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11 October 2022
Our ref: KA/C13054

Land and Housing Corporation
Via email: LAHCProcurement@facs.nsw.gov.au

Attention: Rukshani Dharmasena

Dear Sir

PROPOSED HOUSING DEVELOPMENT
MONARO HIGHWAY, COOMA, NSW (LOTS 2, 3, & 4, DP1285072)

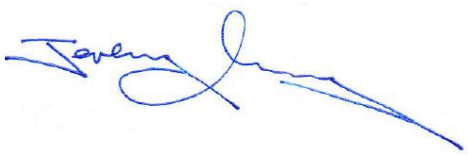
GEOTECHNICAL INVESTIGATION REPORT

We are pleased to present our geotechnical investigation report for the proposed housing development along Monaro Highway, in Cooma, NSW.

The report outlines the methods and results of exploration, describes site subsurface conditions and provides recommendations for building footing design, excavation conditions, preparation of subgrades, stability of cut and fill batters, provides indicative design CBR values, and site drainage advice.

Should you require any further information regarding this report, please do not hesitate to contact our office.

Yours faithfully
ACT Geotechnical Engineers Pty Ltd



Jeremy Murray
Senior Geotechnical Engineer
Director
FIEAust CPEng EngExec RPEQ NER APEC Engineer IntPE (Aust)

LAND AND HOUSING CORPORATION

PROPOSED HOUSING DEVELOPMENT
MONARO HIGHWAY, COOMA, NSW (LOTS 2, 3, & 4, DP1285072)

GEOTECHNICAL INVESTIGATION REPORT

JULY 2022

LAND AND HOUSING CORPORATION

PROPOSED HOUSING DEVELOPMENT
MONARO HIGHWAY, COOMA, NSW (LOTS 2, 3, & 4, DP1285072)

GEOTECHNICAL INVESTIGATION REPORT

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MONARO HIGHWAY, COOMA, NSW (LOTS 2, 3, & 4, DP1285072)

GEOTECHNICAL INVESTIGATION REPORT

1 INTRODUCTION

At the request of the NSW Land and Housing Corporation, ACT Geotechnical Engineers Pty Ltd carried out a geotechnical investigation for a proposed subdivision located along Monaro Highway, in Cooma, NSW.

The project involves the construction of a residential housing development, comprising one or two-storey houses and associated driveways and access roads. The aim of the investigation was to:

(i) Identify subsurface conditions including the extent and nature of any fill materials, soil strata, bedrock type and depth, and groundwater presence.

(ii) Advise on excavation conditions and suitability of excavated material for use as structural fill.

(iii) Provide site classification to AS2870 "Residential Slabs & Footings".

(iv) Advise on suitable footings systems, founding depths, allowable bearing pressures and design parameters for ground slabs.

(v) Provide guidelines for construction of controlled fill platforms.

(vi) Advise on stable batter slopes and retaining wall design parameters.

(vii) Provide lab testing results of site soils for CBR value.

(viii) Provide subgrade CBR value(s) for pavement design.

(ix) Drainage and other geotechnical advice.

2 SITE DESCRIPTION & GEOLOGY

The approximately 33.3 hectare site is bounded by Monaro Highway to the NW, Polo Flat Road to the SE and the Cooma-Bombala Railway Line to the south, in Cooma, NSW. The lots can be described as Lots 2, 3, and 4, DP1285072.

The site is presently undeveloped, farmer grazing land, and the groundsurface is undulating and covered in pasture grass. Figure 1 shows the site locality, while Figure 2 is a recent aerial photograph showing the present site layout.

The 1:250,000 Bega & Malacoota Geology Map documents the area to be underlain by Tertiary Age Monaro Volcanic Complex bedrock, which includes medium to very coarse grained porphyritic dolerite and massive to vesicular dark blue-grey to black porphyritic basalt.

3 INVESTIGATION METHODS

To establish the subsurface conditions, a JCB3CX backhoe with a 450mm bucket attachment was used to dig sixteen (16) test pits on the block designated TP01 to TP16 on 3 June 2022. Figure 1 is an aerial photograph that shows the location of the investigation test pits. The subsurface profile was

logged in general accordance with AS1726 – 2017 "Geotechnical Site Investigations" by an experienced geotechnical engineer. The locations of the test pits are shown on Figure 2, and the detailed logs are included in Appendix A.

Definitions of geotechnical engineering terms used in the report on the excavation logs, including a copy of the USCS chart, are provided in Appendix B.

4 INVESTIGATION RESULTS

4.1 Subsurface Conditions

The subsurface conditions of the proposed development were investigated by sixteen (16) test pits designated TP1 to TP16. The excavation logs in Appendix A can be referred to for more detail. Investigation test pits found the subsurface profile to comprise:

Geological Profile	Typical Depth Interval	Description
TOPSOIL	0.0m to 0.1m/0.3m	Silty SAND; fine to medium sand, low plasticity silt, dark brown, with grass rootlets, dry to moist, loose.
RESIDUAL SOIL	0.1m/0.3m to 0.4m/>1.5m	Silty Sandy CLAY, Sandy Gravelly CLAY, Silty Sandy GRAVEL, Clayey Sandy SILT, Clayey Gravelly SAND; fine to coarse sand, low to medium plasticity clay, fine to coarse sized volcanic/basalt gravel, dry to moist, firm to very stiff, medium dense to very dense.
WEATHERED BEDROCK	Below 0.4m/>1.5m	Extremely to Highly Weathered (EW-HW) BASALT; fine to medium grained, grey, low strength, dry to moist.

Table 1 summarizes the depths of bedrock and refusal encountered during the investigation.

Table 1 – Depth of Bedrock

Test Pit No.	Depth to EW-HW bedrock (m)	Depth to bucket refusal/medium strong bedrock (m)
TP1	0.6m	1.0m
TP2	1.3m	1.3m
TP3	1.1m	1.2m
TP4	1.1m	1.3m
TP5	0.55m	0.9m
TP6	0.4m	0.6m
TP7	0.8m	1.2m
TP8	1.1m	1.4m
TP9	0.5m	0.7m
TP10	1.0m	1.2m
TP11	>1.5m	>1.5m
TP12	0.5m	0.8m

Test Pit No.	Depth to EW-HW bedrock (m)	Depth to bucket refusal/medium strong bedrock (m)
TP13	0.9m	1.1m
TP14	>1.5m	>1.5m
TP15	1.0m	>1.2m
TP16	0.55m	0.95m

4.2 Groundwater

Groundwater was not encountered in the boreholes, and the soils were mostly dry to moist. Permanent groundwater is not expected within at least 5m depth of the existing ground surface levels. However, temporary, perched seepages could be encountered following rainfall within the more pervious soils.

4.3 Laboratory Test Results

The CBR samples were collected from representative subgrade depths in all of the boreholes. The results are summarized in Table 2 and the test certificates are shown in Appendix B.

Table 2 – CBR Test Results

Test Pit Number	Sampling Depth (m)	CBR (%)	Swell (%)
TP1	0.4m - 0.6m	16%	1.0%
TP2	0.7m – 0.9m	8%	0.5%
TP3	0.4m – 0.6m	19%	0.5%
TP4	0.7m – 0.9m	2.5%	0.5%
TP5	0.2m – 0.4m	9%	2.0%
TP6	0.2m – 0.4m	18%	1.0%
TP7	0.2m – 0.5m	5%	2.0%
TP8	0.3m – 0.5m	11%	0.5%
TP9	0.2m – 0.4m	6%	1.5%
TP10	0.3m – 0.5m	9%	1.5%
TP11	0.4m – 0.6m	3%	4.5%
TP12	0.2m – 0.4m	17%	0.5%
TP13	0.4m – 0.7m	5%	5.0%
TP14	0.2m – 0.4m	5%	2.0%
TP15	0.5m – 0.7m	20%	0.5%
TP16	0.3m – 0.5m	8%	1.0%

5 DISCUSSION & RECOMMENDATIONS

5.1 Site Classification

The residual soils at the site within the depth of suction change are slightly to moderately reactive in terms of potential shrink-swell movements that may occur due to soil moisture changes. The characteristic ground surface movement "ys", as defined by AS2870 for the range of normal soil moisture conditions is estimated to be between 0mm to 30mm for the encountered subsurface profile described in Section 4. The summary of ys and site classifications for each test pit is presented in Table 3 below.

Table 3 – Summary of Site Classifications

Test Pit No.	Approx. Characteristic Ground Surface Movement (mm)	Site Classification
TP1	10.23mm	"S" – Slightly Reactive
TP2	21.36mm	"M" – Moderately Reactive
TP3	9.30mm	"S" – Slightly Reactive
TP4	12.97mm	"S" – Slightly Reactive
TP5	9.30mm	"S" – Slightly Reactive
TP6	~0.0mm	"S" – Slightly Reactive / "A" – non-reactive
TP7	12.10mm	"S" – Slightly Reactive
TP8	14.01mm	"S" – Slightly Reactive
TP9	5.35mm	"S" – Slightly Reactive
TP10	15.42mm	"S" – Slightly Reactive
TP11	20.89mm	"M" – Moderately Reactive
TP12	5.35mm	"S" – Slightly Reactive
TP13	8.69mm	"S" – Slightly Reactive
TP14	22.05mm	"M" – Moderately Reactive
TP15	9.39mm	"S" – Slightly Reactive
TP16	9.33mm	"S" – Slightly Reactive

Normal moisture conditions are those caused by seasonal and regular climatic effects.

Should earthworks (cut or fill) be undertaken on the site, or other activities which may cause abnormal moisture conditions to impact the soils within or near the building envelope beyond those addressed herein, the site classification shall be reassessed.

5.2 Building Footings

AS2870 provides "deemed-to-comply" footing/slab designs, which for a Class "S"/"M" site includes stiffened rafts, stiffened footing slabs, waffle rafts, and strip and/or pad footings with above ground floors. Footings and slabs should be designed in accordance with the principles of AS2870.

