Geotechnical Investigation Report

GEOTECHNICAL REPORT FOR

36-38 RODLEY AVENUE, PENRITH NSW

Prepared for:

INGLOW INVESTMENT TWO PTY LTD

Reference: P1720_ 01 rev1

13 August 2019

Morrow Geotechnics Pty Ltd | ABN 42 605 892 126
PO Box 4069, Carlton NSW 2218
P: 0405 843 933 | E: info@morrowgeo.com.au

Document Set ID: 8825174
Version: 1, Version Date: 26/08/2019

1 PROJECT BACKGROUND

Morrow Geotechnics Pty Ltd has undertaken a Geotechnical Investigation to provide geotechnical advice and recommendations for the proposed development at 36-38 Rodley Avenue, Penrith NSW (the site).

1.1 Proposed Development

Architectural Drawings for the site have been prepared by Morson Group and dated 1 July 2019. From the drawings provided, Morrow Geotechnics understands that the proposed development involves demolition of existing structures at the site and construction of a six-storey residential structure over a two level basement. Excavation is expected to extend to a depth of approximately 6.5 m below existing ground level (mBGL).

1.2 Investigation Intent

The purpose of the investigation is to provide geotechnical advice and recommendations specific to the ground conditions observed at site for the proposed development. These recommendations include:

- Foundation advice along with relevant geotechnical design parameters;
- Excavation and shoring advice along with relevant geotechnical design parameters;
- Approaches to minimise the impact of the proposed development through vibration, ground movement or groundwater drawdown;
- Other relevant geotechnical issues which may impact construction; and
- Recommendations for further geotechnical input.

1.3 Published Geological Mapping

Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Penrith 1:100,000 Geological Series Sheet 9030 (DMR 1991), indicates that the site overlies the Cranebrook Formation of the Quaternary Period, which typically comprises gravel, sand, silt and clay.

1.4 Published Soil Landscapes

The Soil Conservation Service of NSW Penrith 1:100,000 Soil Landscapes Series Sheet 9030 (1st Edition) indicates that the alluvial landscape at the site likely comprises the Richmond Landscape. This landscape type typically includes Quaternary terraces of the Nepean and Georges Rivers, with slopes of < 1 %. It generally comprises poorly structured orange to red clay loams, clays and sands. These soils are noted to present localised seasonal waterlogging, localised flood hazard and localised water erosion hazard on terrace edges.

2 OBSERVATIONS

2.1 Investigation Methods

Fieldwork was undertaken by Morrow Geotechnics on 29 and 30 July 2019. Work carried out as part of this investigation includes:

- Review of publicly available information from previous reports in the project area, published geological and soil mapping and government agency websites;
- Site walkover inspection by a Geotechnical Engineer to assess topographical features, condition of surrounding structures and site conditions;
- Dial Before You Dig (DBYD) services search of proposed borehole locations;
- Drilling of two boreholes (BH1 and BH2) by a track mounted drill rig using solid flight augers equipped with a tungsten-carbide bit (TC bit) and rock rolling. The boreholes were extended beyond rock rolling by NMLC coring techniques to depths of 15.81, and 13.54 m below ground level (mBGL) respectively. Rock core was boxed and photographed and point load tests were undertaken on selected core sample to assess rock strength. Borehole locations are shown on **Figure 1** and borehole logs are presented in **Appendix A**;
- Groundwater observations within boreholes during drilling.

2.2 Subsurface Conditions

The stratigraphy at the site is characterised by alluvial soils and cobble overlying interbedded sandstone and siltstone bedrock. Observations taken during the investigation have been used to produce a stratigraphic model of the site. The observed stratigraphy has been divided into four geotechnical units.

A summary of the subsurface conditions across the site, interpreted from the investigation results, is presented in **Table 1**. More detailed descriptions of subsurface conditions at the test locations are available in the borehole logs presented in **Appendix A**. The details of the method of soil and rock classification, explanatory notes and abbreviations adopted in the borehole logs are also presented in **Appendix A**.

TABLE 1 SUMMARY OF INFERRED SUBSURFACE CONDITIONS

Unit	Material	Approx. Depth Range of Unit [1] mBGL		Comments
		BH1	BH2	
1	Topsoil / Fill	0.0 to 0.4	0.0 to 0.2	Generally fine to medium grained Silty SAND with some gravel and organic material present. Fill material within Unit 1 is inferred to be uncontrolled and poorly compacted.
2	Alluvial Soil	0.4 to 3.5	0.2 to 3.6	Generally medium to high plasticity silty clay and fine to medium grained sand. Medium dense.
3	Alluvial Cobble	3.5 to 10.56	3.6 to 10.4	Generally cobble with some gravel and sand.
4	Laminite	10.56 +	10.4 +	Generally slightly weathered to fresh, medium to high strength. Defects are generally clay seams, horizontally oriented bedding partings and joint inclined up to 70°.

Notes:

1 Depths shown are based on material observed within test locations and will vary across the site.

2.3 Groundwater Observations

A Piezometer was installed within BH1 and bailed dry of drilling fluids on 29 July 2019. Groundwater levels within BH1 were measured during a site visit on 6 August 2019 at 5.8 mBGL.

2.4 Laboratory Test Results

Six soil samples were selected for laboratory testing. A summary of test results is provided in **Table 2**.

TABLE 2 SUMMARY OF CHEMICAL LABORATORY TEST RESULTS

Sample ID	BH1 SPT1	BH1 SPT2	BH1 SPT3	BH2 SPT1	BH2 SPT2	BH2 SPT3
Depth	0.5m	1.5m	3.0m	0.5m	1.5m	3.0m
Conductivity (µS/cm)	95	200	290	77	74	46
Exchangeable Sodium %	-	25.7	-	-	4.6	-
Cation Exchange Capacity (meq/100g)	-	20	-	-	4.2	-

3 RECOMMENDATIONS

3.1 Excavation Retention

Temporary batters may be considered for retention during basement excavation only where adequate room for full batter construction is available. Temporary batter slopes of 1V:1H will be possible for all units above the water table provided that surface water is diverted away from the batter faces and batter heights are kept to less than 4m. Where batters extend beyond 4 m height benching may be required and further advice should be sought from a qualified geotechnical engineer. Permanent batters of 2H:1V may be employed for excavation design above the water table. Permanent batters will require surface protection or revegetation to prevent erosion and slaking.

