LCI (Australia) Pty Ltd

Geotechnical Assessment for SYD08: 57 Station Road, Seven Hills, NSW

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P2007944JR05V05
May 2022

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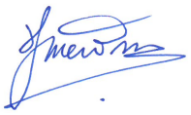
Document and Distribution Status

Author(s)	Reviewer(s)	Project Manager/ Director	Signature
Wasiul Bari	Surendran Karasu	Surendran Karasu	

Revision No.	Description	Status	Release Date	Document Location			
				File Copy	LCI (Australia) Pty Ltd		
1	Geotechnical Assessment	Draft	17.12.2021	1H, 1P, 1E	1P		
2	Geotechnical Assessment	Draft	28.01.2022	1H, 1P, 1E	1P		
3	Geotechnical Assessment	Final	11.02.2022	1H, 1P, 1E	1P		
4	Geotechnical Assessment	Final	24.03.2022	1H, 1P, 1E	1P		
5	Geotechnical Assessment	Final	10.05.2022	1H, 1P, 1E	1P		

Distribution Types: F = Fax, H = Hard copy, P = PDF document, E = Other electronic format. Digits indicate number of document copies.

All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Introduction

1.1 Purpose

This geotechnical assessment report has been prepared on behalf of Lehr Consultants International (Australia) Pty Ltd (LCI) in support of a State Significant Development Application (SSDA) submitted to the Department of Planning and Environment (DPE) under Part 4 of the *Environmental Planning and Assessment Act 1979 (EP&A Act 1979)*.

LCI is seeking to secure approval for the construction of a new data storage centre development on the site known as 57 Station Road, Seven Hills ('the site'), located within the Blacktown City Council local government area (LGA). The proposed development will comprise the erection of a new two-storey data centre at the rear of the site, associated plant and equipment, car parking areas, landscaping, and civil works.

This report provides a geotechnical assessment to support detailed design of the proposed development and responds to the Industry Specific Secretary's Environmental Assessment Requirements (SEARs) issued by DPE on 23 December 2021. An outline of the SEARs relevant to this geotechnical assessment, and how they have been responded to, is summarised in Table 1 below.

Table 1: Summary of SEARs response.

Issue and Assessment Requirements	Documentation	Response
13. Ground and Water Conditions		
• Provide an assessment of the potential impacts on soil resources, including related infrastructure and riparian lands on and near the site.	• Assessment was undertaken based on field observations and testing as well as laboratory test results. Assessment results are reported in P2007944JR05V03 prepared by Martens and Associates Pty Ltd.	This element is considered satisfied because: • The Fill material to be compliant with AS3798 (Section 7.1.3). • The recommendations for site preparation and earthworks are provided in Sections 6.4 (Pavement design), 7.1.3 and 7.1.5 to ensure compliance with AS3798. • The recommendations for drainage works are provided in Sections 6.4.2 (Pavement design) and 7.1.7 • Recommendations for temporary and permanent batters are provided in Section 7.1.2.
• Provide an assessment of salinity and acid sulfate soil impacts.	• Assessment was undertaken based on field observations and testing as well as laboratory test results. Assessment results are reported in P2007944JR05V03 prepared by Martens and Associates Pty Ltd.	This element is considered satisfied because: • Recommendations for saline soil management are provided in Section 7.1.9.

1.2 Site Location

The site is within the Blacktown local government area (LGA), however is on the boundary of the Parramatta LGA also. The site is in the Seven Hills Industrial Area, approximately 3.8 km east of the Blacktown CBD and 6.8 km west of the Parramatta CBD, and approximately halfway between Toongabbie and Seven Hills railway stations. Site location is shown in Map 01, Attachment A.

1.3 Site Description

The site is located on land known as 57 Station Road, Seven Hills, described legally as Lot B in DP 404669. The site is rectangular in shape with an area of 2.57 ha and a northeast-southwest orientation. It is a corner lot with a frontage of around 111 m to Station Road to the southwest, and 242 m to McCoy Street road reserve to the southeast. The majority of the McCoy Street road reserve is unformed, with a formed 80 m long driveway providing access to the adjoining McCoy Park.

The site is currently occupied by a range of buildings and structures associated with the previous industrial uses. An HV transmission tower is also located on the Site in the south, at the corner of Station Road and McCoy Street. Vehicular access is provided via three separate crossings along Station Road.

1.4 Overview of Approved Development

The Site is subject to an existing development approval, issued by Blacktown City Council under DA-21-01058 on 10 January 2022. The development consent permits:

- *Removal of trees, bulk earthworks, stormwater drainage works and construction of a single storey data centre to operate 24 hours a day 7 days a week with ancillary offices, on-site parking and associated landscaping.*

The existing approval permits tree removal, bulk earthworks, and drainage works across the entirety of the site, with the construction of a data centre on approximately the front third as depicted in the Figure 1 below. The balance of the site is the location of the proposed SSDA, excluding bulk earthworks.

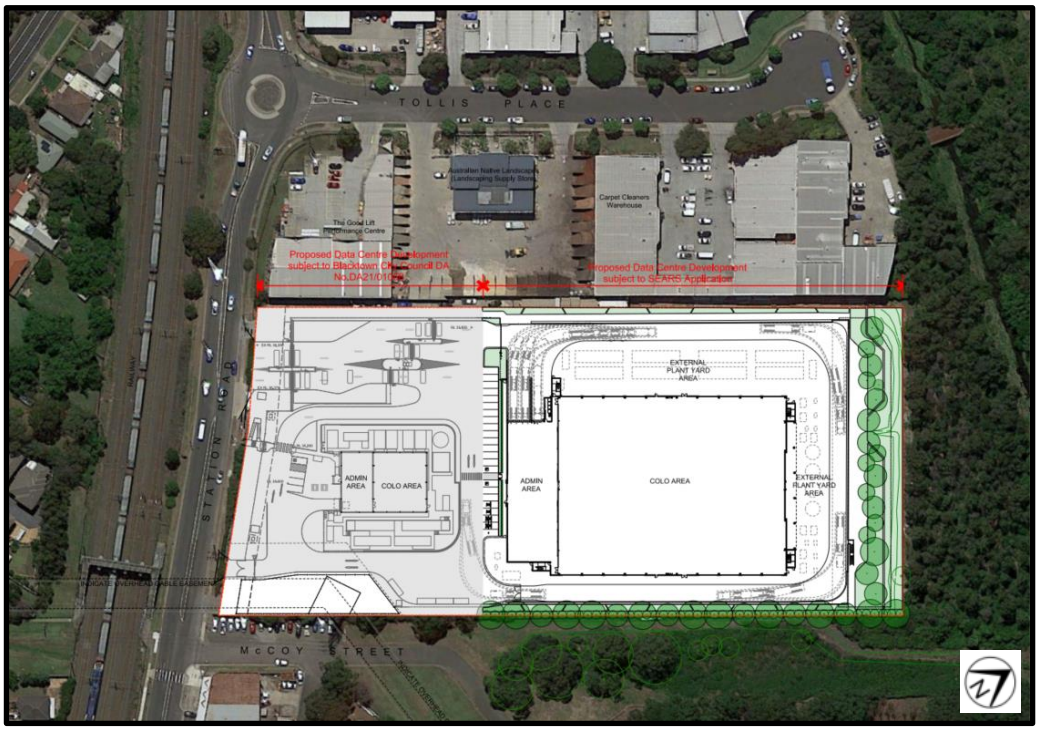


Figure 1: Site Plan for approved data centre on Site, under DA-21-01058 (Source: DEM architects).

1.5 Overview of Proposed Development

The SSDA seeks approval for the construction and use of a new data storage premises at the rear of the site (known as SYD08). The particulars of the Proposal are as follows:

- Construction of a new two-storey 19.2 MW data centre at the rear of the site including ancillary office space.
- A total floor area of approximately 8076 sqm.
- Provision of external plant (such as transformers and external switchgear) in plant yards to the west, north and south of the proposed data hall, as well as rooftop plant, which will be screened. External plant is smaller in dimensions and weights than the generators.
- Provision of 9 new generators in addition to 3 approved generators under DA-21-01058 (making a site total of 12 generators) each with integral fuel tanks (Capacity for up to 289,000L of diesel fuel

storage). Each fuel tank weighing around 97000kg. Generator operation will take place 24 hours a day, 7 days a week.

- New vehicular circulation to provide access to Station Road, connecting into new driveways already approved under DA-21-01058.
- Multiple 12m high water tanks (2 at this stage).
- Construction of new internal roads and car parking areas to provide 31 parking bays.
- Landscaping works.

An overview of the proposed development is presented in Figure 2 below.

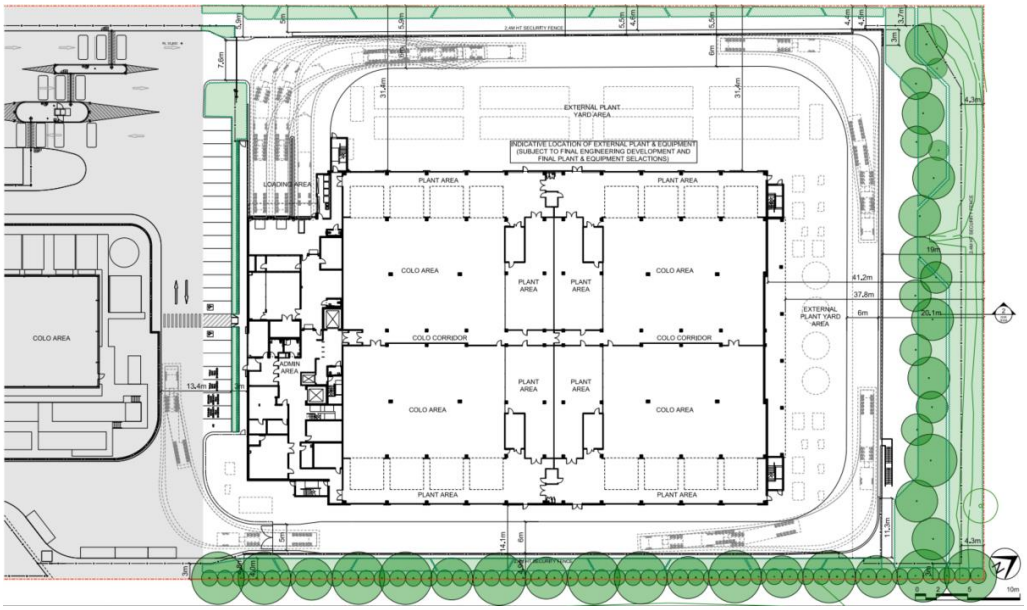


Figure 2: Overview of proposed development (Source: DEM architects).

2 Proposed Development and Previous Assessments

Proposed development details including previous assessments are summarised in Table 2.

Table 2: Summary of proposed development.

Item	Details
Investigation Area	The total area of the site is approximately 2.6 ha (based on SIX Maps). The investigation area (IA), i.e. SYD08, covers the eastern portion of the site and has an area of approximately 1.4 ha (based on SIX Maps).
Previous Assessments	1. A desktop geotechnical assessment was previously conducted by Martens and Associates (MA) to identify potential geotechnical constraints across the site and provide preliminary geotechnical recommendations including advice on further geotechnical investigations that could be undertaken to better define these constraints. The findings of the desktop geotechnical assessment are presented in MA's letter report referenced P2007944JC01V02, dated October 2020 (MA, 2020a). 2. A preliminary geotechnical assessment was previously conducted by MA to support a due diligence assessment to assess the feasibility of the site for the proposed development. Results of this assessment are presented in MA's report reference P2007944JR02V02, dated December 2020 (MA, 2020b). The investigation involved drilling of five boreholes (BH101 to BH105) and installation of two groundwater monitoring wells (MW01 and MW02). Out of the five boreholes and two monitoring wells, three boreholes (BH103 to BH105) and one monitoring well (MW02) were drilled / installed across the IA as shown in Map 01, Attachment A (refer Attachment B for borehole and monitoring well logs and Attachment C for rock core photos). 3. A preliminary slainity assessment was previously conducted by MA to assess salinity condition of the site soils and to support a Development Application (DA) to Council. Results of this assessment are presented in MA's report reference P2007944JR03V01, dated May 2021 (MA, 2021a). The investigation involved drilling of five boreholes (BH301 to BH305). Out of the five boreholes, four boreholes (BH302 to BH105) were drilled across the IA as shown in Map 01, Attachment A, Attachment A (refer Attachment B for borehole logs).
Proposed Development	We understand from the proposal plans of the development (ACOR, 2021a and ACOR, 2021b) and LCI Consultants that the proposed development will include: o Construction of a new at-grade multistorey hyper scale data centre (known as SYD08) in the eastern portion of the site, comprising: i) A new two storey new two-storey 19.2 MW data centre with a finished floor level of approximately RL 34.0 mAHD. We understand that structural loads from 1st floor of the data centre will be supported by pile foundations and the ground floor slab will be designed as a slab on ground. ii) Construction of a bank of multiple generators, each with integral fuel tanks (Capacity for up to 280,000L of diesel fuel storage). The combined weight of the generator and fuel tank is expected to be approximately 97,000

Item	Details
	kg. The generator will be supported by a 17 m long × 3.8 m wide slab on ground founding on newly placed engineered fill. An allowable bearing capacity of 30 kPa is required for the slab on ground. iii) Construction of multiple elevated (12 m high) water tanks. iv) Construction of new internal roads and car parking areas. We understand that filling up to approximately 5.0 m above existing ground level is required to reach the design ground floor level of SYD08. Reinforced earth keystone block retaining walls with a maximum height of approximately 5.0 m will be constructed along the northern, eastern and southern boundaries of the IA as permanent support for the fill platform. A geotechnical assessment for the retaining wall was conducted in December 2021 by MA for FDC construction to support structural design of the proposed retaining walls. Results of this assessment including design and construction recommendation for the retaining wall are presented in MA's report reference P2007944JR04V01, dated December 2021 (MA, 2021b). We note that a one storey building known as SYD09 will be constructed in the western portion of the site. However, the scope of field investigation and laboratory testing undertaken and recommendation presented in this report are associated only for the design and construction of SYD08 and must not be used for the design and construction of SYD 09.

3 Investigation Scope and Laboratory Testing

3.1 Field investigation

Field investigations conducted between 1 and 3 December 2021 included:

- Review of DBYD survey plans and buried service locating on site.
- A walkover inspection of the site to review local geology, soil exposures, surface hydrology, topography and drainage.
- Drilling of seven boreholes: BH501 to BH504 and BH506 to BH508 including NMLC rock coring up to a maximum depth of 9.55 m below ground level (mbgl). We note that drilling of BH505 could not be undertaken due to time constraint. Refer Attachment B for borehole logs, Attachment C for rock core photos and associated explanatory notes in Attachment F.
- Standard Penetration Tests (SPT) were undertaken in boreholes (except in BH508) at 1.0 mbgl and 1.5 m depth intervals thereafter, in soil.
- Collection of soil and rock samples for laboratory testing and future reference.

An additional field investigations conducted on 20 December 2021 comprised:

- Excavation of twelve test pits (TP101 to TP112) up to excavation termination target depth of 3.5 mbgl to assess the existing fill condititions at the site (Refer Attachment B for test pit logs).
- Collection of two bulk soil samples for laboratory California Bearing Ratio (CBR) testing.

Investigation locations are shown in Maps 01 and 02, Attachment A. Some site photographs captured during our field investigation, are presented in Figures 3 and 4, Attachment A.

3.2 Laboratory Testing

Laboratory testing carried out by National Association of Testing Authorities (NATA) accredited laboratories included:

- Point load strength index testing on twenty rock core samples, Atterberg limits testing on two soil samples, particle size distribution (PSD) testing on two soil samples and CBR testing on two bulk soil samples by Resource Laboratories.
- Salinity and soil aggressivity testing on four soil samples by Envirolab Services.

Laboratory test certificates are provided in Attachment D. We note that only the scope of field investigation and laboratory testing undertaken for this detailed design stage are presented in Section 3.

4 General Site Details and Investigation Findings

4.1 General Site Details

General site details are summarised in Table 3.

Table 3: Summary of general site details based on desktop review, site walkover and site investigations.

Item	Comment
Topography	Within undulating terrain, on a northeast facing slope, approximately 35 m south of Blacktown Creek. The site is characterised by two near level terraces (western upper and eastern lower terraces) separated by a northwest-southeast aligned approximately 4 m high steep cut batter near the central portion of the site. A northwest-southeast aligned drainage depression extends along the eastern boundary of the site. The proposed SYD 08 data centre is located within the eastern lower terrace. A layout of the site is presented in Map 01, Attachment A. Historical aerial photographs (Nearmap) show that a former east-west aligned drainage channel extends diagonally near the eastern portion of the site. The drainage channel was filled as part of the previous development purposes.
Expected geology	The majority of the site is mapped in the Ashfield Shale outcrop zone with a small portion of the site along the eastern site boundary mapped in the Quaternary deposits. Ashfield Shale typically comprises dark-grey to black claystone-siltstone and fine sandstone-siltstone laminite. Quaternary deposits generally comprises fine-grained sand, silt and clay (*Penrith 1:100,000 Geological Series Sheet 9030*, 1991).
Expected soil landscape	The NSW Office of Environment and Heritage's (OEH) information system (eSPADE) indicates the site to be located in the Blacktown (bt) soil landscape, consisting of gently undulating rises on Wianamatta Group shales. This soil landscape is characterised by > 200 cm of soil on lower side slopes. This soil landscape is often associated with localised seasonal waterlogging, localised water erosion hazard, moderately reactive highly plastic subsoil and localised surface movement potential.
Salinity risk potential	The 1:100,000 Salinity Potential in Western Sydney Map (DIPNR, 2002) indicates the site to be located in an area of moderate salinity potential.
Typical slopes, aspect, elevation	The near level terraces have grades of less than approximately 10% towards the northeast. The central steep cut batter has grades of approximately 50 %. The elevation of the IA ranges between approximately 27.5 mAHD in the eastern portion and 34 mAHD in the western portion (ACOR, 2021b).
Existing development	The IA is currently occupied by two vacant metal buildings formerly used as timber warehouse.
Vegetation	Grass, with shrubs and trees along the eastern and southern site boundaries. The central cut batter is densely vegetated.
Neighbouring environment	The site is bordered by Station Road to the west, commercial developments to the north, forested land to the east and McCoy Street and McCoy park to the south.
Drainage	Via overland flow towards the northeast into the drainage depression discharging into Blacktown Creek to the east.

4.2 Subsurface Conditions

Considering site elevation and topography in conjunction with investigation findings, soils across IA are assessed to be associated with the Quaternary deposits underlain by Ashfield Shale. Investigation revealed the following generalised subsurface units likely underlie a gravel / concrete pavement of thickness between approximately 100 mm and 200 mm across the IA:

Unit A: Fill comprising silty clay / gravelly sandy silt / silty sand encountered up to between approximately 1.0 (BH501) mbgl and 2.6 mbgl (BH506). Deeper fill is encountered in the eastern portion of the IA. Existing fill contains unsuitable materials (i.e. concrete, metal and wood fragments) and inferred to have been placed under uncontrolled condition. Test pit investigation also confirmed the presence of unsuitable material, particularly within top 1.5 m of existing fill profile.

Unit B: Alluvial firm to stiff silty clay encountered up to between approximately 1.7 mbgl (BH508) and 4.0 mbgl (BH504). This unit was not encountered in the western portion (BH501 to BH503) of the IA. Test pit investigation encountered rootlets and organic matter.

Unit C: Residual soil comprising:

C1: Stiff silty clay encountered below pavement material in the western portion and below Unit B in the eastern portion, up to between approximately 0.5 mbgl (BH502) and 5.5 mbgl (BH103).

C2: Residual very stiff grading to hard silty clay encountered up to between approximately 1.25 mbgl (BH502) and 5.6 mbgl (BH504).

Unit D: Weathered shale, encountered from between 1.25 mbgl (BH502) and 5.5 mbgl (BH103):

D1: Highly to moderately weathered, low strength (Class IV) shale encountered up to between approximately 2.39 mbgl (BH502) and 5.82 mbgl (BH506).

D2: Moderately to slightly weathered, medium strength (Class III) shale encountered up to between approximately 5.25 mbgl (BH501) and 8.42 mbgl (BH507).

D3: Slightly weathered to fresh, high strength (Class I)I shale encountered up to maximum investigation termination depth of 9.55 mbgl.

Rock classification (Class IV to Class II) is based on Pells et al. (1998) for Sydney Sandstone and Shale. A summary of the subsurface units encountered in each borehole is presented in Tables 4 and 5.

Table 4: Summary of subsurface units within BH501 to BH504 and BH506.

Subsurface Units	Material	Depth (mbgl)				
		BH501 (30.0 mAHD)	BH502 (29.8 mAHD)	BH503 (29.8 mAHD)	BH504 (29.6 mAHD)	BH506 (29.1 mAHD)
Unit A	FILL: Silty CLAY / Gravelly Sandy SILT	0.2 – 1.0	NE [4]	0.2 – 1.5	0.2 – 2.3	0.2 – 2.6
Unit B	ALLUVIUM: Silty CLAY (firm and stiff)	NE [4]	NE [4]	NE [4]	2.3 – 4.0	2.6 – 3.5
Unit C1	RESIDUAL: Silty CLAY (stiff)	1.0 – 1.6 [2]	0.1 – 0.5	1.5 – 5.2	4.0 – 5.0	2.6 – 4.5
Unit C2	RESIDUAL: Silty CLAY (very stiff to hard)	NE [4]	0.5 – 1.25 [2]	5.2 – 5.5 [2]	5.0 – 5.6 [2]	4.5 – 4.8 [2]
Unit D1	SHALE: Class IV [1]	1.6 – 4.25	1.25 – 2.39	NE [4]	NE [4]	4.8 – 5.82
Unit D2	SHALE: Class III[1]	4.25 – 5.25	NE [4]	5.5 – 5.78	5.6 – 6.06	NE [4]
Unit D3	SHALE: Class II [1]	5.25 – 8.31 [3]	2.39 – 5.08 [3]	5.78 – 8.82 [3]	6.06 – 9.55 [3]	5.82 – 8.55 [3]

Notes:

1. Based on Pells et al. (1998).
2. V-bit refusal depth.
3. Borehole termination depth.
4. Not encountered.

Table 5: Summary of subsurface units within BH507 to BH508 and BH103 to BH105.

