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[Consulting Engineers – Land Development](#)
[Geotechnical/Acid Sulphate Soil/Groundwater Monitoring](#)

Our reference: 24040

22 July 2024

David Jones & Anita Jones
29 Stirling Crescent
High Wycombe WA 6057

C/- Planning Solutions
Attention: Joshua Carmody

Geotechnical Investigation – 29 Stirling Crescent, High Wycombe.

Dear Joshua

Introduction

Brown Geotechnical visited the above site on 2nd July 2024 to carry out a geotechnical investigation for a proposed commercial development including warehouses, offices and truck parking.

In addition to the three test holes previously carried out by Brown Geotechnical as part of the preliminary investigation for the area Structure Plan, four additional test holes were extended to a depth of 4m using an electric friction cone penetrometer (CPT) rig to allow for confirmation of soil depth and type across the site.

At the time of the investigation the site was occupied by an existing single storey residence and out-buildings. A large, approximately 1.5m deep, pond occupied the southern corner of the lot, and occasional medium to large tree were scattered across the property.

Brief

The report will address:

- Subsurface conditions,
- The existing soil classification in accordance with (AS2870-2011),
- Any earthworks required to obtain a classification suitable for development,
- Suitability of in-situ soil for use as engineering fill in the development,
- Soil bearing capacity and settlements,
- Retaining wall parameters,
- CBR for car park pavement design,
- Earthquake sub-soil class (AS1170.4-2007),
- Groundwater levels,
- Site permeability and drainage issues.

Laboratory Test Results

Table 1 – Geotechnical Test Results

Sample Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	LL (%)	PL (%)
CPT4	0.5	43	57	0	39	17

Ground Conditions

The natural in-situ soil below the site is a medium grained, non-cohesive, well-draining sand. CPT 1 and 4 noted a very dense / cemented layer at approx. 2.5m to 3m. Experience in the area suggests this to be an iron cemented silty sand layer, locally known as coffee rock. It is usually approx. 0.5m thick. CPT2 and CPT3 pushed through the layer, though the zone still appears to be cemented.

The rear third of the site has a layer of clayey sand fill approx. 0.5m - 1m thick (see attached plan). The fill is compact and appears free from any deleterious materials but has some cohesive (plastic) fines, though only a small area was investigated. The area is raised 0.5m – 1.0m above the adjacent paddocks to the northwest. A sample taken at CPT4 has a moderate fines content, with low plasticity and low shrink swell potential.

The ground either side of the pond has a thin layer of fill to approx. 0.3m - 0.5m.

Site Classification

The site classification for the site will depend on whether the clayey sand fill is removed or retained.

If the clayey sand fill remains, specifically in the rear third of the site, it has been determined that the appropriate site classification for footing design in this area is Class 'S' in accordance with AS2870-2011 (refer Table 2) and following the earthworks and foundation considerations below.

If the clayey sand fill is removed, which is recommended, the site classification will be Class 'A'.

It is therefore considered that the land is suitable for development.

Table 2 - Definition of Site Classifications (Australian Standard AS2870-2011)

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement for moisture changes ($y_s < 20\text{mm}$).
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes (y_s 20–40mm).
H1	Highly reactive clay site, which can experience moderate to high ground movement from moisture changes (y_s 40–60mm)
H2	Highly reactive clay site, which can experience high ground movement from moisture changes (y_s 60–75mm)
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes ($y_s > 75\text{mm}$)

y_s : Characteristic Surface Movement

Earthworks

All earthworks should be undertaken in accordance with AS3798-1996 "Guidelines on earthworks for commercial and residential developments".

Topsoil / Fill

Topsoil is not suitable for foundation support and should be removed. There are some trees across the site. Unless they are to be retained, they should be removed with the entire root bulb material. The excavations should then be backfilled with material exhibiting the same geotechnical properties as the surrounding soils, then compacted as stated below.

All uncontrolled materials associated with the demolition of the existing structures, including footings, etc, should be removed from site.

Proof Rolling and Site Compaction

Prior to footing placement or placing any additional fill on site, the sand should be proof rolled to achieve at least 98% SMDD.

Should the clayey sand fill be retained, or re-worked, it should be compacted to a dry density ratio of at least 95% MMDD. Compaction should be checked using nuclear dry density tests.

Imported Fill Material

Any sand fill imported to obtain site formation levels, should be compacted in layers not more than 300mm thick to at least 98% SMDD. In-situ density tests should be carried out to calibrate the PSP to specific densities of the compacted material. Moisture conditioning (wetting) of the sand may be required to optimise compaction. Imported sand should ideally contain less than 5% non-plastic fines to retain good drainage characteristics and should be compacted at optimum moisture content.

Following excavation for foundations, the bases of pad and strip footings should also be compacted to achieve at least 98% SMDD.

Earthwork Inspections

A geotechnical consultant should be engaged to inspect the site following the removal of topsoil, trees, buildings and other unsuitable materials, and to confirm the compaction of the subsurface following proof rolling. Inspections and auditing of the earthworks should be carried out by the geotechnical consultant to enable confirmation of the final site classification.

Pond Backfill

It is understood, following discussions with the owner, that the pond is man-made and does not contain a clay liner. It is assumed the water within the pond is natural groundwater at the natural groundwater level.

Prior to backfilling, the pond should be dewatered, and any fines and sludge removed. The excavations should then be backfilled with material exhibiting the same geotechnical properties as the surrounding soils, then compacted as stated above. Only following the backfill and compaction should the dewatering be stopped.