For design of flexible shoring systems a triangular pressure distribution may be employed using the parameters provided in **Table 3**. For design of rigid anchored or braced walls, a trapezoidal earth pressure distribution should be used with a maximum pressure of $0.65.K_a.\gamma.H$ (kPa), where 'H' is the effective vertical height of the wall in metres.

TABLE 3 EARTH PRESSURE PARAMETERS

Material		Unit 1 Topsoil / Fill	Unit 2 Alluvial Soil	Unit 3 Alluvial Cobble	Unit 4 Laminite
Bulk Unit Weight (kN/m^3)		17	17	19	24
Earth Pressure Coefficients	At rest, K_o	0.53	0.50	0.38	0.20
	Passive, K_p	2.77	3.00	4.20	5.00
	Active, K_a	0.36	0.33	0.24	0.10

1 Unit Weight is based on visual assessment only, order of accuracy is approximately ±10%.
2 Earth pressures are provided on the assumption that the ground behind the retaining wall is flat and drained.

In addition, design of retaining walls should consider the following:

- Appropriate surcharge loading from construction equipment, vehicular traffic and neighbouring structures at finished surface level should be taken into account in the retention design. Surcharge loads on retention structures may be calculated using a rectangular stress block with an earth pressure coefficient of 0.5 applied to surcharge loads at ground surface level.
- Anchor design should ignore the contribution of any bonded length within a wedge which extends upwards at 45^{o} from the base of the excavation to account for a failure wedge forming behind the shoring system.

3.2 Soil and Rock Excavatability

The expected ability of equipment to excavate the soil and rock encountered at the site is summarised in **Table 4**. This assessment is based on available site investigation data and guidance on the assessment of excavatability of rock by Pettifer and Fookes (1994). The presence of medium to high strength bands in lower strength rock and the discontinuity spacing may influence the excavatability of the rock mass.

TABLE 4 SOIL AND ROCK EXCAVATABILITY

Unit	Material	Excavatability
1	**Topsoil / Fill**	Easy digging by 20t Excavator
2	**Alluvial Soil**	Easy digging by 20t Excavator
3	**Alluvial Cobble**	Moderate to hard ripping by 20t Excavator
4	**Laminite**	Hard ripping by 20t Excavator with hydraulic hammering required where medium strength shale is encountered within Unit 4

The excavation methodology may also be affected by the following factors:

- Scale and geometry of the excavation;
- Availability of suitable construction equipment;
- Potential reuse of material on site; and
- Acceptable excavation methods, noise, ground vibration and other environmental criteria.

3.3 Excavation Vibration Considerations

As a guide, safe working distances for typical items of vibration intensive plant are listed in **Table 5**. The safe working distances are quoted for both "cosmetic" damage (refer British Standard BS 7385:1993) and human comfort (refer NSW Environmental Protection Agency Vibration Guideline).The safe working distances should be complied with at all times, unless otherwise mitigated to the satisfaction of the relevant stakeholders.

TABLE 5 RECOMMENDED SAFE WORKING DISTANCES FOR VIBRATION INTENSIVE PLANT

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385:1993) [1]	Human Response (EPA Vibration Guideline)
Vibratory Roller	< 50 kN (typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (typically 2-4 tonnes)	6 m	20 m
	< 200 kN (typically 4-6 tonnes)	12 m	40 m
	< 300 kN (typically 7-13 tonnes)	15 m	100 m
	< 300 kN (typically 13-18 tonnes)	20 m	100 m
	< 300 kN (typically >18 tonnes)	25 m	100 m
Small Hydraulic Hammer	300 kg – 5 to 12 t excavator	2 m	7 m
Medium Hydraulic Hammer	900 kg – 12 to 18 t excavator	7 m	23 m
Large Hydraulic Hammer	1600 kg – 18 to 34 t excavator	22 m	73 m
Vibratory Pile Driver	Sheet Piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Notes:

1 More stringent conditions may apply to heritage buildings or other sensitive structures.

In relation to human comfort (response), the safe working distances in **Table 5** relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are permitted, as discussed in British Standard BS 6472-1:2008.

The safe working distances provided in **Table 5** are given for guidance only. Monitoring of vibration levels may be required to ensure vibrations levels remain below threshold values during the construction period.

3.4 Foundation Design

The parameters given in **Table 6** may be used for the design of pad footings and bored piles. Morrow Geotechnics recommends that a Preliminary Geotechnical Strength Reduction Factor (GSRF) of 0.4 is used for the design of piles in accordance with AS 2159:2009 if no allowance is made for pile testing during construction. Should pile testing be nominated, the GSRF may be reviewed and a value of 0.55 to 0.65 may be expected.

Ultimate geotechnical strengths are provided for use in limit state design. Allowable bearing pressures are provide for serviceability checks. These values have been determined to limit settlements to an acceptable level for conventional building structures, typically less than 1% of the minimum footing dimension.

TABLE 6 PAD FOOTING AND PILE DESIGN PARAMETERS

Material		Unit 1 Topsoil / Fill	Unit 2 Alluvial Soil	Unit 3 Alluvial Cobble	Unit 4 Laminite
Allowable Bearing Pressure (kPa)		N/A	180	600	3500
Ultimate Vertical End Bearing Pressure (kPa)		N/A	550	1800	10500
Elastic Modulus (MPa)		3	30	75	200
Allowable Shaft Adhesion (kPa)	In Compression	0	20	50	300
	In Tension	0	10	25	150
Susceptibility to Liquefaction during an Earthquake		Medium	Medium	Low	Low

Notes:

1 Side adhesion values given assume there is intimate contact between the pile and foundation material. Design engineer to check both 'piston' pull-out and 'cone' pull-out mechanics in accordance with AS4678-2002 Earth Retaining Structures.