Subsurface Units	Material	Depth (mbgl)				
		BH507 (29.3 mAHD)	BH508 (29.1 mAHD)	BH103 (29.5 mAHD)	BH104 (29.1 mAHD)	BH105 (28.6 mAHD)
Unit A	FILL: Silty CLAY / Silty SAND	0.2 – 2.5	0.15 – 1.5	0.0 – 2.2	0.0 – 1.5	0.0 – 1.5
Unit B	ALLUVIUM: Silty CLAY (firm and stiff)	2.5 – 3.7	1.5 – 1.7	2.2 – 3.0	1.5 – 2.2	1.5 – 1.8 [2]
Unit C1	RESIDUAL: Silty CLAY (stiff)	3.7 – 4.3	1.7 – 2.5	3.0 – 5.5 [2]	2.2 – 4.4	1.8 – 4.3
Unit C2	RESIDUAL: Silty CLAY (very stiff to hard)	4.3 – 4.6 [2]	2.5 – 4.3 [2]	NE [4]	4.4 – 4.6	NE [5]
Unit D1	SHALE: Class IV [1]	4.6 – 5.25	4.3 – 5.18	5.5 – 5.8	4.6 – 5.5	4.3 – 5.2 [3]
Unit D2	SHALE: Class III[1]	8.02 – 8.42 [3]	NE [4]	5.8 – 6.22	NE [4]	NA [8]
Unit D3	SHALE: Class II [1]	5.25 – 8.02	5.18 – 8.15 [3]	6.22 – 8.82	5.5 – 8.5 [3]	NA [8]

Notes:

1. Based on Pells et al. (1998).
2. V-bit refusal depth.
3. Borehole termination depth.
4. Not encountered.
5. Not applicable.

4.3 Groundwater

Groundwater inflow was not encountered during drilling of BH501, BH502, BH507 and BH508 up to 5.1 mbgl.

Groundwater inflow was encountered during drilling of BH503, BH504, BH506 and BH103 to BH105 and excavation of TP109 and TP110. A summary of groundwater inflow level observed during drilling of boreholes and excavation of test pits is provided in Table 6.

Table 6: Summary of groundwater levels.

Location	Geology	Surface Level (mAHD)	Depth of Groundwater inflow (mbgl)	Groundwater Inflow Level (mAHD)	Date
BH503	Residual	29.8	3.75	26.05	02.12.2021
BH504	Residual	29.6	5.4	24.2	02.12.2021
BH506	Residual	29.1	4.2	24.9	02.12.2021
BH103	Residual	29.5	5.35	24.15	17.11.2020
BH104	Residual	29.1	4.2	24.9	04.11.2020
BH105	Fill	28.6	1.3	27.3	04.11.2020
TP109	Residual	29.1	3.4	25.7	20.12.2021
TP110	Residual	29.1	3.4	25.7	20.12.2021

Notes:

1. Surface level estimated from ACOR, 2021b.

Groundwater inflow was encountered in BH105 at the interface of fill and alluvial soil below 1.3 mbgl. We consider this groundwater level to be a result of seepage from nearby Blacktown Creek and former drainage channel.

A summary of standing groundwater level readings in MW02, recorded on 16 and 20 October 2020 is provided in Table 7.

Table 7: Summary of standing groundwater levels measured in monitoring wells.

Location	Approximate Surface Level (mAHD) [1]	Standing Water Levels (mAHD / mbgl)	
		16/10/2020	20/10/2020
MW02	29.5	26.7 / 2.80	26.41 / 3.09

Notes:

1. Surface level estimated from ACOR, 2021b.

Based on our observations and groundwater level measurement as well as engineering judgement, we infer and conclude the following:

- The groundwater is expected to be located within the residual soil near the soil and rock interface.
- The groundwater is expected to be located within the alluvial soil profile across the south eastern portion of the IA in the vicinity of Blacktown Creek and former drainage channel.

- Ephemeral perched groundwater may be encountered within the soil profile, particularly across the eastern portion of the IA in close proximity to existing and former drainage channels, originating from infiltration of surface water during prolonged or intense rainfall events.

5 Geotechnical Assessment

5.1 Laboratory Test Results

5.1.1 Atterberg Limits Testing

Laboratory Atterberg limits test results are presented in Table 8 (refer Attachment D for laboratory test certificate).

Table 8: Summary of laboratory Atterberg limits test results.

BH	Depth (mbgl)	Soil Type	Atterberg Limits (%)				Plasticity Classification	Potential Volume Change [2]
			LL[1]	PL[1]	PI[1]	LS[1]		
BH501	1.2-1.5	Silty CLAY	67	19	48	14.5	High	Medium
BH504	2.5-2.95	Silty CLAY	52	17	35	13.5	High	Medium

Notes:

1. LL = Liquid limit, PL= Plastic limit, PI=Plasticity index, LS = Linear shrinkage.
2. Based on Hazelton and Murphy, 2016.

Laboratory test results indicate that the tested natural soil samples are generally of high plasticity, which may result in moderate ground movement due to soil moisture changes.

5.1.2 Particle Size Distribution (PSD)

Laboratory Particle Size Distribution (PSD) test results are reproduced in Table 9 (refer Attachment D for laboraory test certificate).

Table 9: Summary of laboratory Particle Size Distribution test results.

Sample ID [1]	% Gravel [2]	% Sand	% Clay & Silt
BH503/1.0-1.5	13	21	66
BH507/2.5-2.95	1	3	96

Notes:

1. Borehole#/Depth (mbgl).
2. % Gravel summary includes all material greater than 2.36 mm sieve size.

Site-won excavated fill / alluvial soils typically comprise silt and clay, with / trace sand and trace gravels. We nota that the PSD of site-won residual soil is expected to be similar to that of alluvial soil. Considering the soil reactivity results of the tested soil samples, the clay portion of these materials is likely to be of generally high plasticity. Suitability for re-use of these materials is discussed in Sections 6.4.4 and 7.1.3.

5.1.3 Laboratory Point Load

Laboratory point load strength index test results are summarised in Table 10 (refer Attachment D for point load test certificate). Point load test results reported in MA, 2020b also reproduced in Table 10. Rock core photos are provided in Figures 5 - 14, Attachment C.

Table 10: Point load strength index and UCS test results.

Borehole	Sample Depth (mbgl)	Point Load Strength Index $I_{s(50)}$ (MPa)		UCS [1] (MPa)	Rock Strength [2]
		Diametral	Axial		
BH501	4.6-4.7	0.32	0.58	6.4-11.6	Medium
	6.6-6.73	0.42	1.7	8.4-34.0	Medium to high
	8.01-8.14	0.12 [4]	2.2	2.4-44.0	High [5]
BH502	2.45-2.62	0.18 [4]	0.74	3.6-14.8	Medium [5]
	4.62-4.72	0.22 [4]	0.97	4.4-19.4	Medium [5]
BH503	5.78-5.89	0.22 [4]	0.77	4.4-15.4	Medium [5]
	7.0-7.12	0.19 [4]	1.2	3.8-24.0	High [5]
	8.05-8.16	0.83	2.2	16.6-44.0	High [5]
BH504	6.26-6.37	0.89	1.8	17.8-36.0	High [5]
	7.88-8.00	0.67	1.3	13.4-26.0	High [5]
	9.26-9.41	0.78	1.5	15.6-30.0	High [5]
BH506	6.06-6.28	0.21 [4]	0.97	4.2-19.4	Medium [5]
	7.02-7.12	0.47	1.5	9.4-30.0	High [5]
	8.27-8.39	0.17 [4]	1.6	3.4-32.0	High [5]
BH507	5.25-5.37	0.37	1.2	7.4-24.0	Medium to high
	6.86-6.96	0.79	1.2	15.8-24.0	Medium to high
	8.05-8.15	0.59	1.4	11.8-28.0	Medium to high
BH508	5.18-5.27	0.25	0.47	5.0-9.4	Medium [5]
	6.52-6.64	0.68	1.1	13.6-22.0	Medium to high
	8.00-8.15	0.87	1.7	17.4-34.0	Medium to high
BH103 [6]	5.8-5.92	0.70 [4]	2.20	14.0-44.0	High [5]
	7.16-7.29	0.28 [4]	1.90	5.6-38.0	High [5]
	8.54-8.66	0.32 [4]	2.10	6.4-42.0	High [5]
BH104 [6]	5.85-5.95	0.50 [4]	1.50	10.0-30.0	High [5]
	6.9-7.0	0.94 [4]	3.00	18.8-60.0	High [5]
	8.4-8.5	0.73 [4]	1.50	14.6-30.0	High [5]

Notes:

1. Unconfined Compressive Strength (UCS) of intact material, assuming UCS = 20 x $I_{s(50)}$.
2. Strength classification based on AS1726 (2017).
3. Insufficient solid core sample was available for diametral test.
4. Lower diametral strength in comparison to axial strength possibly due to presence of defects / bedding corresponding with load direction.
5. Rock strength determine from axial value and applies to vertical loading.
6. Reproduced from MA, 2020b.

Test results and observations during rock coring indicate that the bedrock across the IA is likely to consist of highly to moderately weathered, low strength shale with some lower and higher strength bands / layers from between approximately 1.25 mbgl (BH502) and 5.5 mbgl (BH103) to between approximately 2.39 mbgl (BH502) and 5.8 mbgl (BH103), becoming moderately to slightly weathered, medium strength with some higher strength bands / layers from between approximately 4.25 mbgl (BH501) and 5.8 mbgl (BH103) to between approximately 5.25 mbgl (BH501) and 8.42 mbgl (BH507). Slightly weathered to fresh, high strength shale with some lower strength bands / layers was encountered from between approximately 2.39 mbgl (BH502) and 6.22 mbgl (BH103) to 9.55 mbgl (BH504).

It should be considered that testing was carried out on relatively intact core samples. Engineering properties of the rock mass will be impacted by the presence of the numerous defects and discontinuities, including weathered and fractured zones in the rock profile.

5.1.4 Salinity Classification

Laboratory test results for salinity classification are summarised in Table 10 (refer Attachment D for test certificate). Salinity classification test results reported in MA, 2020b also reproduced in Table 11.

Table 11: Salinity test results.

Sample ID [1]	Material	$EC_{(1:5)}$ (dS/m)	EC_e (dS/m) [2]	Salinity Classification [3]
BH501/0.7-0.9	Silty CLAY	0.30	2.55	Slightly saline
BH503/1.5-1.7	Silty CLAY	0.084	0.50	Non-saline
BH504/3.0-3.5	Silty CLAY	0.32	2.24	Slightly saline
BH507/4.0-4.3	Silty CLAY	0.15	0.90	Non-saline
BH103/2.3-2.5 [4]	Silty CLAY	0.77	5.39	Moderately saline
BH104/0.7-0.8 [4]	Silty CLAY	0.088	0.62	Non-saline

Sample ID [1]	Material	$EC_{(1:5)}$ (dS/m)	EC_e (dS/m) [2]	Salinity Classification [3]
BH105/2.5-2.95 [4]	Silty CLAY	0.084	0.59	Non-saline

Notes:

1. Borehole#/Depth (mbgl).
2. Based on EC to EC_e multiplication factors from Table 6.1 in *Site Investigations for Urban Salinity* (2002) guidelines.
3. Based on Table 6.2 of DLWC (2002) where EC_e <2 dS/m = non-saline, EC_e of 2-4 dS/m = slightly saline, EC_e of 4-8 dS/m = moderately saline, EC_e of 8-16 dS/m = very saline and EC_e of >16 dS/m = highly saline.
4. Reproduced from MA, 2020b.

Results indicate residual soils at the IA can generally be categorised as non-saline. Fill and alluvial soils encountered across the IA are indicative of slightly to moderately saline.

5.1.5 Foundation Exposure Classification Testing

Test results for exposure classification are summarised in Table 12 (refer Attachment D for exposure classification test certificate). Exposure classification test results reported in MA, 2020b also reproduced in Table 12.

Table 12: Exposure classification test results.

Sample ID[1]	Material	EC_e (dS/m) [2]	pH	Sulphate (SO_4) (mg/kg)	Resistivity (ohm.cm)	Chloride (Cl) (mg/kg)	Exposure Classification		
							AS 2159 [3]	AS 2159 [4]	AS 3600 [5]
BH501/0.7-0.9	Silty CLAY	2.55	6.2	73	3400	360	Non-aggressive	Non-aggressive	A1
BH503/1.5-1.7	Silty CLAY	0.50	6.1	54	12000	72	Non-aggressive	Non-aggressive	A1
BH504/3.0-3.5	Silty CLAY	2.24	6.4	20	3100	380	Non-aggressive	Non-aggressive	A1
BH507/4.0-4.3	Silty CLAY	0.90	8.5	48	6800	100	Non-aggressive	Non-aggressive	A1
BH103/2.3-2.5 [6]	Silty CLAY	5.39	6.7	60	13	940	Non-aggressive	Moderate	A2
BH104/0.7-0.8 [6]	Silty CLAY	0.62	6.4	10	110	54	Non-aggressive	Moderate	A1
BH105/2.5-2.95 [6]	Silty CLAY	0.59	7.7	10	120	63	Non-aggressive	Moderate	A1

Notes:

1. Borehole#/Depth (mbgl).
2. From column 4 of Table 10.

3. Exposure classification for concrete piles in soil based on Table 6.4.2(C) of AS 2159 (2009).
4. Exposure classification for steel piles in soil based on Table 6.5.2(C) of AS 2159 (2009).
5. Exposure classification for buried reinforced concrete based on Tables 4.8.1 and 4.8.2 of AS 3600 (2018).
6. Reproduced from MA, 2020b.

In accordance with AS2159 (2009), an exposure classification of 'Non-aggressive' and 'Moderate' should be adopted for preliminary design of buried concrete and steel piles, respectively. In accordance with AS3600 (2018) an exposure classification of 'A1' and 'A2' should be adopted for shallow concrete footings founding in residual and alluvial soil, respectively.

5.1.6 California Bearing Ratio (CBR) Testing

Laboratory CBR test results are summarised in Table 13 (refer Attachment D for CBR test certificate).

Table 13: CBR test results.

Borehole Number	Sample Depth (mbgl)	Material	CBR [1] Value (%)
TP106	2.0 – 2.4	Silty CLAY	4.5
TP112	1.6 – 2.0	Silty CLAY	2.0

Notes:
1. Four day soak, compacted to 98 % SMDD (±2 % of OMC), applying a 4.5 kg surcharge.

5.2 Preliminary Material Properties

Preliminary material properties inferred from observations during borehole drilling, such as auger penetration resistance, SPT and laboratory test results as well as engineering judgement are summarised in Table 14.

Table 14: Preliminary estimates of soil and rock strength properties.

Layer [1]	$Y_{in\text{-}situ}$ [2] (kN/m³)	Cu [3] (kPa)	C ′ [4] (kPa)	Ø' [5] (deg)	E' [6] (MPa)	k_S [7] (MPa/m)
FILL: Silty CLAY / Gravelly Sandy SILT / Silty SAND (moist)	16	NA [8]	NA [8]	NA [8]	NA [8]	NA [8]
ALLUVIAL: Silty CLAY (firm and stiff, moist)	17	25	1	24	5	5
RESIDUAL: Silty CLAY (stiff, moist)	18	75	4	26	15	20
RESIDUAL: Silty CLAY (very stiff to hard, moist)	19	120	5	28	30	30
WEATHERED ROCK: Class IV SHALE	22	NA [8]	100	30	200	150
WEATHERED ROCK: Class III SHALE	23	NA [8]	150	32	350	250
WEATHERED ROCK: Class II SHALE	23	NA [8]	250	34	500	350

Notes:

1. Refer to borehole logs in Attachment B for material description details.
2. Material in-situ unit weight, based on visual assessment (±10 %).
3. Average undrained shear strength (± 5 kPa) estimate assuming normally consolidated clay.
4. Average drained cohesion.
5. Effective internal friction angle (±2 °) estimate, assuming drained conditions; may be dependent on rock defect conditions.
6. Average effective elastic modulus (±10 %) estimate, that should be adopted to calculate lateral deflection of pile under serviceability loading.
7. Modulus of subgrade reaction estimate. For horizontal modulus, 1/3 vertical Ks may be adopted.
8. Not applicable.

5.3 Risk of Slope Instability

No evidence of former or current slope movement, such as leaning trees, was observed across the cut batter and within the site. We consider the risk to property and loss of life by potential slope instability, such as landslide or soil creep, to be very low subject to the recommendations in this report and adoption of relevant engineering standards and guidelines. A detailed slope risk assessment in accordance with Australian Geomechanics Society's Landslide Risk Management Guidelines (2007) was not undertaken.

Recommendations presented in this report are provided to mitigate risks associated with potential excavation instability during construction.

5.4 Geotechnical Constraints

The proposed development is inferred to be impacted by the following key geotechnical constraints:

- Existing uncontrolled fill up to approximately 2.6 mbgl (BH506) containing unsuitable materials (i.e. concrete and wood fragments). The fill material generally comprise firm silty clay, which is susceptible to consolidation settlement. Therefore, the existing fill is considered unsuitable as foundation material for new engineered fill and structures.

- Excavation of pile into high and potential higher strength shale may be difficult with conventional piling rig and tools.

- We do not expect that the removal of existing fill, will extend below groundwater level in the western and north eastern portions of the IA. However, excavations may encounter seepage / ephemeral perched groundwater in the fill profile or fill / natural soil interface. Seepage inflow is expected to be low.

- Cutting associated to fill removal in the south eastern portion of the IA may extend below permanent groundwater level.

6 Preliminary Pavement Thickness Design

6.1 Overview

Preliminary flexible and rigid pavement thicknesses design for the proposed car parking areas were undertaken in accordance with Blacktown City Council Engineering Guide for Development (BCC, 2005a), Blacktown City Council Engineering Works Specification Civil (BCC, 2005b) and Austroads - Guide to Pavement Technology Part 2 : Pavement Structural Design (Austroads, 2017).

6.2 Design Parameters

6.2.1 Equivalent Standard Axles (ESA) and Heavy Vehicle Axle Groups (HVAG)

Flexible Pavement

A traffic loading of 5 x 10^4 Equivalent Standard Axles (ESA) was adopted in accordance BCC, 2005a.

Rigid Pavement

An axle loading of 2.0×10^5 HVAG for the proposed carpark was adopted in accordance with Austroads, 2017.

6.2.2 Pavement Design Life

A design life of 20 years was adopted in the design of flexible and rigid pavements.

6.2.3 Concrete Flexural Strength and Load Safety Factor for Rigid Pavement

A minimum concrete flexural strength of 4.0 MPa was adopted in the design. Considering a project reliability of 80%, a load safety factor of 1.05 was adopted in accordance with Austroads, 2017.

6.2.4 Design CBR

Test result returned CBR values of 2.0 % and 4.5 % for the existing fill and alluvial soil, respectively. However, given that enginnered fill of thickness between approximately 1.5 and 5.0 m will be placed across the footprint of SYD08 including across the access road and carpark bays. Considering the likely composition of the engineered fill materials, a subgrade CBR of 5.0 % has been adopted for design purposes.

6.3 Preliminary Pavement Thickness

The pavement thickness design was carried out using Austroads (2017) and adopting a CBR value of 5 %.

Flexible Pavement

Table 15 presents recommended pavement materials and material thicknesses for the flexible pavement.

Table 15: Preliminary pavement material thickness design for CBR 5 %.

Layer	Thickness (mm)	Total Thickness (mm)	Materials
Wearing Course	50	280	Two layers of AC10 with a total minimum thickness of 50 mm
Base	100 [1]		DGB20
Sub-base	130 [1]		DGS20 or DGS40

Notes:

1. Based on Figure 12.2 of Austroads, 2017.

Rigid Pavement

Based on the above (Section 6.2) design parameters, we recommend the following preliminary pavement materials and material thicknesses for rigid pavement.

- Thickness of subbase = 125 mm (DGS 20 or DGS40).
- Thickness of concrete base = 160 mm (based on Figure 12.13, Austroads, 2017).
- Minimum steel reinforcing fabric size = SL 92.

We note that the recommended preliminary pavement thicknesses may need to be revised depending on the treatment method and following development of the final rigid pavement jointing details.

6.4 Earthworks

6.4.1 Subgrade Preparation

The subgrade of the pavement is to be trimmed and compacted, following the removal of unsuitable materials such as loose surface soils. Minimum relative density of subgrade shall be 100 % Maximum Dry Density (MDD) at a standard compactive effort within -3 % of optimum moisture content (OMC).

Prior to placement of pavement material, the treated subgrade shall be proof rolled using a 8 tonne smooth drum roller with minimum 6 passes and approved by a geotechnical engineer. If localised soft spots are encountered, they can be treated by one of the following methods subject to final design and adopted subgrade treatment option:

- Removal and replacement with approved fill under geotechnical engineer's direction.
- Further *in-situ* stabilisation with cement / lime or similar binding agent.

Use of stabilisation method and extent will depend on the condition of material to be stabilized.

