical strength reduction factor is based on AS 2159 and assumes the following:-

- The design of piles will be based on the recommendations given within this geotechnical report and completed by a competent bridge design engineer having moderate experience in similar conditions.
- No additional investigations will be carried out.
- No pile load testing will be completed during construction.

- No supervision of the pile installation by a qualified Geotechnical Engineer will be completed, however it is recommended such supervision is allowed for to determine the design founding materials.

The reduction factor may be adjusted following additional investigations and communication with the pile design engineers and pile contractors, based on Average Risk Rating.

6.3.3.1 Screw Piles

For screw piles, skin friction values in Table 5 should be ignored due to the disturbance of soil during pile installation. The actual capacity of a steel screw pile depends on the soil conditions but also on structural considerations of the piles such as the strength of the helix and the helix/shaft joint. It is considered that structural section capacity as well as geotechnical capacity will need to be considered where the required load carrying capacity of individual steel screw piles is greater than (say) 600kN.

Measurement of installation torque should not be relied upon to indicate pile capacity, as it has been documented that significantly misleading results can be obtained. For this reason, piling contractors would be responsible for assessment of actual pile capacities for their piles. Structural capacity of the steel screw pile should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

6.3.3.2 Driven Piles

Driven piles may only be adopted where vibrations are within acceptable levels, accepted by Council and approved by the piling contractor and design engineer. Where piles are driven to refusal within the weathered rock, it would be expected that the working load would be governed by the structural capacity of the pile.

Where piles are founded in the weathered rock, but are not driven to practical refusal, it is recommended that pile working loads are assessed on the basis of the following methods:-

- Recognised pile driving formulae, such as the Hiley formula, to predict working loads. A factor of safety appropriate to the particular pile driving formula should be used.
- Static pile load testing to assess the load-settlement behaviour of the pile.
- A pile driving analyser (e.g. CAPWAP). This may provide a more reliable prediction of working load than pile driving formulae.

6.3.3.3 Bored (Non-Displacement) Piles

The recommended geotechnical design parameters assume that adequate base cleanliness is achieved. In this regard, the base should be free from loose soil, rock and other debris over at least 80% of its area. In addition, careful attention should be given to avoid smearing of clay along the pile shaft. The presence of smearing will significantly reduce shaft adhesion in the weathered rock.

The recommended shaft adhesion values assume a clean socket with roughness category R2 or better. Roughness category R2 requires grooves of depth 1mm to 4mm and width greater than 2mm at a spacing of 50mm to 200mm.

It is recommended that suitably qualified personnel inspect footing excavations to confirm that the conditions encountered are consistent with design assumptions. For bored pile construction it is essential that the person is present during the drilling of the piers to log the soil profile and to confirm that the conditions encountered are consistent with design assumptions.

6.3.4 Pile Design Parameters

The ultimate geotechnical design parameters presented in Table 5 may be used for the design with the appropriate geotechnical strength reduction factor applied.

Table 5: Ultimate Unfactored Parameters for Pile Design(1)

Material Description	Young's Modulus (MPa)	Non-Displacement Piles		Displacement Piles	
		$F_{m.s}$ (kPa)	F_b (1) (MPa)	$F_{m.s}$ (kPa)	F_b (1) (MPa)
Residual Clayey SAND (Medium Dense or Denser)	5-10	15	NR	30(2)	NR
Sandy CLAY / Extremely Weathered Rock (Very Stiff / Hard)	20-30	60	NR	60(2)	NR
META-SANDSTONE(3) (Very Low Strength)	100	120	2.0 (Serviceability 1.0 MPa)	120(2)	4.0(2)

Notes: $F_{m.s}$ – Ultimate shaft adhesion

F_b – Ultimate End Bearing Capacity (Ultimate)

NR – Not recommended, however further consideration can be given and GI must be contacted for advice.

(1) Ultimate bearing pressures are developed with large settlements, typically >5% of the pile diameter. To limit settlements to less than 1% of pile diameter, the recommended serviceability can be considered by the pile designers.

(2) It is assumed that displacement piles will be driven to a set or effective refusal as discussed in Section 6.4.3.2.

6.4 Earthquake Site Sub-Soil Classification

In accordance with AS 1170.4-2007[3] the site sub soil classification is Class C_e – Shallow Soil site using the layered soil profile as per AS 1170-4 Section 4.2.

[3] Australian Standard AS 1170.4-2007 '*Structural design actions: Part 4 Earthquakes in Australia*', Standards Australia

6.5 Effects of Construction on Adjacent Structures

Ground vibrations due to excavations and construction operations may result in settlement and lateral ground movements on adjacent properties, and beyond these properties. In addition, dewatering can influence the water table of surrounding sites and has the potential to induce settlements, and it is recommended a drawdown analysis be carried out to assess if such effects may occur.

At the time of investigation, the immediate neighbouring properties were occupied by commercial and residential units and dwellings. A dilapidation survey of surrounding structures and in-ground services should be carried out, and any retention systems be designed for the support requirements of these surrounding structures.

6.6 Indicative Pavement Parameters

Subgrade properties below the concrete pavement and imported pavement gravels are likely to comprise "controlled" fill materials (clayey sand mixtures and sandy clay). The results of limited CBR testing from the collected sample from BH 4 returned a CBR value of 19 %. For preliminary pavement design purposes, given the presence of sandy clay materials within the filled stratum, a typical 4-day soaked CBR of 4 % is recommended for these materials at 100 % standard compaction. Confirmatory pavement design parameters must be confirmed during construction, as it will depend on the nature of the subgrade materials.

It is expected that the clay subgrades will exhibit poor subsurface drainage, and it is recommended that subsoil drains be installed early in the works, particularly where pavements adjoin landscaped areas or other water sources.

7. LIMITS OF INVESTIGATION

This report has been prepared for the use of the client based on the information supplied regarding the proposed building construction and has not been prepared for use by parties other than the client and the client's consulting team.

Sub-surface conditions relevant to construction works should be assessed by contractors who can make interpretation of the factual data provided as borehole log and test results, and perform any additional tests as necessary for their own purposes. There are always some variations in sub-surface conditions across a site that cannot be defined even by exhaustive investigation. Hence, it is unlikely that the measurements and values obtained from sampling and testing during the investigation will represent the extremes of conditions which exist within the site.

Should conditions exposed at the site during excavation vary significantly from the interpretation provided in this report, based on the project specific factors cited in the introductory scope of the report, GI must be informed and have the opportunity to review any of the findings of this report.

Further, sub-surface conditions, including groundwater seepage, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay. This report has been completed for preliminary design purposes only and additional investigations will be required prior to detailed design.

Notes on understanding this report are attached as Appendix B.