2 Susceptibility to liquefaction during an earthquake is based on the following definition:

Low - Medium to very dense sands, stiff to hard clays, and rock
Medium - Loose to medium dense sands, soft to firm clays, or uncontrolled fill below the water table
High - Very loose sands or very soft clays below the water table

To adopt these parameters we have assumed that the bases of all pile excavations are cleaned of loose debris and water and inspected by a suitably qualified Geotechnical Engineer prior to pile construction to verify that ground conditions meet design assumptions. Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremmie system could be used.

Selection of footing types and founding depth will need to consider the risk of adverse differential ground movements within the foundation footprint and between high level and deeper footings. Unless an allowance for such movement is included in the design of the proposed development we recommend that all new structures found on natural materials with comparable end bearing capacities and elastic moduli.

3.5 AS1170 Earthquake Site Risk Classification

Assessment of the material encountered during the investigation in accordance with the guidelines provided in AS1170.4-2007 indicates an earthquake subsoil class of Class C_e – Shallow Soil for the site.

3.6 Groundwater Management

Groundwater levels observed on site during the investigation were at approximately 1 m above the proposed bulk excavation level. The soils observed at this level are typically moderately to highly permeable and groundwater management of the excavation to prevent ongoing groundwater inflow will be required. It is recommended that the basement shoring is designed as a tanked system to a minimum of 1 m above the long term measured groundwater level. Watertight shoring walls are usually achieved through either secant piles, cutter soil mix walls or sheet piling. Alternatively, contractors with experience within these ground conditions may prefer a drained excavation during construction and pouring of a monolithic slab with upturn to above the design groundwater level.

If the basement shoring is designed as a watertight wall it will be necessary to design walls to withstand hydrostatic pressures and anchoring or internal bracing will be required.

3.7 Soil Salinity

A soil salinity assessment in accordance with the recommendations of Department of Land and Water Conservation, *Site Investigations for Urban Salinity*, 2002 has been carried out at the site. The laboratory Electrical Conductivity (EC) has multiplied by a factor varying from 7, based on the texture of the soil samples obtained, to obtain Corrected Electrical Conductivity designated as ECe as presented in **Table 7** below. In addition to this Exchangeable Sodium Percentage and Cation Exchange Capacity results have been compared with criteria within the guidelines.

TABLE 7 SOIL SALINITY / SODICITY INTERPRETATION

Sample ID	BH1 SPT1	BH1 SPT2	BH1 SPT3	BH2 SPT1	BH2 SPT2	BH2 SPT3
Depth (mBGL)	0.5m	1.5m	3.0m	0.5m	1.5m	3.0m
Conductivity (µS/cm)	95	200	290	77	74	46
Corrected Electrical Conductivity (dS/m)	0.67	1.40	2.03	0.54	0.52	0.32
Exchangeable Sodium Percentage (%)	-	25.7	-	-	4.6	-
Cation Exchange Capacity (meq/100g)	-	20	-	-	4.2	-
Assessed Sodicity / Salinity	**Non Saline**	**Non Saline / Highly Sodic**	**Slightly Saline**	**Non Saline**	**Non Saline / Non-Sodic**	**Non Saline**

On the basis of laboratory testing undertaken as part of this investigation the site is assessed to be **non-saline to slightly saline** and **non-sodic to highly sodic**.

When wet, sodic soils lose their structure and disperse into very small particles, the small particles fill the pore spaces in the soil effectively blocking them. This impermeable layer can severely impede water movement. Excessive water entering the profile may be prevented from draining further by the sodic layer and result in tunnelling soil erosion. Gullying or tunnelling can be an issue if the sodic subsoil is exposed to rainfall, or construction leads to an outlet developing for water ponded above a sodic layer. With a sodic layer near the surface erosion can be an issue. Plants may have problems establishing if erosion has removed the nutrients and the sodic crust is preventing air and water entering the soil profile. Stability for structures may also be an issue especially if the layer is thick. Calcium, mostly in the form of gypsum, is often added to sodic soil to address the balance between sodium and calcium in the soil.

To minimise the impact of the development on the water and salt processes on the site, possible management options might include:

- minimising water infiltration;
- the use of landscaping using native plants;
- sealing stormwater detention ponds;
- retention of deep rooted vegetation; or
- minimising soil disturbance such as compaction and cut and fill.

To minimise the impact of the water and salt processes on the development, possible management options may include:

- careful installation of damp proof courses;
- water proofing the slab;
- good site drainage; or
- the use of higher strength concrete with thicker cover and exposure class masonry.

4 RECOMMENDATIONS FOR FURTHER GEOTECHNICAL SERVICES

Further geotechnical inspections should be carried out during construction to confirm the geotechnical and hydrogeological model. These should include:

- All excavated material transported off site should be classified in accordance with NSW EPA 2014 - Waste Classification Guideline Part 1; Classifying Waste.
- A suitably qualified geotechnical engineer is to assess the condition of exposed material at foundation or subgrade level to assess the ability of the prepared surface to act as a foundation or as a subgrade.
- Regular inspections of battered and unsupported excavations, where proposed, to confirm geotechnical conditions and to assess the suitability of design assumptions and to provide further advice with regards to excavation retention/ support and proposed construction methodologies, if required.

5 STATEMENT OF LIMITATIONS

The adopted investigation scope was limited by site access restrictions due to presence of structures at the site at the time of our investigation and by the investigation intent. Further geotechnical inspections should be carried out during construction to confirm both the geotechnical model and the design parameters provided in this report.

