GeoEnviro Consultancy Pty Ltd
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2nd July 2018

Our Ref: JG18108A-r1

Colpani Group
65 Alexander Street
CROWS NEST NSW 2065

Attention: Mr Kiran Colpani

Dear Sir

Re Geotechnical Investigation Report
Proposed Mixed Use Development
608-612 High Street Penrith

1. Introduction

As requested, a geotechnical investigation was carried out at the above property on the 5th June 2018. The investigation was commissioned by Mr Kiran Colpani of Colpani Group following our fee proposal referenced PG18444A dated 8th May 2018.

We understand that the proposed development will include the demolition of all existing building and structures and construction of two blocks of six-storey buildings with a single level basement carpark used for commercial and residential purposes. Construction of the basement carpark will require excavation of up to about 3m.

The purpose of the investigation was to assess the site condition and based on the information obtained, to present comments and recommendations on the following;

- Subsurface ground conditions including bedrock and groundwater conditions,
- Comments on platform preparation and site excavation conditions,
- Recommendations on retaining walls and shoring design parameters,
- Recommendation on suitable footing types including allowable bearing capacities,
- Assessment on soil aggressiveness.

2. The Site

The property is located on the southern side of High Street in Penrith with Union Lane to the rear. The site is roughly trapezoidal in shape measuring about 29m along the High Street frontage by about 65m to the rear and about 37m along the Union Lane frontage.

The site is situated on low lying alluvial terrain of the Hawkesbury Nepean river system. Based on the 1:100,000 Geological Map of Penrith, the site is underlain by gravel, sand, silt and clay of the Quaternary Period.

Based on the engineering drawings provided, the site is approximately level with a Reduced Level (RL) of about 27m above the Australian Height Datum (AHD).

At the time of the site investigation, the site consisted of two properties and used mainly as a carpark. The eastern property was covered with gravel with the western property predominantly covered with concrete and a masonry building occupying the north-western portion of the site.

The site abuts to a three-storey building to the east and vacant land to the west.

3. Site Investigation

The fieldwork for the investigation consisted of drilling boreholes at four accessible locations (BH 1 to 4) as shown on the attached Drawing No 1 on the 5th June 2018. The boreholes drilled using spiral augers attached truck mounted B80 drill rig equipped for site investigation purposes.

The boreholes were drilled using spiral augers attached to a TC-bit to refusal depths on dense gravel at about 3.8m to 5.3m below existing ground surface.

In order to assess the strength of the subsurface soil, Standard Penetration Testing (SPT) was carried out in the boreholes. Hand penetrometer testing was carried out on the recovered SPT split-tube clayey samples to augment the SPT results.

The boreholes were noted for groundwater during and shortly after the investigation. Upon completion of the borehole investigation, the boreholes were backfilled with spoil generated from the drilling.

Details of the subsurface profile are summarised on the Borehole Reports attached. Explanatory notes and graphic symbols are also attached defining the terms and symbols used in the Borehole Reports.

Soil samples were taken from the boreholes and sent to Envirolab Services Pty Ltd for the following soil aggressiveness assessment;

- Electrical Conductivity
- Sulphate (SO_4)
- Chloride (Cl)
- Resistivity
- pH

4. Results of Investigation

4.1 Subsurface Conditions

Reference should be made to the Borehole Reports for details of the subsurface conditions encountered in each test location. The following is a summary of the subsurface condition encountered;

Fill

Concrete gravel with thickness of about 50mm was encountered on the surface of all boreholes. Immediately beneath the concrete gravel in all boreholes, fill consisting of Silty Clay, Silty Sand, Gravelly Silty Clay and Sand was encountered to depths ranging from 0.4m to 1.0m below existing ground surface.

Natural Soil

Underlying the fill, natural soil generally consisting of fine to medium grained Silty Sand was encountered in all boreholes. Clayey Sand was encountered at lower depths in BH 1 and 2.

Based on the SPT test results, the natural sandy soil was generally assessed to be loose. Some medium dense sand was encountered in the upper profiles in BH 1. The natural clayey and sandy soil was generally assessed to be dry to moist. Some moist to wet soil was encountered in BH 1 at a depth of about 3.4m below existing ground surface.

Quaternary Gravel

Subrounded river gravels and cobbles were encountered in all boreholes at depths ranging from 3.6m to 5.0m below existing ground surface.

From our assessment of the drilling resistance, the gravels and cobbles were assessed to be dense. The TC bit refused after a short penetration (ie 100m to 300m) into the gravels and cobbles.

Bedrock

Bedrock was not encountered in any of the boreholes which were taken to a maximum depth of 5.3m below existing ground surface.

Groundwater

Groundwater was encountered in BH 1 at a depth of about 7.8m below existing ground surface.

4.2 Laboratory Test Results

For details of the laboratory test results, refer to the attached test reports. The following is a summary of the laboratory test results.