APPENDIX A

SITE PLAN S01 & S02

GEOTECH INVESTIGATIONS PTY LTD
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Tweed Heads South NSW 2486
admin@geotechinvestigations.com

Map description	Borehole Location Plan		
Site location	1-7 Adler Circuit, Yarrabilba QLD		
Client	Radiance Spaces Pty Ltd		
Project name	Proposed Commercial Development		
Project No	GI 6735	**Scale**	Not to scale

GEOTECH INVESTIGATIONS PTY LTD
(07) 5523 3979
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Map description	Borehole Location Plan S02		
Site location	Lot 10, No.1-7 Alder Circuit, Yarrabilba		
Client	Radiance Spaces Pty Ltd		
Project name	Proposed Commercial Development		
Project No	GI 6735-b	**Scale**	Not to scale

APPENDIX B

ENGINEERING LOGS – BOREHOLE PROFILES BH 1 TO BH 12
GEOTECHNICAL REPORT STANDARD NOTES

Geotech Investigations Pty Ltd
3/42 Machinery Dr, Tweed Heads South NSW 2486
Phone: (07) 5523 3979

Engineering Log - Borehole

Borehole No: BH 1

UTM	: 56J	**Driller Rig**	: GT 10	**Job Number**	: GI 6735
Easting	: 509931.1	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing	: 6924796.8	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
RL	: N/A	**Reviewed By**	: AOC	**Location**	: 1-7 Adler Circuit, Yarrabilba QLD
Total Depth	: 5.5m	**Date**	: 07/11/2022		

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		0.5	Fill		SM	Silty SAND (SM) : medium dense, dark grey, fine to coarse grained,	M	MD		
		0.6	Fill		CH	Sandy CLAY (CH) : stiff, high plasticity, grey and orange mottled dark grey, fine to coarse grained sand, (w>wp) .	M	St		
		1	Fill		SM	Silty SAND (SM) : medium dense, dark grey, fine to coarse grained, trace medium plasticity clay,	M	MD		
		1.5								
		1.7	Fill		CH	Sandy CLAY (CH) : stiff, high plasticity, grey and orange mottled dark grey, fine to coarse grained sand, (w>wp) .	M	St		
		2								
		2.5								
		3								
		3.5								
		3.8	Residual		SC	Clayey SAND (SC) : dense, medium plasticity, pale grey mottled orange, fine to coarse grained, (w>wp) .	M	D		
		4								
		4.5								
		5	Rock		SST	Extremely weathered,silty SAND (SST) : dense, pale grey and orange, coarse grained,	M	D-VLS		
		5.5				**BH 1 Terminated at 5.5m (Limit of Auger Depth)**				
		6								

Water
- Water inflow
- Water outflow
- Ground water Level during drilling

Weathering
- **XW** : Extremely weathered
- **DW** : Distinctly weathered
- **HW** : Highly weathered
- **MW** : Moderately weathered
- **SW** : Slightly weathered
- **FR** : Fresh

Altering
- **XA** : Extremely alterated
- **DA** : Distinctly alterated
- **HA** : Highly alterated
- **MA** : Moderately alterated
- **SA** : Slightly alterated

Consistency
- **VS** : Very soft
- **S** : Soft
- **F** : Firm
- **St** : Stiff
- **VSt** : Very stiff
- **H** : Hard
- **FR** : Friable

Moisture
- **D** : Dry
- **M** : Moist
- **W** : Wet

Density
- **VL** : Very loose
- **L** : Loose
- **MD** : Medium dense
- **D** : Dense
- **VD** : Very dense

Rock Strength
- **VLS** : Very low
- **LS** : Low
- **MS** : Medium
- **HS** : High
- **VH** : Very high
- **XH** : Extremely high

Tests&Results
- **U50** : Undisturbed 50mm diam tube.
- **D** : Disturbed sample.
- **SPT** : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- **PP** : Hand penetrometer estimate of unconfined compressive strength, kPa.
- **S** : Vane shear value kPa.
- **DCP** : Dynamic Cone Penetrometer test.

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Engineering Log - Borehole

Borehole No: BH 2

UTM	: 56J	**Driller Rig**	: GT 10	**Job Number**	: GI 6735
Easting	: 509976.2846071922	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing	: 6924767.601875037	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
RL	: N/A	**Reviewed By**	: AOC	**Location**	: 1-7 Adler Circuit, Yarrabilba QLD
Total Depth	: 2.4m	**Date**	: 07/11/2022		

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		0.5	Fill		SM	Silty SAND (SM) : medium dense to dense, dark grey, fine to coarse grained, trace medium plasticity clay,	M	MD-D	4 5 6 4 5 6 5 5 6	
		0.9 1 1.5	Fill		CH	Sandy CLAY (CH) : stiff to very stiff, high plasticity, grey mottled pale grey and orange, fine to coarse grained sand, (w>wp) .	W-M	St-VSt	6 5 4 4 5 6 6 7 6 20	
		2 2	Rock		SST	SANDSTONE: highly weathered, very low strength, pale grey mottled orange, coarse grained, indistinct, moist/dry,	M-D	VLS		
		2.5				**BH 2 refusal at 2.4m (Tungsten carbide Bit Refusal)**				

Water
- Water inflow
- Water outflow
- Ground water Level during drilling

Weathering
- XW : Extremely weathered
- DW : Distinctly weathered
- HW : Highly weathered
- MW : Moderately weathered
- SW : Slightly weathered
- FR : Fresh

Altering
- XA : Extremely alterated
- DA : Distinctly alterated
- HA : Highly alterated
- MA : Moderately alterated
- SA : Slightly alterated

Consistency
- VS : Very soft
- S : Soft
- F : Firm
- St : Stiff
- VSt : Very stiff
- H : Hard
- FR : Friable

Moisture
- D : Dry
- M : Moist
- W : Wet

Density
- VL : Very loose
- L : Loose
- MD : Medium dense
- D : Dense
- VD : Very dense

Rock Strength
- VLS : Very low
- LS : Low
- MS : Medium
- HS : High
- VH : Very high
- XH : Extremely high

Tests&Results
- U50 : Undisturbed 50mm diam tube.
- D : Disturbed sample.
- SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP : Hand penetrometer estimate of unconfined compressive strength, kPa.
- S : Vane shear value kPa.
- DCP : Dynamic Cone Penetrometer test.

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Engineering Log - Borehole

Borehole No: BH 3

UTM	: 56J	**Driller Rig**	: GT 10	**Job Number**	: GI 6735
Easting	: 509963.16554925166	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing	: 6924745.600735741	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
RL	: N/A	**Reviewed By**	: AOC	**Location**	: 1-7 Adler Circuit, Yarrabilba QLD
Total Depth	: 1.2m	**Date**	: 07/11/2022		

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		0.5	Fill		SC	Clayey SAND (SC) : dense, medium plasticity, pale grey and orange mottled grey, fine to coarse grained, trace fine to coarse sized gravel, (w<wp) .	M	D		
		1 1	Rock		SST	SANDSTONE: highly weathered, very low to low strength, pale grey, coarse grained, indistinct, moist/dry,		VLS-LS		
		1.5				**BH 3 refusal at 1.2m (Tungsten carbide Bit Refusal)**				
		2								
		2.5								

Water
- Water inflow
- Water outflow
- Ground water Level during drilling

Weathering
- XW : Extremely weathered
- DW : Distinctly weathered
- HW : Highly weathered
- MW : Moderately weathered
- SW : Slightly weathered
- FR : Fresh

Altering
- XA : Extremely alterated
- DA : Distinctly alterated
- HA : Highly alterated
- MA : Moderately alterated
- SA : Slightly alterated

Consistency
- VS : Very soft
- S : Soft
- F : Firm
- St : Stiff
- VSt : Very stiff
- H : Hard
- FR : Friable

Moisture
- D : Dry
- M : Moist
- W : Wet

Density
- VL : Very loose
- L : Loose
- MD : Medium dense
- D : Dense
- VD : Very dense

Rock Strength
- VLS : Very low
- LS : Low
- MS : Medium
- HS : High
- VH : Very high
- XH : Extremely high

Tests&Results
- U50 : Undisturbed 50mm diam tube.
- D : Disturbed sample.
- SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP : Hand penetrometer estimate of unconfined compressive strength, kPa.
- S : Vane shear value kPa.
- DCP : Dynamic Cone Penetrometer test.