6.4.2 Subsoil Drainage

Surface and sub-soil drainage is to be provided in accordance with Council requirements. Typically, subsurface drains are installed on the upslope side of all internal roads or on both sides where adjacent to vegetated areas, and generally extend 600 mm below pavement level. Austroads advises against extending subsurface drainage into highly reactive soils beneath the pavement.

6.4.3 Placement and Testing of Pavement Material

Pavement materials shall be placed in layers (when compacted) not thicker than 300 mm or less than 100 mm. Pavement base (for flexible pavement) and sub-base shall be compacted to a minimum of 98 % MDD at modified compactive effort within -3 % of optimum moisture content (OMC).

Compaction testing shall be undertaken by a NATA accredited laboratory in accordance with AS1289. Each pavement layer shall be proof rolled under an experienced geotechnical engineers' supervision. Subsequent pavement layers shall not be placed prior to approval of underlying layer by the geotechnical engineer.

6.4.4 Fill Placement

Site-won excavated fill, alluvial and residual soils are considered not suitable for re-use as engineered fill due to their moderate to high reactivity to soil moisture variation and associated difficulties in placement. Suitable low plasticity clay from an approved borrow source or granular fill, approved for use by a Geotechnical Engineer should be adopted. Proof rolling to be witnessed by the project

geotechnical engineer to detect localised soft or unstable areas which should be removed and replaced with engineered fill or alternatively stabilised or bridged. An earthworks specification is to be prepared by the supervising engineer and be implemented by the contractor.

6.4.5 Other Recommendations

Transitioning of existing and new pavement sections, if required, needs to be included in detailed design. The transition zone is to be keyed and adequately offset from wheel paths.

7 Geotechnical Recommendations

7.1 Recommendations

Geotechnical recommendations for site development are provided below. Further general geotechnical recommendations are provided in Attachment E.

7.1.1 Exisitng Fill

The existing fill is considered unsuitable as foundation material and should be removed and replaced with engineered fill. We recommend removal of at least 1.5 m of existing fill across the footprint of the proposed development. The actual extent and depth of removal of existing fill will be decided based on inspection by a qualified geotechnical engineer on site.

7.1.2 Excavation Support

Excavation exceeding 1.0 m depth for the removal of existing fill material must be temporarily battered back to maintain slope stability. Maximum batter grades of 1V:2H should be adopted for temporary slopes (unsupported for less than 1 month) and 1V:3H for longer term unsupported slopes, subject to inspection and approval by a qualified and experienced geotechnical engineer on site.

Where there is insufficient room to provide batter, temporary structural support (shoring) should be provided. Temporary shoring may comprise cantilevered soldier pile walls assuming retained height is not more than 3 m or trench box. Preliminary shoring wall design should adopt preliminary earth pressure coefficients presented in Section 7.2 (Table 16).

7.1.3 Earthworks

New fill placement across the footprint of the proposed development, should be carried out following removal of at least top 1.5 m of existing fill, under the guidance of a geotechnical engineer in accordance with AS3798 (2007) and Councils Earthworks Specification.

Site-won excavated fill and natural soils may be considered suitable for re-use as general fill or landscaping purposes but not suitable as engineered fill. We recommend the use of suitable select / engineered fill from an approved borrow source or granular material. The suitability of fill material should be confirmed by a geotechnical engineer and in

compliance with AS3798 (2007). Weathered shale is not considered suitable and should not be used as engineered fill material.

Site preparation should be carried out as follows:

1. Remove al least top 1.5 m of unsuitable existing fill material across the footprint of the proposed development and replace with engineered fill.

2. A qualified geotechnical engineer should inspect the condition of the exposed material to assess suitability as foundation for new fill placement. This shall include proof rolling of exposed materials with a minimum of 6 passes with 8 tonne smooth drum roller in accordance with Clause 5.5 of AS3798 (2007). If localised soft spots are identified, these shall be treated until conditions are assessed by the geotechnical engineer to be suitable.

Recommendations for new fill placement to reach the design ground level are as follows:

1. Fill material should be placed in horizontal layers of generally not more than 350 mm in loose thickness and with a mixture of materials as uniform as possible. Layer thickness shall be appropriate for the compaction plant adopted and may be varied by the supervising engineer. The maximum particle size within each layer shall not exceed 2/3 of the loose layer thickness.

2. Smooth drum rollers (static or vibrating) are considered suitable compaction plant in accordance with Appendix D of AS3798 (2007). If vibrating rollers are adopted, resultant ground vibration should be assessed and monitored in accordance with AS 2187.2 (2006) to ensure no adverse impacts on nearby structures.

3. Fill material shall be moisture conditioned and compacted to a minimum 98 % density ratio (DR) or 75 % density index (DI) for granular fill at a standard compactive effort within ± 2 % of OMC. The upper 300 mm of fill material shall be compacted to a DR of 100 % or DI of 80 % at a standard compactive effort within ± 2 % of OMC.

4. All fill layers shall be proof rolled prior to the placement of next layer in accordance with Clause 5.5 of AS3798 (2007).

Further geotechnical advice can be provided by MA related to earthworks requirements, including site filling, subject to further

geotechnical investigation to assess the composition of existing fill materials and final design and proposed construction methodologies.

7.1.4 Fill Support / Retaining Walls

New fill platform should be permannatly supported by retaining walls. Design and construction recommendation fro the proposed new retaining walls are presented in MA's report reference P2007944JR04V01, dated December 2021 (MA, 2021b).

7.1.5 Footings and Foundations

We recommend that all structures that are sensitive to settlement (< 10 mm) and the proposed Data Centre building are supported by bored piles founded within sound (competent) rock. We recommend that all piles are inspected by an experienced geotechnical engineer to check adequacy of cleanliness of pile base and to confirm pile socket depth into design strata during pile construction. Load testing to be carried out on selected working piles to confirm the pile geotechnical and structural capacity and ensure that pile settlement is within the specified tolerable limits.

The proposed slab on ground for the ground floor slab and shallow footings, such as pad and strip footings for minor and lightly loaded ancillary structures is considered suitable, subject to removal of existing uncontrolled fill (at least top 1.5 m) and replacement with enginnered fill. They should be founded on engineered fill. Should the existing fill is considered to retain in place, we recommend that ground floor slab for the Data Centre building and 12 m high water tank are supported by piles founding in rock to minimise differential movements. Individual pad footings and all footings within building footprints should not span the interface between different foundation materials. Design parameters for shallow footings and piles are provided in Section 7.2 (Table 16).

Footings should be designed by a suitably qualified and experienced structural or geotechnical engineer.

Should the existing fill is considered to retain in place, we note and recommend the following for generator and lightly loaded ancillary structures foundations founding in newly placed engineered fill:

- For a structural load not exceeding 30 kPa, a total elastic settlement of approximately 15 mm of the new fill is expected.

- A total primary consolidation settlement of between approximately 200 mm and 350 mm is expected for fill height of 2 m and 5 m, respectively. The consolidation settlement values are mainly contributed by the underlying existing fill layer comprising firm clay to depth of approximately 1.5 m and has been estimated based on empirical methods and enginnering judgement. To determine consolidation settlement accurately, provision for instrumentation and monitoring will be requred. They are inexpensive and provide more certainty to minimise risks and associated cost for on going maintenance.

- We recommend that the contractor install instrumentation such as ground settlement markers and settlement plates across the site to monitor the actual settlement. The settlement should be monitored on a weekly basis for the first 2 months and then reduced to a fortnightly basis, if necessary.

- We recommend that the construction works are staged and a lead (waiting) time (say 6 months) is allowed following new fill placement to its full height. This will allow sufficient time for occurring most of the consolidation settlement (say around 80 to 90 %) and stabilisation of the rate of settlement. Following satisfactory stabilisation of the settlement rate, the internal road pavements, underground services, generator and other infrastructure works can commence.

We note that following completion of consolidation settlement, ongoing secondary or creep settlement (say at a rate of 2-3 mm /year) may continue to occur in the long term over a period of say 15 - 20 years. This may require periodic maintenance of road pavements and existing infrastructure over its design life.

7.1.6 Pile Excavations

Pile construction aassociated with the proposed development may need to excavate high strength rock. Contractor should consider the capability of their piling rig and use of adequate tools to excavate through high or potential higher strength rock when developing their excavation methodologies.

7.1.7 Groundwater / Drainage Requirements

Excavation for removal of fill from the IA may encounter permanent / seepage / ephemeral perched groundwater in the soil profile, particularly in close proximity to existing and former drainage channels.

Seepage inflow is expected to be low and should be managed by sump and pump methods.

7.1.8 Soil Erosion Control

Removal of soil overburden should be performed in a manner that reduces the risk of sedimentation occurring in the Council stormwater system and on neighbouring lands. All spoil on site should be properly controlled by erosion control measures to prevent transportation of sediments off-site. Appropriate soil erosion control methods in accordance with Landcom (2004) shall be required.

7.1.9 Saline Soil Management

We recommend that saline soil management strategies are prepared at construction certificate stage following review of proposed development levels. Management strategies may include a combination of, but not be limited to, the following:

- Maintaining natural water balance.
- Limiting irrigation.
- Limiting soil disturbance, such as cut and fill, so saline or sodic subsoils are not exposed or groundwater is not intercepted.
- Planting of suitable salt-tolerant plant species.
- Retention of existing deep-rooted vegetation.
- Offset landscaping and gardens from building and retaining walls.
- Treating soils with gypsum before landscaping to suit selective species.
- Where consistent with future land use and landscaping plan, planting of deep-rooted, preferably native, trees to increase water absorption.
- Sealing, e.g. by lining, of stormwater detention ponds and water features to reduce infiltration.
- Preparing sediment and erosion control plans that take into account saline soils.
- Replacing excavated soils in their original order.

- Any long term irrigation or watering on-site is to be at a level that does not cause groundwater to become perched.

Typical management strategies for new buildings and services include:

- Limiting soil disturbance, such as compaction of soils, cutting and filling.
- Designing and building structures to limit interference with natural water flow on site.
- Using appropriate construction materials and techniques to salt proof buildings and infrastructure.
- Utilising damp proof courses and water proofing of slabs.
- Using exposure grade bricks / masonry below damp course or in retaining walls.
- Providing concrete strength and cover to steel reinforcing in accordance with AS 3600 (2018) and the exposure classifications outlined in Table 12.
- Limiting excess surface water infiltration into the soil by designing, installing and maintaining appropriate stormwater drainage (gutters, downpipes, pits and pipes).

7.1.10 Flood Risk

Council's online mapping system (BLEP, 2015) indicates that a small area in the eastern portion of the site will likely be impacted by moderate risk of flood. We expect that the proposed development area will unlikely to be affected by flood, provided appropriate measures are taken in accordance with Council guideline.

7.2 Preliminary Design Parameters

Preliminary design parameters for footings including earth pressure coefficients for retaining wall design are presented in Table 16. These have been estimated from field test results in conjunction with borehole derived soil / rock profile data. The design parameters assume the base of excavation is free of loose / soft soils or debris and reasonably dry prior to placement of concrete and approved following inspection by an experienced geotechnical engineer.

Table 15 Preliminary geotechnical parameters for soil and rock encountered in boreholes.

Layer	Shallow Footings	Piles / Piers [1]				
	ABC [2, 4]	ABC [2, 4]	ASF [3, 4]	K_a [5]	K_p [5]	K_0 [5]
Select (Engineered) Fill	100 [6]	NA [8]	NA [8]	0.33	3.00	0.50
Existing FILL / ALLUVIUM: Silty SAND / Silty CLAY / Gravelly Sandy SILT (firm and stiff, moist)	NA [8]	NA [8]	NA [8]	0.42	2.37	0.59
RESIDUAL: Silty CLAY (stiff, moist)	150	NA [8]	7	0.39	2.56	0.56
RESIDUAL: Silty CLAY (very stiff to hard, moist)	200	300	15	0.36	2.77	0.53
WEATHERED ROCK: Class IV SHALE	500	1000	150	NA [8]	NA [8]	NA [8]
WEATHERED ROCK: Class III SHALE	NA [8]	1500	250	NA [8]	NA [8]	NA [8]
WEATHERED ROCK: Class II SHALE [7]	NA [8]	3000	300	NA [8]	NA [8]	NA [8]

Notes:

1. Assuming bored cast in-situ pile.
2. Allowable end bearing capacity (kPa) for shallow footings embedded at least 0.3 m and piles embedded at least 0.5 m or 1 pile diameter, whichever is greater, subject to confirmation on site by a geotechnical engineer of inferred foundation conditions.
3. Allowable skin friction (kPa) below 1 m depth for bored pile in compression, assuming intimate contact between pile and foundation material.
4. ABC and ASF are recommended based on adopting a reduction factor of Øg = 0.4 in accordance with AS2159 (2009), typically adopted in geotechnical practice to limit settlement to an acceptable level for conventional building structures (< 1% of minimum footing width).
5. k_a = Coefficient of active earth pressure; k_p = Coefficient of passive earth pressure; k_0 = Coefficient of earth pressure at rest.
6. Subject to removal of existing fill and replacement with select (engineered) fill.
7. Higher values may be adopted for high to very high strength shale, if encountered.
8. Not applicable or side adhesion not recommended either due to shallow depth or potential internal settlement of materials.

7.3 Site Classification

The investigation area (IA) is classified as a class 'P' site in accordance with AS 2870 (2011) due to presence of uncontrolled fill up to approximately 2.6 mbgl.

These site classification may be revisited following placement of enginnered fill across the IA.

7.4 Earthquake Site Subsoil Class

Earthquake site subsoil is classified as a class 'C_e (shallow soil)' in accordance with AS 1170.4 (2007). An earthquake Hazard Factor (z) of 0.08 may be adopted for the site.

7.5 Works Prior to Construction Certificate

We recommend that review of the final design is carried out by a senior geotechnical engineer to confirm adequate consideration of the geotechnical risks and adoption of the recommendations provided in this report.

7.6 Construction Monitoring and Inspections

We recommend the following is inspected and monitored during construction phase of the project (Table 17).

Table 17: Recommended inspection / monitoring requirements during site works.

Scope of Works	Frequency/Duration	Who to Complete
Inspect batters and associated performance, if applicable.	As required	MA [1]
Inspect retention structure (shoring, retaining wall) installations and monitor associated performance, if applicable, to assess need for additional support requirements.	Daily / As required [2]	Builder / MA [1]
Monitor groundwater seepage from excavation faces, if encountered, to assess stability of exposed materials and need for additional drainage requirements.	When encountered	Builder / MA [1]
Proof rolling of exposed subgrade by a geotechnical engineer prior to fill placement	As required [2] / prior to certification	Builder / MA [1]
Audit of fill materials and placement.	As required during earthworks	MA [1]
Monitor consolidation settlement, as necessary.	As required following earthworks	Builder / MA [1]

Scope of Works	Frequency/Duration	Who to Complete
Inspect exposed material at foundation / subgrade level to verify suitability as foundation / lateral support / subgrade.	Prior to reinforcement set-up and concrete placement	MA [1]
Monitor sedimentation downslope of excavated areas.	During and after rainfall events	Builder
Monitor sediment and erosion control structures to assess adequacy and for removal of built up spoil.	After rainfall events	Builder

Notes:

1. MA = Martens and Associates engineer
2. MA inspection frequency to be determined based on initial inspection findings in line with construction program.

8 References

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9 Attachment A – Figures

0 10 20 30 40 50 m

1:1250 @ A3

Map Title / Figure:

Geotechnical Investigation Plan

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Environment | Water | Geotechnics | Civil | Projects

Map 01	Map
57 Station Road, Seven Hills, NSW	Site
Geotechnical Assesssment - SYD 08 Data Centre	Project
	Sub-Project
LCI Consultants	Client
28/01/2022	Date

Project No: P2007944 Map Set: MS05-R01 EPSG: 28356

Project No: P2007944 Map Set: MS05-R01 EPSG: 28356

0 10 20 30 40 50 m

1:1250 @ A3

Map Title / Figure:

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Environment | Water | Geotechnics | Civil | Projects

Map 02	Map
57 Station Road, Seven Hills, NSW	Site
Geotechnical Assesssment - SYD 08 Data Centre	Project
	Sub-Project
LCI Consultants	Client
28/01/2022	Date

Photo 1: Retrieval of fill materials (from ground surface to a depth approximately 1.5 m) from the auger at BH503 (viewing east).

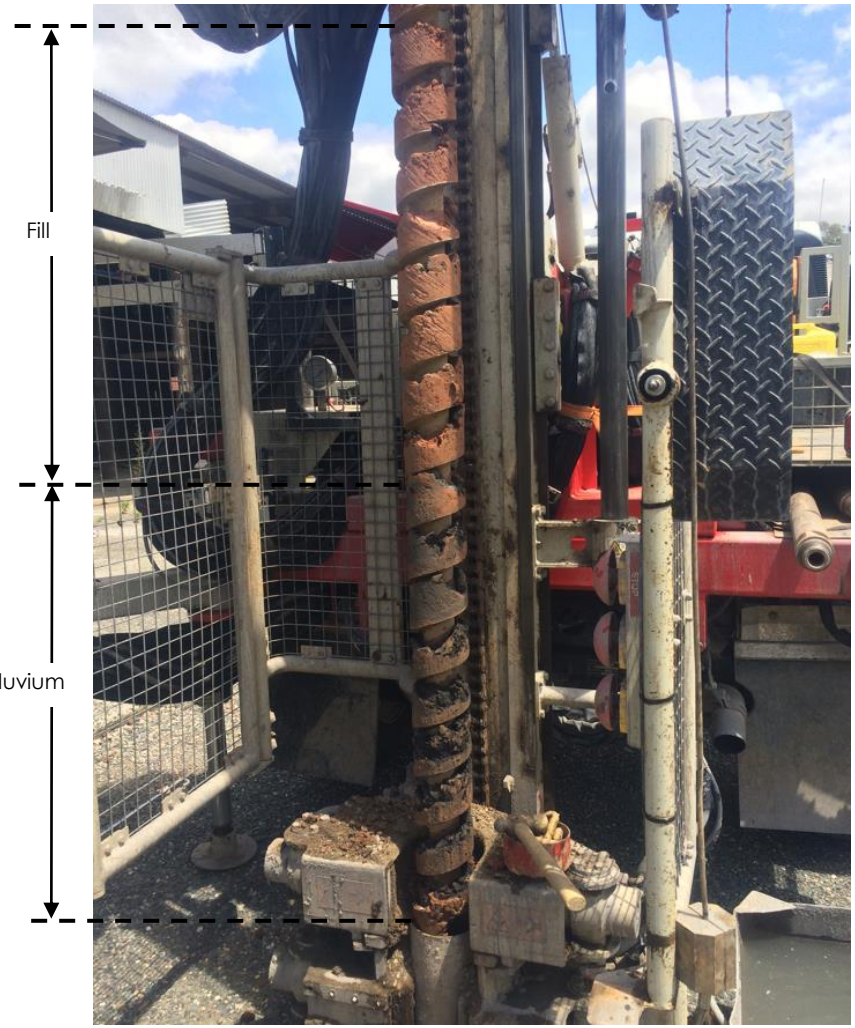

Photo 2: Retrieval of soil (from 1.8 to a depth approximately 3.7 m) from the auger at BH504 (viewing north).

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Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTOS OF FIELD INVESTIGATION** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 2**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		Job No.: P2007944JR05V05

Photo 3: Progress of rock coring at BH501 (viewing west).

Photo 4: Retrieval of rock core (depth approximately 2.3 m to 5.08 m) from BH502 (viewing northwest).