BH	Depth	pH	EC	ECe	Cl^-	SO_4	Resistivity
BH 1	0.40-0.50	7.8	0.15	1.50			
	1.30-1.40	8.1	0.09	0.85	<10	94	12000
	2.60-2.70	8.7	0.05	0.49	<10	<10	
	4.00-4.10	8.1	0.02	0.22	<10	<10	
BH 2	1.10-1.20	7.3	0.03	0.34	<10	20	
	4.00-4.10	6.3	0.02	0.22	<10	25	45000
BH 3	1.00-1.10	7.0	0.04	0.42			
	2.80-2.90	7.2	0.03	0.30	<10	26	33000
	4.80-4.90	7.6	0.03	0.25	<10	<10	
BH 4	1.20-1.10	6.9	0.02	0.16	<10	<10	62000

Note:
EC – Electrical Conductivity (dS/m)
EC_e-Electrical Conductivity (dS/m)
CEC – Cation Exchange Capacity (cmol+/kg)
ESP – Exchangeable Sodium Percentage (%)
Resistivity – ohm/cm
CL – Chloride (mg/kg)
SO4- Sulphate (mg/kg)

5. Assessment and Recommendations

5.1 Excavation Conditions and Vibrations

We understand that the proposed development will include the construction of two blocks of six storey buildings with a single level basement. Construction of single level basement will require excavation up to about 3m deep.

Based on the results of our investigation, the site was found to be predominantly underlain by sands to depths of between 3.6m to 5.0m below existing ground surface. On this basis, basement excavation is expected to be mainly within the natural sandy profile and this may be carried out using a conventional hydraulic excavator. Excavation in the sandy soils is not expected to generate significant vibration resulting in damage to neighbouring buildings.

Not withstanding the above, in view of the close proximity of the excavation works to the neighbouring building on the eastern side, we recommend a dilapidation report be carried out on this building and this should be carried out by a suitably qualified person such as an engineer or a licensed builder. The dilapidation surveys should be presented to the respective property owners to ensure that the surveys presented are fair and reasonable

5.2 Retaining Walls and Shoring

We understand the proposed basement carpark will be constructed right up to or close to the northern and southern boundaries, setback between 1m to 3.5m from the western boundary and between 4m to 5m from the eastern boundary. Care should be taken to ensure the excavation works do not result in undermining of the foundations of the adjoining building to the east and council's footpath and underground services.

Basement construction will need to consider shoring and support of the excavation faces to prevent loss of ground support of footpaths and the adjoining properties. Due to the cohesionless nature of the soil profile, it is necessary to provide continuous support for the overburden soil, therefore a contiguous pier retaining system may be adopted.

As we anticipate groundwater to be present with the gravel stratum, grout injected piles or Continuous Flight Auger (CFA) piles are recommended. The shoring system should be continuous for the full height of the excavation and socketed into gravel or to sufficient depths into sandy soil to achieve adequate toe restraints. The retaining wall may be temporary braced or anchored with permanent support provided by the building floor slabs.

Alternatively, the shoring wall may be designed as a cantilever system and should this system may be the preferred option. If temporary anchors are proposed, permission must be obtained from the adjoining neighbours and the anchors will need to be de-stressed upon completion of building floor slab construction as the slabs will act as permanent restraints.

Shoring will not be required if excavation is further than 1.5 times the depth from the property boundaries. All unretained cut should be battered to not steeper than 1 Vertical to 1.5 Horizontal for the short term.

A slope batter of 1 Vertical to 2 Horizontal is considered stable for the long term.

The shoring wall may form part of the permanent retaining wall system for the proposed basement. The shoring/retaining wall system may be designed based on a rectangular stress block using an "at-rest" lateral earth pressure coefficient (Ko) of 0.6. For passive toe restraint, a passive earth pressure coefficient (Kp) of 2.5 may be adopted for the section in sand and this should be based on a triangular stress block.

The retaining wall design should be taken into consideration surcharge due to adjacent structures or construction loads.

5.3 Footings

Based on the results of the borehole investigation, the site was generally found to be underlain by loose sandy soil overlying dense gravel and cobbles at depths varying from 3.6m to 5.0m below existing ground surface.

We recommend that the proposed building be supported on piers founded on the gravels and cobbles at or below TC bit refusal depths. Based on our experience of sites in the Penrith region and the results of the investigation, we expect the gravel to be dense. On this basis, we consider an allowable bearing capacity of 500 kPa be adopted for piers founded on the gravels at TC bit refusal depths of 3.8m to 5.3m below existing ground surface.

Suitable piles may consist of grout injected piles or continuous flight auger (CFA). Bored piers taken to the gravels/cobble stratum may encounter groundwater, therefore not recommended.