Note: On no account should sand fill be placed into standing water in an attempt to backfill the pond. Saturated soils cannot be compacted and may result in excessive settlement below the future development.

Suitability of Existing Soils for use in the Development

The in-situ sands on site have low fines, are medium grained, cohesionless and free draining. They will be suitable for use as engineering fill in the development.

The clayey sand fill may be retained, however will likely form an impermeable layer restricting drainage. Further inspection and testing of the fill should be carried out as it is uncovered during the development.

Note: If the clayey sand fill is retained below proposed building envelopes, care should be taken avoid placing pad and strip footing across area of differing soil types to avoid differential settlement.

Bearing Capacity

It is understood that approximately 1m of clean sand fill will be imported on to the site during the bulk earthworks. For the estimate bearing capacity purposes, we considered the fill to have been proof rolled to a dense condition.

The following allowable bearing pressures have been based on a dense sand and a Young's modulus, $E = 40 \text{ MPa}$. Potential settlements should be taken into account for design bearing pressures.

Table 3 - Strip Footing Allowable Bearing Pressure and Estimated Settlement

Footing Depth (m)	Footing Width (m)	Allowable Bearing Pressure (kPa)	Estimated Settlement (mm)
0.5	0.5	125	<5
	1.0	150	5-10
	1.5	200	10-15

Table 4 - Pad Footing Allowable Bearing Pressure and Estimated Settlement

Footing Depth (m)	Footing Dimension (m)	Allowable Bearing Pressure (kPa)	Estimated Settlement (mm)
0.5	0.5 x 0.5	150	<5
	1.0 x 1.0	200	5-10
	1.5 x 1.5	250	10-15

The bearing pressures presented in Table 3 and 4 are also based on the following:

- Loading is isolated, vertical, non-eccentric, on level ground, and not influenced by any nearby cuttings or embankments,
- Factor of Safety of 2.5,
- It is recommended that the total settlement be limited to 15mm,
- Differential Settlement to be no greater than nominally half the total.

California Bearing Ratio

An average CBR correlation value of 18% for dense sand (in-situ) is considered adequate for access road and car park pavement design based on the CPT data.

For imported Perth sand fill, typical CBR values can vary from 12 to 20. Testing of additional imported fill should be carried out to determine more accurate values.

Earthquake Sub-Soil Class

The site Sub-Soil Class is considered as a Class C_e.

Retaining Wall Parameters

Assuming compaction / proof rolling of the soils has been carried out as stated above, the following retaining wall parameters have been based on a medium dense sand soil with $\phi=30^\circ$.

$$\gamma=18 \text{ kN/m}^3$$

$$K_o=0.50$$

$$K_a=0.29$$

$$K_p=4.$$

The parameters detailed above assume design of the retaining structure and compaction of the foundations are in accordance with AS 4678-2002, and that backfill material is composed of clean cohesionless sand.

Groundwater

Groundwater was encountered at approx. 1.5m bgl in the CPT probes. The preliminary investigation noted groundwater at 2.3m in TH19, below a 1m layer of fill. This equates to approximately the same level noted in CPT1 where there is no fill present.

The Perth groundwater map indicates the groundwater level to be approx. 19mAHD, or approx. 4m below ground level. The DoW notes these values can vary locally by up to 3m.

The layer of cemented sand / coffee rock seen in the CPT probes at approx. 2.5m could influence the local groundwater level, being an aquiclude to vertical drainage or causing perching of groundwater in sands above the layer.

For more accurate groundwater information, groundwater monitoring bores should be considered.

Permeability and Site Drainage

Drainage within the clayey sand fill will be poor. It is recommended that the material be removed if soakwells are required in the future development.

The drainage characteristics of the sand on site are good. The near surface soil permeability is 5×10^{-4} m/s. Soakwells will be suitable for stormwater runoff within the sand.

Permeability and drainage conditions may be reduced during earthworks due to compaction of in-situ and imported sands. Over compaction during earthworks can seriously reduce soil permeability and drainage potential. It is recommended that further permeability testing be carried out following the completion of earthworks.

Regards

Ken Brown

Senior Geotechnical Engineer
BROWN GEOTECHNICAL

Attachments: 1. Site and Test Location Plan
2. CPT Plots and Test Hole Logs
3. Laboratory Test Certificates
3. Conditions Relating to this Report

Brown Geotechnical

PO Box 278, Como, Western Australia 6952 Phone 0431 122 320 Email admin@browngeotechnical.com.au