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Engineering Log - Borehole

Borehole No: BH 4

UTM	: 56J	**Driller Rig**	: GT 10	**Job Number**	: GI 6735
Easting	: 509949.9600724169	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing	: 6924769.143025925	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
RL	: N/A	**Reviewed By**	: AOC	**Location**	: 1-7 Adler Circuit, Yarrabilba QLD
Total Depth	: 4m	**Date**	: 07/11/2022		

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		0.5	Fill		SC	Clayey SAND (SC) : dense, medium plasticity, pale grey and orange mottled dark grey, fine to coarse grained, trace fine to medium sized gravel, (w<wp) .	M	D	4 5 6 5 7 6 6 8 7 8 9 7 8 10 14	
		1.5	Fill		SM	Silty SAND (SM) : dense to very dense, grey, fine to coarse grained,	M	D-VD		
		1.8	Fill		CH	Sandy CLAY (CH) : stiff, high plasticity, grey and orange mottled pale grey, fine to coarse grained sand, (w>wp) .	M	St		
		2 2.3	Residual		CH	Sandy CLAY (CH) : very stiff, high plasticity, pale grey and orange mottled dark orange, fine to medium grained sand, (w>wp) .	M	VSt		
		2.5 3 3.2	Rock		SST	SANDSTONE: highly weathered, very low strength, pale orange, medium grained, indistinct, moist,	M	VLS		
		3.5								

Water

- Water inflow
- Water outflow
- Ground water Level during drilling

Weathering

- XW : Extremely weathered
- DW : Distinctly weathered
- HW : Highly weathered
- MW : Moderately weathered
- SW : Slightly weathered
- FR : Fresh

Altering

- XA : Extremely alterated
- DA : Distinctly alterated
- HA : Highly alterated
- MA : Moderately alterated
- SA : Slightly alterated

Consistency

- VS : Very soft
- S : Soft
- F : Firm
- St : Stiff
- VSt : Very stiff
- H : Hard
- FR : Friable

Moisture

- D : Dry
- M : Moist
- W : Wet

Density

- VL : Very loose
- L : Loose
- MD : Medium dense
- D : Dense
- VD : Very dense

Rock Strength

- VLS : Very low
- LS : Low
- MS : Medium
- HS : High
- VH : Very high
- XH : Extremely high

Tests&Results

- U50 : Undisturbed 50mm diam tube.
- D : Disturbed sample.
- SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP : Hand penetrometer estimate of unconfined compressive strength, kPa.
- S : Vane shear value kPa.
- DCP : Dynamic Cone Penetrometer test.

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Engineering Log - Borehole

Borehole No: BH 5

UTM	:	**Driller Rig**	: GT 10	**Job Number**	: GI 6735
Easting	: 0	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing	: 0	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
RL	: N/A	**Reviewed By**	:	**Location**	: 1-7 Adler Circuit, Yarrabilba QLD
Total Depth	: 1m	**Date**	: 07/11/2022		

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		0.5	Fill		SC	Clayey SAND (SC) : dense, medium plasticity, pale grey and orange mottled dark grey, fine to coarse grained, trace fine to medium sized gravel,	M	D		
		1				**BH 5 Terminated at 1m (Limit of Investigation)**				
		1.5								
		2								
		2.5								
		3								

Water
- Water inflow
- Water outflow
- Ground water Level during drilling

Weathering
- **XW** : Extremely weathered
- **DW** : Distinctly weathered
- **HW** : Highly weathered
- **MW** : Moderately weathered
- **SW** : Slightly weathered
- **FR** : Fresh

Altering
- **XA** : Extremely alterated
- **DA** : Distinctly alterated
- **HA** : Highly alterated
- **MA** : Moderately alterated
- **SA** : Slightly alterated

Consistency
- **VS** : Very soft
- **S** : Soft
- **F** : Firm
- **St** : Stiff
- **VSt** : Very stiff
- **H** : Hard
- **FR** : Friable

Moisture
- **D** : Dry
- **M** : Moist
- **W** : Wet

Density
- **VL** : Very loose
- **L** : Loose
- **MD** : Medium dense
- **D** : Dense
- **VD** : Very dense

Rock Strength
- **VLS** : Very low
- **LS** : Low
- **MS** : Medium
- **HS** : High
- **VH** : Very high
- **XH** : Extremely high

Tests&Results
- **U50** : Undisturbed 50mm diam tube.
- **D** : Disturbed sample.
- **SPT** : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- **PP** : Hand penetrometer estimate of unconfined compressive strength, kPa.
- **S** : Vane shear value kPa.
- **DCP** : Dynamic Cone Penetrometer test.

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Geotechnical Log - Borehole

BH 6

UTM	: 56J	**Drill Rig**	: GT 10	**Job Number**	: GI 6735-b
Easting (m)	: 509926.4452473023	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing (m)	: 6924808.690862345	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	**Reviewed By**	:	**Location**	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 8.1 m BGL	**Date**	: 14/08/2023	**Loc Comment**	:

Drilling Method	DCP graph	Depth (m)	Water	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing	Elevation (m)
Auger		0.2		Fill		SM	Fill- Silty SAND (SM) : grey, dense, fine to coarse grained, trace fine sized gravel.	D	D		
		0.6		Fill		SM	Fill- Silty SAND (SM) : dark grey, very dense, fine to coarse grained.	M	VD		
		1		Fill		CH	Fill- Sandy CLAY (CH) : high plasticity, dark grey and orange, stiff, fine to coarse grained sand, trace fine to medium sized gravel, inorganic, (w>wp).		St		
		1.5		Fill		SM	Fill- Silty SAND (SM) : dark grey, dense, fine to coarse grained, trace medium plasticity clay.		D		
		2		Fill		SC	Fill- Clayey SAND (SC) : medium plasticity clay, dark grey, dense, fine to coarse grained, (w<wp).				
		3									
		3.7		Residual		CH	Residual- Sandy CLAY (CH) : stiff to very stiff, high plasticity, grey mottled orange, fine to coarse grained sand, inorganic, (w>wp).		St-VSt		

Method
- **EX** excavator
- **BH** backhoe bucket
- **NE** natural exposure
- **EE** existing xcavation
- **RP** ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification

GW	well graded gravels	**SW**	well graded sands
GP	poorly graded gravels	**SP**	poorly graded sands
GM	silty gravel	**SM**	silty sands
GC	clayey gravel	**SC**	clayey sands
ML	inorg silts low plastic	**CL**	inorg clay low plastic
MH	inorg clay high plastic	**CI**	inorg clay med plastic
OL	org silts low plastic	**CH**	inorg clay high plastic
OH	org sills high plastic	**Pt**	peat of high org soils

Consistency
- **VS** Very soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VSt** Very stiff
- **H** Hard

Density
- **VL** Very loose
- **L** Loose
- **MD** Medium dense
- **D** Dense
- **VD** Very dense

Moisture
- **D** Dry
- **M** Moist
- **W** Wet
- **PL** plastic limit
- **LL** liquid limit

Soil Samples
- **B** bulk
- **D** disturbed
- **U(63)** U(63) push tube
- **U(50)** U(50) push tube
- **WS** water

In Situ Testing
- **PP** pen penetrometer
- **VS** vane shear
- **DCP** dynamic cone penetrometer

Laboratory Results
- **UC** undrained unconsol cohesion
- **UF** undrained unconsol friction angle
- **MC** moisture content
- **DD** dry density
- **LL** liquid limit
- **PL** plastic limit
- **LS** linear shrinkage
- **CC** undrained console cohesion
- **CF** undrained console friction angle
- **FH** falling head permeability
- **CH** constan head permeablity
- **CBR** californian bearing ratio