Your attention is drawn to the document “Important Information”, which is included in **Appendix B** of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Morrow Geotechnics, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

6 REFERENCES

AS1726:1993, *Geotechnical Site Investigations*, Standards Australia.

AS2159:2009, *Piling – Design and Installation*, Standards Australia.

AS2870:2011, *Residential Slabs and Footings*, Standards Australia.

AS3798:2007, *Guidelines on Earthworks for Commercial and Residential Developments*, Standards Australia.

Chapman, G.A. and Murphy, C.L. (1989), Soil Landscapes of the Sydney 1:100000 sheet. Soil Conservation Services of NSW, Sydney.

NSW Department of Finance and Service, Spatial Information Viewer, maps.six.nsw.gov.au.

NSW Department of Mineral Resources (1985) Sydney 1:100,000 Geological Series Sheet 9129 (Edition 1). Geological Survey of New South Wales, Department of Mineral Resources.

Pells (2004) Substance and Mass Properties for the Design of Engineering Structures in the Hawkesbury Sandstone, Australian Geomechanics Journal, Vol 39 No 3

7 CLOSURE

Please do not hesitate to contact Morrow Geotechnics if you have any questions about the contents of this report.

For and on behalf of Morrow Geotechnics Pty Ltd,

JBrooker

AMorrow

James Brooker
Geotechnical Engineer

Alan Morrow
Senior Geotechnical Engineer

Plan Source: maps.six.nsw.gov.au, July 2019

morrow

PO Box 4069, Carlton NSW 2218
P: 0405 843 933 | E: info@morrowgeo.com.au

Drawn	ZS
Approved	JB
Date	25/07/2019
Scale	NTS

Inglow Investment Two Pty Ltd
36-38 Rodley Avenue, Penrith NSW
Geotechnical Investigation
Borehole Location Plan

Figure: 1

Project: P1720

Appendix A

BOREHOLE LOGS AND EXPLANATORY NOTES

Project No: P1720
Client: Inglow Investment Two
Project: 36-38 Rodley Ave
Penrith
NSW

Sheet 1 of 3

Contractor: GeoSense
Drill Rig: Hanjin D&B 8D

Logged: JB
Date: 29/07/2019

BH1

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy	Consistency/ Density	Moisture	Additional Observations
HA	L	GWNE		-		FILL - Silty SAND, fine to medium grained, black / dark grey, with fine to medium sub-angular gravel (roadbase)	-	D - M	FILL
SFA			SPT1-1 0.5-0.95 m 2, 2, 2 N = 4 SPT1-2 1.5-1.95 m 3, 3, 4 N = 7	CI - CH	0.5 1.0 1.5 2.0 2.5	Silty CLAY, medium to high plasticity, brown mottled grey - becoming grey mottled orange from 1.3m	F	M ~ PL	ALLUVIAL SOIL
	R		SPT1-3 3.0-3.45 m 8, 7, 9 N = 16		3.0	- becoming mottled orange-brown and grey from 2.8m	St		
RR / NMLC	H	GWNO		-	3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0	Silty GRAVEL, coarse sub-rounded to rounded (basalt and granite), dark grey/dark red, cobble up to 80mm COBBLE, up to 200mm (basalt and granite), dark grey/dark red/brown, with silt, with fine to coarse grained sand, boulders present	-	-	

Project No:	P1720	Contractor:	GeoSense
Client:	Inglow Investment Two	Drill Rig:	Hanjin D&B 8D
Project:	36-38 Rodley Ave Penrith NSW	Logged:	JB
Sheet 2 of 3		Date:	29/07/2019

morrow

BH1

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy	Consistency/ Density	Moisture	Additional Observations
RR / NMLC	H	GWNO		-	8.5 9.0 9.5 10.0 10.5	AS ABOVE, COBBLE, up to 200mm (basalt and granite), dark grey/dark red/brown, with silt, with fine to coarse grained sand, boulders present	-	-	ALLUVIAL SOIL
					11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0	Start Coring at 10.56m			

Project No: P1720
Client: Inglow Investment Two
Project: 36-38 Rodley Avenue
Penrith NSW

Contractor: GeoSense
Drill Rig: Hanjin D&B 8D

Logged: JB
Date: 29/07/2019

Sheet 3 of 3

morrow

BH1

Drilling Method	Water	TCR	RQD (SCR)	Rock Strength EL VL L M H VH EH 0.03 0.3 3 0 0.1 1 10	Weathering	Depth	Stratigraphy	Defect Spacing 10 100 1000 30 300	Defect Description
						8.5 9.0 9.5 10.0 10.5	Start Coring at 10.56m		
NMLC	GWNO	100	89 (87)		SW ~ FR	11.0 11.5	SANDSTONE, fine to medium grained, grey, with carbonaceous laminations, trace of shale laminations, massive		10.60-10.82, DB 10.94-11.00, HB 11.03-11.47, DB
						12.0 12.5 13.0 13.5	LAMINITE, laminated SILTSTONE (80%), dark grey / brown and SANDSTONE (20%), fine grained, pale grey, trace of sandstone bands up to 200 mm thick, subhorizontal bedding at 1-5 mm spacing		11.71, B, 0^o, Pl, Sm, Ct clay 11.76, DB 11.77-11.96, J, 70^o, Un, Ro, Cn 11.99-12.01, HB 12.10-12.64, DB 12.72-12.81, HB 12.95-12.98, Bx3, 0^o, Pl, Sm, Ct clay, ave sp=5mm 13.0, HB 13.20-13.35, DB 13.42, HB 13.57-13.66, DB
		100	100 (99)			14.0 14.5 15.0			13.81-13.82, Sm, clay, 10mm thick 13.88-13.96, DB 14.0, HB 14.18-14.75, DB 14.91, HB 14.95, DB 15.0, HB
						15.5 16.0	End Coring at 15.18m Reached Target Depth		