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTOS OF FIELD INVESTIGATION** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 3**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		Job No.: P2007944JR05V05

10 Attachment B – Borehole, Test Pit and Monitoring Well Logs

CLIENT	LCI Australia Pty Ltd		COMMENCED	01/12/2021	COMPLETED	01/12/2021	**REF BH501**
PROJECT	Geotechnical Assessment		LOGGED	WB	CHECKED	SK	Sheet 1 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948255	RL SURFACE	30 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.31 m depth	LATITUDE	-33.778614	ASPECT	North East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	M	Not Observed		30.00	0.0-0.2/S/1 D			GP	Silty GRAVEL (shale, concrete); fine to medium grained; grey, dark grey; trace sand; trace clay.			PAVEMENT
				0.20	0.00-0.20 m							
	L			29.80	0.3-0.5/S/1 D			CI	FILL: Silty CLAY; medium plasticity; brown, dark brown, trace sand; trace fine iron-indurated gravels; inferred poorly to moderately compacted.	M (<PL)		FILL
	H			*0.60*	0.30-0.50 m							
AD/V				29.40	0.7-0.9/S/1 D			CL	FILL: Silty CLAY; low plasticity; grey and brown; trace organics; trace sand; trace fine shale gravels; inferred poorly compacted.	M (>PL)		
	L			*1.00*	0.70-0.90 m							
			1	29.00	SPT 1.00 m			CH	Silty CLAY; high plasticity; red, red-brown, grey; trace fine shale gravels.	M (<PL)	St	RESIDUAL SOIL
	M				3,5,7							
					N=12							
	H			*1.60*	1.2-1.5/S/1 D							
					1.20-1.50 m							
AD/T				28.40					SHALE; dark grey, highly weathered; inferred low strength.			WEATHERED ROCK
	H		2									1.60: V-bit refusal.
				2.60								
									Continued as Cored Borehole			
			3									
			4									
			5									
			6									
			7									
			8									
			9									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	01/12/2021	COMPLETED	01/12/2021	**REF BH501**
PROJECT	Geotechnical Assessment		LOGGED	WB	CHECKED	SK	Sheet 2 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948255	RL SURFACE	30 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.31 m depth	LATITUDE	-33.778614	ASPECT	North East	SLOPE <5%

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				1							
				2	*2.60*		Continuation from non-cored borehole				
NMLC	Not Observed	100	28 (92)	3	27.40		SHALE; dark grey and brown.	HW - MW		2.63-2.67: DS, Silty Clay 2.70-2.76: DS, Silty Clay 2.87: BP, 0°, CN, Pl, Sm 2.92-2.93: DS, Silty Clay 2.96-3.02: CS 3.15: BP, 0°, CT, Pl, Sm 3.20-3.25: CS 3.30: JT, 15°, UN, Closed 3.34-3.37: DS, Silty Clay 3.39: JT, 0 - 5°, CN, UN, Ro 3.43-3.45: JTSet 2, 0 - 5°, Closed 3.47-3.51: JTSet 3, 5 - 10°, VNR, UN, Ro, 10-20mm spacing 3.59-3.62: CS	
				4	*4.25*						
					25.75		Dark grey.	MW - SW		3.67: JT, 30 - 40°, CN, Pl, Sm 3.71-3.84: JTSet 3, 0 - 5°, CN, UN, Ro, 40-90mm spacing 3.95: BP, 0°, CN, Pl, Sm 4.00: HB 4.01: BP, 0°, CN, Pl, Sm 4.06-4.09: DS, Silty Clay 4.12-4.15: JTSet 2, 0°, CT, UN, Ro 4.20-4.25: JTSet 3, 10 - 15°, CN, UN, Ro, 10-20mm spacing 4.37-4.71: BPSet 4, 0°, CN, Pl, Sm, 100-120mm spacing 4.80: JT, 30 - 40°, CT, Pl, Sm 4.92: BP, 0°, CN, UN, Ro 5.06: JT, 30 - 40°, CT, Pl, Sm 5.09: JT, 0 - 5°, VNR, UN, Ro 5.17-5.18: DS, Silty Clay 5.18-5.20: JTSet 2, 45°, CN, Pl, Sm 5.25: DB 5.33-5.36: CS 5.40-5.90: BPSet 7, 0 - 5°, CN, Pl, Ro, 40-140mm spacing 6.00: HB 6.01: HB 6.13: BP, 0°, CN, UN, Ro 6.22-6.24: DS, Silty Clay 6.37-6.83: BPSet 5, 0°, CN, UN, Ro, 30-230mm spacing 6.99: HB 7.00: HB 7.04: HB 7.12-7.88: BPSet 4, 0 - 5°, CN, UN, Ro, 150-370mm spacing 8.00: HB 8.01: HB 8.15: BP, 5°, CN, UN, Ro	
			85 (100)	6							
				7							
				8	*8.31*			SW - FR			
					21.69		Hole Terminated at 8.31 m				
				9							

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	01/12/2021	COMPLETED	01/12/2021	**REF BH502**
PROJECT	Geotechnical Assessment		LOGGED	WB	CHECKED	SK	Sheet 1 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948336	RL SURFACE	29.8 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 5.08 m depth	LATITUDE	-33.778885	ASPECT	West	SLOPE <2%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	M	Not Observed		*0.10* 29.70				GP	Silty GRAVEL (shale, concrete); fine to medium grained; grey, dark grey; trace sand; trace clay.			PAVEMENT
AD/T	L				0.2-0.5/S/1 D 0.20-0.50 m			CH	Silty CLAY; high plasticity; red, red-brown, grey; trace fine shale gravels; inferred stiff.		St	RESIDUAL SOIL
				0.50 29.30								
AD/V	H				0.6-0.7/S/1 D 0.60-0.70 m			Cl	Silty CLAY (extremely weathered shale); medium plasticity; brown, yellow-brown, pale grey; with fine shale gravels; inferred very stiff.	M (<PL)	VSt	
				1.00 28.80	SPT 1.00-1.25 m				Dark grey and brown.		H	
			1	*1.25* 28.55	7,6/100mm N= Refusal							
AD/T	M								SHALE; dark grey and brown; highly weathered; inferred low strength.			WEATHERED ROCK 1.25: V-bit refusal.
			2	*2.30*								
									Continued as Cored Borehole			
			3									
			4									
			5									
			6									
			7									
			8									
			9									

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PROJECT	Geotechnical Assessment		LOGGED	WB	CHECKED	SK	Sheet 2 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948336	RL SURFACE	29.8 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 5.08 m depth	LATITUDE	-33.778885	ASPECT	West	SLOPE <2%

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				1							
				2	*2.30* 27.50		Continuation from non-cored borehole				
NMLC	Not Observed	100	87 (99)	3			SHALE; dark grey.	MW / SW - FR		2.33-2.34: DS, Silty Clay 2.35-2.36: DS, Silty Clay 2.39: BP, 5°, CT, UN, Ro 2.45-2.88: BPSet 3, 0°, CT, UN, Ro, 170-250mm spacing 3.00: HB 3.18: JT, 5 - 10°, VNR, UN, Ro 3.25: BP, 0°, CN, Pl, Sm 3.46-3.83: JTSet 3, 10 - 20°, VNR, UN, Ro, 170-200mm spacnig 3.97: BP, 0°, CN, UN, Ro 4.04-4.72: BPSet 4, CN, Pl, Sm, 30-340mm spacing 4.09-4.10: DS, Silty Clay	
				4							
	Not Observed			5	*5.08* 24.72		Hole Terminated at 5.08 m			4.95-4.97: HB 5.00: HB 5.04-5.06: HB	
				6							
				7							
				8							
				9							

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Engineering Log - BOREHOLE

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PROJECT	Geotechnical Assessment		LOGGED	WB	CHECKED	SK	Sheet 1 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948672	RL SURFACE	29.8 m	DATUM AHD
EXCAVATION DIMENSIONS		8.82 m depth	LATITUDE	-33.778872	ASPECT	North East	SLOPE <3%

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	M			29.80	0.0-0.2/S/1 D			GP	Silty GRAVEL (shale, concrete); fine to medium grained; grey,			PAVEMENT
				0.20	0.00-0.20 m				dark grey; trace sand; trace clay.			
				29.60				CH	FILL: Silty CLAY; high plasticity; brown, pale red-brown, pale			FILL
					0.3-0.5/S/1 D				grey; trace fine ironstone gravels; inferred poorly to moderately			
					0.30-0.50 m				compacted.	M		
	L									(<PL)		
				1.00								
			1	28.80	SPT 1.00-1.45 m			CL	FILL: Silty CLAY; low plasticity; dark brown, trace ironstone			
					2,2,2				gravels; trace sand; inferred poorly compacted.			
					N=4							
				1.50	1.0-1.5/S /1 D							
					1.00-1.50 m							
				28.30	1.5-1.7/S/1 D			CH	Silty CLAY; high plasticity; red, dark red; trace sand; trace fine	M		RESIDUAL SOIL
					1.50-1.70 m				shale gravels.	(=PL)		
			2									
					2.3-2.5/S/1 D							
					2.30-2.50 m							
AD/V					SPT 2.50-2.95 m							
					4,6,7							
					N=13					M		
			3							(<PL)		
	M										St	
				3.50								
				26.30	3.5-3.7/S/1 D				Brown, yellow-brown, orange.			
		Inflow			3.50-3.70 m							
			4									
					SPT 4.00-4.45 m							
					3,5,5							
					N=10							
										M		
										(>PL)		
			5									
				5.20								
	H			24.60					Possibly extremely weathered rock.		H	
				5.50								
AD/T	M			*5.65*	SPT 5.50-5.55 m				SHALE; dark grey; moderately weathered; inferred low strength.			WEATHERED ROCK
					3/50mm							5.50: V-bit refusal.
					N= Refusal				Continued as Cored Borehole			
			6									
			7									
			8									
			9									

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	02/12/2021	COMPLETED	02/12/2021	**REF BH503**
PROJECT	Geotechnical Assessment		LOGGED	WB	CHECKED	SK	Sheet 2 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948672	RL SURFACE	29.8 m	DATUM AHD
EXCAVATION DIMENSIONS		8.82 m depth	LATITUDE	-33.778872	ASPECT	North East	SLOPE <3%

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				1							
				2							
				3							
				4							
				5							
					5.65		Continuation from non-cored borehole				
NMLC		100	100 (100)	6	24.15		SHALE; dark grey.	MW - SW		5.70-5.75: HB 5.75: DB 5.75-5.77: DB 5.77-5.78: DS, Silty Clay 5.88: BP, 0°, VNR, Pl, Sm 6.00: HB 6.08: JT, 30 - 40°, CN, UN, Ro 6.10-6.58: BPSet 4, 0°, CN, Pl, Sm, 40 - 250mm spacing.	
			91 (99)	7				SW - FR		6.78: BP, 0°, CT, UN, Ro 6.87: JT, 5°, VNR, UN, Ro 6.98: HB 7.00: HB 7.12-7.25: JTSet 2, 0 - 5°, CN, UN, Ro 7.37: BP, 5°, CN, Pl, Sm 7.41-7.45: BPSet 2, 5°, CN, Pl, Sm 7.43: JT, 90°, CN, ST, Ro 7.45-7.48: CS 7.70-7.91: BPSet 2, 0°, CN, Pl, Sm	
					7.48 22.32		Thinly laminated.				
				8						8.00: HB 8.05: HB 8.16-8.29: BPSet 2, 0°, CN, Pl, Sm 8.27: HB	
					8.82 20.98		Hole Terminated at 8.82 m				
				9							

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	02/12/2021	COMPLETED	02/12/2021	**REF BH504**
PROJECT	Geotechnical Assessment		LOGGED	WB	CHECKED	SK	Sheet 1 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948707	RL SURFACE	29.6 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 9.55 m depth	LATITUDE	-33.778672	ASPECT	North East	SLOPE <3%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				29.60				GP	Silty GRAVEL (shale, concrete); fine to medium grained; grey, dark grey; trace sand; trace clay.			PAVEMENT
	M			*0.20* 29.40				CI	FILL: Silty CLAY; medium plasticity; brown, pale grey; trace fine mixed gravels; inferred poorly to moderately compacted.			FILL
				0.50 29.10				CH	FILL: Silty CLAY; high plasticity; brown, dark brown, grey, pale grey; trace sand; trace fine mixed gravels; trace wood fragments; inferred poorly compacted.	M (<PL)		
	L		1		SPT 1.00-1.45 m 2,2,2 N=4 1							
				1.60 28.00					Red, red-brown, grey; inferred poorly to moderately compacted.			
	M		2									
				2.30 27.30				CI-CH	Silty CLAY; medium to high plasticity; dark grey; strong organic smell; trace roots.			ALLUVIUM
AD/V					SPT 2.50-2.95 m 2,4,5 N=9					M (=PL)		
	L-M		3		3.0-3.5/S/1 D 3.00-3.50 m						St	
				4.00 25.60	SPT 4.00-4.45 m 2,5,6 N=11			CH	Silty CLAY; high plasticity; brown, yellow-brown and grey.			RESIDUAL SOIL
	M		4							M (<PL)		
				5.00 24.60				CL	Sandy Silty CLAY: low plasticity; brown, yellow-brown, grey.		VSt	
		▷	5	*5.40*								
				5.60	SPT 5.50-5.62 m 8/120mm N= Refusal				Possibly extremely weathered rock.	M (>PL)	H	
AD/T	H			24.00 *5.85*					SHALE; dark grey; moderately weathered; inferred low to medium strength.			WEATHERED ROCK 5.60: V-bit refusal.
NMLC			6						Continued as Cored Borehole			
			7									
			8									
			9									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	02/12/2021	COMPLETED	02/12/2021	**REF BH504**
PROJECT	Geotechnical Assessment		LOGGED	WB	CHECKED	SK	Sheet 2 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948707	RL SURFACE	29.6 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 9.55 m depth	LATITUDE	-33.778672	ASPECT	North East	SLOPE <3%

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				1							
				2							
				3							
				4							
				5							
					5.85		Continuation from non-cored borehole				
NMLC		100	58 (99)	6	23.75		SHALE; thinly laminated; dark grey.	MW - SW / SW - FR		5.93: JT, 5°, CN, UN, Ro 5.98: HB 6.00: HB 6.02: HB 6.04-6.06: DS, Silty Gravelly Clay. 6.12: BP, 0°, VNR, UN, Ro 6.19: JT, 5°, CT, UN, Ro 6.36-6.60: BPSet 5, 0°, CT, UN, Ro, 20-120mm spacing 6.76-6.77: DS, Silty Gravelly Clay. 6.87: JT, 5°, VNR, UN, Ro 6.94: BP, 0 - 5°, VNR, UN, Ro 6.99: HB 7.00: HB 7.06: JT, 0°, VNR, UN, Ro 7.13-7.89: BPSet 9, 0 - 5°, CN, UN, Ro, 20mm-180mm spacing	
				7							
				8						8.00: HB 8.04: DB 8.14-8.66: BPSet 3, 0°, CN, Pl, Sm, 190mm-340mm spacing	
			100 (100)	9						8.93: HB 9.00: HB 9.04: BP, 0°, CN, Pl, Sm	
					9.55		Hole Terminated at 9.55 m				

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	02/12/2021	COMPLETED	03/12/2021	**REF BH506**
PROJECT	Geotechnical Assessment		LOGGED	WB/BC	CHECKED	SK	Sheet 1 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948992	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.55 m depth	LATITUDE	-33.778586	ASPECT	North	SLOPE <2%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				29.10	0.0-0.5/S/1 D			GP	Silty GRAVEL; fine to medium grained; dark brown, grey; trace sand; inferred poorly to moderately compacted.			PAVEMENT
				0.20	0.00-0.50 m							
				28.90				ML	FILL: Gravelly Sandy SILT; low plasticity; dark brown, grey; inferred poorly to moderately compacted.	M (<<PL)		FILL
	M			*0.80*								
				28.30				CH	FILL: Silty CLAY; high plasticity; brown, red-brown, pale grey; trace sand; inferred poorly compacted.			
			1		SPT 1.00-1.45 m 2,2,3 N=5							
				2.00								
			2	27.10				CH	FILL: Silty CLAY; high plasticity; grey and brown; trace roots; trace ironstone gravels; inferred poorly to moderately compacted.			
AD/V				*2.60*	SPT 2.50-2.95 m 3,3,4 N=7					M (<PL)		
	L			26.50				CH	Silty CLAY; high plasticity; grey, dark grey, brown; inferred stiff.			ALLUVIUM
			3									
				3.50								
				25.60				CH	Silty CLAY; high plasticity; brown and grey; trace ironstone and slate gravels; trace sand.		St	RESIDUAL SOIL
				4.00								
			4	25.10	SPT 4.00-4.45 m 2,4,5 N=9			CL	Silty CLAY; low plasticity; brown, red - brown, orange and grey; low plasticity; with gravels; with sand; trace roots.			
		Inflow		*4.50*						M (>PL)	VSt - H	
				24.60					Possibly extremely weathered rock.			
	H			*4.80*								
AD/T				24.30					SHALE; grey, dark grey and brown; highly weathered; very low to low strength.			WEATHERED ROCK 4.80: V-bit refusal.
			5	*5.10*					Continued as Cored Borehole			
			6									
			7									
			8									
			9									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	02/12/2021	COMPLETED	03/12/2021	**REF BH506**
PROJECT	Geotechnical Assessment		LOGGED	WB/BC	CHECKED	SK	Sheet 2 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948992	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.55 m depth	LATITUDE	-33.778586	ASPECT	North	SLOPE <2%

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				1							
				2							
				3							
				4							
				5	*5.10*		Continuation from non-cored borehole				
NMLC		100	25 (30)	6	24.00		SHALE; thinly laminated; dark grey and brown.	MW		5.10-5.32: FZ	
					5.55 23.55		Dark grey	SW - FR		5.42: BP, 0°, CN, Pl, Sm 5.44-5.50: CS 5.54: BP, CN, Pl, Sm 5.56-5.63: JT, 80°, CN, ST, Ro 5.64-5.70: BPSet 2, 0°, CN, Pl, Sm 5.74-5.81: CS 5.91-5.95: BPSet 2, 0°, CN, Pl, Sm 6.00: HB 6.06-6.78: BPSet 8, 0 - 5°, CN, Pl, Sm, 10mm-200mm spacing	
			65 (98)	7						7.00: HB 7.01: HB 7.11: BP, 5°, CN, Pl, Sm 7.70-7.94: BPSet 4, 0 - 5°, CN, Pl, Sm, 10mm-160mm spacing	
				8	*8.55* 20.55					8.00: HB 8.02-8.39: BPSet 4, 5°, CN, Pl, Sm, 50mm-200mm spacing	
				9			Hole Terminated at 8.55 m				

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	03/12/2021	COMPLETED	03/12/2021	**REF BH507**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948634	RL SURFACE	29.3 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.42 m depth	LATITUDE	-33.778336	ASPECT	North East	SLOPE <3%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	H			29.30				GP	Silty GRAVEL; fine to medium grained; angular; grey and brown.			PAVEMENT
				0.20								
				29.10				CI-CH	FILL: Silty CLAY; medium to high plasticity; pale grey, brown, red-brown; with gravels; inferred poorly to moderately compacted.			FILL
					0.5/S/1 D 0.50 m							
			1		SPT 1.00-1.45 m 2,3,3 N=6							
				2.00								
			2	27.30				CH	FILL: Silty CLAY; high plasticity; pale grey and brown; trace rootlets; organic smell; inferred poorly to moderately compacted.			
AD/V	L-M	Not Observed		*2.50*						M (<PL)		
				26.80	SPT 2.50-2.95 m 3,4,4 N=8			CI	Silty CLAY; medium plasticity; grey and dark grey and brwon.			ALLUVIUM
			3								St	
				3.70								
				25.60				CH	Silty CLAY; high plasticity; brown, orange - brown and grey; trace ironstone gravels.			RESIDUAL SOIL
			4		SPT 4.00-4.45 m 3,4,5 N=9							
				4.30								
				25.00	4.0-4.3/S/1 D 4.00-4.30 m			CH	Silty CLAY; high plasticity; pale grey, yellow brown and dark red; trace gravels.		VSt	
				4.60								
AD/T	M-H			24.70					SHALE; grey, dark grey and brown; highly weathered; very low to low strength.			WEATHERED ROCK 4.60: V-bit refusal.
			5	*5.10*								
									Continued as Cored Borehole			
			6									
			7									
			8									
			9									

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	03/12/2021	COMPLETED	03/12/2021	**REF BH507**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 2 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948634	RL SURFACE	29.3 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.42 m depth	LATITUDE	-33.778336	ASPECT	North East	SLOPE <3%

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				1							
				2							
				3							
				4							
				5	*5.10*		Continuation from non-cored borehole				
NMLC	Not Observed	100	76 (95)	6	24.20		SHALE; thinly laminated; dark grey and grey.	MW SW SW - FR		5.12-5.13: DS, Silty Clay 5.14-5.15: DS, Silty Clay 5.16-5.17: DS, Silty Clay 5.21: HB 5.25-5.62: BPSet 4, 0°, CN, Pl, Sm, 130-110mm spacing 5.72: DB 5.85-5.95: BPSet 2, 0°, CN, Pl, Sm 6.09: BP, 0°, CN, UN, Ro 6.09-6.11: JT, 90°, CN, UN, Ro 6.16: JT, 10 - 15°, CN, UN, Ro 6.17-6.25: JT, 90°, CN, UN, Ro 6.22-6.23: BPSet 2, 0°, CT, Pl, Closed 6.25-6.26: BPSet 2, 0°, CN, Pl, Sm 6.45-6.66: BPSet 2, CN, UN, Ro 6.87: BP, 0°, CN, Pl, Sm 6.97: HB 7.00: HB 7.13-7.92: BPSet 9, 0 - 5°, VNR, UN, Ro, 30-170mm spacing	
			70 (100)	7							
				8	*8.42*					8.00: HB 8.01: HB 8.02-8.40: BPSet 6, 0 - 5°, CN, Pl, Sm, 30mm-100mm spacing 8.16-8.22: BPSet 4, 0 - 5°, CT, Pl, Closed. 10-20mm spacing 8.29: JT, 5 - 10°, VNR, UN, Ro	
				9	20.88		Hole Terminated at 8.42 m				

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	03/12/2021	COMPLETED	03/12/2021	**REF BH508**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948878	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.15 m depth	LATITUDE	-33.778427	ASPECT	North East	SLOPE <3%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	H			*0.15* 28.95					CONCRETE.			PAVEMENT
								CH	FILL: Silty CLAY; high plasticity; dark brown, red and dark grey; with gravel; inferred poorly to moderately compacted.			FILL
					0.5/S/1 D 0.50 m							
	M		1							M (<PL)		
				1.50 27.60	1.5/S/1 D 1.50 m			CI	Silty CLAY; medium plasticity; dark grey; inferred stiff.	M (=PL)		ALLUVIUM
AD/V		Not Observed		*1.70* 27.40				CI-CH	Silty CLAY; medium to high plasticity; brown and grey; trace gravels; inferred stiff.			RESIDUAL SOIL
			2		2.0/S/1 D 2.00 m						St	
				2.50 26.60	2.5/S/1 D 2.50 m				Brown with grey mottling; inferred very stiff.			
	L		3							M (<PL)		
											VSt	
			4	*4.30* 24.80								
AD/T	L			*4.68*					SHALE: dark grey and brown; highly weathered; inferred very low to low strength.			WEATHERED ROCK 4.30: V-bit refusal
									Continued as Cored Borehole			
			5									
			6									
			7									
			8									
			9									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	03/12/2021	COMPLETED	03/12/2021	**REF BH508**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 2 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948878	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.15 m depth	LATITUDE	-33.778427	ASPECT	North East	SLOPE <3%