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Geotechnical Log - Borehole

BH 6

UTM	: 56J	**Drill Rig**	: GT 10	**Job Number**	: GI 6735-b
Easting (m)	: 509926.4452473023	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing (m)	: 6924808.690862345	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	**Reviewed By**	:	**Location**	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 8.1 m BGL	**Date**	: 14/08/2023	**Loc Comment**	:

Drilling Method	DCP graph	Depth (m)	Water	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing	Elevation (m)
Auger		5 (5)		Residual		CH	Residual- Sandy CLAY (CH) : stiff to very stiff, high plasticity, grey mottled orange, fine to coarse grained sand, inorganic, (w>wp).		St-VSt		
				Rock		MSS	Extremelyweathered, rock- Silty SAND (MSS) : very dense, orange and pale grey, fine grained, trace low plasticity clay.		VD		
		5.8		Residual		CL-CI	Residual- Sandy CLAY (CL-CI) : hard, low to medium plasticity, orange mottled grey, fine grained sand, inorganic, (w>wp).		H		
		6									
		7									
		7.7		Rock		MSS	Rock- META SILTSTONE/SANDSTONE: highly weathered, very low strength, pale grey mottled orange brown, fine grained, moist, (ban).		VLS		

Method
- **EX** excavator
- **BH** backhoe bucket
- **NE** natural exposure
- **EE** existing xcavation
- **RP** ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification

GW	well graded gravels	**SW**	well graded sands
GP	poorly graded gravels	**SP**	poorly graded sands
GM	silty gravel	**SM**	silty sands
GC	clayey gravel	**SC**	clayey sands
ML	inorg silts low plastic	**CL**	inorg clay low plastic
MH	inorg clay high plastic	**CI**	inorg clay med plastic
OL	org silts low plastic	**CH**	inorg clay high plastic
OH	org sills high plastic	**Pt**	peat of high org soils

Consistency
- **VS** Very soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VSt** Very stiff
- **H** Hard

Density
- **VL** Very loose
- **L** Loose
- **MD** Medium dense
- **D** Dense
- **VD** Very dense

Moisture
- **D** Dry
- **M** Moist
- **W** Wet
- **PL** plastic limit
- **LL** liquid limit

Soil Samples
- **B** bulk
- **D** disturbed
- **U(63)** U(63) push tube
- **U(50)** U(50) push tube
- **WS** water

In Situ Testing
- **PP** pen penetrometer
- **VS** vane shear
- **DCP** dynamic cone penetrometer

Laboratory Results
- **UC** undrained unconsol cohesion
- **UF** undrained unconsol friction angle
- **MC** moisture content
- **DD** dry density
- **LL** liquid limit
- **PL** plastic limit
- **LS** linear shrinkage
- **CC** undrained console cohesion
- **CF** undrained console friction angle
- **FH** falling head permeability
- **CH** constan head permeablity
- **CBR** californian bearing ratio

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Geotechnical Log - Borehole

BH 6

UTM	: 56J	**Drill Rig**	: GT 10	**Job Number**	: GI 6735-b
Easting (m)	: 509926.4452473023	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing (m)	: 6924808.690862345	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	**Reviewed By**	:	**Location**	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 8.1 m BGL	**Date**	: 14/08/2023	**Loc Comment**	:

Drilling Method	DCP graph	Depth (m)	Water	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing	Elevation (m)
Auger				Rock		MSS	Rock- META SILTSTONE/SANDSTONE: highly weathered, very low strength, pale grey mottled orange brown, fine grained, moist, (ban).		VLS		
							BH 6 Terminated at 8.1 m				
		9									
		10									
		11									

Method
- **EX** excavator
- **BH** backhoe bucket
- **NE** natural exposure
- **EE** existing xcavation
- **RP** ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification
- **GW** well graded gravels
- **GP** poorly graded gravels
- **GM** silty gravel
- **GC** clayey gravel
- **ML** inorg silts low plastic
- **MH** inorg clay high plastic
- **OL** org silts low plastic
- **OH** org sills high plastic
- **SW** well graded sands
- **SP** poorly graded sands
- **SM** silty sands
- **SC** clayey sands
- **CL** inorg clay low plastic
- **CI** inorg clay med plastic
- **CH** inorg clay high plastic
- **Pt** peat of high org soils

Consistency
- **VS** Very soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VSt** Very stiff
- **H** Hard

Density
- **VL** Very loose
- **L** Loose
- **MD** Medium dense
- **D** Dense
- **VD** Very dense

Moisture
- **D** Dry
- **M** Moist
- **W** Wet
- **PL** plastic limit
- **LL** liquid limit

Soil Samples
- **B** bulk
- **D** disturbed
- **U(63)** U(63) push tube
- **U(50)** U(50) push tube
- **WS** water

In Situ Testing
- **PP** pen penetrometer
- **VS** vane shear
- **DCP** dynamic cone penetrometer

Laboratory Results
- **UC** undrained unconsol cohesion
- **UF** undrained unconsol friction angle
- **MC** moisture content
- **DD** dry density
- **LL** liquid limit
- **PL** plastic limit
- **LS** linear shrinkage
- **CC** undrained console cohesion
- **CF** undrained console friction angle
- **FH** falling head permeability
- **CH** constan head permeablity
- **CBR** californian bearing ratio

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Geotechnical Log - Borehole

BH 7

UTM	: 56J	**Drill Rig**	: GT 10	**Job Number**	: GI 6735-b
Easting (m)	: 509923.1229697462	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing (m)	: 6924783.110177448	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	**Reviewed By**	:	**Location**	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 3.8 m BGL	**Date**	: 14/08/2023	**Loc Comment**	:

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	DCP graph	Testing
Auger		0.3	Fill		SM	Fill- Silty SAND (SM) : grey, dense, fine to coarse grained, trace fine sized gravel.	D	D		
		2	Fill		CH	Fill- Sandy CLAY (CH) : high plasticity, grey and orange mottled pale grey, stiff to very stiff, fine to coarse grained sand, inorganic, (w<wp).	M	St-VSt		
		2.4	Fill		SM	Fill- Silty SAND (SM) : grey, dense to very dense, fine to coarse grained.		D-VD		
		3.4	Residual		CH	Residual- Sandy CLAY (CH) : stiff to very stiff, high plasticity, grey and orange, fine to coarse grained sand, inorganic, (w>wp).		St-VSt		
			Rock		SST	Rock- SANDSTONE: highly weathered, very low strength, pale grey mottled orange, fine to medium grained, indistinct, moist/dry.	M-D	VLS		
						BH 7 Terminated at 3.8 m				

Method
EX excavator
BH backhoe bucket
NE natural exposure
EE existing xcavation
RP ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification
GW	well graded gravels	**SW**	well graded sands
GP	poorly graded gravels	**SP**	poorly graded sands
GM	silty gravel	**SM**	silty sands
GC	clayey gravel	**SC**	clayey sands
ML	inorg silts low plastic	**CL**	inorg clay low plastic
MH	inorg clay high plastic	**CI**	inorg clay med plastic
OL	org silts low plastic	**CH**	inorg clay high plastic
OH	org sills high plastic	**Pt**	peat of high org soils

Consistency
VS	Very soft
S	Soft
F	Firm
St	Stiff
VSt	Very stiff
H	Hard

Density
VL	Very loose
L	Loose
MD	Medium dense
D	Dense
VD	Very dense

Moisture
D	Dry
M	Moist
W	Wet
PL	plastic limit
LL	liquid limit

Soil Samples
B	bulk
D	disturbed
U(63)	U(63) push tube
U(50)	U(50) push tube
WS	water