Project No:	P1720	Contractor:	GeoSense
Client:	Inglow Investment Two	Drill Rig:	Hanjin D&B 8D
Project:	36-38 Rodley Avenue Penrith NSW		
		Logged:	JB
		Date:	29/07/2019

morrow

BH1

Project No:	P1720	Contractor:	GeoSense
Client:	Inglow Investment Two	Drill Rig:	Hanjin D&B 8D
Project:	36-38 Rodley Ave Penrith NSW	Logged:	JB
Sheet 1 of 3		Date:	30/07/2019

BH2

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy	Consistency/ Density	Moisture	Additional Observations
HA	L	GWNE		SM		TOPSOIL - Silty SAND, find to medium grained, brown, root fibres present, poorly graded	-	D	TOPSOIL
SFA	L		SPT2-1 0.5-0.95 m 4, 4, 5 N = 9	CI	0.5 1.0	Silty CLAY, medium plasticity, orange-brown mottled grey, trace of fine to medium grained sand	St	M - PL	ALLUVIAL SOIL
			SPT2-2 1.5-1.95 m 4, 4, 3 N = 7	SC	1.5 2.0 2.5 3.0	SAND, fine to medium grained, orange-brown/pale grey, with clay, poorly graded	MD	D - M	
	R		SPT3-3 3.0-3.45 m 8, 7, 7 N = 14	SP	3.5	SAND, fine to medium grained, red, trace of clay, poorly graded - trace of medium to coarse rounded gravel (basalt and granite) granite) from 3.5m			
RR / NMLC	H	GWNO		-	4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0	COBBLE up to 200mm (basalt and granite), with silt, with fine to coarse grained sand, trace of medium to coarse rounded gravel (basalt and granite), boulders present	-	-	

Project No:	P1720	Contractor:	GeoSense	morrow
Client:	Inglow Investment Two	Drill Rig:	Hanjin D&B 8D	
Project:	36-38 Rodley Ave Penrith NSW			
		Logged:	JB	**BH2**
Sheet 2 of 3		Date:	30/07/2019	

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy	Consistency/ Density	Moisture	Additional Observations
RR / NMLC	H	GWNO		-	8.5 9.0 9.5 10.0	AS ABOVE, COBBLE up to 200mm (basalt and granite), with silt, with fine to coarse grained sand, trace of medium to coarse rounded gravel (basalt and granite), boulders present	-	-	ALLUVIAL SOIL
					10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0	Start Coring at 10.4m			

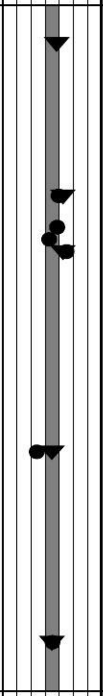
Project No: P1720
Client: Inglow Investment Two
Project: 36-38 Rodley Avenue
Penrith NSW

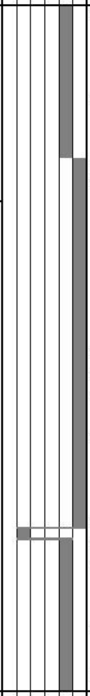
Contractor: GeoSense
Drill Rig: Hanjin D&B 8D

Logged: JB
Date: 30/07/2019

BH2

Sheet 3 of 3





Drilling Method	Water	TCR	RQD (SCR)	Rock Strength EL VL L M H VH EH 0.03 0.3 3 0 0.1 1 10	Weathering	Depth	Stratigraphy	Defect Spacing 10 100 1000 30 300	Defect Description
						8.5 9.0 9.5 10.0	Start Coring at 10.4m		
NMLC	GWNO	100	97 (94)		SW ~ FR	10.5 11.0	SANDSTONE, fine to grained, grey, trace of carbonaceous laminations, massive		10.41-10.66, DB 10.83-11.02, HB 11.09-11.13, J, 45°, Pl, Ro, Cn
						11.5 12.0 12.5 13.0 13.5	LAMINITE, laminated SILTSTONE (80%), dark grey and SANDSTONE (20%), fine grained, pale grey, subhorizontal bedding at 1-10 mm spacing		11.20-11.96, DB 12.00, HB 12.01, DB 12.26, HB 12.41-12.68, DB 12.79-12.97, J, 90°, Pl, Ro, Cn 12.84-12.86, Bx2, 0°, Pl, Sm, Ct clay, sp=20mm 13.00-13.04, HB 13.22, DB 13.50-13.54, J, 45°, Pl, Ro, Cn
						14.0 14.5 15.0 15.5 16.0	End Coring at 13.54m Reached Target Depth		

Project No: P1720
Client: Inglow Investment Two
Project: 36-38 Rodley Avenue Penrith NSW
Contractor: GeoSense
Drill Rig: Hanjin D&B 8D
Logged: JB
Date: 30/07/2019

BH2

POINT LOAD STRENGTH INDEX

Project No. P1720

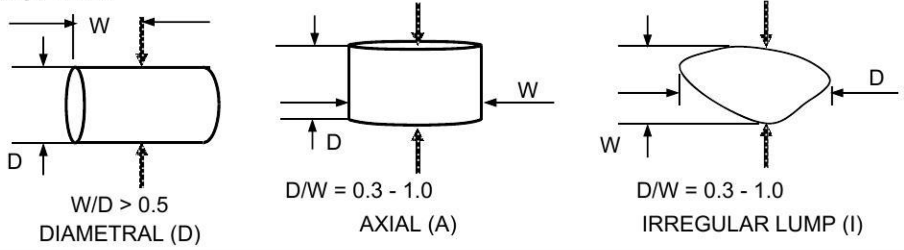
Client: Inglow Investments Two Pty Ltd
Project: Geotechnical Investigation
Location: 36-38 Rodley Avenue, Penrith NSW

Date: 29 & 30 July 2019
Tested by: JB
Data checked:

Test Machine: GSA
Test Locality: JB
Core Size: 52 mm

Bore/TP	Depth (m)	Rock Type	Moisture Condition	Test Type	W (mm)	D (mm)	Load kN (P)	Failure Type	Point Load Strength Index $Is_{(50)}$ (MPa)	Strength Classification
BH1	10.70	SW-FR SANDSTONE	F	D	52	49	2.93	2	1.21	H
BH1	10.70	SW-FR SANDSTONE	F	A	52	45	5.61	1	1.96	H
BH1	11.30	SW-FR SANDSTONE	F	A	52	45	4.20	1	1.47	H
BH1	11.33	SW-FR SANDSTONE	F	D	52	48	2.86	2	1.22	H
BH1	11.33	SW-FR SANDSTONE	F	A	52	47	4.94	4	1.67	
BH1	11.39	SW-FR SANDSTONE	F	D	52	49	2.31	2	0.95	M
BH1	11.39	SW-FR SANDSTONE	F	A	52	48	5.60	4	1.86	
BH1	12.20	SW-FR SANDSTONE	F	A	52	43	2.00	4	0.72	
BH1	12.26	SW-FR SANDSTONE	F	D	52	50	0.06	2	0.02	EL
BH1	12.26	SW-FR SANDSTONE	F	A	52	40	1.80	4	0.69	
BH1	12.55	SW-FR SANDSTONE	F	A	52	42	3.12	1	1.15	H
BH1	13.20	SW-FR SANDSTONE	F	A	52	40	3.39	1	1.30	H
BH1	14.13	SW-FR SANDSTONE	F	A	52	46	7.39	4	2.54	
BH1	14.24	SW-FR SANDSTONE	F	D	52	49	4.10	2	1.69	H
BH1	14.24	SW-FR SANDSTONE	F	A	52	43	5.95	1	2.15	H
BH1	15.10	SW-FR SANDSTONE	F	D	52	49	4.78	2	1.97	H
BH2	10.47	SW-FR SANDSTONE	F	A	52	52	0.73	4	0.23	
BH2	10.52	SW-FR SANDSTONE	F	D	52	50	0.07	2	0.03	EL
BH2	10.52	SW-FR SANDSTONE	F	A	52	49	1.52	4	0.50	
BH2	10.58	SW-FR SANDSTONE	F	A	52	38	2.33	1	0.93	M
BH2	11.28	SW-FR SANDSTONE	F	D	52	49	2.71	2	1.12	H
BH2	11.28	SW-FR SANDSTONE	F	A	52	49	4.63	1	1.51	H
BH2	11.42	SW-FR SANDSTONE	F	D	52	50	2.42	2	0.97	M
BH2	11.42	SW-FR SANDSTONE	F	A	52	46	2.45	4	0.84	
BH2	11.47	SW-FR SANDSTONE	F	D	52	50	1.04	2	0.42	M
BH2	11.47	SW-FR SANDSTONE	F	A	52	42	1.62	4	0.60	
BH2	11.52	SW-FR SANDSTONE	F	D	52	48	6.40	2	2.73	H
BH2	11.52	SW-FR SANDSTONE	F	A	52	45	3.74	1	1.31	H
BH2	12.46	SW-FR SANDSTONE	F	D	52	49	0.51	2	0.21	L
BH2	12.46	SW-FR SANDSTONE	F	A	52	48	1.93	1	0.64	M
BH2	13.34	SW-FR SANDSTONE	F	D	52	49	1.68	2	0.69	M
BH2	13.34	SW-FR SANDSTONE	F	A	52	50	2.14	1	0.69	M

TEST TYPE :



MOISTURE CONDITION :
Field (F), Saturated (S), Dry (D)

FAILURE TYPE :
1. Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.
2. Fracture along bedding.
3. Fracture influenced by pre-existing joint plane (J), microfracture (M), vein (V), chemical alteration (C).
4. Chip or partial fracture.

NOTES For specimens tested parallel to plane of weakness $D_e^2 = D^2$
For specimens tested perpendicular to plane of weakness $D_e^2 = 4WD/\pi$

GENERAL

Information obtained from site investigations is recorded on log sheets. The “Cored Drill Hole Log” presents data from an operation where a core barrel has been used to recover material - commonly rock. The “Non-Core Drill Hole - Geological Log” presents data from an operation where coring has not been used and information is based on a combination of regular sampling and insitu testing. The material penetrated in non-core drilling is commonly soil but may include rock. The “Excavation - Geological Log” presents data and drawings from exposures of soil and rock resulting from excavation of pits, trenches, etc.

The heading of the log sheets contains information on Project Identification, Hole or Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material substance description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The common depth scale is 8m per drill log sheet and about 3-5m for excavation logs sheets.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is inevitable in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures. Material description and classifications are based on SAA Site Investigation Code AS 1726 - 1993 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

DRILLING

Drilling & Casing

ADV	Auger Drilling with V-Bit
ADT	Auger Drilling with TC Bit
WB	Wash-bore drilling
RR	Rock Roller
NMLC	NMLC core barrel
NQ	NQ core barrel
HMLC	HMLC core barrel
HQ	HQ core barrel

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

VE	Very Easy
E	Easy
M	Medium
H	High
VH	Very High

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

D	Disturbed
B	Bulk
U	Undisturbed
SPT	Standard Penetration Test
N	Result of SPT (sample taken)
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer Test

EXCAVATION LOGS

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the “Structure and other Observations” column. The depth of the base of excavation (for the logged section) at the appropriate depth in the “Material Description” column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added.

MATERIAL DESCRIPTION - SOIL

Classification Symbol - In accordance with the Unified Classification System (AS 1726-1993, Appendix A, Table A1)

Material Description - In accordance with AS 1726-1993, Appendix A2.3

Moisture Condition

D	Dry, looks and feels dry
M	Moist, No free water on remoulding
W	Wet, free water on remoulding

Consistency - In accordance with AS 1726-1993, Appendix A2.5

VS	Very Soft	< 12.5 kPa
S	Soft	12.5 – 25 kPa
F	Firm	25 – 50 kPa
St	Stiff	50 – 100 kPa
VSt	Very Stiff	100 – 200 kPa
H	Hard	> 200 kPa

Strength figures quoted are the approximate range of undrained shear strength for each class.