Alternatively, steel screw piles may be adopted and adoption of piling system will need to consider adequate corrosion protection. Further consultation with the proprietary piling contraction should be sought for pile design capacities.

5.4 Basement Slab and Construction

Some groundwater seepage into the excavation may occur during and after construction. Perimeter drains should be constructed to collect seepage from the cut faces. Provision of a sub-floor drainage layer and a permanent sump and pump within the basement floor will also be required.

As the underlying sandy soil was assessed to be loose, some densification of the sandy subgrade will be required by rolling with a heavy compactor. Care should be taken to ensure that rolling and compaction will not result in excessive vibration causing damage to surrounding properties.

For slab on ground slab construction, the car park basement slab should have regularly spaced dowelled or keyed movement joints and is underlain by a compacted granular sub-base layer. The sub-base layer should be compacted to not less than 100% of Standard Maximum Dry Density.

Alternatively, the basement floor slab may be designed as a fully suspended slab system.

5.5 Soil Aggressiveness

The fundamental criterion for assessing soil salinity is based on Electrical Conductivity.

Class	EC_e (ds/m)
Non-Saline	<2
Slightly Saline	2-4
Moderately Saline	4-8
Very Saline	8-16
Highly Saline	>16

In addition to the above, the presence of Sulphate and Chloride in the soil has the potential to cause high soil aggressivity to concrete and steel structures, in particular if the structures are in direct contact with the soil. The following is a measure of soil aggressivity to concrete based on the Australian Standard.

Sulfate expressed as SO_3		PH	Chloride in water (ppm)	Soil conditions A*	Soil conditions B#
In Soil (ppm)	In Groundwater (ppm)				
<5000	<1000	>5.5	<6000	Mild	Non-aggressive
5000-10000	1000-3000	4.5-5.5	6000-12000	Moderate	Mild
10000-20000	3000-10000	4-4.5	12000-30000	Severe	Moderate
>20000	>10000	<4	>30000	Very Severe	Severe

Approximate 100ppm of SO4=80ppm of SO3
* Soil condition A = High permeability soils (eg sands and gravels) which is below groundwater
# Soil conditions B = Low permeability soils (eg silts and clays) and all soils above groundwater

The following is a measure of soil aggressivity to steel piles based on the Australian Standard.

pH	Chlorides (Cl)		Resistivity Ohm.cm	Soil conditions A*	Soil conditions B#
	In Soil Ppm	In water ppm			
>5	<5000	<1000	>5000	Non-aggressive	Non-aggressive
4-5	5000-20000	1000-10000	2000-5000	Mild	Non-aggressive
3-4	20000-50000	10000-20000	1000-2000	Moderate	Mild
<3	>50000	>20000	<1000	Severe	Moderate

* Soil condition A = High permeability soils (eg sands and gravels) which is below groundwater
# Soil conditions B = Low permeability soils (eg silts and clays) and all soils above groundwater

The laboratory test results indicate the insitu soil to be Non to Moderately Saline with EC values ranging from 1.76 to 6.93 dS/m.

The subsurface soil was found to have low concentrations of Sulphate however in an environment with the lowest pH of 7.2, the soil is considered to be Non aggressive to buried concrete structures

The subsurface soil was found to have low concentrations of Chloride, and with the lowest resistivity of 1300 ohm/m, the site was assessed to be Mildly aggressive to buried steel structures. We note that for steel piled foundation system where the screw piles are taken to below ground water table, we recommend the piles be designed for a Moderately aggressive condition.

6. Limitations

The interpretation and recommendations submitted in this report are based in part upon data obtained from a limited number of test pits at a site with restricted access. There is no investigation which is thorough enough to determine all site conditions and anomalies, no matter how comprehensive the investigation program is as site data is derived from extrapolation of limited test locations. The nature and extent of variations between test locations may not become evident until construction.

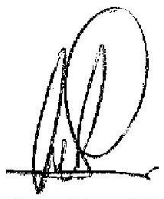
Groundwater conditions are only briefly examined in this investigation. The groundwater conditions may vary seasonally or as a consequence of construction activities on or adjacent to the site.

In view of the above, the subsurface soil and rock conditions between the test locations may be found to be different or interpreted to be different from those expected. If such differences appear to exist, we recommend that this office be contacted without delay.

The statements presented in this document are intended to advise you of what should be your realistic expectations of this report and to present you with recommendations on how to minimise the risk associated with groundworks for this project. The document is not intended to reduce the level of responsibility accepted by GeoEnviro Consultancy Pty Ltd, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in to doing.
Your attention is drawn to the attached “Explanatory Notes” and this document should be read in conjunction with our report

Should you have any queries, please contact the undersigned.