In Situ Testing
PP	pen penetrometer
VS	vane shear
DCP	dynamic cone penetrometer

Laboratory Results
UC	undrained unconsol cohesion
UF	undrained unconsol friction angle
MC	moisture content
DD	dry density
LL	liquid limit
PL	plastic limit
LS	linear shrinkage
CC	undrained console cohesion
CF	undrained console friction angle
FH	falling head permeability
CH	constan head permeablity
CBR	californian bearing ratio

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Geotechnical Log - Borehole

BH 8

UTM	: 56J	**Drill Rig**	: GT 10	**Job Number**	: GI 6735-b
Easting (m)	: 509939.81712019164	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing (m)	: 6924800.938034507	**Logged By**	: Dean Wedge	**Project**	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	**Reviewed By**	:	**Location**	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 7.5 m BGL	**Date**	: 14/08/2023	**Loc Comment**	:

Drilling Method	DCP graph	Depth (m)	Water	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing	Elevation (m)
Auger		1		Fill		SM	Fill- Silty SAND (SM) : dark grey, dense to very dense, fine to coarse grained, trace medium plasticity clay.	M	D-VD		
		1.1		Fill		CH	Fill- Sandy CLAY (CH) : high plasticity, grey mottled orange and brown, stiff to very stiff, fine to coarse grained sand, inorganic, (w>wp).		St-VSt		
		2		Fill		CH	As above, but grey and orange mottled red.				
		2.5		Fill		SM	Fill- Silty SAND (SM) : dark grey, dense, fine to coarse grained.		D		
		2.8		Fill		SM	As above, but grey.				
		3									
		3.5		Residual		CI	Residual- Sandy CLAY (CI) : stiff to very stiff, medium plasticity, grey mottled orange, fine to coarse grained sand, inorganic, (w>wp).		St-VSt		

Method
- **EX** excavator
- **BH** backhoe bucket
- **NE** natural exposure
- **EE** existing xcavation
- **RP** ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification

GW	well graded gravels	**SW**	well graded sands
GP	poorly graded gravels	**SP**	poorly graded sands
GM	silty gravel	**SM**	silty sands
GC	clayey gravel	**SC**	clayey sands
ML	inorg silts low plastic	**CL**	inorg clay low plastic
MH	inorg clay high plastic	**CI**	inorg clay med plastic
OL	org silts low plastic	**CH**	inorg clay high plastic
OH	org sills high plastic	**Pt**	peat of high org soils

Consistency
- **VS** Very soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VSt** Very stiff
- **H** Hard

Density
- **VL** Very loose
- **L** Loose
- **MD** Medium dense
- **D** Dense
- **VD** Very dense

Moisture
- **D** Dry
- **M** Moist
- **W** Wet
- **PL** plastic limit
- **LL** liquid limit

Soil Samples
- **B** bulk
- **D** disturbed
- **U(63)** U(63) push tube
- **U(50)** U(50) push tube
- **WS** water

In Situ Testing
- **PP** pen penetrometer
- **VS** vane shear
- **DCP** dynamic cone penetrometer

Laboratory Results
- **UC** undrained unconsol cohesion
- **UF** undrained unconsol friction angle
- **MC** moisture content
- **DD** dry density
- **LL** liquid limit
- **PL** plastic limit
- **LS** linear shrinkage
- **CC** undrained console cohesion
- **CF** undrained console friction angle
- **FH** falling head permeability
- **CH** constan head permeablity
- **CBR** californian bearing ratio

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Geotechnical Log - Borehole

BH 8

UTM	: 56J	Drill Rig	: GT 10	Job Number	: GI 6735-b
Easting (m)	: 509939.81712019164	Driller Supplier	: Geotech Investigations	Client	: Radiance Spaces Pty Ltd
Northing (m)	: 6924800.938034507	Logged By	: Dean Wedge	Project	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	Reviewed By	:	Location	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 7.5 m BGL	Date	: 14/08/2023	Loc Comment	:

Drilling Method	DCP graph	Depth (m)	Water	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing	Elevation (m)
Auger		5		Residual		CI	Residual- Sandy CLAY (CI) : stiff to very stiff, medium plasticity, grey mottled orange, fine to coarse grained sand, inorganic, (w>wp).		St-VSt		
		6		Rock		MSS	Extremelyweathered, rock- Silty SAND (MSS) : very dense, pale grey, fine to medium grained, trace low plasticity clay.		VD		
		7									
		7.2		Rock		MSS	Rock- META SILTSTONE/SANDSTONE: highly weathered, very low strength, pale grey and orange brown, fine grained, moist, (bands of extremally weathered rock t/out).		VLS		
							BH 8 Terminated at 7.5 m				

Method
EX excavator
BH backhoe bucket
NE natural exposure
EE existing xcavation
RP ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification
GW	well graded gravels	**SW**	well graded sands
GP	poorly graded gravels	**SP**	poorly graded sands
GM	silty gravel	**SM**	silty sands
GC	clayey gravel	**SC**	clayey sands
ML	inorg silts low plastic	**CL**	inorg clay low plastic
MH	inorg clay high plastic	**CI**	inorg clay med plastic
OL	org silts low plastic	**CH**	inorg clay high plastic
OH	org sills high plastic	**Pt**	peat of high org soils

Consistency
VS	Very soft
S	Soft
F	Firm
St	Stiff
VSt	Very stiff
H	Hard

Density
VL	Very loose
L	Loose
MD	Medium dense
D	Dense
VD	Very dense

Moisture
D	Dry
M	Moist
W	Wet
PL	plastic limit
LL	liquid limit

Soil Samples
B	bulk
D	disturbed
U(63)	U(63) push tube
U(50)	U(50) push tube
WS	water

In Situ Testing
PP	pen penetrometer
VS	vane shear
DCP	dynamic cone penetrometer

Laboratory Results
UC	undrained unconsol cohesion
UF	undrained unconsol friction angle
MC	moisture content
DD	dry density
LL	liquid limit
PL	plastic limit
LS	linear shrinkage
CC	undrained console cohesion
CF	undrained console friction angle
FH	falling head permeability
CH	constan head permeablity
CBR	californian bearing ratio

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Geotechnical Log - Borehole

BH 9

UTM	: 56J	**Drill Rig**	: Hilux	**Job Number**	: GI 6735-b
Easting (m)	: 509948.0	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing (m)	: 6924752.0	**Logged By**	: Phil Walle	**Project**	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	**Reviewed By**	:	**Location**	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 2 m BGL	**Date**	: 28/08/2023	**Loc Comment**	:

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	DCP graph	Testing
Auger		0	Fill		SM	Fill- Silty SAND (SM) : pale orange and pale brown, very dense, fine to coarse grained, with fine to coarse sized gravel, trace medium plasticity clay.	D	VD	8 10 15 augered out	
		0.5	Fill		Cl	Fill- Sandy CLAY (Cl) : medium plasticity, mottled orange and brown, stiff, fine to medium grained sand, trace fine to medium sized gravel, (w>wp).	M	St	3 3 4 7 3 3 3 3 3 3 4	PP: 160 PP: 150 PP: 140
		1								
		1.5	Residual		SC	Residual- Clayey SAND (SC) : dense, medium plasticity clay, orange mottled pale grey, fine to medium grained.	M-D	D	11 15	
		2				**BH 9 Terminated at 2 m**				

Method
- **EX** excavator
- **BH** backhoe bucket
- **NE** natural exposure
- **EE** existing xcavation
- **RP** ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification

GW	well graded gravels	**SW**	well graded sands
GP	poorly graded gravels	**SP**	poorly graded sands
GM	silty gravel	**SM**	silty sands
GC	clayey gravel	**SC**	clayey sands
ML	inorg silts low plastic	**CL**	inorg clay low plastic
MH	inorg clay high plastic	**CI**	inorg clay med plastic
OL	org silts low plastic	**CH**	inorg clay high plastic
OH	org sills high plastic	**Pt**	peat of high org soils

Consistency
- **VS** Very soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VSt** Very stiff
- **H** Hard

Density
- **VL** Very loose
- **L** Loose
- **MD** Medium dense
- **D** Dense
- **VD** Very dense

Moisture
- **D** Dry
- **M** Moist
- **W** Wet
- **PL** plastic limit
- **LL** liquid limit

Soil Samples
- **B** bulk
- **D** disturbed
- **U(63)** U(63) push tube
- **U(50)** U(50) push tube
- **WS** water

In Situ Testing
- **PP** pen penetrometer
- **VS** vane shear
- **DCP** dynamic cone penetrometer

Laboratory Results
- **UC** undrained unconsol cohesion
- **UF** undrained unconsol friction angle
- **MC** moisture content
- **DD** dry density
- **LL** liquid limit
- **PL** plastic limit
- **LS** linear shrinkage
- **CC** undrained console cohesion
- **CF** undrained console friction angle
- **FH** falling head permeability
- **CH** constan head permeablity
- **CBR** californian bearing ratio

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Geotechnical Log - Borehole

BH 10

UTM	: 56J	**Drill Rig**	: Hilux	**Job Number**	: GI 6735-b
Easting (m)	: 509929.73558133945	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing (m)	: 6924759.737377159	**Logged By**	: Phil Walle	**Project**	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	**Reviewed By**	:	**Location**	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 1.5 m BGL	**Date**	: 28/08/2023	**Loc Comment**	:

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	DCP graph	Testing
Auger		0.2	Fill		SM	Fill- Sandy SILT (SM) : medium plasticity, grey, very stiff, fine to medium grained sand, inorganic.	D	VSt	Augered out	
		0.5	Fill		CI	Fill- Sandy CLAY (CI) : medium plasticity, mottled orange and brown, stiff, fine to medium grained sand, trace fine to medium sized gravel, inorganic, (w>wp).	M	St	to 0.5m	
		1	Residual		SC	Residual- Clayey SAND (SC) : dense, medium plasticity clay, orange mottled pale grey and brown, fine to medium grained, trace fine to coarse sized gravel, (with silt, gravel is cemented sand, w<wp, possibly (ci) sandy clay very stiff. friable).	M-D	D	7 7 7 7 7 8 7 8 8	
		2				**BH 10 Terminated at 1.5 m**				

Method
EX excavator
BH backhoe bucket
NE natural exposure
EE existing xcavation
RP ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification

GW	well graded gravels	**SW**	well graded sands
GP	poorly graded gravels	**SP**	poorly graded sands
GM	silty gravel	**SM**	silty sands
GC	clayey gravel	**SC**	clayey sands
ML	inorg silts low plastic	**CL**	inorg clay low plastic
MH	inorg clay high plastic	**CI**	inorg clay med plastic
OL	org silts low plastic	**CH**	inorg clay high plastic
OH	org sills high plastic	**Pt**	peat of high org soils

Consistency
VS Very soft
S Soft
F Firm
St Stiff
VSt Very stiff
H Hard

Density
VL Very loose
L Loose
MD Medium dense
D Dense
VD Very dense

Moisture
D Dry
M Moist
W Wet
PL plastic limit
LL liquid limit

Soil Samples
B bulk
D disturbed
U(63) U(63) push tube
U(50) U(50) push tube
WS water

In Situ Testing
PP pen penetrometer
VS vane shear
DCP dynamic cone penetrometer

Laboratory Results
UC undrained unconsol cohesion
UF undrained unconsol friction angle
MC moisture content
DD dry density
LL liquid limit
PL plastic limit
LS linear shrinkage
CC undrained console cohesion
CF undrained console friction angle
FH falling head permeability
CH constan head permeablity
CBR californian bearing ratio

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Geotechnical Log - Borehole

BH 11

UTM	: 56J	**Drill Rig**	: Hilux	**Job Number**	: GI 6735-b
Easting (m)	: 509913.49328209023	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing (m)	: 6924765.230244266	**Logged By**	: Phil Walle	**Project**	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	**Reviewed By**	:	**Location**	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 1.8 m BGL	**Date**	: 28/08/2023	**Loc Comment**	:

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	DCP graph	Testing
Auger		0.2	Fill		SM	Fill- Sandy SILT (SM) : medium plasticity, grey, very stiff, fine to medium grained sand, inorganic.	D	VSt	6 4	
		0.5	Fill		CI	Fill- Sandy CLAY (CI) : medium plasticity, mottled orange and brown, stiff, fine to medium grained sand, trace fine to medium sized gravel, inorganic, (w>wp).	M	St	4 4 4	
		1	Residual		SC	Residual- Clayey SAND (SC) : dense, medium plasticity clay, orange mottled pale grey and brown, fine to medium grained, trace fine to coarse sized gravel, (with silt, gravel is cemented sand, w<wp, possibly (ci) sandy clay very stiff. friable).	M-D	D	5 7 7 8 7 7 7 8	
		2				**BH 11 Terminated at 1.8 m**				

Method
EX excavator
BH backhoe bucket
NE natural exposure
EE existing xcavation
RP ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification
GW	well graded gravels	**SW**	well graded sands
GP	poorly graded gravels	**SP**	poorly graded sands
GM	silty gravel	**SM**	silty sands
GC	clayey gravel	**SC**	clayey sands
ML	inorg silts low plastic	**CL**	inorg clay low plastic
MH	inorg clay high plastic	**CI**	inorg clay med plastic
OL	org silts low plastic	**CH**	inorg clay high plastic
OH	org sills high plastic	**Pt**	peat of high org soils

Consistency
VS	Very soft
S	Soft
F	Firm
St	Stiff
VSt	Very stiff
H	Hard

Density
VL	Very loose
L	Loose
MD	Medium dense
D	Dense
VD	Very dense

Moisture
D	Dry
M	Moist
W	Wet
PL	plastic limit
LL	liquid limit

Soil Samples
B	bulk
D	disturbed
U(63)	U(63) push tube
U(50)	U(50) push tube
WS	water

In Situ Testing
PP	pen penetrometer
VS	vane shear
DCP	dynamic cone penetrometer

Laboratory Results
UC	undrained unconsol cohesion
UF	undrained unconsol friction angle
MC	moisture content
DD	dry density
LL	liquid limit
PL	plastic limit
LS	linear shrinkage
CC	undrained console cohesion
CF	undrained console friction angle
FH	falling head permeability
CH	constan head permeablity
CBR	californian bearing ratio

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Geotechnical Log - Borehole

BH 12

UTM	: 56J	**Drill Rig**	: Hilux	**Job Number**	: GI 6735-b
Easting (m)	: 509899.6988575784	**Driller Supplier**	: Geotech Investigations	**Client**	: Radiance Spaces Pty Ltd
Northing (m)	: 6924771.710989276	**Logged By**	: Phil Walle	**Project**	: Proposed Commercial Development
Ground Elevation	: Not Surveyed	**Reviewed By**	:	**Location**	: Lot 10, No.1-7 Alder Circuit, Yarrabilba
Total Depth	: 1.5 m BGL	**Date**	: 28/08/2023	**Loc Comment**	:

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	DCP graph	Testing
Auger		0.2	Fill		SM	Fill- Sandy SILT (SM) : medium plasticity, grey, very stiff, fine to medium grained sand, inorganic.	D	VSt	6 4	
		1	Residual		SC	Residual- Clayey SAND (SC) : dense, medium plasticity clay, orange mottled pale grey and brown, fine to medium grained, trace fine to coarse sized gravel, (with silt, gravel is cemented sand, w<wp, possibly (ci) sandy clay very stiff. friable).	M-D	D	6 7 8 7 7 8 7 6 8 10 11	
		2				**BH 12 Terminated at 1.5 m**				

Method
- **EX** excavator
- **BH** backhoe bucket
- **NE** natural exposure
- **EE** existing xcavation
- **RP** ripper

Water
- complete water less
- Water inflow
- water level
- Level during drilling
- **P** partial water loss
- **N** none encountered

USC Classification
- **GW** well graded gravels
- **GP** poorly graded gravels
- **GM** silty gravel
- **GC** clayey gravel
- **ML** inorg silts low plastic
- **MH** inorg clay high plastic
- **OL** org silts low plastic
- **OH** org sills high plastic
- **SW** well graded sands
- **SP** poorly graded sands
- **SM** silty sands
- **SC** clayey sands
- **CL** inorg clay low plastic
- **CI** inorg clay med plastic
- **CH** inorg clay high plastic
- **Pt** peat of high org soils

Consistency
- **VS** Very soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VSt** Very stiff
- **H** Hard

Density
- **VL** Very loose
- **L** Loose
- **MD** Medium dense
- **D** Dense
- **VD** Very dense

Moisture
- **D** Dry
- **M** Moist
- **W** Wet
- **PL** plastic limit
- **LL** liquid limit

Soil Samples
- **B** bulk
- **D** disturbed
- **U(63)** U(63) push tube
- **U(50)** U(50) push tube
- **WS** water

In Situ Testing
- **PP** pen penetrometer
- **VS** vane shear
- **DCP** dynamic cone penetrometer

Laboratory Results
- **UC** undrained unconsol cohesion
- **UF** undrained unconsol friction angle
- **MC** moisture content
- **DD** dry density
- **LL** liquid limit
- **PL** plastic limit
- **LS** linear shrinkage
- **CC** undrained console cohesion
- **CF** undrained console friction angle
- **FH** falling head permeability
- **CH** constan head permeablity
- **CBR** californian bearing ratio

SCOPE These standard notes may be of assistance when understanding terms and recommendations given in this report. These notes are for general conditions and not all terms given may be of concern to the report attached. The descriptive terms adopted by Geotech Investigations Pty Ltd are given below and are largely consistent with Australian Standards AS1726-1993 'Geotechnical Site Investigations'.

CLIENT can be described and is limited to the financier of this geotechnical investigation.

LEGALITY and privacy of this document is based on communication between Geotech Investigations Pty Ltd and the client. Unless indicated otherwise the report was prepared specifically for the client involved and for the purposes indicated by the client. Use by any other party for any purpose, or by the client for a different purpose, will result in recommendations becoming invalid and Geotech Investigations Pty Ltd will hold no responsibility for problems which may arise.

GEOTECHNICAL REPORTS are predominantly derived using professional estimates determined from the results of fieldwork, in-situ and laboratory testing and experience from previous investigations in the area, from which geotechnical engineers then formulate an opinion about overall subsurface conditions. The client must be made aware that the investigations are undertaken to ensure minimal site impact using test-pits or small diameter boreholes and soil conditions on-site may vary from those encountered during the investigation.

CLIENTS RESPONSIBILITY to notify this office should there be adjustments in proposed structure/location or inconsistencies with material descriptions given in this report and those encountered on site. Geotech Investigations Pty Ltd is able to provide a range of services from on-site inspections to full project supervision to confirm recommendations given in the report.

CSIRO Publication BTF 18 'Foundation Maintenance and Footing Performance: A Homeowner's Guide' explains how to adequately maintain drainage during and post construction which lies as the responsibility of the client. Suitable drainage ensures recommendations given in this report remain valid.

INVESTIGATION METHODS adopted by Geotech Investigations Pty Ltd are designed to incorporate individual project-specific factors to obtain information on the physical properties of soil and rock around a site to design earthworks and foundations for proposed structures. The following methods of investigation currently adopted by this company are summarised below:-

HAND AUGER – investigations enable field work to be undertaken where access is limited. The materials must have sufficient cohesion to stand unsupported in an unlined borehole and there must be no large cobbles boulders or other obstructions which would prevent rotation of the auger.

TEST-PITS – investigations are carried out with an excavator or backhoe, allowing a visual inspection of sub-surface material in-situ and from samples removed. The limit of investigation is restricted by the reach of the excavator or backhoe.

CONTINUOUS SPIRAL FLIGHT AUGERING TECHNIQUES – investigations are advanced by pushing a 100mm diameter spiral into the sub-surface and withdrawing it at regular intervals to allow sampling or testing as it emerges.

WASH BORING – investigations are advanced by removing the loosened soil from the borehole by a stream of water or drilling mud issuing from the lower end of the wash pipe which is worked up and down or rotated by hand in the borehole. The water or mud carries the soil up the borehole where it overflows at ground level where the soil in suspension is allowed to settle in a pond or tank and the fluid is re-circulated or discharged to waste as required.

NON-CORE ROTARY DRILLING – investigations are advanced using a rotary bit with water 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 feel and rate of penetration.

ROTARY MUD DRILLING – is carried out as above using mud as support and circulating fluid for the borehole drilling. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling.

CONTINUOUS CORE DRILLING – investigations are carried out in rock material, specimens of rock in the form of cylindrical cores are recovered from the drill holes by the means of core barrel. The core barrel is provided at its lower end with a detachable core bit which carries industrial diamond chips in a matrix of metal. Rotation of the barrel by means of the drill rods causes the core bit to cut an annulus in the rock, the cuttings being washed to the surface by a stream of pumped down the hollow drill rods.

TESTING METHODS adopted by Geotech Investigations Pty Ltd to determine soil properties include but not limited to the following:-

U50 – Undisturbed samples are obtained by inserting a 50mm diameter thin-walled steel tube into the material and withdrawing with a sample of the soil in a moderately undisturbed condition.

PP – Pocket Penetrometer tests are commonly used on thin walled tube samples of cohesive soils to evaluate consistency and approximate unconfined compressive strength of saturated cohesive soils. They may also be used for the same purpose in freshly excavated trenches.

VS – Vane Shear test are commonly used in-situ or on thin walled tube samples of cohesive soils by introducing the vane into the material where the measurement of the undrained shear strength is required. Then the vane is rotated and the torsional force required to cause shearing is calculated.

DCP – Dynamic Cone Penetrometer tests are commonly used in-situ to measure the strength attributes of penetrability and compaction of sub-surface materials.

SPT – Standard Penetration Tests are commonly used to determine the density of granular deposits but are occasionally used in cohesive material as a means of determining strength and also of obtaining a relatively unmixed sample. Samples and results are obtained by driving a 50mm diameter split tube through blows from a slide hammer with a weight of 63.5kg falling through a distance of 760mm. Blow counts are recorded for 150mm intervals with the sum of the number of blows required for the second and third 150mm of penetration is termed the "standard penetration resistance" or the "N-value".

GEOLOGICAL ORIGINS of sub-surface material plays a considerable role in the development of engineering parameters and have been summarised as follows:-

FILL – materials are man made deposits, which may be significantly more variable between test locations than naturally occurring soils.