For structures founded at existing grade, footings, including thickened sections of slabs forming footings should be founded below any topsoil or uncontrolled fill soils. Shallow footings could be founded in newly placed or existing controlled fill following removal of any topsoil material (see Section 5.6). Alternatively, footings could be founded on piers extending to weathered bedrock.

If designing footings based on engineering principles, recommended allowable end-bearing pressures for various footing systems and likely foundation materials are provided in Table 4.

Table 4 - Recommended Allowable End-Bearing Pressures for Footings

Foundation Material Type	Depth Below Existing Surface Level	Allowable End-Bearing Pressure			Allowable Shaft Adhesion on Bored Piers	
		Strips	Pads	Bored Piers	Downward Loading	Uplift
Stiff to Very Stiff & Dense to Very Dense Residual Soils	Below 0.4m/0.6m	100kPa	150kPa	200kPa	20kPa	10kPa
EW/HW Bedrock	Below 0.4m/>1.5m	300kPa	400kPa	600kPa	50kPa	25kPa
HW/MW Bedrock	Below 0.6m/>1.5m	1000kPa	1500kPa	2000kPa	100kPa	50kPa

All footings should be inspected and approved by an experienced geotechnical engineer to confirm the foundation material and design values, and to ensure the excavations are clean and stable.

Ground slabs can be constructed on the natural soils or newly placed controlled fill, following the removal of any topsoil and uncontrolled fill material. Following excavation to required level, slab areas on soil should be proof-rolled by a pad foot roller to check for any weak, wet or deforming soils that may require replacement. Suitable replacement fill should be compacted in not thicker than 150mm layers to not less than 98%StdMDD.

5.3 Excavation Conditions & Use of Excavated Material

The soils and weak bedrock are readily excavated by backhoe and medium sized excavator to 0.6m/>1.5m depth; however, hard digging conditions due to rock fragments within the soil units ("floaters") could be encountered. Excavation of the stronger bedrock below 0.6m/>1.5m depth could require heavy excavator or dozer (D8 or large) ripping and rock hammering.

The low/medium plasticity alluvial/residual soils can be used in controlled fill construction of building platforms, although rock particles should be broken down to <75mm size. Any medium to high plasticity soil, and silty topsoil/alluvial material are not typically used in controlled fill construction but the topsoil could be used in non-structural applications such as landscaping, while high plasticity clays could be used as a clay capping/lining material.

If imported fill is required, a suitable select fill material would include a low or medium plasticity soil such as clayey sand or gravelly clayey sand, containing between 25% and 50% fines less than 0.075mm size (silt and clay), and no particles greater than 75mm size.

5.4 Stable Excavation Batters

Temporary site excavations to 1.5m depth can be formed at 1(H):1(V), although loose fill should be cut back at 2(H):1(V). If required and space allows, deeper temporary cuts can be formed at 2(H):1(V) or benched at 1.5m intervals in soils, and 0.5(H):1(V) in weak rock. A geotechnical engineer should inspect all cut batters during construction to confirm stability. Exposed temporary batters should be protected from the weather by black plastic pinned to the face with link-wire mesh, or similar.

Permanent cut & fill batter slopes should be formed at no steeper than 2(H):1(V) in soil and EW bedrock and be protected against erosion by shotcreting, stone pitching or other suitable methods. Alternatively permanent excavations can be supported by structural retaining walls.

5.5 Low Retaining Walls

Retaining walls constructed in open excavation, with the gap between the excavation face and the wall backfilled later, can be designed for an earth pressure distribution given by:

$$\sigma_h = (K\gamma' h) + Kq$$

where,

σ_h is the horizontal earth pressure acting on the back of the wall, in kPa

K is the dimensionless coefficient of earth pressure; this can be assumed to be 0.4 when the top of the wall is unrestrained horizontally, and 0.6 when the top of the wall is restrained (i.e. by building slabs etc.)

γ' is the effective unit weight of the backfill, and can be assumed to be 20kN/m^3 for a lightly compacted soil backfill

h is the height of the backfill, in metres

q is any uniform distributed vertical surcharge acting on the top of the backfill, in kPa

Apart from structural restraints such as floor slabs, resistance to overturning and sliding of retaining walls is provided by frictional and adhesive resistance on the base, and by passive resistance at the toe of the wall. For a natural soil or controlled fill foundation, an ultimate base friction factor (tanδ) of 0.4, base adhesion (c) of 50kPa, and allowable passive earth pressure coefficient Kp=2.5 can be used for calculation of sliding resistance. For calculating sliding resistance of concrete on the weathered bedrock, an ultimate base friction factor (tanδ) of 0.6 can be used, with an ultimate base adhesion (c) value of 100kPa.

Free-draining granular backfill or synthetic fabric drains should be installed behind all walls. These should connect to weep holes and/or a collector drain, and ultimately to the stormwater system. Granular backfill should be wrapped in a suitable filter fabric to minimise infiltration of silt/clay fines

5.6 Controlled Fill Construction

For construction of any new fill foundation platforms and road subgrades, it is recommended that:

- Areas be fully stripped of all topsoil, slopewash, organic material and uncontrolled fill material. A general stripping depth of up to 0.1m/0.7m is recommended. Stripped foundations should be proof-rolled by a vibratory pad-foot roller of not less than 9 tonne static mass to check for any weak or wet areas that would require replacement. No fill should be placed until a geotechnical engineer has confirmed the suitability of the foundation.

- Controlled fill comprising suitable site excavated or imported materials of not greater than 75mm maximum particle size, be compacted in not greater than 150mm layers to not less than 98%StdMDD at about OMC.

- Fill placement and control testing be overviewed and certified by a geotechnical engineer at Level 1 or 2 involvement of AS3798 – 2007 "Guidelines on Earthworks for Commercial & Residential Developments" (Reference 3).

5.7 Design CBR Values

On-grade carpark, and access ramp subgrades should be stripped of all topsoil and uncontrolled fill, and soil subgrades then proof-rolled by a pad-foot roller to check for any wet or otherwise weak spots which may require additional removal. Suitable replacement fill can be compacted in not thicker than 150mm layers, to not less than 98%StdMDD.

On-grade pavements are expected to comprise natural soils or controlled fill, and pavements can be designed for a subgrade CBR value of 3%, when compacted to 98%StdMDD. Cut, in-situ bedrock subgrades would have a CBR value of 12%. A geotechnical engineer should inspect prepared subgrades to confirm design values, and preferably view a proof-roll to identify any soft spots or other weaknesses.

5.8 Earthquake Site Factor

Table 2.3 of AS1170.4 "Minimum Design Loads on Structures - Part 4: Earthquake Loads" (Reference 4) lists the earthquake acceleration coefficients for major centres to be considered in structural design. The Cooma area has an acceleration coefficient of 0.09.

Section 4.2 of AS1170.4 "Minimum Design Loads on Structures – Part 4: Earthquake Loads" lists the site sub-soil classes to be considered in structural design. The site is classified as a "Class C_e – Shallow Soil Site".

5.9 Site Drainage

Groundwater was not encountered in the boreholes during the investigation. The permanent groundwater table is expected to be well below expected excavations, although temporary perched seepages will be present following rain, but should be readily controllable through the use of pumps during construction.

Suitable surface drainage should be provided to ensure rainfall run-off or other surface water cannot pond against buildings or pavements. Drainage should be provided behind all retaining walls, and subsoil drains should be installed along the upslope sides of access roads and carparks.

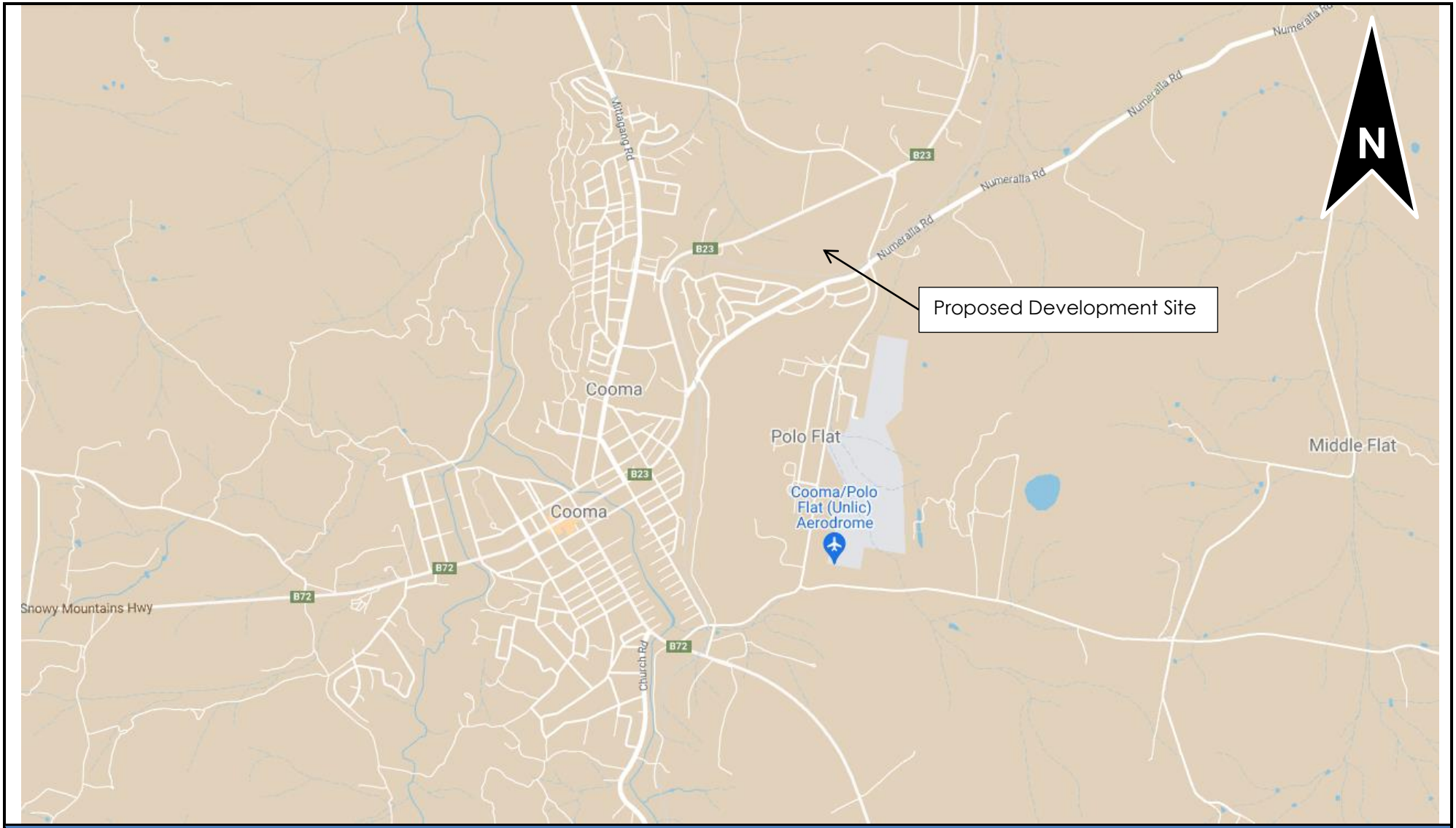
REFERENCES

1 Lewis P.C. and Glen R.A., 1995, Bega - Mallacoota 1:250 000 Geological Sheet SJ/55-04 & part SJ/55-08, 2nd edition, Geological Survey of New South Wales, Sydney