Yours faithfully
GeoEnviro Consultancy Pty Ltd



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Director

Attachment: Drawing No 1: Borehole Location Plan
Borehole Reports
Laboratory Test Reports
Explanatory Notes

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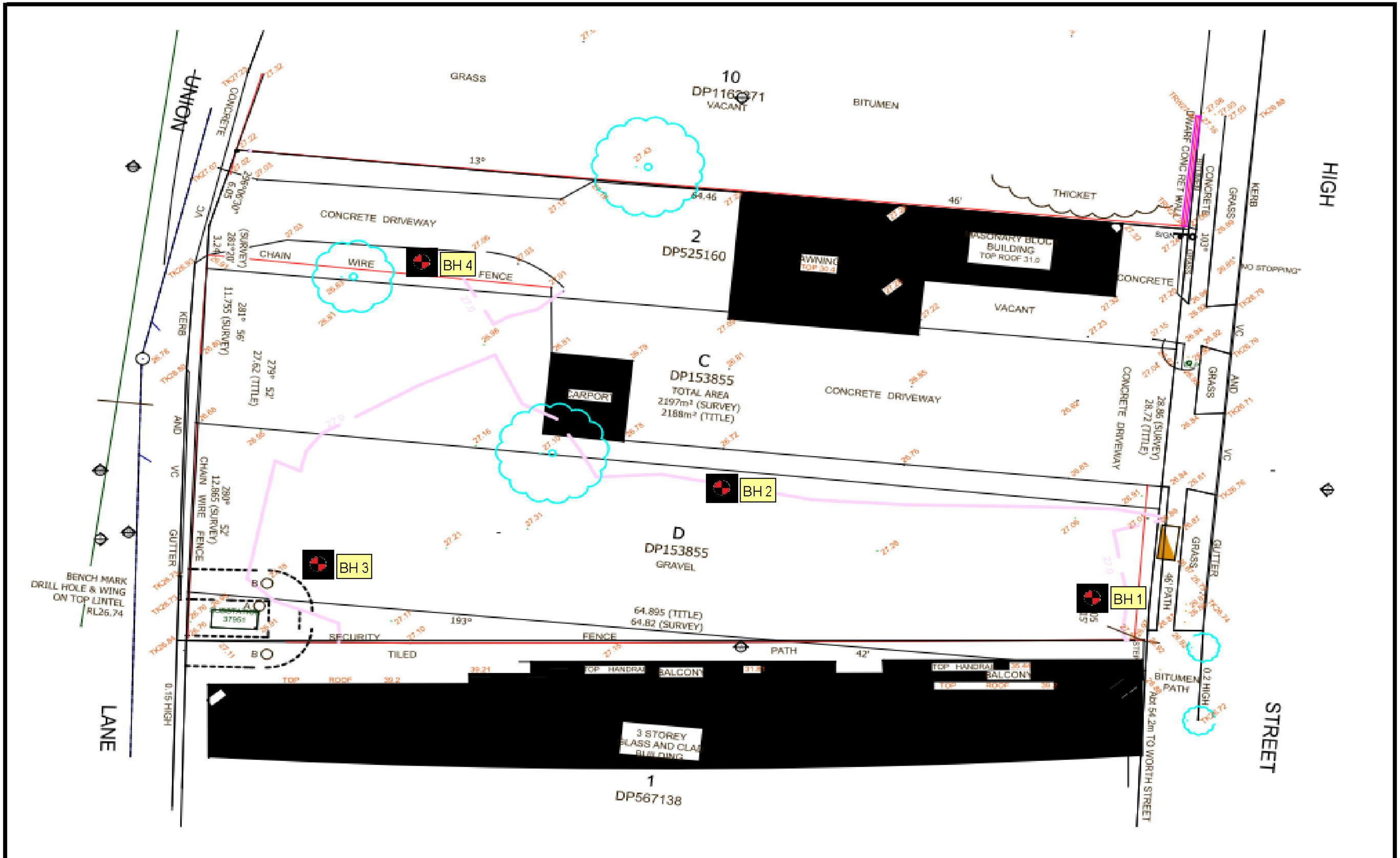

Legend

(symbol)	Borehole

GeoEnviro Consultancy

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Drawn By: AT	Date: 27/6/18	Colpani Group
Checked By: SL	Date: 27/6/18	608-612 High Street Penrith
Revision By:	Date:	Borehole Location Plan
Scale: Not to Scale	A3	Project No: JG18108A / Drawing No: 1

GeoEnviro Consultancy Pty Ltd
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Borehole Report

Borehole no: 1

Client: Colpani Group
Project: Proposed Mixed Use Development
Location: 608-612 High Street Penrith