RESIDUAL – soils are present in a region because of weathering over the geological time scale.

COLLUVIAL – soils have been deposited recently, on the geological time scale, as soils being transported slowly down slope due to gravitational creep.

ALLUVIAL – soils have been deposited recently, on the geological time scale, as water borne materials.

AEOLIAN – soils have been deposited recently, on the geological time scale, as wind borne materials.

SOIL DESCRIPTION is based on an assessment of disturbed samples, as recovered from boreholes and excavations, and from undisturbed materials. Soil descriptions adopted by Geotech Investigations Pty Ltd are largely consistent with AS 1726-2017 '*Geotechnical Site Investigation'.* Soil types are described according to the predominating particle size and behaviour, qualified by the grading of other particles present on the following bases detailed in Table 1.

COHESIVE SOILS ability to hold moisture known as its liquid limit is the state of a soil when it goes from a solid state to a liquid state described in Table 2

TABLE 1

Soil Classification	Particle Size
Clay	< 0.002 mm
Silt	0.002 – 0.06 mm
Sand	0.06 – 2.00 mm
Gravel	2.00 – 60.0 mm

TABLE 2

Descriptive Type	Range of Liquid Limit %
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50

Furthermore to soil description cohesive soils are described on their strength (assessed in conjunction with penetration tests) and liquid limit. Non-cohesive soil strengths are described by their density index. With descriptions for cohesive and non-cohesive soils summarised in Table 3.

TABLE 3

COHESIVE SOILS		NON-COHESIVE SOILS	
Term	**Undrained Shear Strength kPa**	**Term**	**Density Index %**
Very soft	≤ 12	Very Loose	≤15
Soft	> 12 ≤25	Loose	> 15 ≤35
Firm	> 25 ≤50	Medium Dense	> 35 ≤65
Stiff	> 50 ≤100	Dense	> 65 ≤85
Very Stiff	> 100 ≤200	Very Dense	> 85
Hard	> 200		

Description of terms used to describe material portion are summarised in Table 4.

TABLE 4

COARSE GRAINIED SOILS		FINE GRAINED SOILS	
% Fines	**Modifier**	**% Coarse**	**Modifier**
≤ 5	Omit or 'trace'	≤ 15	Omit or 'trace'
> 5 ≤12	Describe as 'with'	> 15 ≤30	Describe as 'with'
> 12	Prefix soil as 'silty/clayey'	> 30	Prefix soil as 'sandy/gravelly'

ROCK DESCRIPTIONS are determined from disturbed samples or specimens collected during field investigations. A rocks presence of defects and the effects of weathering are likely to have a great influence on engineering behaviour.

Rock Material Weathering Classification is summarised in Table 5.

TABLE 5

Term	Symbol	Definition
Residual Soils	-	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported
Extremely Weathered Rock	XW	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrates or can be remoulded, in water
Distinctly Weathered Rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to decomposition of weathering products in pores
Slightly Weathered Rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock
Fresh rock	FR	Rock shows no signs of decomposition or staining

Rock Material Strength Classification is summarised in Table 6.

TABLE 6

Term	Symbol	Point load index (MPa) I_s50	Field guide to strength
Extremely Low	EL	≤0.03	Easily remoulded by hand to a material with soil properties
Very Low	VL	>0.03 ≤0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 3cm thick can be broken by finger pressure
Low	L	>0.1 ≤0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen 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
Medium	M	>0.3 ≤1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty
High	H	>1.0 ≤3.0	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
Very High	VH	>3.0 ≤10	Hand specimen breaks with pick after more than one blow; rock rings under hammer
Extremely High	EH	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer

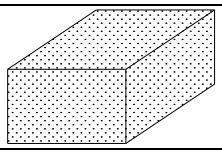
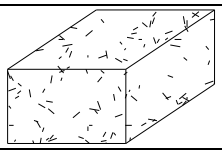
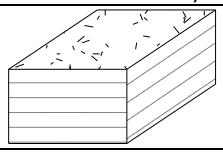
Rock Material Defect Shapes are summarised in Table 7.

TABLE 7

Term	Description
Planar	The defect does not vary in orientation.
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps.
Irregular	The defect has many sharp changes of orientation
Smooth	The defect has a flat even finish
Rough	The defect has a irregular disoriented finish

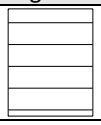
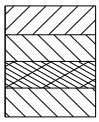
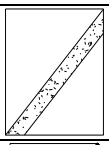
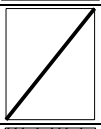
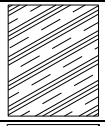
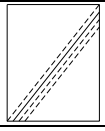
Rock Material Texture and Fabric are summarised in Table 8.

TABLE 8

Geological Description	Massive		Layered (Bedded foliate cleaved)
Diagram			
Fabric Type	Effectively homogenous and isotropic. Bulky or equi-dimensional grains uniformly distributed	Effectively homogeneous and isotropic. Elongated	Effective homogeneous with planar anisotropy. Elongated or tabular grains or pores in a layered arrangement

Rock Material Defect Type is summarised in Table 9

TABLE 9

Term	Definition	Diagram
Bedding	Signifying existence of beds or laminate. Planes dividing sedimentary rocks of the same or different lithology. Structure occurring in granite and similar rocks evident in a tendency to split more or less horizontally to the land surface	
Cross Bedding	Also called cross-lamination or false bedding. The structure commonly present in granular sedimentary rocks, which consists of tabular, irregularly lenticular or wedge-shaped bodies lying essentially parallel to the general stratification and which them selves show pronounced lamination structure in which the laminae are steeply inclined to the general bedding.	
Crushed Seam	A fracture at a more or less acute angle to applied force generally with some pulverized material along its surface	
Joint	A fracture in rock, generally more or less vertical or transverse to bedding, along which no appreciable movement has occurred.	
Parting	A small joint in rock or a layered rock where the tendency of crystals to separate along certain planes that are not true cleavage planes.	
Sheared Zone	A fracture that results from stresses which tend to shear one part of a specimen past the adjacent part	

APPENDIX C

LABORATORY TESTING
– CALIFORNIA BEARING RATIO RESULT

Material Test Report

Report Number: P22053-1
Issue Number: 1
Date Issued: 13/12/2022
Client: Geotech Investigations Pty Ltd
3/42 Machinery Drive, Tweed Heads South NSW 2486
Contact: James Walle
Project Number: P22053
Project Name: Lot 10, No.1-7 Alder Circuit
Project Location: Yarrabilba
Client Reference: GI6735
Work Request: 151
Sample Number: S151A
Date Sampled: 02/12/2022
Dates Tested: 05/12/2022 - 12/12/2022
Sampling Method: AS 1289.1.2.1 6.5.3 - Power auger drilling
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BoreHole 5, Depth: 0.2-0.6m**
Material: Silty Gravelly SAND

SPEC GEOTECHNICAL TESTING
Spec Geotechnical Testing Pty Ltd
192 Round Mountain Rd Bogangar NSW 2488
Phone: 0479 101 710
Email: grant@specgeotest.com

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Grant Porter
Laboratory Manager
NATA Accredited Laboratory Number: 21021

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**19**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.89		
Optimum Moisture Content (%)	12.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	99.0		
Dry Density after Soaking (t/m^3)	1.87		
Field Moisture Content (%)	10.3		
Moisture Content at Placement (%)	12.1		
Moisture Content Top 30mm (%)	14.9		
Moisture Content Rest of Sample (%)	12.7		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	28.1		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1