Site and Test Location Plan



ELECTRIC FRICTION-CONE PENETROMETER

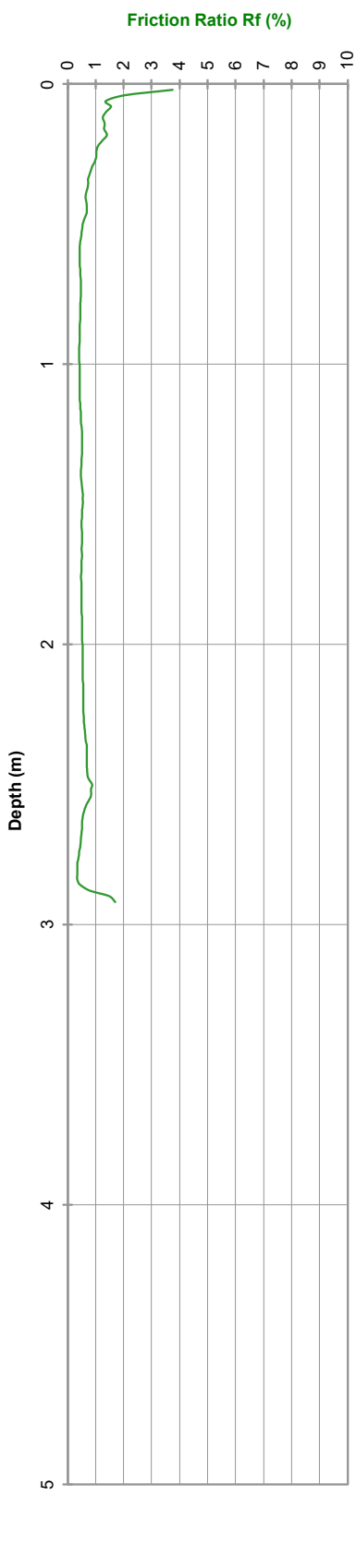
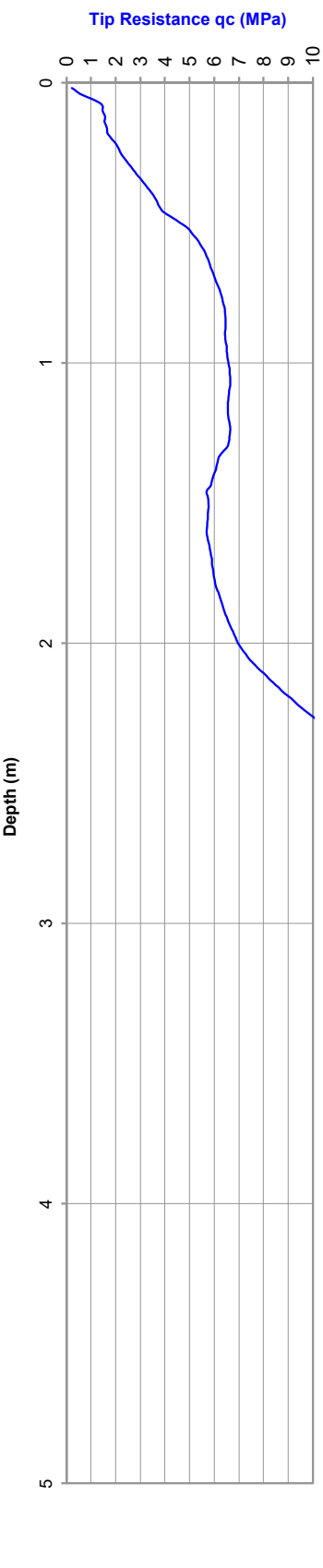
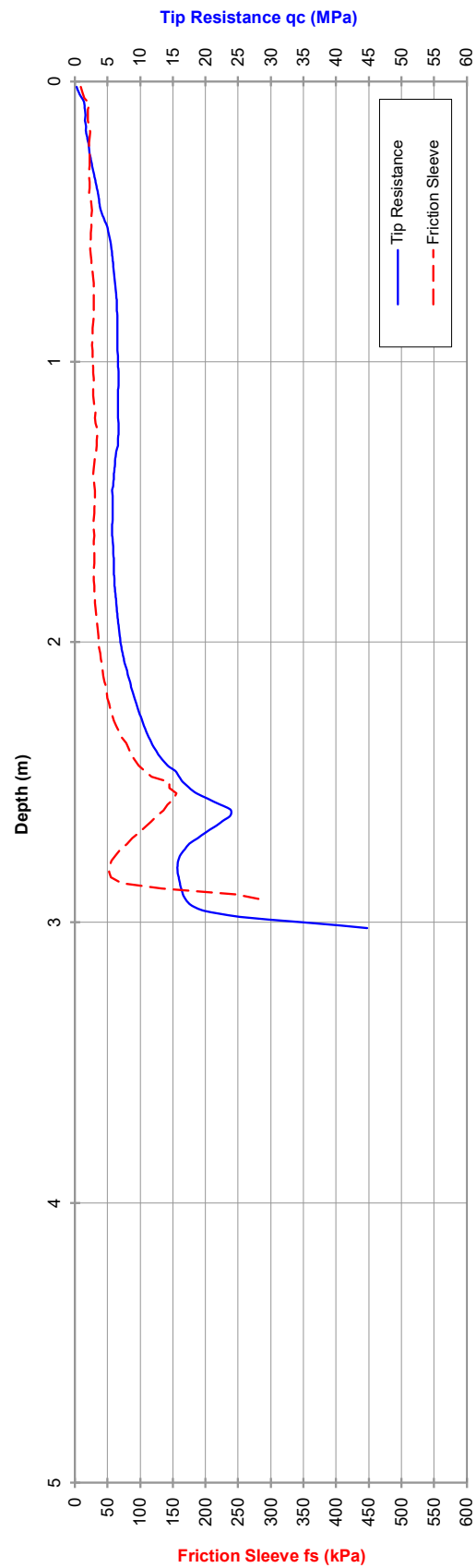
CLIENT: Brown Geotechnical
PROJECT: 29 Stirling Crescent
LOCATION: High Wycombe

Job No.: 24024
RL (m):
Co-ords:

Probe I.D

CPT 01

02-Jul-24



ELECTRIC FRICTION-CONE PENETROMETER

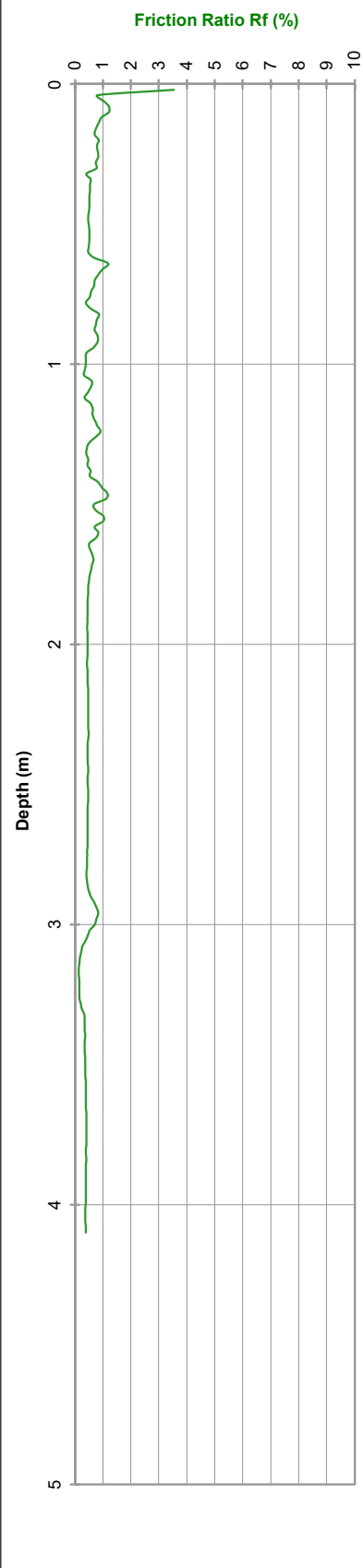
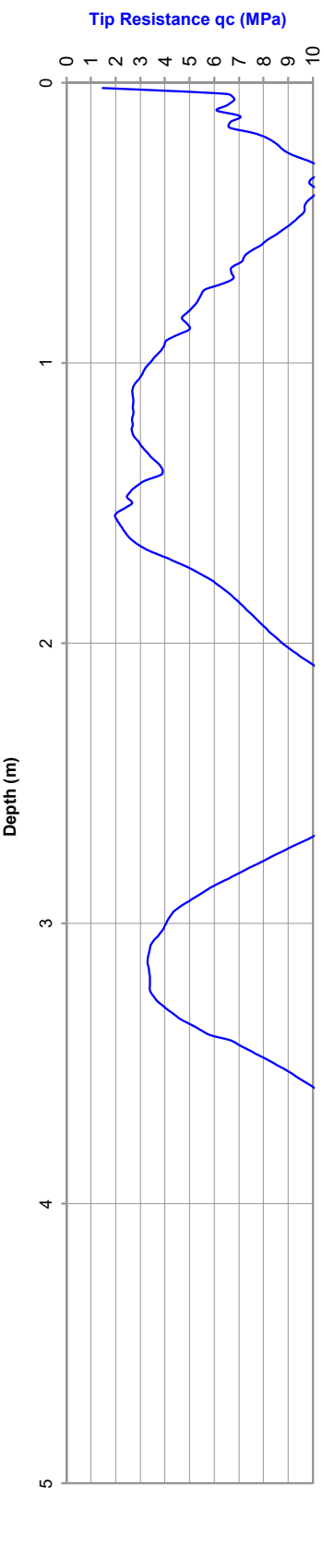
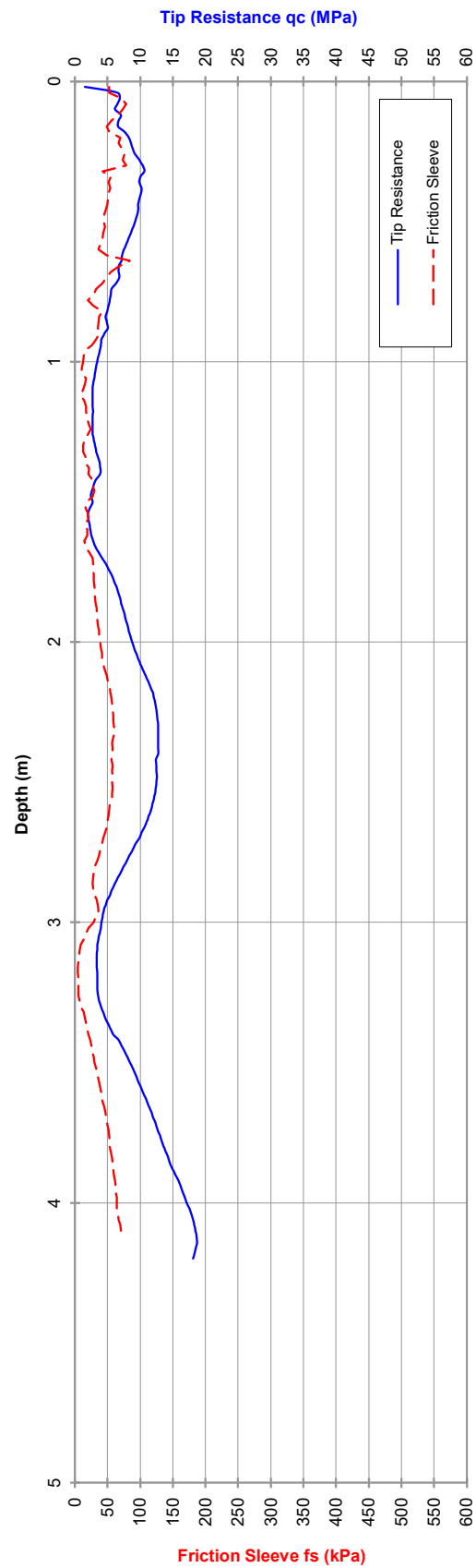
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PROJECT: 29 Stirling Crescent
LOCATION: High Wycombe