2 Standards Australia, "AS2870 – Residential Slabs & Footings", 2011.

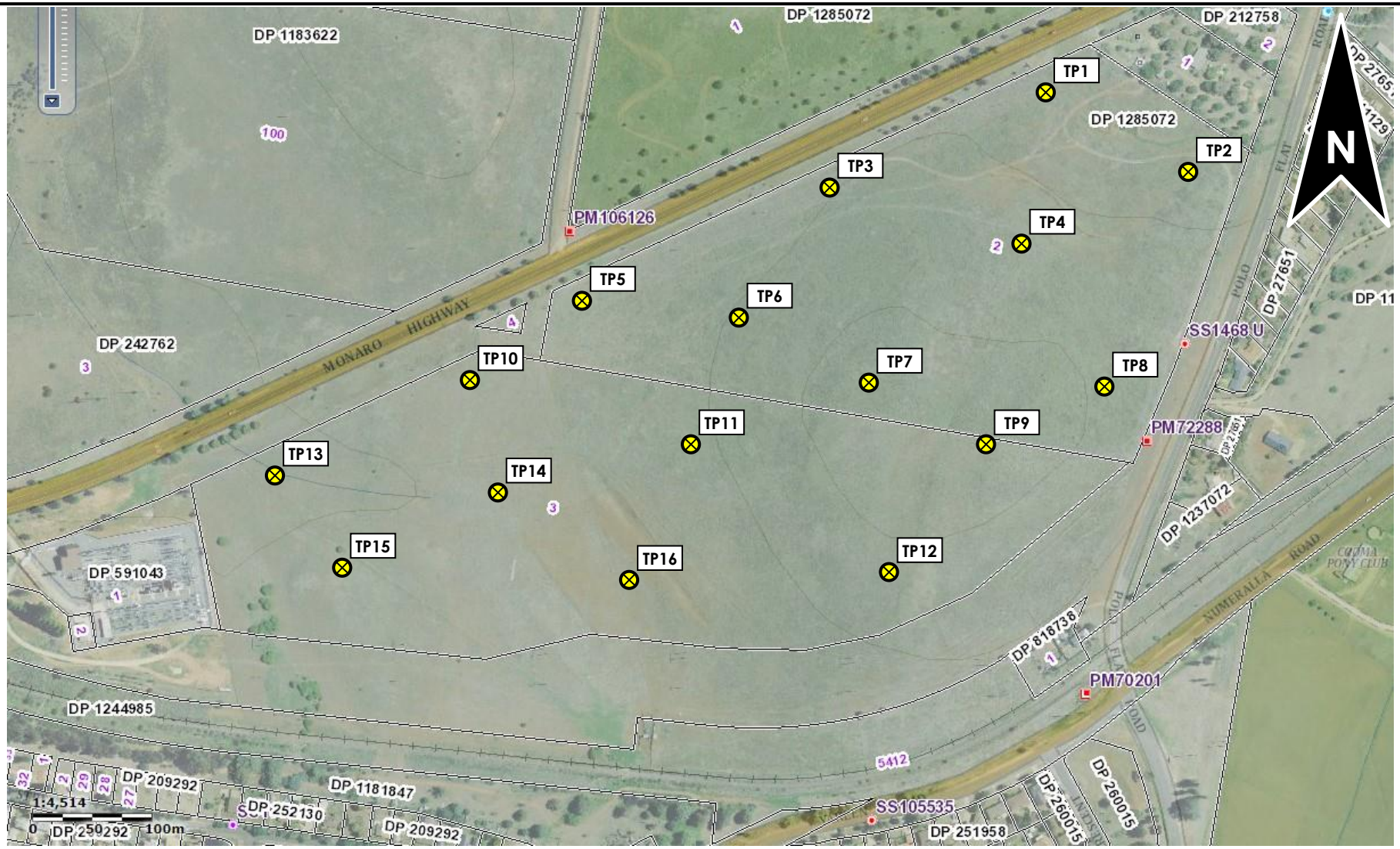
3 Standards Australia, "AS3798 - Guidelines on earthworks for commercial and residential developments", 2007.

4 Standards Australia, "AS1170.4 – 2007 – Minimum Design Loads on Structures – Part 4 Earthquake Loads".



LAND AND HOUSING CORPORATION
PROPOSED HOUSING DEVELOPMENT – MONARO HIGHWAY, COOMA, NSW
SITE LOCALITY

ACT Geotechnical Engineers Pty Ltd	**C12575**	**FIGURE 1**



LAND AND HOUSING CORPORATION
PROPOSED HOUSING DEVELOPMENT – MONARO HIGHWAY, COOMA, NSW
AERIAL PHOTOGRAPH AND TEST PIT LOCATIONS

ACT Geotechnical Engineers Pty Ltd	C12575	FIGURE 2

APPENDIX A
Excavation Logs TP1 to TP16

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Unit 5, 9 Beaconsfield Street Fyshwick ACT 2609
Phone: (02) 6285 1547

Engineering Log - Testpit

Testpit No: TP01

UTM	: 55H	Excavator	: 3.5T Excavator with 400mm bucke	Job Number	: C13054
Easting	: 693409.2	Excavator Supplier	: Ground Control ACT	Client	: Land and Housing Corporation
Northing	: 5990039.4	Logged By	: Kris Alipio	Project	: Proposed Housing Development
RL	: N/A	Reviewed By	:	Location	: Monaro Highway, Cooma
Total Depth	: 1m	Date	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples: Disturbed Sample
	0		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		CL-CI	Silty to sandy CLAY (CL-CI) : Firm to stiff, low to medium plasticity, red-brown, fine to coarse grained sand, w < PL.	w < PL		
	0.4		Residua		CL-CI	Sandy to gravelly CLAY (CL-CI) : , Very stiff, low to medium plasticity, red-brown and grey, fine to coarse sized gravel, fine to coarse grained sand, w < PL.	w < PL		CBR
	0.5								
	0.6		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
	1					**TP01 refusal at 1m**			
	1.5								
	2								

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Engineering Log - Testpit

Testpit No: TP02

UTM	: 55H	Excavator	: 3.5T Excavator with 400mm bucke	Job Number	: C13054
Easting	: 693409.20	Excavator Supplier	: Ground Control ACT	Client	: Land and Housing Corporation
Northing	: 5990039.45	Logged By	: Kris Alipio	Project	: Proposed Housing Development
RL	: N/A	Reviewed By	:	Location	: Monaro Highway, Cooma
Total Depth	: 1.3m	Date	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples: Disturbed Sample
	0		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		CL-CI	Silty to sandy CLAY (CL-CI) : Firm to stiff, low to medium plasticity, red-brown, fine to coarse grained sand, w < PL.	w < PL		
	0.5		Residua		CL-CI	AS ABOVE:Stiff to very stiff,	w < PL		CBR
	0.9		Residua		CL-CI	Sandy to gravelly CLAY (CL-CI) : Very stiff, low to medium plasticity, red-brown and grey, fine to coarse sized gravel, fine to coarse grained sand, w < PL.	w < PL		
	1					**TP02 refusal at 1.3m (refusal in cobbles (bedrock?))**			
	1.5								
	2								

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Engineering Log - Testpit

Testpit No: TP03

UTM	: 55H	**Excavator**	: 3.5T Excavator with 400mm bucke	**Job Number**	: C13054
Easting	: 692949.45	**Excavator Supplier**	: Ground Control ACT	**Client**	: Land and Housing Corporation
Northing	: 5990008.38	**Logged By**	: Kris Alipio	**Project**	: Proposed Housing Development
RL	: N/A	**Reviewed By**	:	**Location**	: Monaro Highway, Cooma
Total Depth	: 1.2m	**Date**	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples: Disturbed Sample
	0		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		OL	Clayey to sandy SILT (OL) : , Firm to stiff, low plasticity, dark brown, low plasticity clay, fine to coarse grained sand, organic, w ≈ PL.	w ≈ PL		
	0.4		Residua		GM	Silty to sandy GRAVEL (GM) : Dense to very dense, fine to coarse sized, angular to sub-angular, black and red-brown, low plasticity clay, fine to coarse grained sand, Moist to Dry.	M-D		CBR
	0.5								
	1								
	1.1		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
						TP03 refusal at 1.2m			
	1.5								
	2								