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				1							
				2							
				3							
				4							
					4.68		Continuation from non-cored borehole				
NMLC	Not Observed	100	49 (94)	5	24.42		SHALE; thinly laminated; dark grey.	HW		4.72: HB 4.77: HB 4.84-4.89: DS, Silty clay 4.92: BP, 0°, VNR, Pl, Sm 4.92-4.98: JT, 90°, CN, UN, Ro 5.02: BP, 10 - 15°, CT, UN, Ro 5.02-5.05: JT, 60°, CN, UN, Ro 5.13-5.38: BPSet 5, 0°, CN, Pl, Sm, 40-100mm spacing 5.60-5.63: DB 5.73-5.95: BPSet 4, 0°, CN, Pl, Sm, 10-110mm spacing	
	Not Observed		97 (100)	6				SW - FR		6.00: HB 6.14-6.83: BPSet 4, 0°, CN, Pl, Sm, 110mm-320mm spacing 6.51-6.52: CS	
				7						7.00: HB 7.03: BP, 5°, CN, UN, Ro 7.28-7.92: BPSet 5, 0°, CN, Pl, Sm, 60mm-220mm spacing	
				8	***8.15***					8.00: HB	
					20.95		Hole Terminated at 8.15 m				
				9							

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	15/10/2020	COMPLETED	15/10/2020	**REF BH103**
PROJECT	Preliminary Geotechnical Assessment		LOGGED	WB	CHECKED	SVK/SK	Sheet 1 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948642	RL SURFACE	29.5 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.82 m depth	LATITUDE	-33.778558	ASPECT	Northeast	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M		2	29.50	PID 0.00 m 7.1 ppm 0.00-0.2/S/1 D 0.00-0.20 m PID 0.10 m 8 ppm			CL-CI	FILL: Silty CLAY; low to medium plasticity; pale grey, grey, brown, red-brown; trace fine siltstone and shale gravel; inferred poorly to moderately compacted.			FILL
					SPT 1.00-1.45 m 3,5,6 N=11 1 1.0-1.45/S/1 D 1.00-1.45 m PID 1.50 m 8 ppm					M (<<PL)		
				2.20	1.8-2.0/S/1 D 1.80-2.00 m							
				27.30	2.3-2.5/S/1 D 2.30-2.50 m SPT 2.50-2.95 m 2,3,3 N=6			CI-CH	Silty CLAY; medium to high plasticity; dark grey; trace fine subrounded to rounded gravels; organic smell.		F	ALLUVIUM
				3.00	PID 2.50 m 7 ppm							
				26.50	2 2.5-2.95/S/1 D 2.50-2.95 m 2.9-3.0/S/1 D 2.90-3.00 m PID 3.00 m 7.3 ppm			CH	Silty CLAY; high plasticity; brown, red-brown, grey; trace fine ironstone gravels; inferred stiff.	M (<PL)		RESIDUAL SOIL
			4	4.00	3.7-4.0/S/1 D							
				25.50	3.70-4.00 m PID 4.00 m 7 ppm				Brown, red-brown, orange, grey and pale grey.		St	
					4.5-4.8/S/1 D 4.50-4.80 m							
AD/T		▽		5.50								
				5.65	PID 5.50 m 7.4 ppm				SHALE; dark grey; moderately weathered; inferred low strength.			WEATHERED ROCK
			6						Continued as Cored Borehole			5.50: V-bit refusal.
			8									
			10									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	15/10/2020	COMPLETED	15/10/2020	**REF BH103**
PROJECT	Preliminary Geotechnical Assessment		LOGGED	WB	CHECKED	SVK/SK	Sheet 2 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948642	RL SURFACE	29.5 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.82 m depth	LATITUDE	-33.778558	ASPECT	Northeast	SLOPE <5%

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				2							
				4							
					5.65		Continuation from non-cored borehole				
NMLC		100	72 (100)	6	23.85		SHALE; black with dark grey; thinly laminated.	MW SW FR		5.65-5.79: BPSet 6, 0°, CN, Pl, Sm, 10-30mm spacing.	
					6.70 22.80		Water loss.			6.00: HB 6.07-6.22: BPSet 3, 0°, CN, Pl, Sm, 60-90mm spacing. 6.46-6.55: BPSet 2, 0°, CN, Pl, Sm 6.72: BP, 0°, CN, UN, Ro	
			78 (100)	8	*8.82*					7.00: HB 7.07-7.10: BPSet 2, 0 - 5°, CN, Pl, Sm 7.12: HB 7.13: HB 7.16: JT, 5°, CT, Pl, Ro 7.30: DB 7.40: BP, 0°, CN, UN, Ro 7.59: BP, 0°, CN, UN, Ro 7.75-7.76: BPSet 2, 0°, CN, UN, Ro 7.86: BP, 0°, CN, Pl, Sm 7.90-7.91: JTSet 2, 0 - 5°, CN, UN, Ro 8.00: HB 8.12: HB 8.46: BP, 0°, CN, Pl, Sm 8.53-8.54: BPSet 2, 0°, CN, Pl, Ro 8.65: JT, 0°, CN, UN, Ro 8.73: BP, 0°, CN, Pl, Ro 8.75: JT, 5°, CN, UN, Ro	
				10	20.68		Hole Terminated at 8.82 m				

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	15/10/2020	COMPLETED	16/10/2020	**REF BH104**
PROJECT	Preliminary Geotechnical Assessment		LOGGED	WB	CHECKED	SVK/SK	Sheet 1 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948763	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.50 m depth	LATITUDE	-33.778073	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	H			29.10	PID 0.00 m 1.3 ppm 0.1-0.3/S/1 D 0.10-0.30 m			CI-CH	FILL: Silty CLAY; medium to high plasticity; grey, brown; trace sand; trace mixed gravels; inferred moderately compacted.	M (<<PL)		FILL
				0.50								
AD/T	L			28.60	PID 0.60 m 0.3 ppm 0.7-0.8/S/1 D 0.70-0.80 m			CI	FILL: Silty CLAY; medium to high plasticity; grey, dark grey, brown, red-brown; trace mixed gravels; trace wood; trace fabric; inferred poorly compacted.			
	L				SPT 1.00-1.45 m 2,4,5 N=9							
				1.50	1							
				27.60	PID 1.50 m 9.1 ppm 1.6-1.8/S/1 D 1.60-1.80 m			CI	Silty CLAY; medium plasticity; grey; organic smell; inferred firm to stiff.		F - St	ALLUVIUM
			2	***2.20***						M (<PL)		
AD/V	M			26.90	2.3-2.4/S/1 D 2.30-2.40 m SPT 2.50-2.95 m 2,5,6 N=11 PID 2.50 m 7 ppm 2			CH	Silty CLAY; high plasticity; brown, grey; with shale bands.			RESIDUAL SOIL
				3.50							St	
				25.60				CI	Silty CLAY; medium plasticity; brown; trace sand; trace fine shale gravels.			
				4.00	3.8-4.0/S/1 D 3.80-4.00 m							
			4	25.10	SPT 4.00-4.45 m 2,3,5 N=8				Brown, red-brown, grey, orange; trace fine ironstone gravels.	M (>PL)		
				4.40								
AD/T	H			***4.60***	PID 4.00 m 7.6 ppm				Inferred very stiff to hard.		VSt - H	
	M			***4.72***	3				SHALE; dark grey; moderately weathered; inferred low strength.			WEATHERED ROCK
					4.0-4.45/S/1 D 4.00-4.45 m				Continued as Cored Borehole			4.60: V-bit refusal.
			6									
			8									
			10									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	15/10/2020	COMPLETED	16/10/2020	**REF BH104**
PROJECT	Preliminary Geotechnical Assessment		LOGGED	WB	CHECKED	SVK/SK	Sheet 2 OF 2
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948763	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.50 m depth	LATITUDE	-33.778073	ASPECT	East	SLOPE <5%

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				2							
				4							
					4.72		Continuation from non-cored borehole				
					24.38		SHALE; dark grey and brown; thinly laminated.	MW / SW		4.79: BP, 0°, CT, Pl, Sm 4.83-4.84: DS, Silty clay 4.88-4.89: DS, Silty clay 4.92: BP, 0°, CN, Pl, Sm 4.97-5.00: BPSet 2, 0°, VNR, Pl, Sm 5.03-5.33: BPSet 10, 0 - 5°, CN, Pl, Ro, 10-50mm spacing 5.34: JT, 5°, CN, UN, Ro 5.37-5.44: BPSet 3, 5°, CN, Pl, Ro, 10-50mm spacing 5.48-5.60: JTSet 3, 0 - 5°, CN, UN, Ro, 10-100mm spacing 5.66-5.68: BPSet 2, 5 - 10°, CN, Pl, Ro 5.77: BP, 5°, VNR, UN, Ro 5.95: BP, 0°, CN, UN, Ro 6.00: HB 6.30: JT, 5°, CN, UN, Ro 6.68-6.70: BPSet 3, CN, Pl, Sm, 10mm spacing 7.00: HB 7.14: BP, 0°, CN, Pl, Ro 7.19: HB 7.20: DB 7.54: BP, 5°, CN, UN, Ro 7.96: BP, 5°, CN, UN, Ro 8.00: HB 8.04: CS 8.20: JT, 10 - 15°, CN, UN, Ro 8.26: BP, 0 - 5°, CN, UN, Ro	
		100	49 (100)	6	*5.08*		Black with dark grey.	SW - FR			
			89 (100)	8							
					8.50						
					20.60		Hole Terminated at 8.50 m				
				10							

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	16/10/2020	COMPLETED	16/10/2020	**REF BH105**
PROJECT	Preliminary Geotechnical Assessment		LOGGED	WB	CHECKED	SVK/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.949336	RL SURFACE	28.6 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 5.20 m depth	LATITUDE	-33.778533	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	H			28.60	PID 0.10 m 2.1 ppm 0.2-0.3/S/1 D 0.20-0.30 m PID 0.50 m 3.9 ppm			SM	FILL: Silty SAND; fine to medium grained; grey, brown, pale grey; trace concrete fragments; trace mixed gravels; inferred moderately compacted; poorly graded.	M		FILL
				1.00	0.9-1.0/S/1 D							
	L	▽		27.60	0.90-1.00 m SPT 1.00-1.45 m 3,4,5 N=9				Trace clay; inferred poorly to moderately compacted.	W		
				1.50								
AD/V	M		2	27.10 *1.80* 26.80	PID 1.00 m 0.5 ppm 1 1.0-1.45/S/1 D 1.00-1.45 m 1.6-1.7/S/1 D 1.60-1.70 m 1.9-2.0/S/1 D 1.90-2.00 m PID 2.25 m 0.1 ppm SPT 2.50-2.95 m 3,6,7 N=13 2 2.5-2.95/S/1 D 2.50-2.95 m			CL-CI CI	Silty CLAY; low to medium plasticity; grey, hydrocarbon smell; inferred stiff. Silty CLAY; medium plasticity; brown, grey.	M (>PL)	St	ALLUVIUM RESIDUAL SOIL
			4	*4.30*								
AD/T				24.30					SHALE; dark grey; highly weathered; inferred low strength.			WEATHERED ROCK 4.30: V-bit refusal.
				5.20					Hole Terminated at 5.20 m			5.20: TC-bit refusal on inferred medium strength shale.
			6									
			8									
			10									

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Engineering Log - BOREHOLE

CLIENT	LCI Australia Pty Ltd		COMMENCED	15/10/2020	COMPLETED	15/10/2020	**REF BH103/MW02**
PROJECT	Preliminary Geotechnical Assessment		LOGGED	WB	CHECKED	SVK/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills, NSW		GEOLOGY	Ashfield Shale	VEGETATION	None	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.948642	RL SURFACE	29.5 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 8.82 m depth	LATITUDE	-33.778558	ASPECT	Northeast	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
AD/V		16/10/20		29.50	0.00-0.2/S/1 D 0.00-0.20 m			CL-CI	FILL: Silty CLAY; low to medium plasticity; pale grey, grey, brown, red-brown; trace fine siltstone and shale gravel; inferred poorly to moderately compacted.			MW02: Concrete
					1 1.0-1.45/S/1 D 1.00-1.45 m					M (<<PL)		
			2		1.8-2.0/S/1 D 1.80-2.00 m							Cuttings
				2.20								
				27.30	2.3-2.5/S/1 D 2.30-2.50 m			CI-CH	Silty CLAY; medium to high plasticity; dark grey; trace fine subrounded to rounded gravels; organic smell.		F	
					2 2.5-2.95/S/1 D 2.50-2.95 m							
		20/10/20		*3.00*								Casing
				26.50	2.9-3.0/S/1 D 2.90-3.00 m			CH	Silty CLAY: high plasticity; brown, red-brown, grey; trace fine ironstone gravels; inferred stiff.			
					3.7-4.0/S/1 D 3.70-4.00 m					M (<PL)		
	M		4	*4.00*								
				25.50					Brown, red-brown, orange, grey and pale grey.		St	
					4.5-4.8/S/1 D 4.50-4.80 m							Bentonite
				5.50								
AD/T				*5.65*					SHALE; dark grey; moderately weathered; inferred low strength.			
				23.85	1 C 5.65-8.82 m				SHALE; black with dark grey; thinly laminated.			
			6									Screen
				6.70								
				22.80					Water loss.			Sand
NMLC										M (<PL)		
			8									
				8.82								
									Hole Terminated at 8.82 m			
			10									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP101**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	150.94911	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		3.50 m depth	LATITUDE	-33.77874	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				29.10					CONCRETE SLAB			
				0.10								
				29.00				CI-CH	FILL: Silty CLAY; medium to high plasticity; brown, pale grey and yellow; trace gravels			FILL
			0.5									
			1.0							M (<PL)		
			1.5									
E		Not Encountered										
				2.00								
			2.0	27.10				CH	Silty CLAY; high plasticity; dark grey and black; with organics			ALLUVIUM
			2.5							M (<PL)		
			3.0									
			3.5	***3.50***					Hole Terminated at 3.50 m (Target depth reached)			

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP102**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94888	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		3.50 m depth	LATITUDE	-33.77868	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				29.10					CONCRETE SLAB			
				0.10								
				29.00				SW	FILL: Gravelly SAND; medium grain; brown	D		FILL
				0.20								
				28.90				CI-CH	FILL: Silty CLAY; medium to high plasticity; brown, pale grey, yellow and red; trace siltstone and ironstone gravels; trace wood fragments			
			0.5							M (<<PL)		
				1.00								
			1.0	28.10				CI	FILL: Silty CLAY; medium plasticity; reddish brown			
					1 D 1.10-1.30 m							
				1.50								
			1.5	27.60				CI	FILL: Silty CLAY; medium plasiticty; red and pale grey with some yellow mottling; trace gravels			
E		Not Encountered										
				2.00								
			2.0	27.10				CH	Silty CLAY; high plasticity; dark grey; with rootlets and organics; trave gravels			ALLUVIUM
										M (<PL)		
			2.5		D 2.50-2.70 m							
				3.00								
			3.0	26.10				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets			RESIDUAL SOIL
			3.5	*3.50*					Hole Terminated at 3.50 m (Target depth reached)			

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP103**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94876	RL SURFACE	29.6 m	DATUM AHD
EXCAVATION DIMENSIONS		3.50 m depth	LATITUDE	-33.77858	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E		Not Encountered	0.5	29.60				GP	Sandy GRAVEL; fine to medium grained; angular; grey	D		PAVEMENT
				0.20 29.40				CI	FILL: Silty CLAY; medium plasiticty; red and pale grey with some yellow mottling; trace gravels			FILL
			1.0		1 D 1.20-1.40 m							
			1.5							M (<PL)		
			2.0	*2.00* 27.60				CH	Silty CLAY; high plasticity; dark grey; with rootlets and organics; trace gravels			ALLUVIUM
			2.5		D 2.50-2.70 m							
			3.0	*3.00* 26.60				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets			RESIDUAL SOIL
					D 3.30-3.50 m							
			3.5	*3.50*					Hole Terminated at 3.50 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP104**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94865	RL SURFACE	30 m	DATUM AHD
EXCAVATION DIMENSIONS		3.50 m depth	LATITUDE	-33.77847	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E		Not Encountered	0.5	30.00				GP	Sandy silty GRAVEL; fine to medium grain; angular; grey and brown	D		PAVEMENT
				0.20 29.80				CI	FILL: Silty CLAY; medium plasiticty; pale greywith some red mottling; trace ironstone and siltstone gravels			FILL
			1.0									
				1.30 28.70				CL-CI	FILL: Silty CLAY; low to medium plasiticty; reddish brown with some pale grey mottling; trace gravels	M (<PL)		
			1.5									
				2.10 27.90				CH	Silty CLAY; high plasticity; dark grey; with rootlets and organics; trace gravels			ALLUVIUM
			2.0									
				2.90 27.10				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets			RESIDUAL SOIL
			2.5									
				3.50					Hole Terminated at 3.50 m (Target depth reached)			
			3.0									
			3.5									

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP105**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT	Excavator		LONGITUDE	150.94846	RL SURFACE	30 m	DATUM AHD
EXCAVATION DIMENSIONS	3.50 m depth		LATITUDE	-33.77838	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E		Not Encountered	0.5	30.00				GP	Sandy silty GRAVEL; fine to medium grained; angular; grey and brown	D		PAVEMENT
				0.20 29.80				CL-CI	FILL: Silty CLAY; low to medium plasiticty; brown with some yellow, red and pale grey mottling; trace gravels			FILL
			1.0									
			1.5							M (<PL)		
			2.0	*2.00* 28.00				CI-CH	Silty CLAY; medium to high plasticity; dark grey; with rootlets and organics; trace gravels			ALLUVIUM
			2.5	*2.50* 27.50				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets			RESIDUAL SOIL
			3.0									
			3.5	*3.50*					Hole Terminated at 3.50 m (Target depth reached)			

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP106**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94843	RL SURFACE	30 m	DATUM AHD
EXCAVATION DIMENSIONS		3.50 m depth	LATITUDE	-33.77821	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E		Not Encountered	0.5	30.00					CONCRETE SLAB			
				0.10								
				29.90				GP	Sandy Silty GRAVEL; fine to medium grained; angular; grey and brown	D		FILL
				0.30								
				29.70				CI	FILL: Silty CLAY; medium plasiticty; brown and pale grey with some red and yellow mottling; trace gravels			
			1.0									
			1.5									
				1.70								
				28.30				CH	Silty CLAY; high plasticity; dark grey; with rootlets and organics; trace gravels	M (<PL)		ALLUVIUM
			2.0		1 CBR 2.00-2.40 m							
			2.5									
				2.70								
				27.30				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets			RESIDUAL SOIL
			3.0									
				3.50								
			3.5						Hole Terminated at 3.50 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

MARTENS & ASSOCIATES PTY LTD
Suite 201, 20 George St. Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP107**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94864	RL SURFACE	29.6 m	DATUM AHD
EXCAVATION DIMENSIONS		3.60 m depth	LATITUDE	-33.77821	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E		Not Encountered	0.5	29.60				GP	GRAVEL and COBBLES; grey; with sand	D		PAVEMENT
				0.30 29.30				CI	FILL: Silty CLAY; medium plasiticty; brown and pale grey with some red and yellow mottling; trace gravels; trace wood fragments			FILL
			1.0									
			1.5	*1.80* 27.80				CH	Silty CLAY; high plasticity; dark grey; with rootlets and organics; trace gravels	M (<PL)		ALLUVIUM
			2.0	*2.10* 27.50				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets			RESIDUAL SOIL
			2.5									
			3.0									
			3.5	*3.60*					Hole Terminated at 3.60 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP108**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94894	RL SURFACE	29.6 m	DATUM AHD
EXCAVATION DIMENSIONS		3.60 m depth	LATITUDE	-33.77829	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				29.60					Shale COBBLES; grey; with sand	D		PAVEMENT
				0.30								
				29.30				CI	FILL: Silty CLAY; medium plasiticty; brown and pale grey with some red and yellow mottling; trace gravels			FILL
			0.5									
			1.0									
				1.40								
				28.20				CH	Silty CLAY; high plasticity; dark grey with brown mottling; trace rootlets and organics; trace gravels			ALLUVIUM
			1.5									
E		Not Encountered		*1.80*								
				27.80				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets	M (<PL)		RESIDUAL SOIL
			2.0									
			2.5									
			3.0									
			3.5									
				3.60								
									Hole Terminated at 3.60 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

martens

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP109**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94902	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		3.60 m depth	LATITUDE	-33.77845	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				29.10				GP	Sandy GRAVEL; fine to medium grained; angular; pale brown; with cobbles	D		PAVEMENT
				0.20								
				28.90				CI-CH	FILL: Silty CLAY; medium to high plasiticty; brown, pale grey, yellow and red; trace ironstone and siltsone gravels; trace timber			FILL
			0.5									
			1.0									
			1.5									
				1.60								
E				27.50				CH	Silty CLAY; high plasticity; dark grey; trave rootlets and organics; trace gravels	M (<PL)		ALLUVIUM
			2.0									
				2.10								
				27.00				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets			RESIDUAL SOIL
			2.5									
			3.0									
		▽	3.5							M (=PL)		
				3.60								
									Hole Terminated at 3.60 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP110**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94914	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		3.50 m depth	LATITUDE	-33.77854	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				29.10					CONCRETE SLAB			
				0.15								
				28.95				GP	Siltstone and shale GRAVEL; grey and dark grey; with sand	D		FILL
				0.30								
				28.80				CI-CH	FILL: Silty CLAY; medium to high plasticity; brown, pale grey, yellow and red; trace ironstone and siltsone gravels; trace wood fragments			
			0.5									
					1 D 0.90-1.10 m							
			1.0									
				1.40								
				27.70				CH	Silty CLAY; high plasticity; dark grey; with rootlets and organics; trace gravels			ALLUVIUM
			1.5									
E					D 1.70-1.80 m					M (<PL)		
			2.0									
				2.20								
				26.90				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets			RESIDUAL SOIL
			2.5									
			3.0									
					D 3.10-3.30 m							
		▽								M (=PL)		
			3.5	*3.50*								
									Hole Terminated at 3.50 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP111**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94887	RL SURFACE	29.6 m	DATUM AHD
EXCAVATION DIMENSIONS		2.70 m depth	LATITUDE	-33.77854	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E		Not Encountered	0.5	29.60				SP	Gravelly SAND; medium to coarse grain; brown; with bricks	D		PAVEMENT
				0.30 29.30				CL-CI	FILL: Silty CLAY; low to medium plasiticty; brown and pale grey, yellow and red; trace ironstone and siltsone gravels and cobbles			FILL
			1.0									
			1.5							M (<PL)		
				1.70 27.90				CH	Silty CLAY; high plasticity; dark grey; with rootlets and organics; trace gravels			ALLUVIUM
			2.0									
				2.40 27.20				CI-CH	Silty CLAY; medium to high plasticity; brown and pale grey; trace rootlets			RESIDUAL SOIL
			2.5	*2.70*					Hole Terminated at 2.70 m (Target depth reached)			
			3.0									
			3.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - TEST