Job No.: 24024
RL (m):
Co-ords:

Probe I.D

CPT 02

02-Jul-24



ELECTRIC FRICTION-CONE PENETROMETER

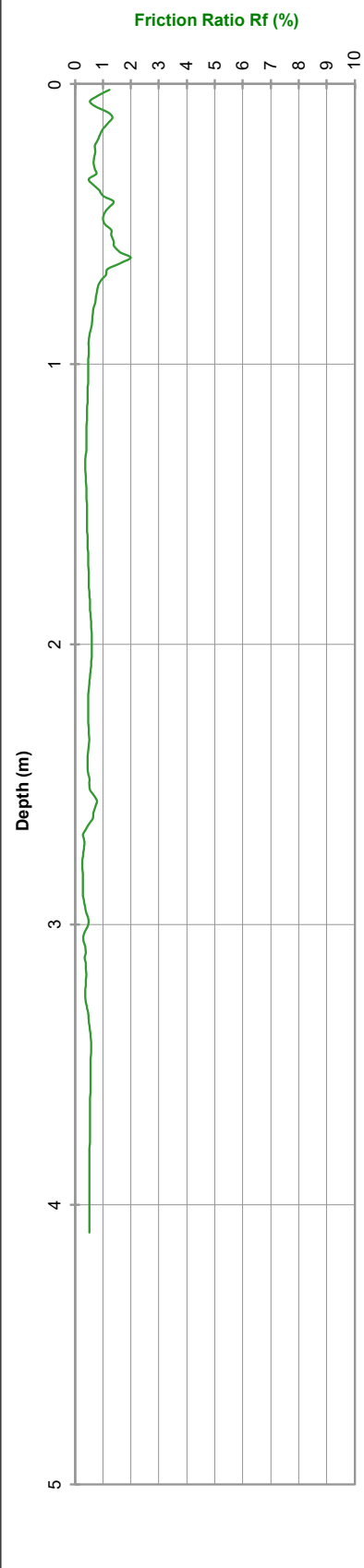
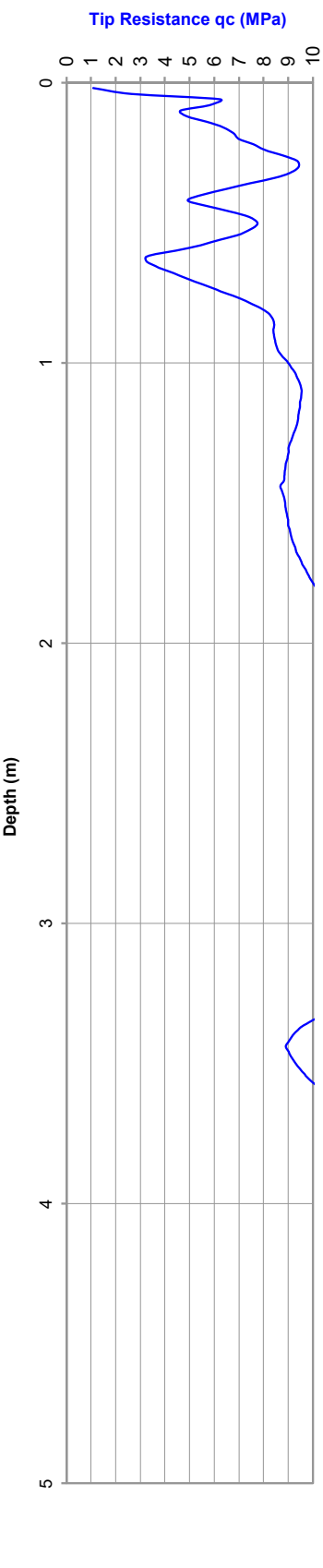
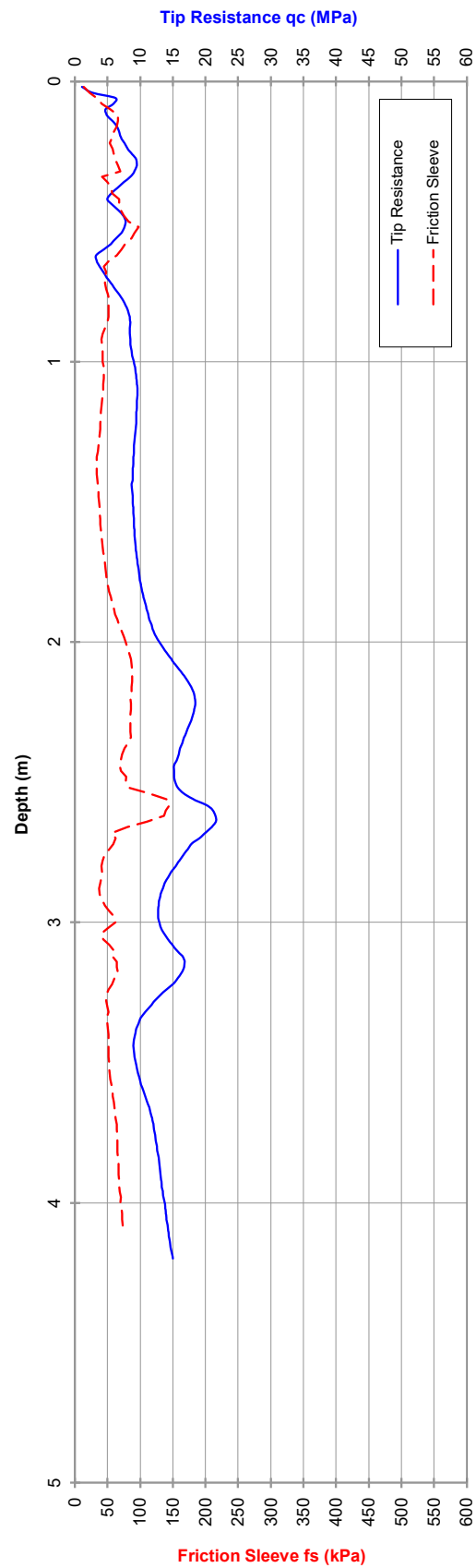
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PROJECT: 29 Stirling Crescent
LOCATION: High Wycombe