Job no: JG18108A
Date: 27/6/18
Logged by: AT

Drill Model and Mounting: B80 | Slope: 90° | R.L. Surface: -
Hole Diameter: 100mm | Bearing: Vertical | Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC	NIL	DRY		0.0			Recycled Concrete: 50mm.t				
							Fill: Silty Clay: medium plasticity, brown with gravel	D			
							Fill: Silty Sand: fine to medium grained brown with gravel				
			5,5,6 N=11	1.0		SM	Silty Sand: fine to medium grained, light brown orange	D	MD		
				2.0			As above but red brown with trace of clay	D-M			
			2,3,3 N=6	3.0					L		
						SC	Clayey Sand: fine to medium grained, light brown	M-W	(L)		
			3,4,12 /100mm N>16	4.0							SPT bouncing at 4.4m TC bit refusal at 4.5m
							River Gravel/Cobble				
							End of BH 1 at 4.5m				
				5.0							
				6.0							
				7.0							
				8.0							

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Form no. R007/Ver04/06/10

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Borehole Report

Borehole no: 2

Client: Colpani Group
Project: Proposed Mixed Use Development
Location: 608-612 High Street Penrith

Job no: JG18108A
Date: 27/6/18
Logged by: AT

Drill Model and Mounting: B80 | Slope: 90° | R.L. Surface: -
Hole Diameter: 100mm | Bearing: Vertical | Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description (Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component)	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC	NIL	DRY					Recycled Concrete: 50mm.t				
							Fill: Gravelly Silty Clay: medium plasticity, brown	D			
						SM	Silty Sand: fine to medium grained, brown red	D			
			4,3,3 N=6	1.0					L		
				2.0			As above but red brown				
				3.0							
						SC	Clayey Sand: fine to medium grained, light brown	D-M	(L)		SPT bouncing at 4.35m
			4,8,10 /50mm N>18	4.0							TC bit refusal at 4.5m
							River Gravel/Cobble				
							End of BH 2 at 4.5m				
				5.0							
				6.0							
				7.0							
				8.0							

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Borehole Report

Borehole no: 3

Client: Colpani Group	Job no: JG18108A
Project: Proposed Mixed Use Development	Date: 27/6/18
Location: 608-612 High Street Penrith	Logged by: AT

Drill Model and Mounting: B80	Slope: 90°	R.L. Surface: -
Hole Diameter: 100mm	Bearing: Vertical	Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC	NIL	DRY					Recycled Concrete: 50mm.t				
							Fill: Sand: fine to medium grained, brown grey	D			
							As above but red brown				
				1.0		SM	Silty Sand: fine to medium grained, brown	D			
			3,3,3 N=6						L		
				2.0							
			3,2,4 N=6	3.0							
							As above but brown red with trace of clay	M			
				4.0							
							As above but grey brown				
				5.0			River Gravel/Cobble				TC bit refusal at 5.3m
							End of BH 3 at 5.3m				
				6.0							
				7.0							
				8.0							

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Borehole Report

Borehole no: 4

Client: Colpani Group
Project: Proposed Mixed Use Development
Location: 608-612 High Street Penrith

Job no: JG18108A
Date: 27/6/18
Logged by: AT

Drill Model and Mounting: B80 | Slope: 90° | R.L. Surface: -
Hole Diameter: 100mm | Bearing: Vertical | Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC	NIL	DRY					Recycled Concrete: 50mm.t				
							Fill: Silty Sand: fine to medium grained, brown	D			
						SM	Silty Sand: fine to medium grained, red brown	D-M			
			2,2,1 N=3	1.0					L		
				2.0							
							As above but grey brown with trace of clay	M			
				3.0							
							River Gravel/Cobble				TC bit refusal at 3.8m
				4.0			End of BH 4 at 3.8m				
				5.0							
				6.0							
				7.0							
				8.0							

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CERTIFICATE OF ANALYSIS 193483

Client Details

Client	Geoenviro Consultancy Pty Ltd
Attention	Solern Liew
Address	PO Box 1543, Macquarie Centre, North Ryde, NSW, 2113

Sample Details

Your Reference	**JG18108A, Penrith**
Number of Samples	10 Soil
Date samples received	06/06/2018
Date completed instructions received	06/06/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	14/06/2018
Date of Issue	13/06/2018

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Misc Inorg - Soil						
Our Reference		193483-1	193483-2	193483-3	193483-4	193483-5
Your Reference	UNITS	BH 1	BH 1	BH 1	BH 1	BH 2
Depth		0.40-0.50	1.30-1.40	2.60-2.70	4.00-4.10	1.10-1.20
Date Sampled		05/06/2018	05/06/2018	05/06/2018	05/06/2018	05/06/2018
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	07/06/2018	07/06/2018	07/06/2018	07/06/2018	07/06/2018
Date analysed	-	07/06/2018	07/06/2018	07/06/2018	07/06/2018	07/06/2018
pH 1:5 soil:water	pH Units	7.8	8.1	8.7	8.1	7.3
Electrical Conductivity 1:5 soil:water	µS/cm	150	85	49	22	34
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	94	<10	<10	20
Resistivity in soil*	ohm m	[NA]	120	[NA]	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		193483-6	193483-7	193483-8	193483-9	193483-10
Your Reference	UNITS	BH 2	BH 3	BH 3	BH 3	BH 4
Depth		4.00-4.10	1.00-1.10	2.80-2.90	4.80-4.90	1.20-1.10
Date Sampled		05/06/2018	05/06/2018	05/06/2018	05/06/2018	05/06/2018
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	07/06/2018	07/06/2018	07/06/2018	07/06/2018	07/06/2018
Date analysed	-	07/06/2018	07/06/2018	07/06/2018	07/06/2018	07/06/2018
pH 1:5 soil:water	pH Units	6.3	7.0	7.2	7.6	6.9
Electrical Conductivity 1:5 soil:water	µS/cm	22	42	30	25	16
Chloride, Cl 1:5 soil:water	mg/kg	<10	[NA]	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	25	[NA]	26	<10	<10
Resistivity in soil*	ohm m	450	[NA]	330	[NA]	620