CLIENT	LCI Australia Pty Ltd		COMMENCED	20/12/2021	COMPLETED	20/12/2021	**REF TP112**
PROJECT	Geotechnical Assessment		LOGGED	BC	CHECKED	WB/SK	Sheet 1 OF 1
SITE	57 Station Road, Seven Hills		GEOLOGY	Ashfield Shale	VEGETATION	Nil	PROJECT NO. P2007944
EQUIPMENT		Excavator	LONGITUDE	150.94919	RL SURFACE	29.1 m	DATUM AHD
EXCAVATION DIMENSIONS		2.00 m depth	LATITUDE	-33.77866	ASPECT	East	SLOPE <5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				29.10				GP	Sandy GRAVEL; fine to medium grain; angular; grey; with cobbles	D		PAVEMENT
				0.30								
				28.80				CI	Silty CLAY; medium plasticity; brown and pale grey with some red and yellow mottling; trace gravels			FILL
E		Not Encountered	0.5									
			1.0							M (<PL)		
			1.5		1 CBR 1.60-2.00 m							
				2.00								
			2.0						Hole Terminated at 2.00 m (Target depth reached)			
			2.5									
			3.0									
			3.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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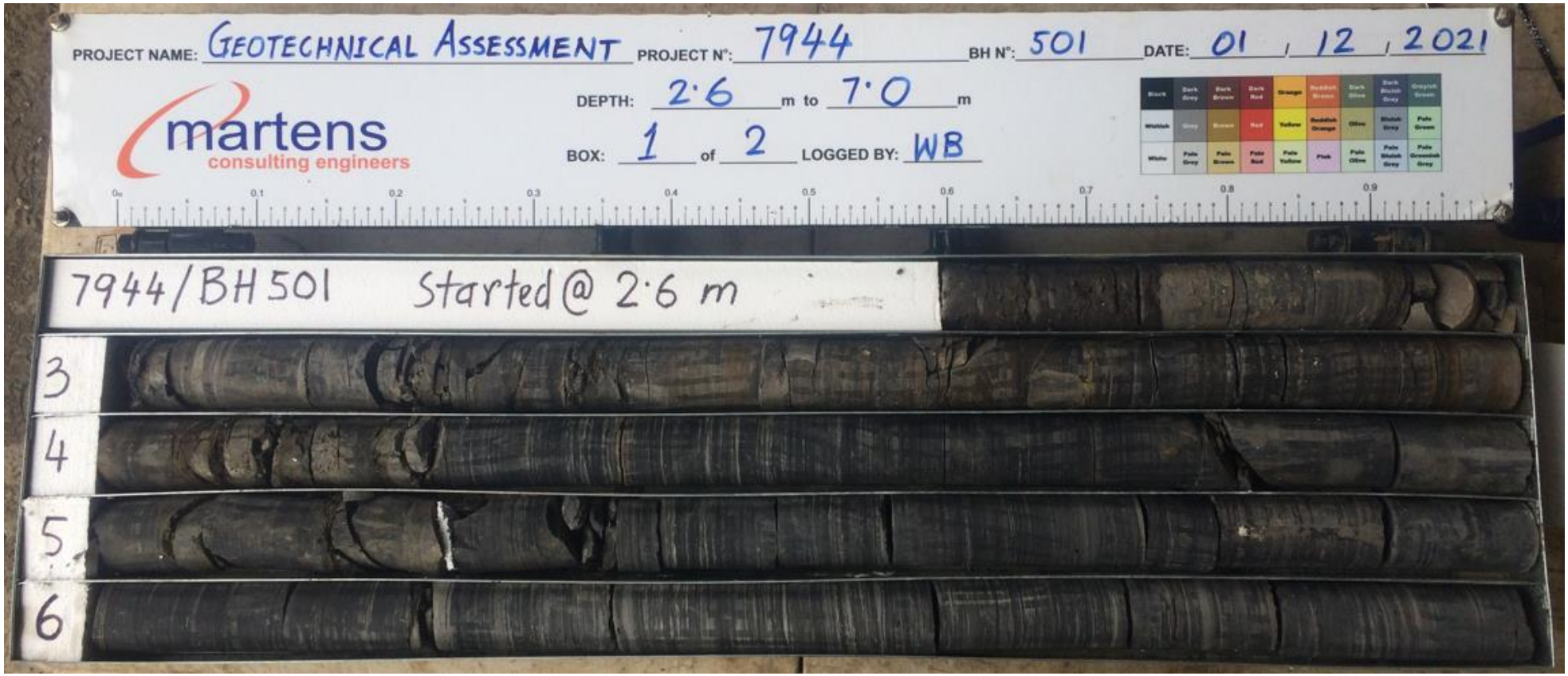
Engineering Log - TEST

11 Attachment C – Rock Core Photos



Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH501- Box 1 of 2)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 5**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05

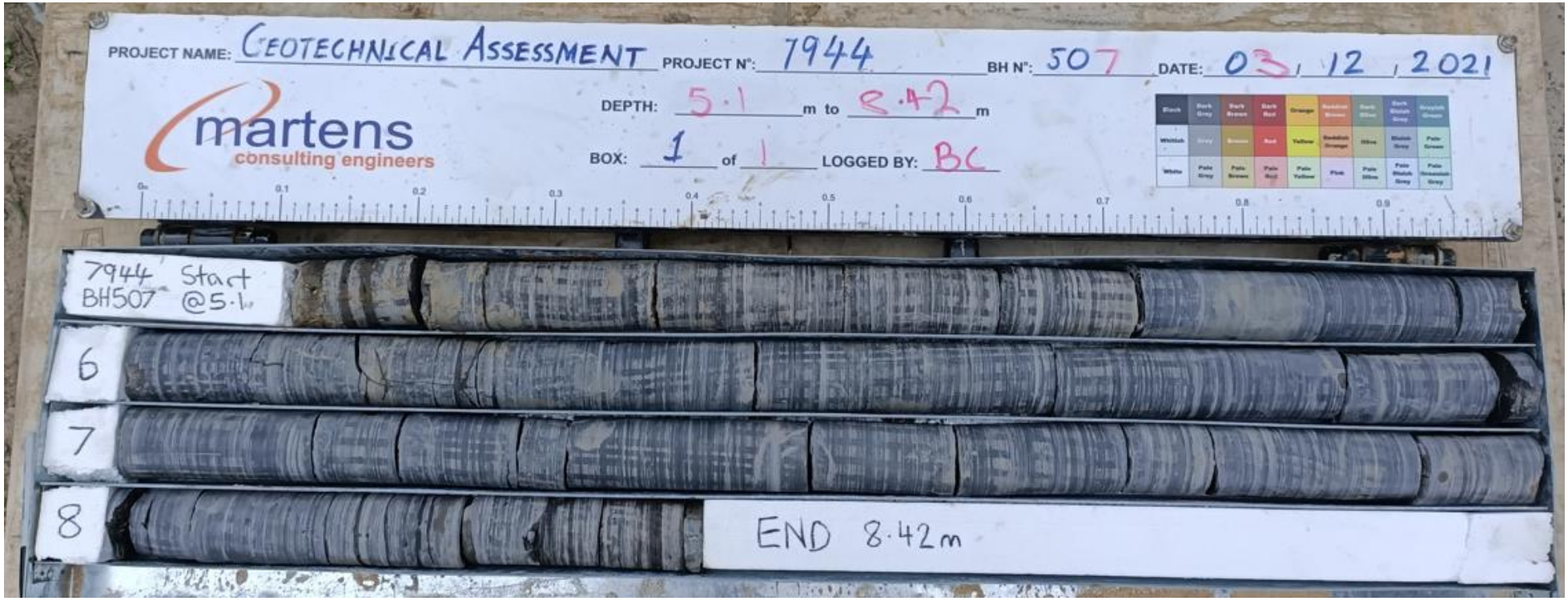
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH501- Box 2 of 2)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 6**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH502- Box 1 of 1)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 7**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH503- Box 1 of 1)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 8**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH504- Box 1 of 1)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 9**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05

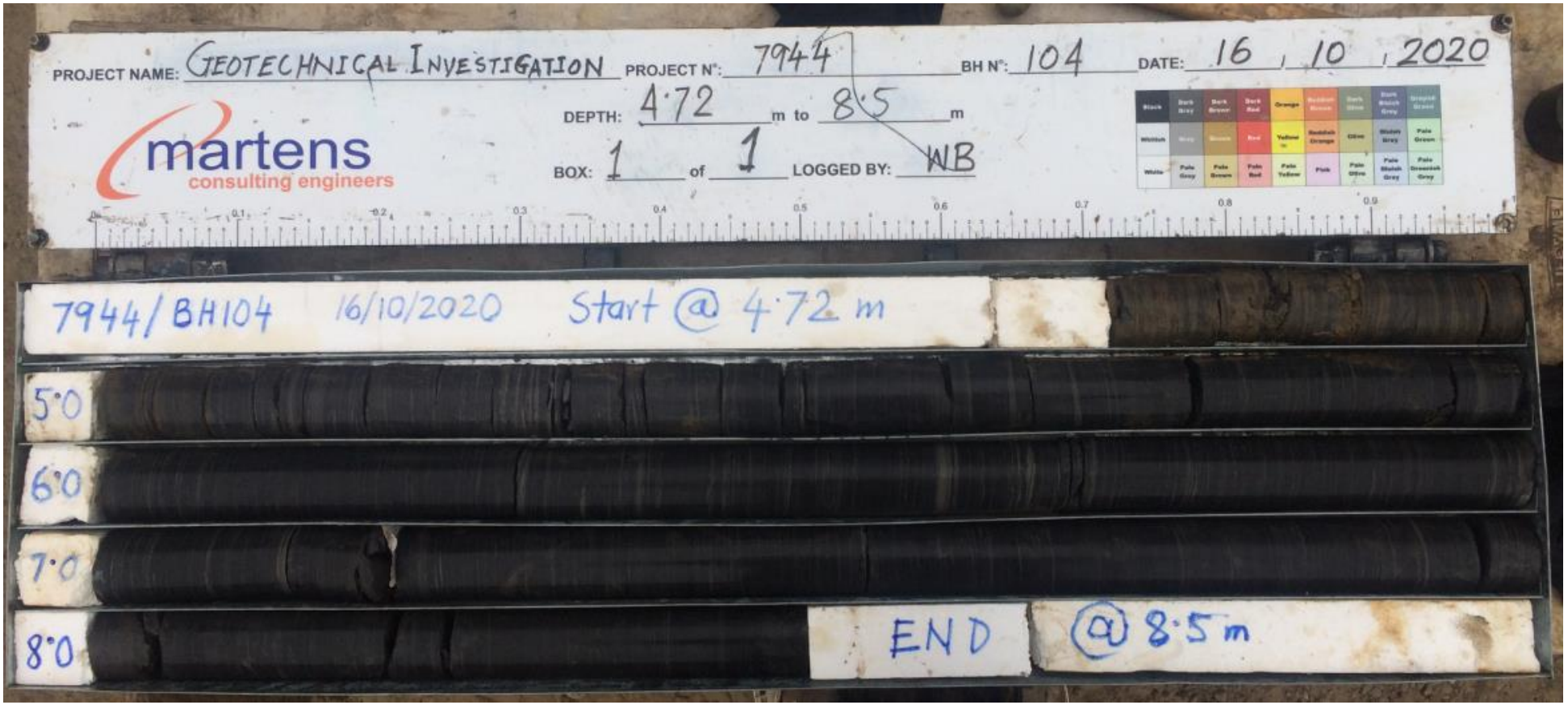
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH506 - Box 1 of 1)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 10**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05



Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH507 - Box 1 of 1)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 11**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH508 - Box 1 of 1)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 12**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH103)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 13**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05



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Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	WB	**PHOTO OF ROCK CORE (BH104)** **57 Station Road, Seven Hills, NSW**	Drawing: **FIGURE 14**
Approved:	SK		
Date:	10.05.2022		
Scale:	NA		File No: P2007944JR05V05

12 Attachment D – Laboratory Test Certificates

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 | **Fax:** (02) 9674 7755 | **Email:** info@resourcelab.com.au

Test Report

Customer: Martens & Associates Pty Ltd
Project: P2007944
Location: 57 Station Road, Seven Hills, NSW

Job number: 21-0141
Report number: 1

Point Load Strength Index

Sampling method: Tested as received
Test method(s): AS 4133.4.1 Clause 3.2, 3.3

	Results				
Laboratory sample no.	26271	26272	26273	26274	26275
Customer sample no.	7944/BH501/ 4.6-4.7	7944/BH501/ 6.6-6.73	7944/BH501/ 8.01-8.14	7944/BH502/ 2.45-2.62	7944/BH502/ 4.62-4.72
Sample depth	4.60-4.70m	6.60-6.73m	8.01-8.14m	2.45-2.62m	4.62-4.72m
Date sampled	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021
Date tested	15/12/2021	15/12/2021	15/12/2021	15/12/2021	15/12/2021
Lithological description	LAMINITE	LAMINITE	LAMINITE	LAMINITE	LAMINITE
Diametral					
Moisture content condition	Dry	Dry	Dry	Dry	Dry
Nature of weakness planes	Laminated	Laminated	Laminated	Laminated	Laminated
Specimen size					
Length (mm)	105.0	131.0	130.0	170.0	100.0
Diameter (mm)	51.6	51.7	51.7	51.7	51.7
I_s (MPa)	**0.31**	**0.42**	**0.12**	**0.18**	**0.22**
$I_{s(50)}$ (MPa)	**0.32**	**0.42**	**0.12**	**0.18**	**0.22**
Axial					
Moisture content condition	Dry	Dry	Dry	Dry	Dry
Nature of weakness planes	Laminated	Laminated	Laminated	Laminated	Laminated
Specimen size					
Height (mm)	39.0	39.0	39.1	38.5	33.0
Diameter (mm)	51.6	51.7	51.7	51.7	51.7
I_s (MPa)	**0.58**	**1.7**	**2.2**	**0.74**	**1.0**
$I_{s(50)}$ (MPa)	**0.58**	**1.7**	**2.2**	**0.74**	**0.97**

Notes:

Approved Signatory: C. Greely **Date:** 15/12/2021

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 | **Fax:** (02) 9674 7755 | **Email:** info@resourcelab.com.au

Test Report

Customer: Martens & Associates Pty Ltd
Project: P2007944
Location: 57 Station Road, Seven Hills, NSW

Job number: 21-0141
Report number: 1

Point Load Strength Index

Sampling method: Tested as received
Test method(s): AS 4133.4.1 Clause 3.2, 3.3

	Results				
Laboratory sample no.	26276	26277	26278	26279	26280
Customer sample no.	7944/BH503/ 5.78-5.89	7944/BH503/ 7.0-7.12	7944/BH503/ 8.05-8.16	7944/BH504/ 6.26-6.37	7944/BH504/ 7.88-8.00
Sample depth	5.78-5.89m	7.00-7.12m	8.05-8.16m	6.26-6.37m	7.88-8.00m
Date sampled	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021
Date tested	15/12/2021	15/12/2021	15/12/2021	15/12/2021	15/12/2021
Lithological description	LAMINITE	LAMINITE	LAMINITE	LAMINITE	LAMINITE
Diametral					
Moisture content condition	Dry	Dry	Dry	Dry	Dry
Nature of weakness planes	Laminated	Laminated	Laminated	Laminated	Laminated
Specimen size					
Length (mm)	110.0	110.0	100.0	105.0	102.0
Diameter (mm)	51.3	51.5	51.8	51.7	51.7
I_s (MPa)	**0.22**	**0.19**	**0.82**	**0.88**	**0.66**
$I_{s(50)}$ (MPa)	**0.22**	**0.19**	**0.83**	**0.89**	**0.67**
Axial					
Moisture content condition	Dry	Dry	Dry	Dry	Dry
Nature of weakness planes	Laminated	Laminated	Laminated	Laminated	Laminated
Specimen size					
Height (mm)	38.4	31.3	34.9	41.7	44.6
Diameter (mm)	51.3	51.5	51.8	51.7	51.7
I_s (MPa)	**0.76**	**1.2**	**2.2**	**1.8**	**1.3**
$I_{s(50)}$ (MPa)	**0.77**	**1.2**	**2.2**	**1.8**	**1.3**

Notes:

Approved Signatory: C. Greely **Date:** 15/12/2021

resource laboratories
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ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 | **Fax:** (02) 9674 7755 | **Email:** info@resourcelab.com.au

Test Report

Customer: Martens & Associates Pty Ltd
Project: P2007944
Location: 57 Station Road, Seven Hills, NSW

Job number: 21-0141
Report number: 1

Point Load Strength Index

Sampling method: Tested as received
Test method(s): AS 4133.4.1 Clause 3.2, 3.3

	Results				
Laboratory sample no.	26281	26282	26283	26284	26285
Customer sample no.	7944/BH504/ 9.26-9.41	7944/BH506/ 6.06-6.28	7944/BH506/ 7.02-7.12	7944/BH506/ 8.27-8.39	7944/BH507/ 5.25-5.37
Sample depth	9.26-9.41m	6.06-6.28m	7.02-7.12m	8.27-8.39m	5.25-5.37m
Date sampled	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021
Date tested	15/12/2021	15/12/2021	15/12/2021	15/12/2021	15/12/2021
Lithological description	LAMINITE	LAMINITE	LAMINITE	LAMINITE	LAMINITE
Diametral					
Moisture content condition	Dry	Dry	Dry	Dry	Dry
Nature of weakness planes	Laminated	Laminated	Laminated	Laminated	Laminated
Specimen size					
Length (mm)	150.0	120.0	100.0	120.0	120.0
Diameter (mm)	51.8	51.6	51.5	51.6	51.6
I_s (MPa)	**0.77**	**0.20**	**0.46**	**0.17**	**0.37**
$I_{s(50)}$ (MPa)	**0.78**	**0.21**	**0.47**	**0.17**	**0.37**
Axial					
Moisture content condition	Dry	Dry	Dry	Dry	Dry
Nature of weakness planes	Laminated	Laminated	Laminated	Laminated	Laminated
Specimen size					
Height (mm)	32.3	37.7	33.6	36.8	42.1
Diameter (mm)	51.8	51.6	51.5	51.6	51.6
I_s (MPa)	**1.6**	**0.98**	**1.5**	**1.6**	**1.2**
$I_{s(50)}$ (MPa)	**1.5**	**0.97**	**1.5**	**1.6**	**1.2**

Notes:

Approved Signatory: C. Greely **Date:** 15/12/2021

NATA ACCREDITED FOR TECHNICAL COMPETENCE
Accredited for compliance with ISO/IEC 17025 - Testing.