Job No.: 24024
RL (m):
Co-ords:

Probe I.D

CPT 03

02-Jul-24



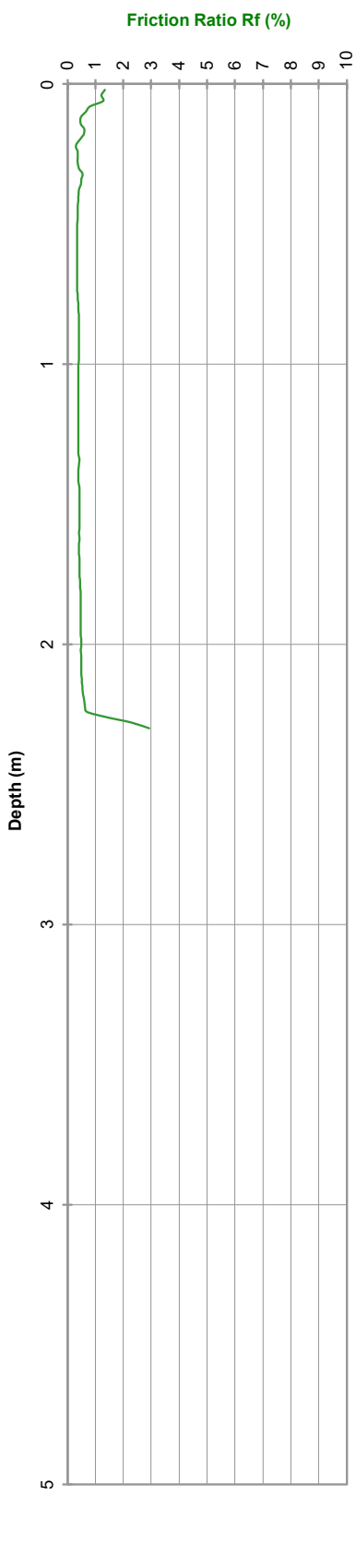
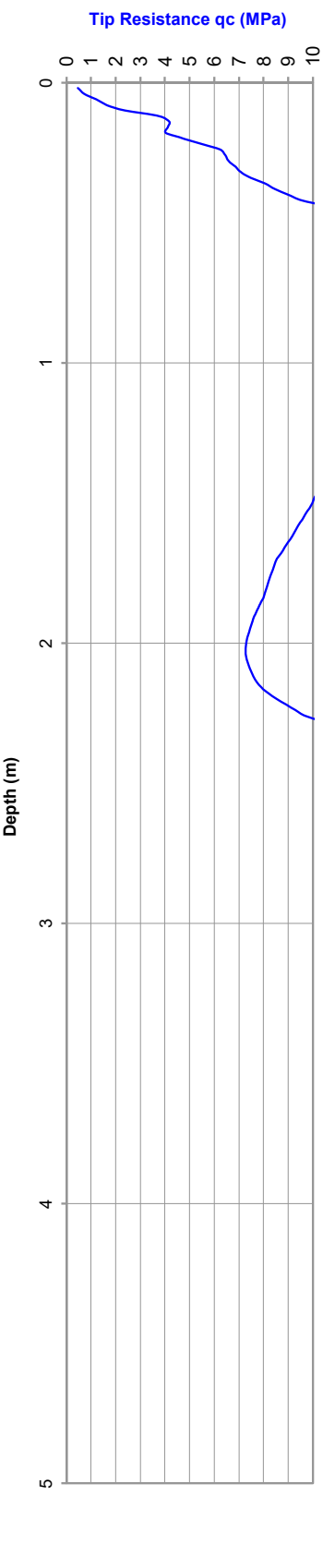
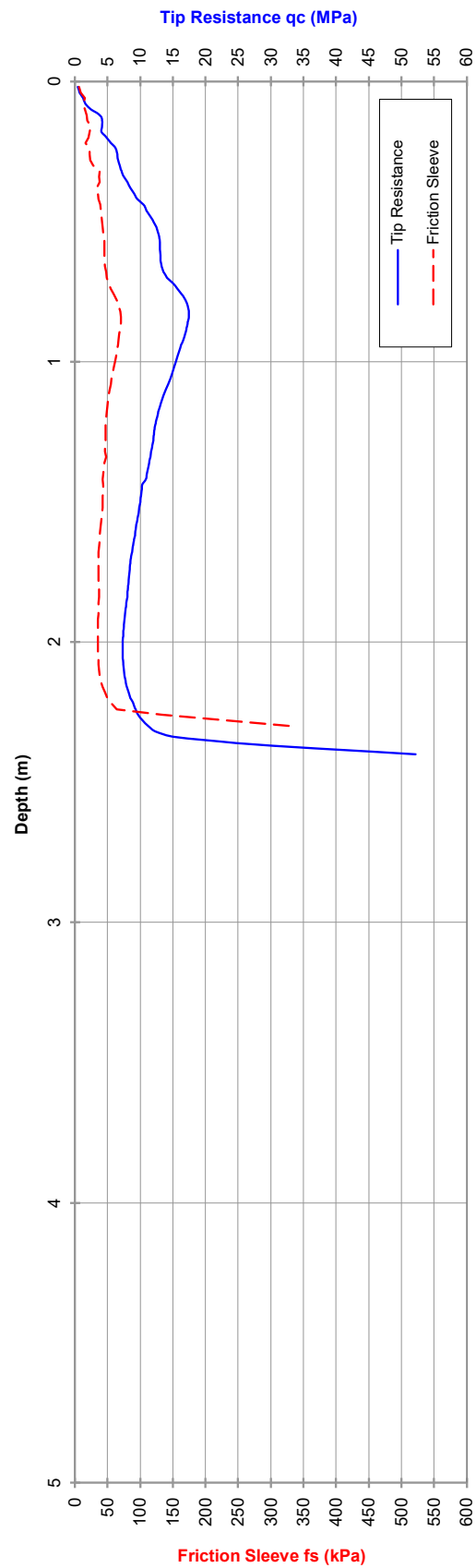
ELECTRIC FRICTION-CONE PENETROMETER