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Engineering Log - Testpit

Testpit No: TP04

UTM	: 55H	**Excavator**	: 3.5T Excavator with 400mm bucke	**Job Number**	: C13054
Easting	: 693309.54	**Excavator Supplier**	: Ground Control ACT	**Client**	: Land and Housing Corporation
Northing	: 5989880.11	**Logged By**	: Kris Alipio	**Project**	: Proposed Housing Development
RL	: N/A	**Reviewed By**	:	**Location**	: Monaro Highway, Cooma
Total Depth	: 1.3m	**Date**	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples
			Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		OL	Clayey to sandy SILT (OL) : , Firm to stiff, low plasticity, dark brown, low plasticity clay, fine to coarse grained sand, organic, w ≈ PL.	w ≈ PL		
	0.5								
	0.7		Residua		CL-CI	Sandy CLAY (CL-CI) : , Very stiff, low to medium plasticity, red-brown, fine to coarse grained sand, trace fine to medium sized gravel, w < PL.	w < PL		CBR
	1								
	1.1		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
						TP04 refusal at 1.3m			
	1.5								
	2								

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Phone: (02) 6285 1547

Engineering Log - Testpit

Testpit No: TP05

UTM	: 55H	Excavator	: 3.5T Excavator with 400mm bucke	Job Number	: C13054
Easting	: 692604.61	Excavator Supplier	: Ground Control ACT	Client	: Land and Housing Corporation
Northing	: 5989485.15	Logged By	: Kris Alipio	Project	: Proposed Housing Development
RL	: N/A	Reviewed By	:	Location	: Monaro Highway, Cooma
Total Depth	: 0.8m	Date	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples: Disturbed Sample
	0		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		CL-Cl	Sandy to gravelly CLAY (CL-Cl) : , Very stiff, low to medium plasticity, red-brown, fine to coarse sized gravel, fine to coarse grained sand, w < PL.	w < PL		CBR
	0.5								
	0.55		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
	1					**TP05 refusal at 0.8m**			
	1.5								
	2								

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Unit 5, 9 Beaconsfield Street Fyshwick ACT 2609
Phone: (02) 6285 1547

Engineering Log - Testpit

Testpit No: TP06

UTM	**: 55H**	**Excavator**	**: 3.5T Excavator with 400mm bucke**	**Job Number**	**: C13054**
Easting	**: 691816.7**	**Excavator Supplier**	**: Ground Control ACT**	**Client**	**: Land and Housing Corporation**
Northing	**: 5989944.8**	**Logged By**	**: Kris Alipio**	**Project**	**: Proposed Housing Development**
RL	**: N/A**	**Reviewed By**	**:**	**Location**	**: Monaro Highway, Cooma**
Total Depth	**: 0.6m**	**Date**	**: 03/06/2022**		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples
			Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.15		Residua		GM	Silty to sandy GRAVEL (GM) : Dense to very dense, , fine to coarse sized, angular to sub-angular, black and red-brown, low plasticity clay, fine to coarse grained sand, Moist to Dry.	M-D		CBR
	0.4		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
	0.5					**TP06 refusal at 0.6m**			
	1								
	1.5								
	2								

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Engineering Log - Testpit

Testpit No: TP07

UTM	: 55H	Excavator	: 3.5T Excavator with 400mm bucke	Job Number	: C13054
Easting	: 692405.96	Excavator Supplier	: Ground Control ACT	Client	: Land and Housing Corporation
Northing	: 5989458.73	Logged By	: Kris Alipio	Project	: Proposed Housing Development
RL	: N/A	Reviewed By	:	Location	: Monaro Highway, Cooma
Total Depth	: 1.2m	Date	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples
	0.1		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.5		Residua		CL-Cl	Silty to sandy CLAY (CL-Cl) : Firm to stiff, low to medium plasticity, red-brown, fine to coarse grained sand, trace fine to medium sized gravel, w < PL.	w < PL		CBR
	0.8		Residua		SC	Clayey to gravelly SAND (SC) : Medium dense, , Very stiff, fine to coarse grained, low to medium plasticity, red-brown and brown, low plasticity clay, fine to coarse sized gravel, Dry.	D		
	1		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
	1.5					**TP07 refusal at 1.2m**			
	2								

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Engineering Log - Testpit

Testpit No: TP08

UTM	: 55H	**Excavator**	: 3.5T Excavator with 400mm bucke	**Job Number**	: C13054
Easting	: 693336.45	**Excavator Supplier**	: Ground Control ACT	**Client**	: Land and Housing Corporation
Northing	: 5989910.41	**Logged By**	: Kris Alipio	**Project**	: Proposed Housing Development
RL	: N/A	**Reviewed By**	:	**Location**	: Monaro Highway, Cooma
Total Depth	: 1.4m	**Date**	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples
									Disturbed Sample
			Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		CL-CI	Silty to sandy CLAY (CL-CI) : , Firm to stiff, low to medium plasticity, red-brown, fine to coarse grained sand, trace fine to medium sized gravel, w < PL.	w < PL		CBR
	0.5								
	0.6		Residua		SC	Clayey to gravelly SAND (SC) : Medium dense, , Very stiff, fine to coarse grained, low to medium plasticity, red-brown and brown, low plasticity clay, fine to coarse sized gravel, Dry.	D		
	1								
	1.1		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
						TP08 refusal at 1.4m			
	1.5								
	2								

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Engineering Log - Testpit

Testpit No: TP09

UTM	: 55H	**Excavator**	: 3.5T Excavator with 400mm bucke	**Job Number**	: C13054
Easting	: 693080.52	**Excavator Supplier**	: Ground Control ACT	**Client**	: Land and Housing Corporation
Northing	: 5989339.68	**Logged By**	: Kris Alipio	**Project**	: Proposed Housing Development
RL	: N/A	**Reviewed By**	:	**Location**	: Monaro Highway, Cooma
Total Depth	: 0.7m	**Date**	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples
	0		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		SC	Clayey to gravelly SAND (SC) : Medium dense, , Very stiff, fine to coarse grained, low to medium plasticity, red-brown and brown, low plasticity clay, fine to coarse sized gravel, Dry.	D		CBR
	0.5		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			Disturbed Sample
	0.7					**TP09 refusal at 0.7m**			
	1								
	1.5								
	2								

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Engineering Log - Testpit

Testpit No: TP10

UTM	: 55H	**Excavator**	: 3.5T Excavator with 400mm bucke	**Job Number**	: C13054
Easting	: 692757.69	**Excavator Supplier**	: Ground Control ACT	**Client**	: Land and Housing Corporation
Northing	: 5989282.09	**Logged By**	: Kris Alipio	**Project**	: Proposed Housing Development
RL	: N/A	**Reviewed By**	:	**Location**	: Monaro Highway, Cooma
Total Depth	: 1.2m	**Date**	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples
			Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.3		Residua		CL-Cl	Sandy CLAY (CL-Cl) : Firm to stiff, low to medium plasticity, red-brown, fine to coarse grained sand, trace medium to coarse sized gravel, w < PL.	w < PL		CBR
	0.5		Residua		CL-Cl	Sandy to gravelly CLAY (CL-Cl) : , Very stiff, low to medium plasticity, red-brown, fine to coarse sized gravel, fine to coarse grained sand, w < PL.	w < PL		
	1		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
						TP10 refusal at 1.2m			
	1.5								
	2								

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Engineering Log - Testpit

Testpit No: TP11

UTM	: 55H	Excavator	: 3.5T Excavator with 400mm bucke	Job Number	: C13054
Easting	: 692681.19	Excavator Supplier	: Ground Control ACT	Client	: Land and Housing Corporation
Northing	: 5989354.36	Logged By	: Kris Alipio	Project	: Proposed Housing Development
RL	: N/A	Reviewed By	:	Location	: Monaro Highway, Cooma
Total Depth	: 1.5m	Date	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples: Disturbed Sample
	0		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		CL-CI	Silty to sandy CLAY (CL-CI) : Medium dense, , Stiff, low to medium plasticity, red-brown, fine to coarse grained sand, trace fine sized gravel, w < PL.	w < PL		CBR
	0.5								
	0.7		Residua		SC	Clayey to gravelly SAND (SC) : Medium dense to dense, fine to coarse grained, brown and grey, low plasticity clay, fine to coarse sized gravel, Dry.	D		
	1								
	1.5					**TP11 Terminated at 1.5m**			
	2								

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Engineering Log - Testpit

Testpit No: TP12

UTM	: 55H	**Excavator**	: 3.5T Excavator with 400mm bucke	**Job Number**	: C13054
Easting	: 693036.13	**Excavator Supplier**	: Ground Control ACT	**Client**	: Land and Housing Corporation
Northing	: 5989370.98	**Logged By**	: Kris Alipio	**Project**	: Proposed Housing Development
RL	: N/A	**Reviewed By**	:	**Location**	: Monaro Highway, Cooma
Total Depth	: 0.8m	**Date**	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples
	0		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		SC	Clayey to gravelly SAND (SC) : Medium dense, , Very stiff, fine to coarse grained, low to medium plasticity, red-brown and brown, low plasticity clay, fine to coarse sized gravel, Dry.	D		CBR
	0.5		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
						TP12 refusal at 0.8m			
	1								
	1.5								
	2								

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Engineering Log - Testpit

Testpit No: TP13

UTM	: 55H	Excavator	: 3.5T Excavator with 400mm bucke	Job Number	: C13054
Easting	: 692662.54	Excavator Supplier	: Ground Control ACT	Client	: Land and Housing Corporation
Northing	: 5989873.05	Logged By	: Kris Alipio	Project	: Proposed Housing Development
RL	: N/A	Reviewed By	:	Location	: Monaro Highway, Cooma
Total Depth	: 1.1m	Date	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples: Disturbed Sample
			Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.3		Residua		SM	Silty to gravelly SAND (SM) : Medium dense, , Very stiff, fine to coarse grained, low to medium plasticity, dark brown and brown, fine to coarse sized gravel, Moist.	M		CBR
	0.5								
	0.9		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
	1					**TP13 refusal at 1.1m**			
	1.5								
	2								