Density Index. (%) is estimated or is based on SPT results.

VL	Very Loose	< 15 %
L	Loose	15 – 35 %
MD	Medium Dense	35 – 65 %
D	Dense	65 – 85 %
VD	Very Dense	> 85 %

MATERIAL DESCRIPTION -ROCK

Material Description

Identification of rock type, composition and texture based on visual features in accordance with AS 1726-1993, Appendix A3.1-A3.3 and Tables A6a, A6b and A7.

Core Loss

Is shown at the bottom of the run unless otherwise indicated.

Bedding

Thinly Laminated	< 6 mm
Laminated	6 - 20
Very Thinly Bedded	20 - 60
Thinly Bedded	60 - 200
Medium Bedded	200 – 600
Thickly Bedded	600 – 2000
Very Thickly Bedded	> 2000

Weathering - No distinction is made between weathering and alteration. Weathering classification assists in identification but does not imply engineering properties.

Fresh (F)	Rock substance unaffected by weathering
Slightly Weathered (SW)	Rock substance partly stained or discoloured. Colour and texture of fresh rock recognisable.
Moderately Weathered (MW)	Staining or discolouration extends throughout rock substance. Fresh rock colour not recognisable.
Highly Weathered (HW)	Stained or discoloured throughout. Signs of chemical or physical alteration. Rock texture retained.
Extremely Weathered (EW)	Rock texture evident but material has soil properties and can be remoulded.

Strength - The following terms are used to described rock strength:

Rock Strength Class	Abbreviation	Point Load Strength Index, Is(50) (MPa)
Extremely Low	EL	< 0.03
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	H	1 to 3
Very High	VH	3 to 10
Extremely High	EH	≥ 10

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical estimated strength by using:

° Diametral Point Load Test

Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown.

MATERIALS STRUCTURE/FRACTURES

ROCK

Natural Fracture Spacing - A plot of average fracture spacing excluding defects known or suspected to be due to drilling, core boxing or testing. Closed or cemented joints, drilling breaks and handling breaks are not included in the Natural Fracture Spacing.

Visual Log - A diagrammatic plot of defects showing type, spacing and orientation in relation to core axis.

Defects	———	Defects open in-situ or clay sealed
	– – – – – –	Defects closed in-situ
	…………………	Breaks through rock substance

Additional Data - Description of individual defects by type, orientation, in-filling, shape and roughness in accordance with AS 1726-1993, Appendix A Table A10, notes and Figure A2.

Orientation - angle relative to the plane normal to the core axis.

Type	BP	Bedding Parting
	JT	Joint
	SM	Seam
	FZ	Fracture Zone
	SZ	Shear Zone
	VN	Vein
	FL	Foliation
	CL	Cleavage
	DL	Drill Lift
	HB	Handling Break
	DB	Drilling Break
Infilling	CN	Clean
	X	Carbonaceous
	Clay	Clay
	KT	Chlorite
	CA	Calcite
	Fe	Iron Oxide
	Qz	Quartz
	MS	Secondary Mineral
	MU	Unidentified Mineral
Shape	PR	Planar
	CU	Curved
	UN	Undulose
	ST	Stepped
	IR	Irregular
	DIS	Discontinuous
Rougness	POL	Polished
	SL	Slickensided
	S	Smooth
	RF	Rough
	VR	Very Rough

SOIL

Structures - Fissuring and other defects are described in accordance with AS 1726-1993, Appendix A2.6, using the terminology for rock defects.

Origin - Where practicable an assessment is provided of the probable origin of the soil, eg fill, topsoil, alluvium, colluvium, residual soil.

Appendix B

Laboratory Certificates

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Alan Morrow
Client	MORROW GEOTECHNICS PTY LTD
Address	PO BOX 4069 CARLTON NSW 2218
Telephone	(Not specified)
Facsimile	(Not specified)
Email	alan@morrowgeo.com.au
Project	**P1720 Penrith**
Order Number	(Not specified)
Samples	6

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE196324 R0**
Date Received	12 Aug 2019
Date Reported	13 Aug 2019

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Bennet Lo	Dong Liang
Senior Organic Chemist/Metals Chemis	Metals/Inorganics Team Leader

		Sample Number	SE196324.001	SE196324.002	SE196324.003	SE196324.004
		Sample Matrix	Soil	Soil	Soil	Soil
		Sample Date	12 Aug 2019	12 Aug 2019	12 Aug 2019	12 Aug 2019
		Sample Name	SPT 1-1	SPT 1-2	SPT 1-3	SPT 2-1
Parameter	Units	LOR				
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 13/8/2019						
Conductivity of Extract (1:5 as received)	µS/cm	1	**95**	**200**	**290**	**77**
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	**120**	**260**	**340**	**87**
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 13/8/2019						
Exchangeable Sodium, Na	mg/kg	2	-	**1200**	-	-
Exchangeable Sodium, Na	meq/100g	0.01	-	**5.2**	-	-
Exchangeable Sodium Percentage*	%	0.1	-	**25.7**	-	-
Exchangeable Potassium, K	mg/kg	2	-	**250**	-	-
Exchangeable Potassium, K	meq/100g	0.01	-	**0.64**	-	-
Exchangeable Potassium Percentage*	%	0.1	-	**3.1**	-	-
Exchangeable Calcium, Ca	mg/kg	2	-	**100**	-	-
Exchangeable Calcium, Ca	meq/100g	0.01	-	**0.51**	-	-
Exchangeable Calcium Percentage*	%	0.1	-	**2.5**	-	-
Exchangeable Magnesium, Mg	mg/kg	2	-	**1700**	-	-
Exchangeable Magnesium, Mg	meq/100g	0.02	-	**14**	-	-
Exchangeable Magnesium Percentage*	%	0.1	-	**68.6**	-	-
Cation Exchange Capacity	meq/100g	0.02	-	**20**	-	-
Moisture Content Method: AN002 Tested: 12/8/2019						
% Moisture	%w/w	0.5	**22**	**25**	**14**	**11**