Probe I.D

CLIENT: Brown Geotechnical
PROJECT: 29 Stirling Crescent
LOCATION: High Wycombe

Job No.: 24024
RL (m):
Co-ords:

CPT 04
02-Jul-24



NOTES

BOREHOLE / TEST PIT STIRLING HATCH.GPJ GINT AUSTRALIA.GDT 13/08/14

CLIENT Marwon Pty Ltd PROJECT NAME Stirling Crescent/Hatch Court LSP
PROJECT NUMBER 14010 PROJECT LOCATION High Wycombe

DATE STARTED 25/06/14 COMPLETED 25/06/14 R.L. SURFACE 24.0 DATUM m AHD
DRILLING CONTRACTOR _____ SLOPE 90° BEARING ---
EQUIPMENT 5 tonne excavator HOLE LOCATION 31.92991S 116.00179E MGA
HOLE SIZE 0.5m x 1m LOGGED BY KB CHECKED BY KB

NOTES _____

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, grey, silty sand, with rootlets, moist		
						FILL: Dense, brown, clayey sand fill		
		23.5	0.5					
		23.0	1.0					
						SAND: Medium dense, medium, grey, trace silt, moist		
		22.5	1.5					
		22.0	2.0					
						wet below 2.3m		
		21.5	2.5					
						Borehole TH19 terminated at 2.5m		
		21.0	3.0					

CLIENT Marwon Pty Ltd PROJECT NAME Stirling Crescent/Hatch Court LSP
PROJECT NUMBER 14010 PROJECT LOCATION High Wycombe

DATE STARTED 25/06/14 COMPLETED 25/06/14 R.L. SURFACE 23.8 DATUM m AHD
DRILLING CONTRACTOR _____ SLOPE 90° BEARING ---
EQUIPMENT hand auger HOLE LOCATION 31.93049S 116.005206E MGA
HOLE SIZE 0.5m x 1m LOGGED BY KB CHECKED BY KB

NOTES _____

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, grey, silty sand, with rootlets, moist		
						FILL: Dense, brown, clayey sand fill		
		23.5						
			0.5					
		23.0						
			1.0			SAND: Medium dense, medium, grey, trace silt, moist		
		22.5						
			1.5					
						Borehole TH20 terminated at 1.5m		
		22.0						
			2.0					
		21.5						
			2.5					
		21.0						
			3.0					