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Phone: (02) 6285 1547

Engineering Log - Testpit

Testpit No: TP14

UTM	**: 55H**	**Excavator**	**: 3.5T Excavator with 400mm bucke**	**Job Number**	**: C13054**
Easting	**: 692602.4**	**Excavator Supplier**	**: Ground Control ACT**	**Client**	**: Land and Housing Corporation**
Northing	**: 5989491.1**	**Logged By**	**: Kris Alipio**	**Project**	**: Proposed Housing Development**
RL	**: N/A**	**Reviewed By**	**:**	**Location**	**: Monaro Highway, Cooma**
Total Depth	**: 1.5m**	**Date**	**: 03/06/2022**		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples
									Disturbed Sample
	0.15		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.5		Residua		CL-CI	Silty CLAY (CL-CI) : Firm, low to medium plasticity, red-brown, w < PL.	w < PL		CBR
	0.7		Residua		CL-CI	Silty CLAY (CL-CI) : Stiff, angular to sub-angular, low to medium plasticity, dark brown, low plasticity clay, w < PL.	w < PL		
	1		Residua		SM	Silty SAND (SM) : Medium dense, fine to coarse grained, dark brown, Moist to Dry. (could be fill)	M-D		
	1.5					**TP14 Terminated at 1.5m**			
	2								

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Unit 5, 9 Beaconsfield Street Fyshwick ACT 2609
Phone: (02) 6285 1547

Engineering Log - Testpit

Testpit No: TP15

UTM	: 55H	Excavator	: 3.5T Excavator with 400mm bucke	Job Number	: C13054
Easting	: 691903.88	Excavator Supplier	: Ground Control ACT	Client	: Land and Housing Corporation
Northing	: 5990338.51	Logged By	: Kris Alipio	Project	: Proposed Housing Development
RL	: N/A	Reviewed By	:	Location	: Monaro Highway, Cooma
Total Depth	: 1.2m	Date	: 03/06/2022		

Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples: Disturbed Sample
	0		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.3		Residua		SM	Silty to gravelly SAND (SM) : Medium dense, , Very stiff, fine to coarse grained, low to medium plasticity, dark brown and brown, fine to coarse sized gravel, Moist.	M		
	0.5		Residua		GC	Clayey to sandy GRAVEL (GC) : Dense, fine to coarse sized, angular to sub-angular, brown and red-brown, low plasticity clay, fine to coarse grained sand, Moist to Dry.	M-D		
	1		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
						TP15 refusal at 1.2m			
	1.5								
	2								

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Unit 5, 9 Beaconsfield Street Fyshwick ACT 2609
Phone: (02) 6285 1547

Engineering Log - Testpit

Testpit No: TP16

UTM	: 55H	Excavator	: 3.5T Excavator with 400mm bucke	Job Number	: C13054
Easting	: 692957.96	Excavator Supplier	: Ground Control ACT	Client	: Land and Housing Corporation
Northing	: 5989440.42	Logged By	: Kris Alipio	Project	: Proposed Housing Development
RL	: N/A	Reviewed By	:	Location	: Monaro Highway, Cooma
Total Depth	: 0.95m	Date	: 03/06/2022		

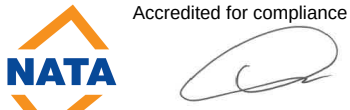
Drilling Method	Depth (m)	DCP	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Testing	Samples: Disturbed Sample
	0		Topsoil		SM	Silty SAND (SM) : Loose, fine to medium grained, dark brown, Moist to Dry.	M-D		
	0.2		Residua		CL-CI	Silty to sandy CLAY (CL-CI) : , Very stiff, low to medium plasticity, red-brown and brown, fine to coarse grained sand, w < PL.	w < PL		CBR
	0.5								
	0.55		Rock		BAS	BASALT : Highly weathered, low to medium strength, fine to medium grained, grey, indistinct Moist to Dry.			
	1					**TP16 refusal at 0.95m**			
	1.5								
	2								

APPENDIX B
Laboratory Test Certificates

Material Test Report

J & A Geotech Testing Pty Ltd

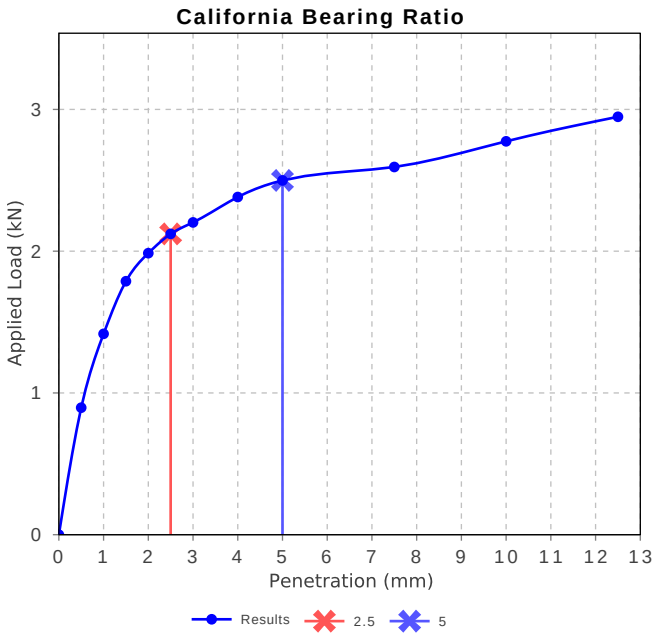
Canberra Laboratory
Unit 2, 25 Dacre Street Mitchell ACT 2911
Phone: (02) 6255 5363
Email: scott.miller@jageotech.com.au
Accredited for compliance with ISO/IEC 17025 - Testing



Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353A
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH01, Depth: 0.4-0.6m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**16**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.69		
Optimum Moisture Content (%)	16.5		
Laboratory Density Ratio (%)	95.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.59		
Field Moisture Content (%)	21.5		
Moisture Content at Placement (%)	16.6		
Moisture Content Top 30mm (%)	31.3		
Moisture Content Rest of Sample (%)	22.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.3		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	18.2		



Material Test Report

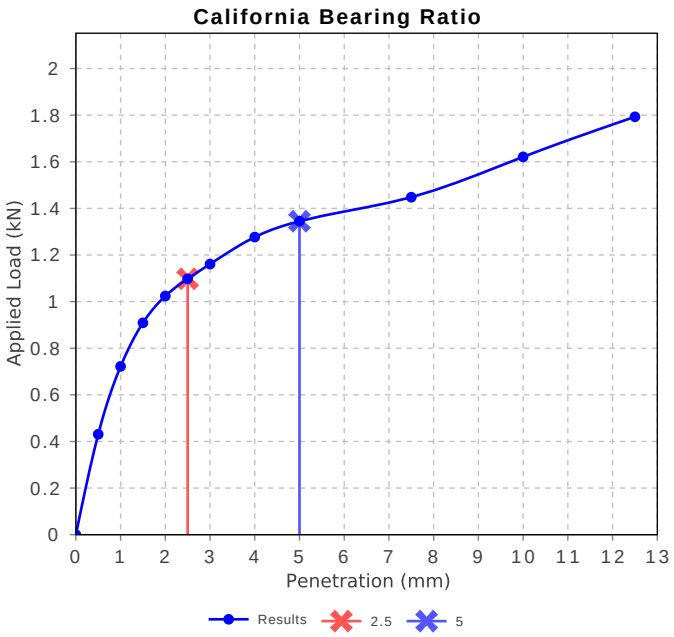
J & A Geotech Testing Pty Ltd

Canberra Laboratory
Unit 2, 25 Dacre Street Mitchell ACT 2911
Phone: (02) 6255 5363
Email: scott.miller@jageotech.com.au
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number:	**CP221048-1**
Issue Number:	1
Date Issued:	21/06/2022
Client:	ACT Geotechnical Engineers Pty Ltd
	Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number:	CP221048
Project Name:	Proposed Housing Development
Project Location:	Monaro Highway, Cooma NSW
Work Request:	5353
Sample Number:	CS5353B
Date Sampled:	06/06/2022
Dates Tested:	06/06/2022 - 20/06/2022
Sampling Method:	Sampled by Client
	The results apply to the sample as received
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Site Selection:	Selected by Client
Sample Location:	**BH02, Depth: 0.7-0.9m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**8**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.42		
Optimum Moisture Content (%)	31.0		
Laboratory Density Ratio (%)	94.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.34		
Field Moisture Content (%)	37.5		
Moisture Content at Placement (%)	30.8		
Moisture Content Top 30mm (%)	47.3		
Moisture Content Rest of Sample (%)	37.7		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.1		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1.7		



Material Test Report

J & A Geotech Testing Pty Ltd

Canberra Laboratory
Unit 2, 25 Dacre Street Mitchell ACT 2911
Phone: (02) 6255 5363
Email: scott.miller@jageotech.com.au

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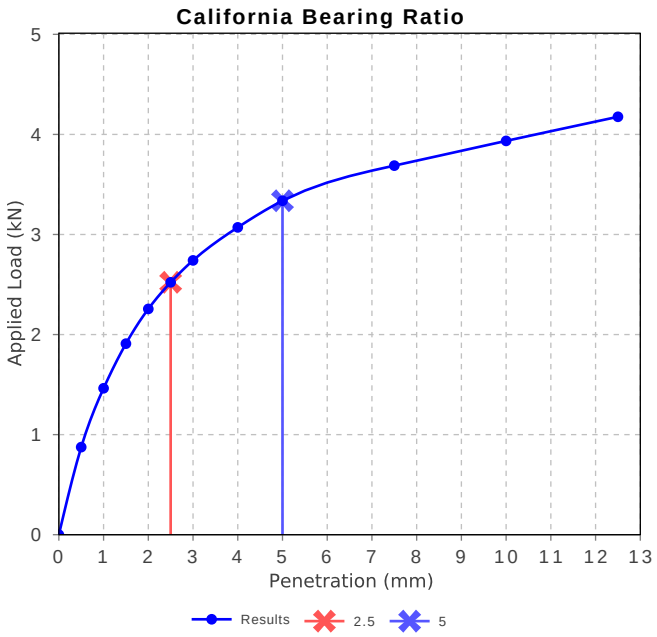
NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353C
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH03, Depth: 0.4-0.6m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**19**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.68		
Optimum Moisture Content (%)	19.5		
Laboratory Density Ratio (%)	95.0		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.59		
Field Moisture Content (%)	20.0		
Moisture Content at Placement (%)	19.5		
Moisture Content Top 30mm (%)	26.7		
Moisture Content Rest of Sample (%)	20.4		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.2		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	20.7		