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			07/06/2018	2	07/06/2018	07/06/2018		07/06/2018	[NT]
Date analysed	-			07/06/2018	2	07/06/2018	07/06/2018		07/06/2018	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	8.1	8.1	0	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	2	85	95	11	95	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	<10	<10	0	94	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	94	110	16	103	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	2	120	110	9	[NT]	[NT]

Document Set ID: 8331296
Version: 1, Version Date: 09/08/2018

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Document Set ID: 8331296
Version: 1, Version Date: 09/08/2018

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details	
Client	Geoenviro Consultancy Pty Ltd
Attention	Solern Liew

Sample Login Details	
Your reference	JG18108A, Penrith
Envirolab Reference	193483
Date Sample Received	06/06/2018
Date Instructions Received	06/06/2018
Date Results Expected to be Reported	14/06/2018

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	10 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	16.6
Cooling Method	Ice Pack
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

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Sample ID	Misc Inorg - Soil
BH 1-0.40-0.50	✓
BH 1-1.30-1.40	✓
BH 1-2.60-2.70	✓
BH 1-4.00-4.10	✓
BH 2-1.10-1.20	✓
BH 2-4.00-4.10	✓
BH 3-1.00-1.10	✓
BH 3-2.80-2.90	✓
BH 3-4.80-4.90	✓
BH 4-1.20-1.10	✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.

Requests for longer term sample storage must be received in writing.

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GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

ENVIROLAB Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 193483
Date Received: 6/6/18
Time Received: 18:30
Received By: KL ELS.
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Laboratory Test Request/Chain of Custody Record

Job Details
Job Number: JG18108A
Client:
Project: Proposed Residential Unit Development
Location: 608-612 High Street Penrith

Sample Date: 5/6/18
Sampled By: AT
Project Manager: SL
Store Location:

External Laboratory Details:
Laboratory name: Envirolab Services Pty Ltd
Address: 12 Ashley Street
Chatswood
Contact: Tania Notaris

Sampling Details | Depth (m) | Sample Type | Test Required (\) | Test Performed(X)

Location	From	To	Soil	Water	Metals (As Cd Cr Cu Pb Zn Ni Hg)	OCP / PCB		Combination 5	Combination 5a	Combimation 12a		Asbestos		pH	EC	CEC/ESP	Cl / SO4	Resistivity								Keep Sample
BH 1 1	0.40	0.50	DG											/	/											
BH 1 2	1.30	1.40	DG											/	/		/	/								
BH 1 3	2.60	2.70	DG											/	/		/									
BH 1 4	4.00	4.10	DG											/	/		/									
BH 2 5	1.10	1.20	DG											/	/		/									
BH 2 6	4.00	4.10	DG											/	/		/	/								
BH 3 7	1.00	1.10	DG											/	/		/									
BH 3 8	2.80	2.90	DG											/	/		/	/								
BH 3 9	4.80	4.90	DG											/	/		/									
BH 4 10	1.20	1.10	DG											/	/		/	/								

Relinquished by

Laboratory	Name	Signature	Date
GeoEnviro Consultancy	Adrian Tejada	[signature]	5/06/2018

Received By ELS syd

Laboratory	Name	Signature	Date
	KL.	[signature]	6/6/18.

Legend

DB Disturbed Sample (Bulk, Plastic bag)
DS Disturbed Sample (Small, Plastic bag)
DG Disturbed Sample (Glass Jar)
STP Standard Penetration Test Sample

U50 Undisturbed Sample, 50mm Tube
U75 Undisturbed Sample, 75mm Tube
WG Water Sample, Amber Glass Jar
WP Water Sample, Plastic Bottle

Y Keep Sample
N Discard Sample

EXPLANATORY NOTES

Introduction

These notes have been provided to amplify the geotechnical report with regard to investigation procedures, classification methods and certain matters relating to the Discussion and Comments sections. Not all notes are necessarily relevant to all reports.