SOIL | AGGREGATE | CONCRETE | CRUSHING

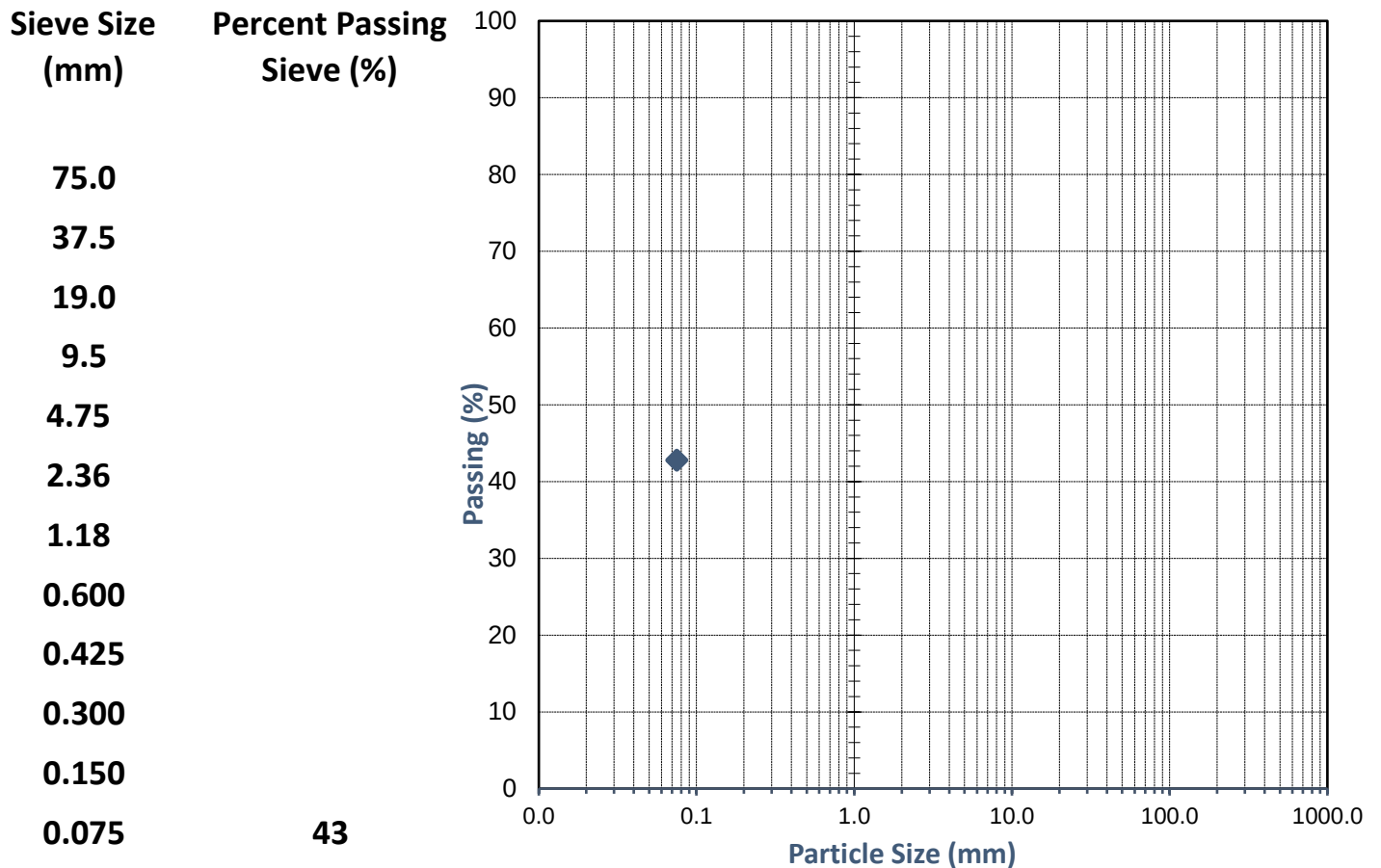
TEST REPORT - AS 1289.3.6.1 (% Fines)

Client:	Brown Geotechnical	Ticket No.	S13725
Client Address:	PO Box 278, Como WA 6952	Report No.	WG24.10365_1_%FINES
Project:	29 Stirling Crescent	Sample No.	WG24.10365
Location:	High Wycombe	Date Sampled:	2/07/2024
Sample Identification:	CPT4 - 0.5m	Date Tested:	04/07 - 05/07/2024

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments: Clients request for the % Fines of Material passing 0.075mm only.

Approved Signatory:

Name: Natasha Bielawski

Date: 05/July/2024



Accreditation No. 20599
Accredited for compliance
with ISO/IEC 17025 - Testing

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.2, 3.2.1, 3.3.1 & 3.4.1

Client:	Brown Geotechnical	Ticket No.	S13725
Client Address:	PO Box 278, Como WA 6952	Report No.	WG24.10365_1_PI
Project:	29 Stirling Crescent	Sample No.	WG24.10365
Location:	High Wycombe	Date Sampled:	2/07/2024
Sample Identification:	CPT4 - 0.5m	Date Tested:	5/07/2024

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:

Sampled by Client, Tested as Received

History of Sample:

Oven Dried <50°C

Method of Preparation:

Dry Sieved

AS 1289.3.1.2	Liquid Limit (%)	39
AS 1289.3.2.1	Plastic Limit (%)	17
AS 1289.3.3.1	Plasticity Index (%)	22
AS 1289.3.4.1	Linear Shrinkage (%)	8.0
AS 1289.3.4.1	Length of Mould (mm)	250
AS 1289.3.4.1	Condition of Dry Specimen	-

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 08/July/2024



Accreditation No. 20599

Accredited for compliance

with ISO/IEC 17025 - Testing

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CONDITIONS RELATING TO THIS REPORT

1. This report has been prepared for the sole use of the client. It has been issued in accordance with the agreed terms and scope detailed in the proposal for the investigation. No responsibility or liability to any third party is accepted for any damages arising out of the use of this report.
2. This report has been prepared by suitably qualified and experienced personnel for the purposes stated herein. Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussion of findings and recommendations given. No responsibility for the consequences of extrapolation by others is accepted by the company.
3. Findings and conclusions produced in the report are based on the investigation of the sub-surface through isolated locations. Conditions between investigated sites are based on extrapolation, interpretation and professional estimates. Unexpected variations in ground conditions often occur which cannot always be anticipated. The conclusions and recommendations in the report were considered accurate at the time of issue and based on certain assumptions at the time. Conditions and assumptions change with time and may affect the accuracy of the report.
4. Certain content within this report is based on information provided by the client and/or other parties and the accuracy of this information cannot be guaranteed.
5. These conditions must be read as part of the report and must be reproduced with all future copies.
6. The recommendations of this report should be considered a starting point. Recommendations should be continuously reviewed during the earthworks stage as sub-surface information and results from monitoring become available. It is strongly recommended that the Brown Geotechnical be retained to provide consultancy and/or inspections during the earthwork stages.