Material Test Report

J & A Geotech Testing Pty Ltd

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Unit 2, 25 Dacre Street Mitchell ACT 2911
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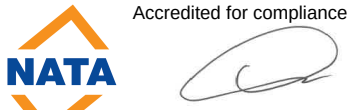
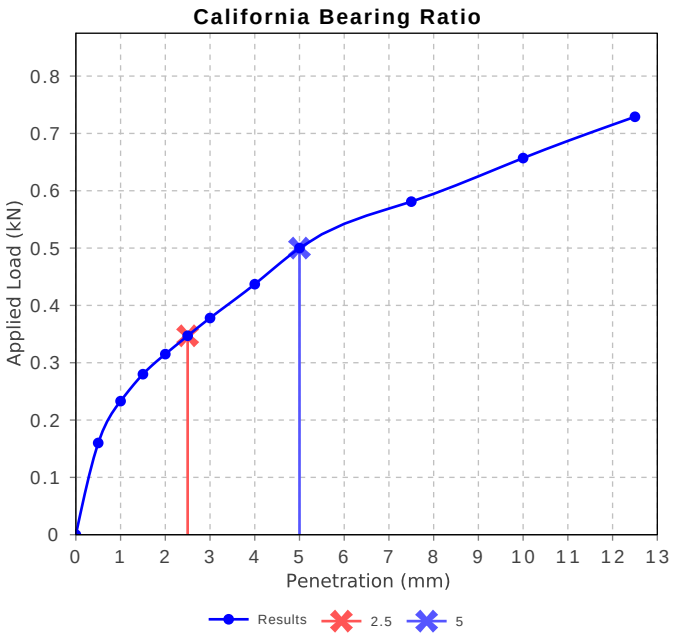


Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353D
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH04, Depth: 0.7-0.9m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**2.5**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.55		
Optimum Moisture Content (%)	27.5		
Laboratory Density Ratio (%)	94.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.42		
Field Moisture Content (%)	31.8		
Moisture Content at Placement (%)	27.3		
Moisture Content Top 30mm (%)	42.6		
Moisture Content Rest of Sample (%)	30.7		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.2		
Swell (%)	3.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1.6		



Material Test Report

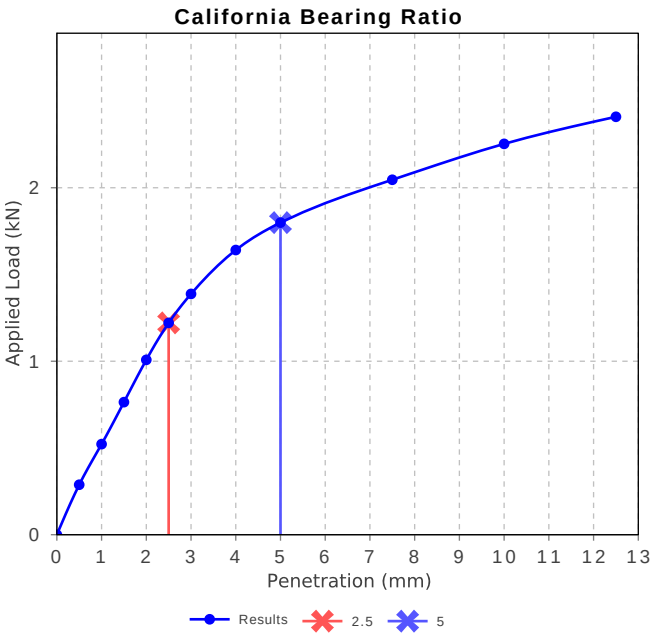
J & A Geotech Testing Pty Ltd

Canberra Laboratory
Unit 2, 25 Dacre Street Mitchell ACT 2911
Phone: (02) 6255 5363
Email: scott.miller@jageotech.com.au
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353E
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH05, Depth: 0.2-0.4m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**9**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.70		
Optimum Moisture Content (%)	19.5		
Laboratory Density Ratio (%)	94.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.58		
Field Moisture Content (%)	22.4		
Moisture Content at Placement (%)	19.6		
Moisture Content Top 30mm (%)	29.0		
Moisture Content Rest of Sample (%)	23.4		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.1		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	6.3		



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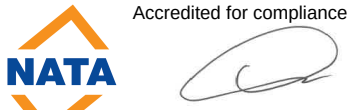
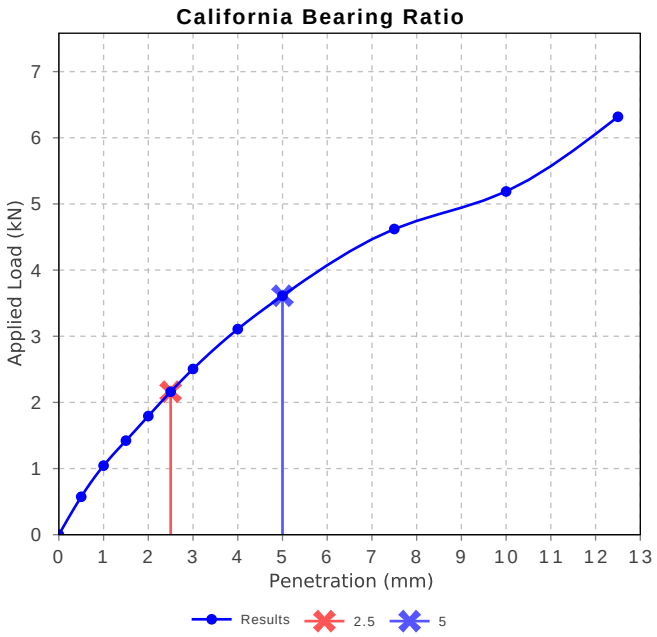


Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353F
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH06, Depth: 0.2-0.4m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**18**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.55		
Optimum Moisture Content (%)	25.5		
Laboratory Density Ratio (%)	95.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.46		
Field Moisture Content (%)	26.5		
Moisture Content at Placement (%)	25.5		
Moisture Content Top 30mm (%)	23.7		
Moisture Content Rest of Sample (%)	21.8		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.2		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



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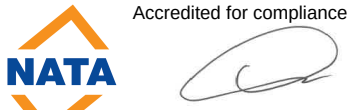
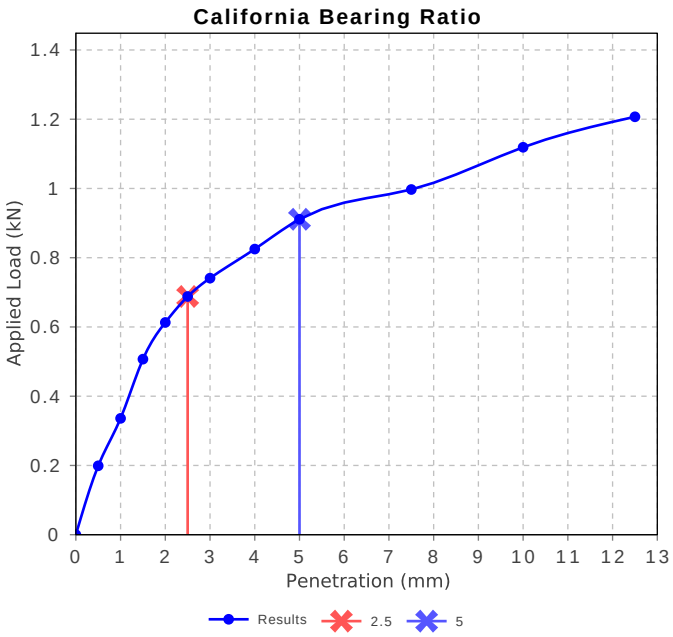


Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353G
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH07, Depth: 0.2-0.5m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.43		
Optimum Moisture Content (%)	28.5		
Laboratory Density Ratio (%)	95.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.32		
Field Moisture Content (%)	34.7		
Moisture Content at Placement (%)	28.7		
Moisture Content Top 30mm (%)	51.0		
Moisture Content Rest of Sample (%)	35.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.3		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	3.8		



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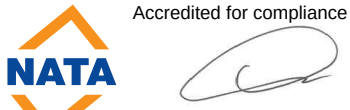
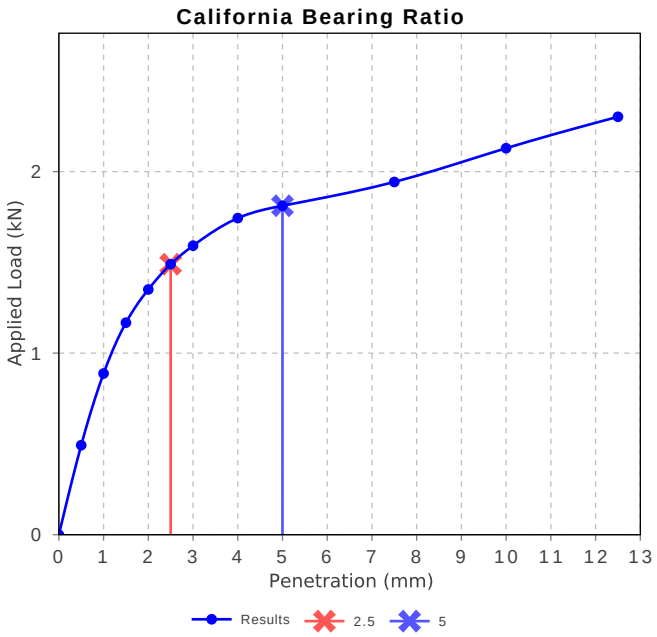


Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353H
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH08, Depth: 0.3-0.5m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**11**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.42		
Optimum Moisture Content (%)	30.5		
Laboratory Density Ratio (%)	95.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.34		
Field Moisture Content (%)	37.7		
Moisture Content at Placement (%)	30.7		
Moisture Content Top 30mm (%)	41.3		
Moisture Content Rest of Sample (%)	31.2		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	167.9		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1.9		



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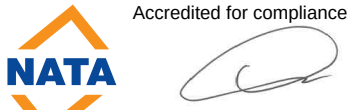
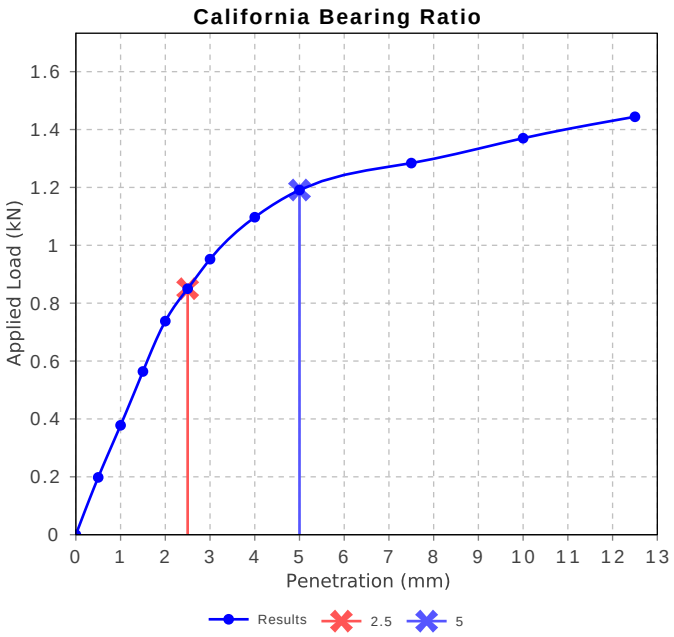


Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353I
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH09, Depth: 0.2-0.4m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**6**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.50		
Optimum Moisture Content (%)	24.0		
Laboratory Density Ratio (%)	94.5		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.39		
Field Moisture Content (%)	31.7		
Moisture Content at Placement (%)	24.0		
Moisture Content Top 30mm (%)	45.1		
Moisture Content Rest of Sample (%)	30.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.1		
Swell (%)	1.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	23.5		



Material Test Report

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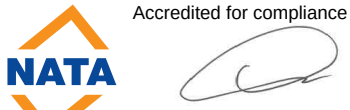
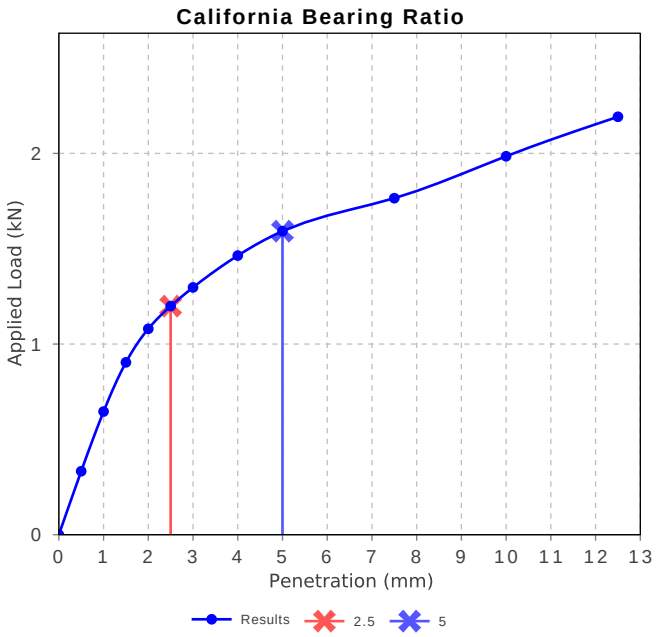


Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353J
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH10, Depth: 0.3-0.5m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**9**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.64		
Optimum Moisture Content (%)	22.5		
Laboratory Density Ratio (%)	95.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.53		
Field Moisture Content (%)	27.5		
Moisture Content at Placement (%)	22.3		
Moisture Content Top 30mm (%)	33.7		
Moisture Content Rest of Sample (%)	25.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.1		
Swell (%)	1.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	2.1		



Material Test Report

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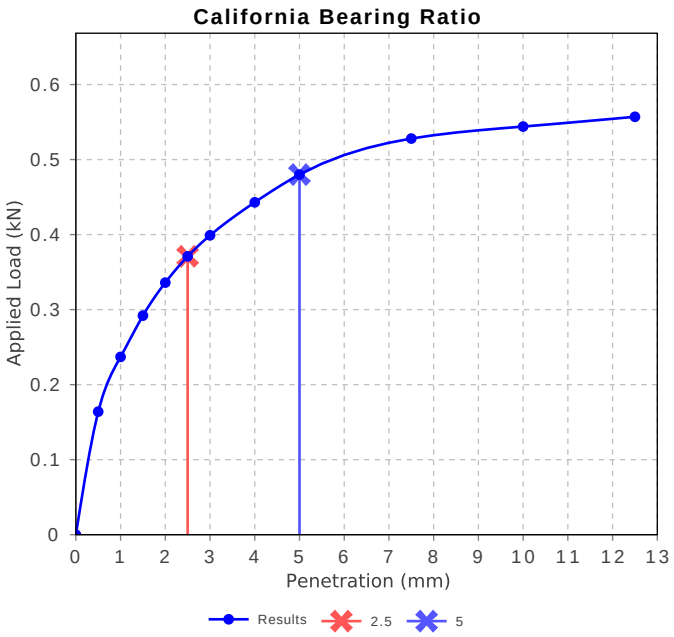
Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353K
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH11, Depth: 0.4-0.6m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**3.0**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.50		
Optimum Moisture Content (%)	24.5		
Laboratory Density Ratio (%)	95.0		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.37		
Field Moisture Content (%)	31.7		
Moisture Content at Placement (%)	24.8		
Moisture Content Top 30mm (%)	46.5		
Moisture Content Rest of Sample (%)	35.7		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.2		
Swell (%)	4.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



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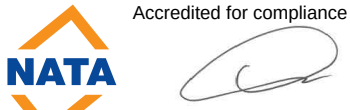
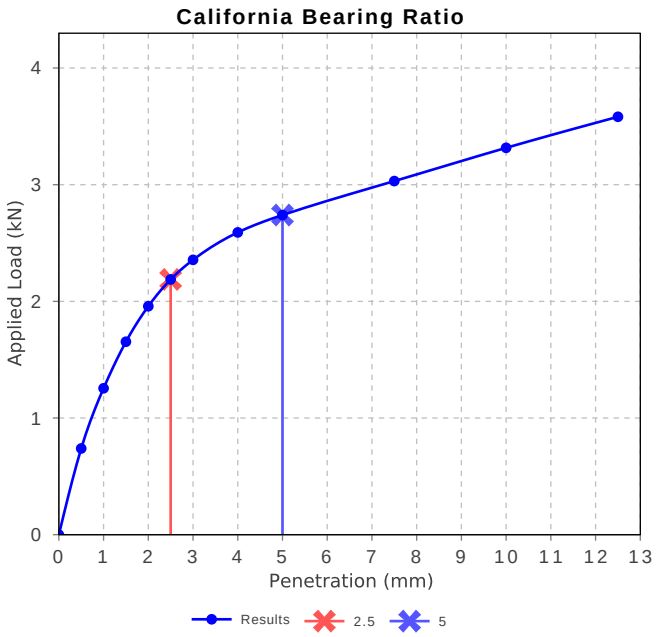


Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353L
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH12, Depth: 0.2-0.4m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**17**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.64		
Optimum Moisture Content (%)	23.0		
Laboratory Density Ratio (%)	95.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.56		
Field Moisture Content (%)	23.7		
Moisture Content at Placement (%)	23.0		
Moisture Content Top 30mm (%)	25.6		
Moisture Content Rest of Sample (%)	24.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.2		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	11.0		



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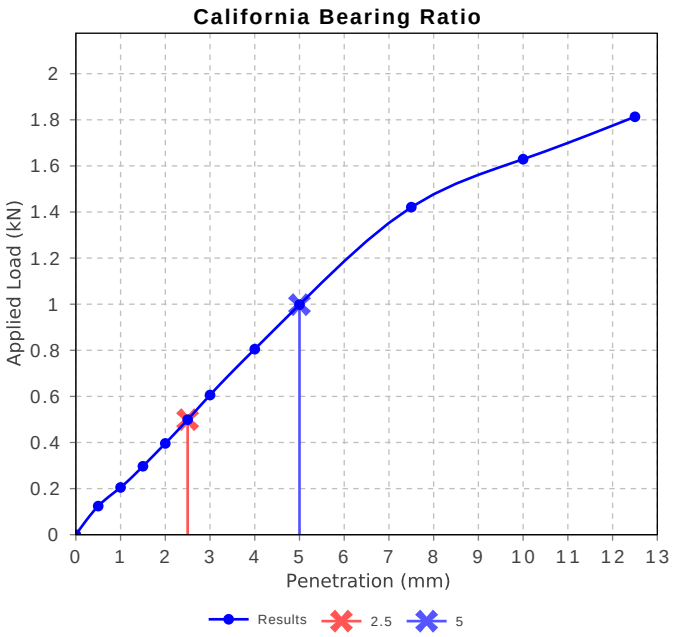
Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353M
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH13, Depth: 0.4-0.7m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**5**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.81		
Optimum Moisture Content (%)	11.0		
Laboratory Density Ratio (%)	95.5		
Laboratory Moisture Ratio (%)	102.0		
Dry Density after Soaking (t/m^3)	1.64		
Field Moisture Content (%)	16.4		
Moisture Content at Placement (%)	11.0		
Moisture Content Top 30mm (%)	22.5		
Moisture Content Rest of Sample (%)	17.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.5		
Swell (%)	5.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	4.7		