NATA Accredited Laboratory Number: **17062**

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 | **Fax:** (02) 9674 7755 | **Email:** info@resourcelab.com.au

Test Report

Customer: Martens & Associates Pty Ltd
Project: P2007944
Location: 57 Station Road, Seven Hills, NSW

Job number: 21-0141
Report number: 1

Point Load Strength Index

Sampling method: Tested as received
Test method(s): AS 4133.4.1 Clause 3.2, 3.3

	Results				
Laboratory sample no.	26286	26287	26288	26289	26290
Customer sample no.	7944/BH507/ 6.86-6.96	7944/BH507/ 8.05-8.15	7944/BH508/ 5.18-5.27	7944/BH508/ 6.52-6.64	7944/BH508/ 8.0-8.15
Sample depth	6.86-6.96m	8.05-8.15m	5.18-5.27m	6.52-6.64m	8.00-8.15m
Date sampled	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021
Date tested	15/12/2021	15/12/2021	15/12/2021	15/12/2021	15/12/2021
Lithological description	LAMINITE	LAMINITE	LAMINITE	LAMINITE	LAMINITE
Diametral					
Moisture content condition	Dry	Dry	Moist	Dry	Dry
Nature of weakness planes	Laminated	Laminated	Laminated	Laminated	Laminated
Specimen size					
Length (mm)	95.0	93.0	90.0	114.0	145.0
Diameter (mm)	51.8	51.8	51.8	51.6	51.8
I_s (MPa)	**0.77**	**0.58**	**0.25**	**0.67**	**0.85**
$I_{s(50)}$ (MPa)	**0.79**	**0.59**	**0.25**	**0.68**	**0.87**
Axial					
Moisture content condition	Dry	Dry	Moist	Dry	Dry
Nature of weakness planes	Laminated	Laminated	Laminated	Laminated	Laminated
Specimen size					
Height (mm)	38.7	38.6	42.0	39.5	42.0
Diameter (mm)	51.8	51.8	51.8	51.6	51.8
I_s (MPa)	**1.2**	**1.4**	**0.46**	**1.1**	**1.4**
$I_{s(50)}$ (MPa)	**1.2**	**1.4**	**0.47**	**1.1**	**1.4**

Notes:

Approved Signatory: C. Greely **Date:** 15/12/2021

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Test Report

Customer: Martens & Associates Pty Ltd
Project: P2007944
Location: 57 Station Road, Seven Hills, NSW

Job number: 21-0141
Report number: 3
Page: 1 of 1

Soil Index Properties

Sampling method: Tested as received

Test method(s): AS 1289.1.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1 .3.4.1

	Results				
Laboratory sample no.	26269	26270			
Customer sample no.	7944/BH501/ 1.2-1.5	7944/BH504/ 2.5-2.95			
Date sampled	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021			
Material description	silty CLAY, trace of gravel, red/pale grey/dark brown	silty CLAY, grey/yellow-brown/red			
Liquid limit (%)	67	52			
Plastic limit (%)	19	17			
Plasticity index (%)	48	35			
Linear shrinkage (%)	14.5	13.5			
Cracking / Curling / Crumbling	-	-			
Sample history	Air dried	Air dried			
Preparation	Dry sieved	Dry sieved			

Approved Signatory: C. Greely **Date:** 20/12/2021

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NATA Accredited Laboratory Number: **17062**

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Test Report

Customer: Martens & Associates Pty Ltd
Job number: 21-0141
Project: P2108531
Report number: 2
Location: 57 Station Road, Seven Hills, NSW
Page: 1 of 1

Particle Size Distribution

Sampling method: Tested as received
Test method(s): AS 1289.1.1, 3.6.1

	Results				
Laboratory sample no.	26267	26268			
Customer sample no.	7944/BH503/ 1.0-1.5	7944/BH507/ 2.5-2.95			
Date sampled	01/12/2021- 03/12/2021	01/12/2021- 03/12/2021			
Material description	silty CLAY, with sand, trace of gravel, brown/ pale grey/red	silty CLAY, dark grey/red-brown			
% Passing AS Sieve					
63.0mm					
53.0mm					
37.5mm					
26.5mm					
19.0mm	100				
13.2mm	98				
9.5mm	97				
6.7mm	94				
4.75mm	92	100			
2.36mm	87	99			
1.18mm	84	99			
600µm	82	98			
425µm	81	98			
300µm	79	98			
150µm	74	97			
75µm	66	96			

Approved Signatory: C. Greely **Date:** 20/12/2021

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NATA Accredited Laboratory Number: **17062**

resource laboratories
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Ph: (02) 9674 7711 | **Fax:** (02) 9674 7755 | **Email:** info@resourcelab.com.au

Test Report

Customer: Martens & Associates Pty Ltd
Job number: 22-0014
Project: P207944
Report number: 1
Location: 57 Station Road, Seven Hills, NSW
Page: 1 of 1

California Bearing Ratio

Sampling method: Tested as received
Test method(s): AS 1289.1.1, 2.1.1, 5.1.1, 6.1.1

	Results			
Laboratory sample no.	26411	26412		
Customer sample no.	7944/TP106/ 2.0-2.4	7944/TP112/ 1.6-2.0		
Date sampled	20/12/2021	20/12/2021		
Material description	silty CLAY, trace of gravel, brown/ dark grey	silty CLAY, trace of gravel, brown/ pale grey/red		
Maximum dry density (t/m^3)	1.48	1.83		
Optimum moisture content (%)	28.4	18.1		
Field moisture content (%)	n/a	n/a		
Oversize retained on 19.0mm sieve (%)	0	6		
Minimum curing time (hours)	96	168		
Dry density before soak (t/m^3)	1.45	1.79		
Dry density after soak (t/m^3)	1.44	1.72		
Moisture content before soak (%)	28.2	17.8		
Moisture content after soak (%)	30.6	20.3		
Moisture content after test - top 30mm (%)	31.1	25.8		
Moisture content after test - remaining depth (%)	29.5	19.6		
Density ratio before soaking (%)	98.5	98.0		
Moisture ratio before soaking (%)	99.0	98.5		
Period of soaking (days)	4	4		
Compactive effort	Standard	Standard		
Mass of surcharge applied (kg)	4.5	4.5		
Swell after soaking (%)	1.0	3.5		
Penetration (mm)	2.5	2.5		
CBR Value (%)	**4.5**	**2.0**		

Notes: Specified LDR: 98 ±1%

Method of establishing plasticity level - Visual / tactile

Approved Signatory: L. Coleman **Date:** 01/02/2022

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NATA Accredited Laboratory Number: **17062**

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

CERTIFICATE OF ANALYSIS 284744

Client Details

Client	Martens & Associates Pty Ltd
Attention	Waisul Bari
Address	Suite 201, 20 George St, Hornsby, NSW, 2077

Sample Details

Your Reference	**P2007944COC08V01, 57 Station Road, Seven Hills**
Number of Samples	4 soil
Date samples received	07/12/2021
Date completed instructions received	07/12/2021

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	14/12/2021
Date of Issue	13/12/2021

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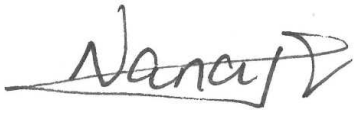
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil					
Our Reference		284744-1	284744-2	284744-3	284744-4
Your Reference	UNITS	7944/BH501/0.7-0.9	7944/BH503/1.5-1.7	7944/BH504/3.0-3.5	7944/BH507/4.0-4.3
Date Sampled		01/12/2021	01/12/2021	01/12/2021	01/12/2021
Type of sample		soil	soil	soil	soil
Date prepared	-	08/12/2021	08/12/2021	08/12/2021	08/12/2021
Date analysed	-	08/12/2021	08/12/2021	08/12/2021	08/12/2021
pH 1:5 soil:water	pH Units	6.2	6.1	6.4	8.5
Electrical Conductivity 1:5 soil:water	µS/cm	300	84	320	150
Chloride, Cl 1:5 soil:water	mg/kg	360	72	380	100
Sulphate, SO4 1:5 soil:water	mg/kg	73	54	20	48
Resistivity in soil*	ohm m	34	120	31	68

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 (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	284744-2
Date prepared	-			08/12/2021	1	08/12/2021	08/12/2021		08/12/2021	08/12/2021
Date analysed	-			08/12/2021	1	08/12/2021	08/12/2021		08/12/2021	08/12/2021
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	6.2	6.4	3	101	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	300	290	3	100	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	360	360	0	102	117
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	73	55	28	102	105
Resistivity in soil*	ohm m	1	Inorg-002	<1	1	34	35	3	[NT]	[NT]

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.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

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: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-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.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

13 Attachment E – General Geotechnical Recommendations

Geotechnical Recommendations

Important Recommendations About Your Site (1 of 2)

These general geotechnical recommendations have been prepared by Martens to help you deliver a safe work site, to comply with your obligations, and to deliver your project. Not all are necessarily relevant to this report but are included as general reference. Any specific recommendations made in the report will override these recommendations.

Batter Slopes

Excavations in soil and extremely low to very low strength rock exceeding 0.75 m depth should be battered back at grades of no greater than 1 Vertical (V) : 2 Horizontal (H) for temporary slopes (unsupported for less than 1 month) and 1 V : 3 H for longer term unsupported slopes.

Vertical excavation may be carried out in medium or higher strength rock, where encountered, subject to inspection and confirmation by a geotechnical engineer. Long term and short term unsupported batters should be protected against erosion and rock weathering due to, for example, stormwater run-off.

Batter angles may need to be revised depending on the presence of bedding partings or adversely oriented joints in the exposed rock, and are subject to on-site inspection and confirmation by a geotechnical engineer. Unsupported excavations deeper than 1.0 m should be assessed by a geotechnical engineer for slope instability risk.

Any excavated rock faces should be inspected during construction by a geotechnical engineer to determine whether any additional support, such as rock bolts or shotcrete, is required.

Earthworks

Earthworks should be carried out following removal of any unsuitable materials and in accordance with AS3798 (2007). A qualified geotechnical engineer should inspect the condition of prepared surfaces to assess suitability as foundation for future fill placement or load application.

Earthworks inspections and compliance testing should be carried out in accordance with Sections 5 and 8 of AS3798 (2007), with testing to be carried out by a National Association of Testing Authorities (NATA) accredited testing laboratory.

Excavations

All excavation work should be completed with reference to the *Work Health and Safety (Excavation Work) Code of Practice (2015)*, by Safe Work Australia. Excavations into rock may be undertaken as follows:

1. Extremely low to low strength rock - conventional hydraulic earthmoving equipment.

2. Medium strength or stronger rock - hydraulic earthmoving equipment with rock hammer or ripping tyne attachment.

Exposed rock faces and loose boulders should be monitored to assess risk of block / boulder movement, particularly as a result of excavation vibrations.

Fill

Subject to any specific recommendations provided in this report, any fill imported to site is to comprise approved material with maximum particle size of two thirds the final layer thickness. Fill should be placed in horizontal layers of not more than 300 mm loose thickness, however, the layer thickness should be appropriate for the adopted compaction plant.

Foundations

All exposed foundations should be inspected by a geotechnical engineer prior to footing construction to confirm encountered conditions satisfy design assumptions and that the base of all excavations is free from loose or softened material and water. Water that has ponded in the base of excavations and any resultant softened material is to be removed prior to footing construction.

Footings should be constructed with minimal delay following excavation. If a delay in construction is anticipated, we recommend placing a concrete blinding layer of at least 50 mm thickness in shallow footings or mass concrete in piers / piles to protect exposed foundations.

A geotechnical engineer should confirm any design bearing capacity values, by further assessment during construction, as necessary.

Shoring - Anchors

Where there is a requirement for either soil or rock anchors, or soil nailing, and these structures penetrate past a property boundary, appropriate permission from the adjoining land owner must be obtained prior to the installation of these structures.

Shoring - Permanent

Permanent shoring techniques may be used as an alternative to temporary shoring. The design of such structures should be in accordance with the findings of this report and any further testing recommended by this report. Permanent shoring may include [but not be limited to] reinforced block work walls, contiguous and semi contiguous pile walls, secant pile walls and soldier pile walls with or without reinforced shotcrete infill panels. The choice of shoring system will depend on the type of structure, project budget and site specific geotechnical conditions.

Permanent shoring systems are to be engineer designed and backfilled with suitable granular

material and free-draining drainage material. Backfill should be placed in maximum 100 mm thick layers compacted using a hand operated compactor. Care should be taken to ensure excessive compaction stresses are not transferred to retaining walls.

Shoring design should consider any surcharge loading from sloping / raised ground behind shoring structures, live loads, new structures, construction equipment, backfill compaction and static water pressures. All shoring systems shall be provided with adequate foundation designs.

Suitable drainage measures, such as geotextile enclosed 100 mm agricultural pipes embedded in free-draining gravel, should be included to redirect water that may collect behind the shoring structure to a suitable discharge point.

Shoring - Temporary

In the absence of providing acceptable excavation batters, excavations should be supported by suitably designed and installed temporary shoring / retaining structures to limit lateral deflection of excavation faces and associated ground surface settlements.

Soil Erosion Control

Removal of any soil overburden should be performed in a manner that reduces the risk of sedimentation occurring in any formal stormwater drainage system, on neighbouring land and in receiving waters. Where possible, this may be achieved by one or more of the following means:

1. Maintain vegetation where possible
2. Disturb minimal areas during excavation
3. Revegetate disturbed areas if possible

All spoil on site should be properly controlled by erosion control measures to prevent transportation of sediments off-site. Appropriate soil erosion control methods in accordance with Landcom (2004) shall be required.

Trafficability and Access

Consideration should be given to the impact of the proposed works and site subsurface conditions on trafficability within the site e.g. wet clay soils will lead to poor trafficability by tyred plant or vehicles.

Where site access is likely to be affected by any site works, construction staging should be organised such that any impacts on adequate access are minimised as best as possible.

Vibration Management

Where excavation is to be extended into medium or higher strength rock, care will be required when using a rock hammer to limit potential structural distress from excavation-induced vibrations where nearby structures may be affected by the works.

To limit vibrations, we recommend limiting rock hammer size and set frequency, and setting the hammer parallel to bedding planes and along defect planes, where possible, or as advised by a geotechnical engineer. We recommend limiting vibration peak particle velocities (PPV) caused by construction equipment or resulting from excavation at the site to 5 mm/s (AS 2187.2, 2006, Appendix J).

Waste – Spoil and Water

Soil to be disposed off-site should be classified in accordance with the relevant State Authority guidelines and requirements.

Any collected waste stormwater or groundwater should also be tested prior to discharge to ensure contaminant levels (where applicable) are appropriate for the nominated discharge location.

MA can complete the necessary classification and testing if required. Time allowance should be made for such testing in the construction program.

Water Management - Groundwater

If the proposed works are likely to intersect ephemeral or permanent groundwater levels, the management of any potential acid soil drainage should be considered. If groundwater tables are likely to be lowered, this should be further discussed with the relevant State Government Agency.

Water Management – Surface Water

All surface runoff should be diverted away from excavation areas during construction works and prevented from accumulating in areas surrounding any retaining structures, footings or the base of excavations.

Any collected surface water should be discharged into a suitable Council approved drainage system and not adversely impact downslope surface and subsurface conditions.

All site discharges should be passed through a filter material prior to release. Sump and pump methods will generally be suitable for collection and removal of accumulated surface water within any excavations.

Contingency Plan

In the event that proposed development works cause an adverse impact on geotechnical hazards, overall site stability or adjacent properties, the following actions are to be undertaken:

1. Works shall cease immediately.
2. The nature of the impact shall be documented and the reason(s) for the adverse impact investigated.
3. A qualified geotechnical engineer should be consulted to provide further advice in relation to the issue.

14 Attachment F – Notes About This Report

Information

Important Information About Your Report (1 of 2)

These notes have been prepared by Martens to help you interpret and understand the limitations of your report. Not all are necessarily relevant to all reports but are included as general reference.

Engineering Reports - Limitations

The recommendations presented in this report are based on limited investigations and include specific issues to be addressed during various phases of the project. If the recommendations presented in this report are not implemented in full, the general recommendations may become inapplicable and Martens & Associates accept no responsibility whatsoever for the performance of the works undertaken.

Occasionally, sub-surface conditions between and below the completed boreholes or other tests may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact Martens & Associates.

Relative ground surface levels at borehole locations may not be accurate and should be verified by on-site survey.

Engineering Reports – Project Specific Criteria

Engineering reports are prepared by qualified personnel. They are based on information obtained, on current engineering standards of interpretation and analysis, and on the basis of your unique project specific requirements as understood by Martens. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the Client.

Where the report has been prepared for a specific design proposal (e.g. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (e.g. to a twenty storey building). Your report should not be relied upon, if there are changes to the project, without first asking Martens to assess how factors, which changed subsequent to the date of the report, affect the report's recommendations. Martens will not accept responsibility for problems that may occur due to design changes, if not consulted.

Engineering Reports – Recommendations

Your report is based on the assumption that site conditions, as may be revealed through selective point sampling, are indicative of actual conditions throughout an area. This assumption often cannot be substantiated until project implementation has commenced. Therefore your site investigation report recommendations should only be regarded as preliminary.

Only Martens, who prepared the report, are fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report, there is a risk that the report will be misinterpreted and Martens cannot be held responsible for such misinterpretation.

Engineering Reports – Use for Tendering Purposes

Where information obtained from investigations is provided for tendering purposes, Martens recommend 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.

Martens would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Engineering Reports – Data

The report as a whole presents the findings of a site assessment and should not be copied in part or altered in any way.

Logs, figures, drawings *etc* are customarily included in a Martens report and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), desktop studies and laboratory evaluation of field samples. These data should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Engineering Reports – Other Projects

To avoid misuse of the information contained in your report it is recommended that you confer with Martens before passing your report on to another party who may not be familiar with the background and purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Subsurface Conditions - General

Every care is taken with the report in relation to interpretation of subsurface conditions, discussion of geotechnical aspects, relevant standards 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 will depend partly on test point (eg. excavation or borehole) spacing and sampling frequency, which are often limited by project imposed budgetary constraints.

Important Information About Your Report (2 of 2)

- Changes in guidelines, standards and policy or interpretation of guidelines, standards and policy by statutory authorities.
- The actions of contractors responding to commercial pressures.
- Actual conditions differing somewhat from those inferred to exist, because no professional, no matter how qualified, can reveal precisely what is hidden by earth, rock and time.

  The actual interface between logged materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

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

Subsurface Conditions - Changes

Natural processes and the activity of man create subsurface conditions. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Reports are based on conditions which existed at the time of the subsurface exploration / assessment.

Decisions should not be based on a report whose adequacy may have been affected by time. If an extended period of time has elapsed since the report was prepared, consult Martens to be advised how time may have impacted on the project.

Subsurface Conditions - Site Anomalies

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

Report Use by Other Design Professionals

To avoid potentially costly misinterpretations when other design professionals develop their plans based on a Martens report, retain Martens to work with other project professionals affected by the report. This may involve Martens explaining the report design implications and then reviewing plans and specifications produced to see how they have incorporated the report findings.

Subsurface Conditions – Geo-environmental Issues

Your report generally does not relate to any findings, conclusions, or recommendations about the potential for hazardous or contaminated materials existing at the site unless specifically required to do so as part of Martens' proposal for works.

Specific sampling guidelines and specialist equipment, techniques and personnel are typically used to perform geo-environmental or site contamination assessments. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Martens for information relating to such matters.

Responsibility

Geo-environmental reporting relies on interpretation of factual information based on professional judgment and opinion and has an inherent level of uncertainty attached to it and is typically far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded.

To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Martens to other parties but are included to identify where Martens' responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Martens closely and do not hesitate to ask any questions you may have.

Site Inspections

Martens will always be pleased to provide engineering inspection services for aspects of work to which this report relates. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site. Martens is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction.

Soil Data

Explanation of Terms (1 of 3)

Definitions

In engineering terms, soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material does not exhibit any visible rock properties and can be remoulded or disintegrated by hand in its field condition or in water, it is described as a soil. Other materials are described using rock description terms.

The methods of description and classification of soils and rocks used in this report are typically based on Australian Standard 1726 and the Unified Soil Classification System (USCS) – refer Soil Data Explanation of Terms (2 of 3). In general, descriptions cover the following properties: strength or density, colour, moisture, structure, soil or rock type and inclusions.

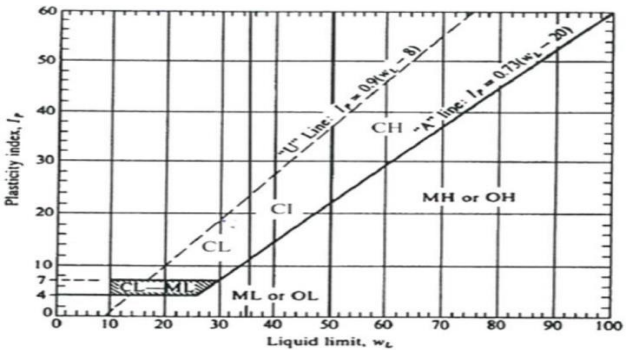
Particle Size

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (e.g. sandy CLAY). Unless otherwise stated, particle size is described in accordance with the following table.

Division	Subdivision		Particle Size (mm)
Oversized	BOULDERS		>200
	COBBLES		63 to 200
Coarse Grained Soil	GRAVEL	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	SAND	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine Grained Soil	SILT		0.002 to 0.075
	CLAY		< 0.002

Plasticity Properties

Plasticity properties of cohesive soils can be assessed in the field by tactile properties or by laboratory procedures.



Soil Moisture Condition

Coarse Grained (Granular) Soil:

Dry (D):	Looks and feels dry. Cemented soils are hard, friable or powdery. Uncemented soils run freely through fingers.
Moist (M):	Feels cool and damp and is darkened in colour. Particles tend to cohere.
Wet (W):	As for moist but with free water forming on hands when handled.

Fine Grained (Cohesive) Soil:

Moist, dry of plastic limit[1] (w < PL):	Looks and feels dry. Hard, friable or powdery.
Moist, near plastic limit (w ≈ PL):	Can be moulded, feels cool and damp, is darkened in colour, at a moisture content approximately equal to the PL.
Moist, wet of plastic limit (w > PL):	Usually weakened and free water forms on hands when handled.
Wet, near liquid limit[2] (w ≈ LL)	
Wet, wet of liquid limit (w > LL)	

[1] Plastic Limit (PL): Moisture content at which soil becomes too dry to be in a plastic condition.

[2] Liquid Limit (LL): Moisture content at which soil passes from plastic to liquid state.

Consistency of Cohesive Soils

Cohesive soils refer to predominantly clay materials.
(Note: consistency is affected by soil moisture condition at time of measurement)

Term	C_u (kPa)	Field Guide
Very Soft (VS)	≤12	A finger can be pushed well into the soil with little effort. Sample exudes between fingers when squeezed in fist.
Soft (S)	>12 and ≤25	A finger can be pushed into the soil to about 25mm depth. Easily moulded by light finger pressures.
Firm (F)	>25 and ≤50	The soil can be indented about 5mm with the thumb, but not penetrated. Can be moulded by strong figure pressure.
Stiff (St)	>50 and ≤100	The surface of the soil can be indented with the thumb, but not penetrated. Cannot be moulded by fingers.
Very Stiff (VSt)	>100 and ≤200	The surface of the soil can be marked, but not indented with thumb pressure. Difficult to cut with a knife. Thumbnail can readily indent.
Hard (H)	> 200	The surface of the soil can only be marked with the thumbnail. Brittle. Tends to break into fragments.
Friable (Fr)	-	Crumbles or powders when scraped by thumbnail. Can easily be crumbled or broken into small pieces by hand.