		Sample Number	SE196324.005	SE196324.006
		Sample Matrix	Soil	Soil
		Sample Date	12 Aug 2019	12 Aug 2019
		Sample Name	SPT 2-2	SPT 2-3
Parameter	Units	LOR		

Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 13/8/2019

Conductivity of Extract (1:5 as received)	µS/cm	1	**74**	**46**
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	**83**	**50**

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 13/8/2019

Exchangeable Sodium, Na	mg/kg	2	**45**	-
Exchangeable Sodium, Na	meq/100g	0.01	**0.19**	-
Exchangeable Sodium Percentage*	%	0.1	**4.6**	-
Exchangeable Potassium, K	mg/kg	2	**70**	-
Exchangeable Potassium, K	meq/100g	0.01	**0.18**	-
Exchangeable Potassium Percentage*	%	0.1	**4.2**	-
Exchangeable Calcium, Ca	mg/kg	2	**510**	-
Exchangeable Calcium, Ca	meq/100g	0.01	**2.6**	-
Exchangeable Calcium Percentage*	%	0.1	**60.2**	-
Exchangeable Magnesium, Mg	mg/kg	2	**160**	-
Exchangeable Magnesium, Mg	meq/100g	0.02	**1.3**	-
Exchangeable Magnesium Percentage*	%	0.1	**31.0**	-
Cation Exchange Capacity	meq/100g	0.02	**4.2**	-

Moisture Content Method: AN002 Tested: 12/8/2019

% Moisture	%w/w	0.5	**11**	**9.5**

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Conductivity and TDS by Calculation - Soil   Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Conductivity of Extract (1:5 as received)	LB180758	µS/cm	1	<1	105%
Conductivity of Extract (1:5 dry sample basis)	LB180758	µS/cm	1		105%

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)   Method: ME-(AU)-[ENV]AN122

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Exchangeable Sodium, Na	LB180742	mg/kg	2		103%
Exchangeable Sodium, Na	LB180742	meq/100g	0.01	<0.01	NA
Exchangeable Sodium Percentage*	LB180742	%	0.1		NA
Exchangeable Potassium, K	LB180742	mg/kg	2		96%
Exchangeable Potassium, K	LB180742	meq/100g	0.01	<0.01	NA
Exchangeable Potassium Percentage*	LB180742	%	0.1		NA
Exchangeable Calcium, Ca	LB180742	mg/kg	2		101%
Exchangeable Calcium, Ca	LB180742	meq/100g	0.01	<0.01	NA
Exchangeable Calcium Percentage*	LB180742	%	0.1		NA
Exchangeable Magnesium, Mg	LB180742	mg/kg	2		87%
Exchangeable Magnesium, Mg	LB180742	meq/100g	0.02	<0.02	NA
Exchangeable Magnesium Percentage*	LB180742	%	0.1		NA
Cation Exchange Capacity	LB180742	meq/100g	0.02	<0.02	NA

Moisture Content   Method: ME-(AU)-[ENV]AN002

Parameter	QC Reference	Units	LOR	DUP %RPD
% Moisture	LB180710	%w/w	0.5	1%

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN122	Exchangeable Cations, CEC and ESP: Soil sample is extracted in 1 M Ammonium Acetate at pH=7 (or 1M Ammonium Chloride at pH=7) with cations (Na, K, Ca & Mg) then determined by ICP OES/ICP MS and reported as Exchangeable Cations. For saline soils, these results can be corrected for water soluble cations and reported as Exchangeable cations in meq/100g or soil can be pre-treated (aqueous ethanol/aqueous glycerol) prior to extraction. Cation Exchange Capacity (CEC) is the sum of the exchangeable cations in meq/100g.
AN122	The Exchangeable Sodium Percentage (ESP) is calculated as the exchangeable sodium divided by the CEC (all in meq/100g) times 100. ESP can be used to categorise the sodicity of the soil as below: ESP < 6% non-sodic ESP 6-15% sodic ESP >15% strongly sodic Method is referenced to Rayment and Lyons, 2011, sections 15D3 and 15N1.-

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au.pv.sgsvr/en-gb/environment.

This document is issued by the Company under its General Conditions of Service accessible at www.sgs.com/en/Terms-and-Conditions.aspx. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client only. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law .

This report must not be reproduced, except in full.

Appendix C

IMPORTANT INFORMATION

Important Information

This Document has been provided by Morrow Geotechnics Pty Ltd subject to the following limitations:

This Document has been prepared for the particular purpose outlined in Morrow Geotechnics' proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

The scope and the period of Morrow Geotechnics' Services are as described in Morrow Geotechnics' proposal, and are subject to restrictions and limitations. Morrow Geotechnics did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. The scope of services may have been limited by such factors as time, budget, site access or other site conditions. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Morrow Geotechnics in regards to it. Any advice given within this document is limited to geotechnical considerations only. Other constraints particular to the project, including but not limited to architectural, environment, heritage and planning matters may apply and should be assessed independently of this advice.

Conditions may exist which were undetectable given the limited nature of the enquiry Morrow Geotechnics was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required. No geotechnical investigation can provide a full understanding of all possible subsurface details and anomalies at a site.

In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Morrow Geotechnics' opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed Morrow Geotechnics to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Morrow Geotechnics for incomplete or inaccurate data supplied by others.

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that Morrow Geotechnics be notified of any variations and be provided with an opportunity to review the recommendations of this report.

This Document is provided for sole use by the Client and is confidential to it and its professional advisers. No responsibility whatsoever for the contents of this Document will be accepted to any person other than the Client. Any use which a third party makes of this Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Morrow Geotechnics accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this Document.