Geotechnical reports are based on information gained from finite sub-surface probing, excavation, boring, sampling or other means of investigation, supplemented by experience and knowledge of local geology. For this reason they must be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods
The methods the description and classification of soils and rocks used in this report are based on Australian standard 1726, the SSA Site investigation Code, in general descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions. Identification and classification of soil and rock involves to a large extent, judgement within the acceptable level commonly adopted by current geotechnical practices.

Soil types are described according to the predominating particle size, qualified by the grading or other particles present (eg sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	Less than 0.002mm
Silt	0.002 to 0.6mm
Sand	0.6 to 2.00mm
Gravel	2.00m to 60.00mm

Soil Classification	Particle size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2.00mm
Gravel	2.00mm to 60.00mm

Cohesive soils are classified on the basis of strength, either by laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Undrained Shear Strength kPa
Very Soft	Less than 12
Soft	12 - 25
Firm	25 - 50
Stiff	50 - 100
Very Stiff	100 - 200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer test (CPT), as below:

Relative Dense	SPT 'N' Value (blows/300mm)	CPT Cone Value (q_c-Mpa)
Very Loose	Less than 5	Less than 2
Loose	5 - 10	2 - 5
Medium Dense	10 - 30	5 - 15
Dense	30 - 50	15 - 25
Very Dense	> 50	> 25

Rock types are classified by their geological names, together with descriptive terms on degrees of weathering strength, defects and other minor components. Where relevant, further information regarding rock classification, is given on the following sheet.

Sampling
Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provided information on plasticity, grained size, colour, type, moisture content, inclusions and depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin walled sample tube (normally know as U_{50}) into the soil and withdrawing a sample of the soil in a relatively undisturbed state. Such Samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Details of the type and method of sampling are given in the report.

Field Investigation Methods
The following is a brief summary of investigation methods currently carried out by this company and comments on their use and application.

Hand Auger Drilling
The borehole is advanced by manually operated equipment. The diameter of the borehole ranges from 50mm to 100mm. Penetration depth of hand augered boreholes may be limited by premature refusal on a variety of materials, such as hard clay, gravels or ironstone.

Test Pits
These are excavated with a tractor-mounted backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3.0m for a backhoe and up to 6.0m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Care must be taken if construction is to be carried out near, or within the test pit locations, to either adequately recompact the backfill during construction, or to design the structure or accommodate the poorly compacted backfill.

Large Diameter Auger (eg Pengo)
The hole is advanced by a rotating plate or short spiral auger generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 05m) and are disturbed, but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers and is usually supplemented by occasional undisturbed tube sampling.

Continuous Spiral Flight Augers
The hole is advanced by using 90mm - 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the augers flights, but they are very disturbed and may be highly mixed with soil of other stratum.

Information from the drilling (as distinct from specific sampling by SPT or undisturbed samples) is of relatively low reliability due to remoulding, mixing or softening of samples by ground water, resulting in uncertainties of the original sample depth.

Continuous Spiral Flight Augers (continued)
The spiral augers are usually advanced by using a V - bit through the soil profile refusal, followed by Tungsten Carbide (TC) bit, to penetrate into bedrock. The quality and continuity of the bedrock may be assessed by examination of the recovered rock fragments and through observation of the drilling penetration resistance.

Non - core Rotary Drilling (Wash Boring)
The hole is advanced by a rotary bit, with water being pumped down the drill rod and returned up the annulus, carrying the cuttings, together with some information from the "feel" and rate of penetration.

Rotary Mud Stabilised Drilling
This is similar to rotary drilling, but uses drilling mud as a circulating fluid, which may consist of a range of products, from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg SPT and U_{50} samples).

Continuous Core Drilling
A continuous core sample is obtained using a diamond tipped core barrel. Providing full core recovery is achieved (which is not always possible in very weak rock and granular soils) this technique provides a very reliable (but relatively expensive) method of investigation. In rocks an NMLC triple tube core barrel which gives a core of about 50mm diameter, is usually used with water flush.

Portable Proline Drilling
This is manually operated equipment and is only used in sites which require bedrock core sampling and there is restricted site access to truck mounted drill rigs. The boreholes are usually advanced initially using a tricone roller bit and water circulation to penetrate the upper soil profile. In some instances a hand auger may be used to penetrate the soil profile. Subsequent drilling into bedrock involves the use of NMLC triple tube equipment, using water as a lubricant.

Standard Penetration Tests
Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils, as a means of determining density or strength and of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289 "Methods of testing Soils for Engineering Purpose"- Test F31.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63Kg hammer with a free fall of 769mm. It is normal for the tube to be driven in three successive 150mm increments and the "N" value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rocks, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In a case where full penetration is obtained with successive blows counts for each 150mm of, say 4, 6, and 7 blows.

  as 4, 6, 7
  N = 13

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm.

  as 15,30/40mm

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally the test methods is used to obtain samples in 50mm diameter thin walled samples tubes in clays. In these circumstances, the best results are shown on the bore logs in brackets.