Density of Granular Soils

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

Relative Density	%	SPT 'N' Value* (blows/300mm)	CPT Cone Value (q_c MPa)
Very loose	≤15	< 5	< 2
Loose	>15 and ≤35	5 - 10	2 - 5
Medium dense	>35 and ≤65	10 - 30	5 - 15
Dense	>65 and ≤85	30 - 50	15 - 25
Very dense	> 85	> 50	> 25

* Values may be subject to corrections for overburden pressures and equipment type and influenced by soil moisture condition at time of measurement.

Minor Components

Minor components in soils may be present and readily detectable, but have little bearing on general geotechnical classification. Terms include:

Description of components	Proportion of component in:					
	coarse grained soil				fine grained soil	
	% Fines	Terminology	% Accessory coarse fraction	Terminology	% Sand/ gravel	Terminology
Minor	≤5	Trace clay / silt, as applicable	≤15	Trace sand / gravel, as applicable	≤15	Trace sand / gravel, as applicable
	>5,≤12	With clay / silt, as applicable	>15,≤30	With sand / gravel, as applicable	>5,≤30	With sand / gravel, as applicable
Secondary	>12	Prefix soil name as 'silty' or 'clayey', as applicable	>30	Prefix soil name as 'sandy' or 'gravelly', as applicable	>30	Prefix soil name as 'sandy' or 'gravelly', as applicable

Soil Data

Explanation of Terms (2 of 3)

martens consulting engineers

Symbols for Soils and Other

SOILS


COBBLES/BOULDERS


GRAVEL (GP or GW)


Silty GRAVEL (GM)


Clayey GRAVEL (GC)


SAND (SP or SW)


Silty SAND (SM)


Clayey SAND (SC)


SILT (ML or MH)


ORGANIC SILT or CLAY (OH or OL)


CLAY (CL, CI or CH)


Silty CLAY


Sandy CLAY


PEAT (Pt)


Gravelly CLAY

OTHER


FILL


TALUS


ASPHALT


CONCRETE


TOPSOIL

Unified Soil Classification Scheme (USCS)

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)					USCS	Primary Name
COARSE GRAINED SOILS More than 65 % of material less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.36 mm.	GRAVEL and GRAVEL-SAND Mixtures (≤ 5% fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes; not enough fines to bind coarse grains; no dry strength	GW	GRAVEL
				Predominantly one size or a range of sizes with some intermediate sizes missing; not enough fines to bind coarse grains; no dry strength	GP	GRAVEL
			GRAVEL-SILT and GRAVEL-SAND-SILT mixtures (≥ 12% fines) [1]	With excess non-plastic fines (for identification procedures see ML below); zero to medium dry strength; may also contain sand	GM	Silty GRAVEL
				With excess plastic fines (for identification procedures see CL below); medium to high dry strength; may also contain sand	GC	Clayey GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.36 mm	SAND and GRAVEL-SAND mixtures (≤5% fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes; not enough fines to bind coarse grains; no dry strength.	SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing; not enough fines to bind coarse grains; no dry strength	SP	SAND
			SAND-SILT and SAND-CLAY mixtures (≥ 12% fines) [1]	With excess non-plastic fines (for identification procedures see ML below); zero to medium dry strength;	SM	Silty SAND
				With excess plastic fines (for identification procedures see CL below); medium to high dry strength	SC	Clayey SAND

FINE GRAINED SOILS More than 35 % of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEDURES ON FRACTIONS < 0.2 MM					
	DRY STRENGTH (Crushing Characteristics)	DILATANCY	TOUGHNESS	DESCRIPTION	USCS	Primary Name
	None to Low	Quick to Slow	Low	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or silt with low plasticity [2]	ML	SILT [3]
	Medium to High	None to Slow	Medium	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays	CL (or CI[4])	CLAY
	Low to Medium	Slow	Low	Organic slits and organic silty clays of low plasticity	OL	Organic SILT or CLAY
	Low to Medium	None to Slow	Low to Medium	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	MH	SILT [3]
	High to Very High	None	High	Inorganic clays of high plasticity, fat clays	CH	CLAY
	Medium to High	None to Very Slow	Low to Medium	Organic clays of medium to high plasticity, organic silt of high plasticity	OH	Organic SILT or CLAY
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture				Pt	PEAT

Notes:

1. Between 5% and 12% - dual classification, e.g. GP-GM.
2. Low Plasticity Clay – Liquid Limit W_L ≤35%; Medium Plasticity Clay – Liquid limit W_L >35%, ≤50%; High Plasticity Clay - Liquid limit W_L > 50%.
3. Low Plasticity Silt – Liquid Limit W_L ≤50%; High Plasticity Silt - Liquid limit W_L > 50%.
4. CI may be adopted for clay of medium plasticity to distinguish from clay of low plasticity.

Soil Data

Explanation of Terms (3 of 3)

Soil Agricultural Classification Scheme

In some situations, such as where soils are to be used for effluent disposal purposes, soils are often more appropriately classified in terms of traditional agricultural classification schemes. Where a Martens report provides agricultural classifications, these are undertaken in accordance with descriptions by Northcote, K.H. (1979) *The factual key for the recognition of Australian Soils*, Rellim Technical Publications, NSW, p 26 - 28.

Symbol	Field Texture Grade	Behaviour of moist bolus	Ribbon length	Clay content (%)
S	Sand	Coherence nil to very slight; cannot be moulded; single grains adhere to fingers	0 mm	< 5
LS	Loamy sand	Slight coherence; discolours fingers with dark organic stain	6.35 mm	5
CLS	Clayey sand	Slight coherence; sticky when wet; many sand grains stick to fingers; discolours fingers with clay stain	6.35mm - 1.3cm	5 - 10
SL	Sandy loam	Bolus just coherent but very sandy to touch; dominant sand grains are of medium size and are readily visible	1.3 - 2.5	10 - 15
FSL	Fine sandy loam	Bolus coherent; fine sand can be felt and heard	1.3 - 2.5	10 - 20
SCL-	Light sandy clay loam	Bolus strongly coherent but sandy to touch, sand grains dominantly medium size and easily visible	2.0	15 - 20
L	Loam	Bolus coherent and rather spongy; smooth feel when manipulated but no obvious sandiness or silkiness; may be somewhat greasy to the touch if much organic matter present	2.5	25
Lfsy	Loam, fine sandy	Bolus coherent and slightly spongy; fine sand can be felt and heard when manipulated	2.5	25
SiL	Silt loam	Coherent bolus, very smooth to silky when manipulated	2.5	25 + > 25 silt
SCL	Sandy clay loam	Strongly coherent bolus sandy to touch; medium size sand grains visible in a finer matrix	2.5 - 3.8	20 - 30
CL	Clay loam	Coherent plastic bolus; smooth to manipulate	3.8 - 5.0	30 - 35
SiCL	Silty clay loam	Coherent smooth bolus; plastic and silky to touch	3.8 - 5.0	30- 35 + > 25 silt
FSCL	Fine sandy clay loam	Coherent bolus; fine sand can be felt and heard	3.8 - 5.0	30 - 35
SC	Sandy clay	Plastic bolus; fine to medium sized sands can be seen, felt or heard in a clayey matrix	5.0 - 7.5	35 - 40
SiC	Silty clay	Plastic bolus; smooth and silky	5.0 - 7.5	35 - 40 + > 25 silt
LC	Light clay	Plastic bolus; smooth to touch; slight resistance to shearing	5.0 - 7.5	35 - 40
LMC	Light medium clay	Plastic bolus; smooth to touch, slightly greater resistance to shearing than LC	7.5	40 - 45
MC	Medium clay	Smooth plastic bolus, handles like plasticine and can be moulded into rods without fracture, some resistance to shearing	> 7.5	45 - 55
HC	Heavy clay	Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to shearing	> 7.5	> 50

Rock Data

Explanation of Terms (1 of 2)

Symbols for Rock

SEDIMENTARY ROCK


BRECCIA


CONGLOMERATE


CONGLOMERATIC SANDSTONE


SANDSTONE/QUARTZITE


SILTSTONE


MUDSTONE/CLAYSTONE


SHALE


COAL


LIMESTONE


LITHIC TUFF

IGNEOUS ROCK


GRANITE


DOLERITE/BASALT

METAMORPHIC ROCK


SLATE, PHYLLITE, SCHIST


GNEISS


METASANDSTONE


METASILTSTONE


METAMUDSTONE

Definitions

Descriptive terms used for Rock by Martens are based on AS1726 and encompass rock substance, defects and mass.

Rock Material	The intact rock that is bounded by defects.
Rock Defect	Discontinuity, fracture, break or void in the material or minerals across which there is little or no tensile strength.
Rock Structure	The nature and configuration of the different defects within the rock mass and their relationship to each other.
Rock Mass	The entirety of the system formed by all of the rock material and all of the defects that are present.

Degree of Weathering

Rock weathering is defined as the degree of decline in rock structure and grain property and can be determined in the field.

Term	Symbol	Definition
Residual soil[1]	RS	Material is weathered to such an extent that it has soil properties. Mass structure, material texture, and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered[1]	XW	Material is weathered to such an extent that it has soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System. Mass structure and material texture and fabric of original rock are still visible.
Highly weathered[2]	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the original colour of the rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered[2]	MW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the rock is not recognisable. Rock strength shows little or no change from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	Rock substance unaffected by weathering. No sign of decomposition of individual materials or colour changes.

Notes:
1 RS and EW material is described using soil descriptive terms.
2. The term "Distinctly Weathered" (DW) may be used to cover the range of substance weathering between EW and SW

Rock Strength

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the loading. The test procedure is described by the International Society of Rock Mechanics.

Term (Strength)	I_s (50) MPa	Uniaxial Compressive Strength MPa	Field Guide	Symbol
Very low	>0.03 ≤0.1	0.6 – 2	May be crumbled in the hand. Sandstone is 'sugary' and friable.	VL
Low	>0.1 ≤0.3	2 – 6	Core 150mm long x 50mm diameter may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	L
Medium	>0.3 ≤1.0	6 – 20	Core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife.	M
High	>1 ≤3	20 – 60	Core 150mm long x 50mm diameter cannot be broken by unaided hands, can be slightly scratched or scored with a knife. Breaks with single blow from pick.	H
Very high	>3 ≤10	60 – 200	Core 150mm long x 50mm diameter, broken readily with hand held hammer. Cannot be scratched with knife. Breaks after more than one pick strike.	VH
Extremely high	>10	>200	A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer.	EH

Rock Data

Explanation of Terms (2 of 2)

Degree of Fracturing

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude fractures such as drilling breaks (DB) or handling breaks (HB).

Term	Description
Fragmented	The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than core diameter.
Highly fractured	Core lengths are generally less than 20 mm to 40 mm with occasional fragments.
Fractured	Core lengths are mainly 30 mm to 100 mm with occasional shorter and longer sections.
Slightly fractured	Core lengths are generally 300 mm to 1000 mm, with occasional longer sections and sections of 100 mm to 300 mm.
Unbroken	The core does not contain any fractures.

Rock Core Recovery

TCR = Total Core Recovery

$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100\,\%$$

SCR = Solid Core Recovery

$$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100\,\%$$

RQD = Rock Quality Designation

$$= \frac{\sum \text{Axial lengths of core} > 100 \text{ mm long}}{\text{Length of core run}} \times 100\,\%$$

Rock Strength Tests

- ▼ Point load strength Index (Is50) - axial test (MPa)
- ▶ Point load strength Index (Is50) - diametral test (MPa)
- ● Uniaxial compressive strength (UCS) (MPa)

Defect Type Abbreviations and Descriptions

Defect Type (with inclination given)

BP	Bedding plane parting
FL	Foliation
CL	Cleavage
JT	Joint
FC	Fracture
SZ/SS	Sheared zone/ seam (Fault)
CZ/CS	Crushed zone/ seam
DZ/DS	Decomposed zone/ seam
FZ	Fractured Zone
IS	Infilled seam
VN	Vein
CO	Contact
HB	Handling break
DB	Drilling break

Planarity

Pl	Planar
Cu	Curved
Un	Undulating
St	Stepped
Ir	Irregular
Dis	Discontinuous

Roughness

Pol	Polished
Sl	Slickensided
Sm	Smooth
Ro	Rough
VR	Very rough

Thickness

Zone	> 100 mm
Seam	> 2 mm < 100 mm
Plane	< 2 mm

Coating or Filling

Cn	Clean
Sn	Stain
Ct	Coating
Vnr	Veneer
Fe	Iron Oxide
X	Carbonaceous
Qz	Quartzite
MU	Unidentified mineral

Inclination

Inclination of defect is measured from perpendicular to and down the core axis.
Direction of defect is measured clockwise (looking down core) from magnetic north.

Test, Drill and Excavation Methods

Explanation of Terms (1 of 3)

Sampling

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

Disturbed samples taken during drilling or excavation provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples may be taken by pushing a thin-walled sampling tube, e.g. U_{50} (50 mm internal diameter thin walled tube), into soils and withdrawing a soil sample 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. Other sampling methods may be used. Details of the type and method of sampling are given in the report.

Drilling / Excavation Methods

The following is a brief summary of drilling and excavation methods currently adopted by the Company and some comments on their use and application.

Hand Excavation - in some situations, excavation using hand tools, such as mattock and spade, may be required due to limited site access or shallow soil profiles.

Hand Auger - the hole is advanced by pushing and rotating either a sand or clay auger, generally 75-100 mm in diameter, into the ground. The penetration depth is usually limited to the length of the auger pole; however extender pieces can be added to lengthen this.

Test Pits - these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils and, if it is safe to descend into the pit, collection of bulk disturbed samples. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (e.g. Pengo) - the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) 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 Sample Drilling (Push Tube) - the hole is advanced by pushing a 50 - 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength *etc.* is only marginally affected.

Continuous Spiral Flight Augers - the hole is advanced using 90 - 115 mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface or, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling - similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling - a continuous core sample is obtained using a diamond tipped core barrel of usually 50 mm internal diameter. Provided full core recovery is achieved (not always possible in very weak or fractured rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

In-situ Testing and Interpretation

Cone Penetrometer Testing (CPT)

Cone penetrometer testing (sometimes referred to as Dutch Cone) described in this report has been carried out using an electrical friction cone penetrometer.

The test is described in AS 1289.6.5.1-1999 (R2013). In the test, a 35 mm diameter rod with a cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system.

Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the push rod centre to an amplifier and recorder unit mounted on the control truck. As penetration occurs (at a rate of approximately 20 mm per second) the information is output on continuous chart recorders. The plotted results given in this report have been traced from the original records. The information provided on the charts comprises:

(i) Cone resistance (q_c) - the actual end bearing force divided by the cross sectional area of the cone, expressed in MPa.

(ii) Sleeve friction (q_f) - the frictional force of the sleeve divided by the surface area, expressed in kPa.

(iii) Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower (A) scale (0 - 5 MPa) 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 - 50 MPa) 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 friction in clays than in sands. Friction ratios of 1 % - 2 % are commonly encountered in sands and very soft clays rising to 4 % - 10 % in stiff clays.

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

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

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 estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes *etc.* 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 on soil classification is required, direct drilling and sampling may be preferable.

Standard Penetration Testing (SPT)

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 also of obtaining a relatively undisturbed sample.

The test procedure is described in AS 1289.6.3.1-2004. The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm penetration depth increments and the 'N' value is taken as the number of blows for the last two 150 mm depth increments (300 mm total penetration). In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued. The test results are reported in the following form:

(i) Where full 450 mm penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7 blows:

as 4, 6, 7
N = 13

(ii) 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, 30/40 mm.

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

Dynamic Cone (Hand) Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods. Two relatively similar tests are used.

Perth sand penetrometer (PSP) - a 16 mm diameter flat ended rod is driven with a 9 kg hammer, dropping 600 mm. The test, described in AS 1289.6.3.3-1997 (R2013), was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

Cone penetrometer (DCP) - sometimes known as the Scala Penetrometer, a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm. The test, described in AS 1289.6.3.2-1997 (R2013), was developed initially for pavement sub-grade investigations, with correlations of the test results with California Bearing Ratio published by various Road Authorities.

Pocket Penetrometers

The pocket (hand) penetrometer (PP) is typically a light weight spring hand operated device with a stainless steel loading piston, used to estimate unconfined compressive strength, q_u, (UCS in kPa) of a fine grained soil in field conditions. In use, the free end of the piston is pressed into the soil at a uniform penetration rate until a line, engraved near the piston tip, reaches the soil surface level. The reading is taken from a gradation scale, which is attached to the piston via a built-in spring mechanism and calibrated to kilograms per square centimetre (kPa) UCS. The UCS measurements are used to evaluate consistency of the soil in the field moisture condition. The results may be used to assess the undrained shear strength, C_u, of fine grained soil using the approximate relationship:

$$q_u = 2 \times C_u.$$

It should be noted that accuracy of the results may be influenced by condition variations at selected test surfaces. Also, the readings obtained from the PP test are based on a small area of penetration and could give misleading results. They should not replace laboratory test results. The use of the results from this test is typically limited to an assessment of consistency of the soil in the field and not used directly for design of foundations.

Test Pit / Borehole Logs

Test pit / borehole log(s) presented herein are an engineering and / or geological interpretation of the subsurface conditions. Their reliability will depend to some extent on frequency of sampling and methods of excavation / drilling. Ideally, continuous undisturbed sampling or excavation / core drilling will provide the most reliable assessment but this is not always practicable, or possible to justify on economic grounds. In any case, the test pit / borehole logs represent only a very small sample of the total subsurface profile.

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

Laboratory Testing

Laboratory testing is carried out in accordance with AS 1289 Methods of Testing Soil for Engineering Purposes. Details of the test procedure used are given on the individual report forms.

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 time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent prior weather changes. They may not be the same at the time of construction as are 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 first be washed out of the hole if water observations are to be made.

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

Test, Drill and Excavation Methods

Explanation of Terms (3 of 3)

DRILLING / EXCAVATION METHOD

HA	Hand Auger	RD	Rotary Blade or Drag Bit	NQ	Diamond Core - 47 mm
AD/V	Auger Drilling with V-bit	RT	Rotary Tricone bit	NMLC	Diamond Core – 51.9 mm
AD/T	Auger Drilling with TC-Bit	RAB	Rotary Air Blast	HQ	Diamond Core – 63.5 mm
AS	Auger Screwing	RC	Reverse Circulation	HMLC	Diamond Core – 63.5 mm
HSA	Hollow Stem Auger	CT	Cable Tool Rig	DT	Diatube Coring
S	Excavated by Hand Spade	PT	Push Tube	NDD	Non-destructive digging
BH	Tractor Mounted Backhoe	PC	Percussion	PQ	Diamond Core - 83 mm
JET	Jetting	E	Tracked Hydraulic Excavator	X	Existing Excavation

SUPPORT

Nil	No support	S	Shotcrete	RB	Rock Bolt
C	Casing	Sh	Shoring	SN	Soil Nail
WB	Wash bore with Blade or Bailer	WR	Wash bore with Roller	T	Timbering

WATER

▽ Water level at date shown

▷ Water inflow

◁ Partial water loss

◀ Complete water loss

GROUNDWATER NOT OBSERVED (NO)	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED (NX)	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

PENETRATION / EXCAVATION RESISTANCE

L	Low resistance: Rapid penetration possible with little effort from the equipment used.
M	Medium resistance: Excavation possible at an acceptable rate with moderate effort from the equipment used.
H	High resistance: Further penetration possible at slow rate & requires significant effort equipment.
R	Refusal/ Practical Refusal. No further progress possible without risk of damage/ unacceptable wear to digging implement / machine.

These assessments are subjective and dependent on many factors, including equipment power, weight, condition of excavation or drilling tools, and operator experience.

SAMPLING

D	Small disturbed sample	W	Water Sample	C	Core sample
B	Bulk disturbed sample	G	Gas Sample	CONC	Concrete Core

U63 Thin walled tube sample - number indicates nominal undisturbed sample diameter in millimetres

TESTING

SPT 4,7,11 N=18	Standard Penetration Test to AS1289.6.3.1-2004 4,7,11 = Blows per 150mm. 'N' = Recorded blows per 300mm penetration following 150mm seating
DCP	Dynamic Cone Penetration test to AS1289.6.3.2-1997. 'n' = Recorded blows per 150mm penetration

Notes:

RW	Penetration occurred under rod weight only
HW	Penetration occurred under hammer and rod weight only
20/100mm	Where practical refusal or hammer double bouncing occurred, blows and penetration for that interval are reported (e.g. 20 blows for 100 mm penetration)

CPT	Static cone penetration test
CPTu	CPT with pore pressure (u) measurement
PP	Pocket penetrometer test expressed as instrument reading (kPa)
FP	Field permeability test over section noted
VS	Field vane shear test expressed as uncorrected shear strength (sv = peak value, sr = residual value)
PM	Pressuremeter test over section noted
PID	Photoionisation Detector reading in ppm
WPT	Water pressure tests

SOIL DESCRIPTION

Density		Consistency		Moisture	
VL	Very loose	VS	Very soft	D	Dry
L	Loose	S	Soft	M	Moist
MD	Medium dense	F	Firm	W	Wet
D	Dense	St	Stiff	Wp	Plastic limit
VD	Very dense	VSt	Very stiff	Wl	Liquid limit
		H	Hard		

ROCK DESCRIPTION

Strength		Weathering	
VL	Very low	EW	Extremely weathered
L	Low	HW	Highly weathered
M	Medium	MW	Moderately weathered
H	High	SW	Slightly weathered
VH	Very high	FR	Fresh
EH	Extremely high		