Dynamic Cone Penetration Test
A modification to the SPT test is where the same driving system is used with a solid 60^0 tipped steel cone of the same diameter as the SPT hollow sampler. The cone can be continuously driven into the borehole and is normally used in areas with thick layers of soft clays or loose sand. The results of this test are shown as 'N_c' on the bore logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing and Interpretation
Cone penetrometer testing (sometimes referred to as Dutch Cone-CPT) described in this report, has been carried out using an electrical friction cone penetrometer and the test is described in Australian Standard 1289 test F5.1.

In the test, a 35mm diameter rod with cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig, which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130mm long sleeve, immediately behind the cone. Transducer in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output on continuous chart recorders. The plotted results in this report have been traced from the original records. The information provided on the charts comprises:

- Cone resistance - the actual end bearing force divided by the cross sectional area of the cone, expressed in Mpa.
- Sleeve friction - the frictional force on the sleeve divided by the surface area, expressed in kPa.
- Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percentage.

There are two scales available for measurement of cone resistance. The lower "A" scale (0-5Mpa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main "B" scale (0-50Mpa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative frictions in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and very soft clays, rising to 4% to 10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

$$q_c \text{ (Mpa)} = (0.4 \text{ to } 0.6) \text{ N (blows per 300mm)}$$

In clays the relationship between undrained shear strength and cone resistance is commonly in the range:

$$q_c = (12 \text{ to} 18)\ C_u$$

Interpretation of CPT values can also be made to allow estimate of modulus or compressibility values to allow calculation of foundation settlements. Inferred stratification, as shown on the attached report, is assessed from the cone and friction traces, from experience and information from nearby boreholes etc.

Cone Penetrometer Testing and Interpretation continued
This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties and where precise information or soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometer (AS1289)
Portable dynamic cone penetrometer tests are carried out by driving a rod in to the ground with a falling weight hammer and measuring the blows per successive 100mm increments of penetration.

There are two similar tests, Cone Penetrometer (commonly known as Scala Penetrometer) and the Perth Sand Penetrometer. Scala Penetrometer is commonly adopted by this company and consists of a 16mm rod with a 20mm diameter cone end, driven with a 9kg hammer, dropping 510mm (AS 1289 Test F3.2).

Laboratory Testing
Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedures are given on the individual report forms.

Engineering Logs
The engineering logs presented herein are an engineering and/or geological interpretation of the sub-surface conditions and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, however, this is not always practicable or possible to justify economically. As it is, the boreholes represent only a small sample of the total sub-surface profile. Interpretation of the information and its application to design and construction should take into account the spacing of boreholes, frequency of sampling and the possibility of other than "straight line" variations between the boreholes.

Ground water
Where ground water levels are measured in boreholes, there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all, during the investigation period.
- A localised perched water table may lead to a erroneous indication of the true water table.
- Water table levels will vary from time to time, due to the seasons or recent weather changes. They may not be the same at the time of construction as indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole if any water observations are to be made.

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

Engineering Reports
Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal is changed, say to a twenty storey building. If this occurs, the company will be pleased to review the report and sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussions of geotechnical aspects and recommendations or suggestions for design and construction. However, the company cannot always anticipate or assume responsibility for:

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

If these occur, the company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the company request immediate notification. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes
Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information trader Documents", published by the Institute of Engineers Australia. Where information obtained for this investigation is provided for tender purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or make additional copies of the report available for contract purpose, at a nominal charge.

Site Inspection
The Company will always be pleased to provide engineering inspection services for geotechnical aspect of work to which this report is related. This could range from a site visit to confirm that the conditions exposed are as expected, to full time engineering presence on site

Review of Design
Where major civil or structural developments are proposed, or where only a limited investigation has been completed, or where the geotechnical conditions are complex, it is prudent to have the design reviewed by a Senior Geotechnical Engineer.

Graphic Symbols For Soil and Rock

SOIL

- Fill
- Topsoil
- Gravel (GW , GP)
- Sand (SP, SW)
- Silt (ML, MH)
- Clay (CL, CH)
- Clayey Gravel (GC)
- Silty Sand (SM)
- Clayey Sand (SC)
- Sandy Silt (ML)
- Gravelly Clay (CL, CH)
- Silty Clay (CL, CH)
- Sandy Clay (CL, CH)
- Peat or Organic Soil

ROCK

- Shale
- Sandstone
- Siltstone,Mudstone,Claystone
- Granite, Gabbro
- Dolerite, Diorite
- Basalt, Andesite

Other Materials

- Concrete
- Bitumen, Asphaltic Concrete, Coal
- Ironstone Gravel
- Organic Material