Material Test Report

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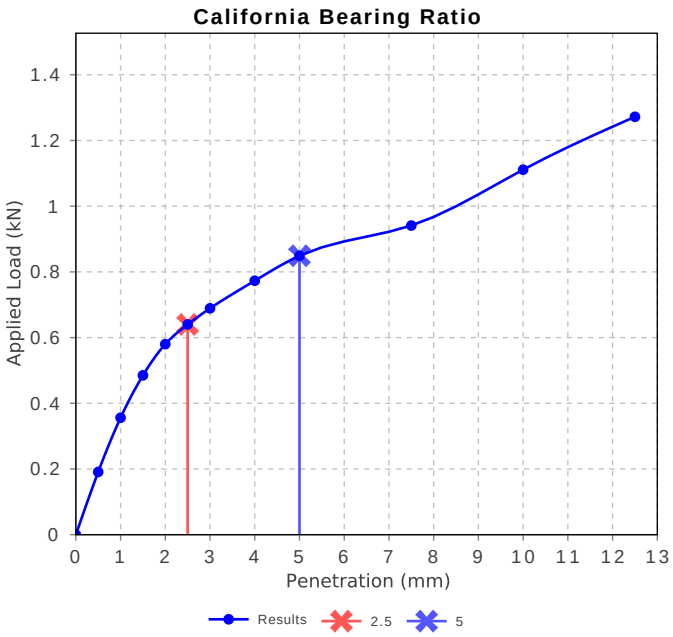
Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353N
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH14, Depth: 0.2-0.4m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5.0**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.52		
Optimum Moisture Content (%)	28.0		
Laboratory Density Ratio (%)	94.5		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.41		
Field Moisture Content (%)	33.3		
Moisture Content at Placement (%)	28.2		
Moisture Content Top 30mm (%)	40.6		
Moisture Content Rest of Sample (%)	29.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.2		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

J & A Geotech Testing Pty Ltd

Canberra Laboratory
Unit 2, 25 Dacre Street Mitchell ACT 2911
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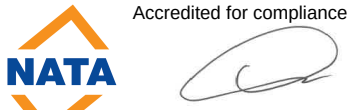
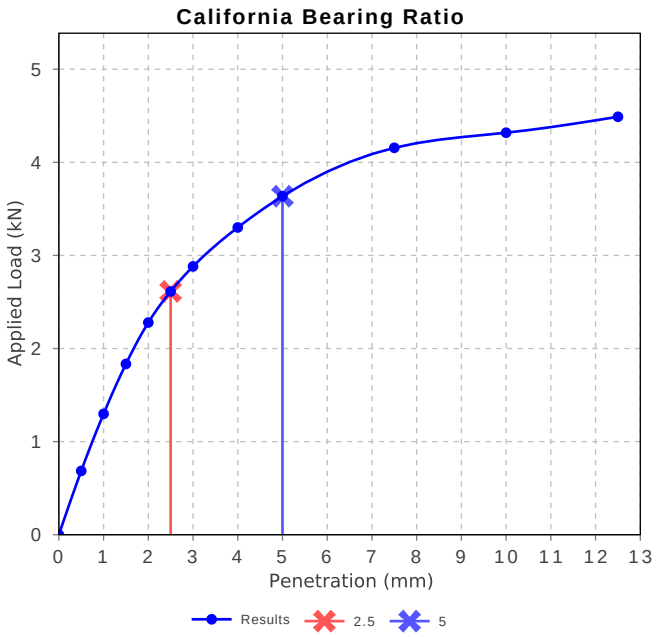
Accredited for compliance with ISO/IEC 17025 - Testing



Approved Signatory: Scott Miller
Lab Manager
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353O
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH15, Depth: 0.5-0.7m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**20**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.70		
Optimum Moisture Content (%)	18.5		
Laboratory Density Ratio (%)	94.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.60		
Field Moisture Content (%)	19.4		
Moisture Content at Placement (%)	18.4		
Moisture Content Top 30mm (%)	21.1		
Moisture Content Rest of Sample (%)	20.8		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	168.6		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1.8		



Material Test Report

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Approved Signatory: Scott Miller
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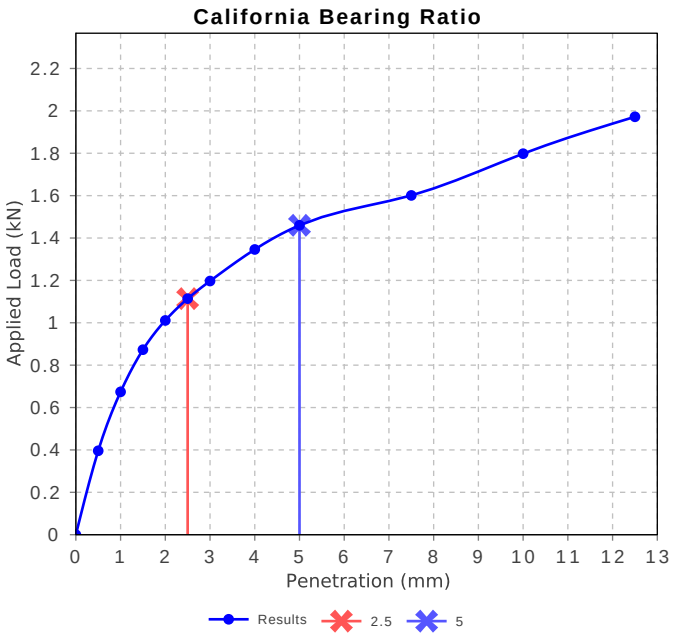
NATA Accredited Laboratory Number: 19979

Report Number: **CP221048-1**
Issue Number: 1
Date Issued: 21/06/2022
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP221048
Project Name: Proposed Housing Development
Project Location: Monaro Highway, Cooma NSW
Work Request: 5353
Sample Number: CS5353P
Date Sampled: 06/06/2022
Dates Tested: 06/06/2022 - 20/06/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH16, Depth: 0.3-0.5m**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**8**		
Method of Compactive Effort	Modified		
Method used to Determine MDD	AS 1289 5.2.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.61		
Optimum Moisture Content (%)	21.0		
Laboratory Density Ratio (%)	95.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.52		
Field Moisture Content (%)	27.9		
Moisture Content at Placement (%)	21.2		
Moisture Content Top 30mm (%)	33.7		
Moisture Content Rest of Sample (%)	25.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	167.9		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	2.6		



APPENDIX C
Definitions of Geotechnical Engineering Terms

DESCRIPTION AND CLASSIFICATION OF SOILS

The methods of description and classification of soils used in this report are based on the Australian Standard 1726 – 1993, Geotechnical site investigations. In general, descriptions cover the following properties – soil type, colour, secondary grain size, structure, inclusions, strength or density and geological description.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (e.g. sandy clay) on the following basis:

Classification	**Particle Size**
Clay	Less than 0.002mm
Silt	0.002mm to 0.06mm
Sand	0.06mm to 2.00mm
Gravel	2.00mm to 60.00mm
Cobbles	60mm (63mm) to 200mm
Boulders	>200mm

Soils are also classified according to the Unified Soil Classifications System which is included in this Appendix. Rock types are classified by their geological names.

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

Consistency	**Shear Strength su(kPa) (Representative Undrained Shear)**	
Very soft	< 12	<2 (~SPT "N")
Soft	12 - 25	2-4
Firm	25 - 50	4-8
Stiff	50 – 100	8-15
Very Stiff	100 – 200	15-30
Hard	> 200	>30

Non-cohesive soils are classified on the basis of relative density, generally from the results of in-situ standard penetration tests as below:

Term	**Relative Density (%)**	**SPT Blows/300mm 'N'**
Very loose	< 15	<4
Loose	15-35	4-10
Medium dense	35-65	10-30
Dense	65-85	30-50
Very Dense	>85	>50

SAMPLING

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

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

Undisturbed samples are generally taken by one of two methods:

1. Driving or pushing a thin walled sample tube into the soil and withdrawing with a sample of soil in a relatively undisturbed state.

2. Core drilling using a retractable inner tube (R.I.T.) core barrel.

Such samples yield information on structure and strength in additions to that obtained from disturbed samples and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

PENETRATION TESTING

The relative density of non-cohesive soils is generally assessed by in-situ penetration tests, the most common of which is the standard penetration test. The test procedure is described in Australian Standard 1289 “Testing Soils for Engineering Purposes” Testing Soils for Engineering Purposes” – Test No. F3.1.

The standard penetration test is carried out by driving a 50mm diameter split tube penetrometer of standard dimensions under the impact of a 63 kg hammer having a free fall of 750mm.

The “N” value is determined as the number of blows to achieve 300mm of penetration (generally after disregarding the first 150mm penetration through possibly disturbed material). The results of these tests can be related empirically to the engineering properties of the soil.

The test is also used to provide useful information in cohesive soils under certain conditions, a good quality disturbed sample being recovered with each test. Other forms of in situ testing are used under certain conditions and where this occurs, details are given in the report.

DEFINITIONS OF ROCK, SOIL, AND DEGREES OF CHEMICAL WEATHERING

GENERAL DEFINITIONS – ROCK AND SOIL

ROCK In engineering usage, rock is a natural aggregate of minerals connected by strong and permanent cohesive forces.

Note: Since "strong" and "permanent" are subject to different interpretations, the boundary between rock and soil is necessarily an arbitrary one.

SOIL In engineering usage, soil is a natural aggregate of mineral grains which can be separated by such gentle mechanical means as agitation in water, can be remoulded and can be classified according to the Unified Soil Classification System. Three principal classes of soil recognized are:

Residual soils: soils which have been formed in-situ by the chemical weathering of parent rock. Residual soil may retain evidence of the original rock texture or fabric or, when mature, the original rock texture may be destroyed.

Transported soils: soils which have been moved from their places of origin and deposited elsewhere. The principal agents of erosion, transport and deposition are water, wind and gravity. Two important types of transported soil in engineering geology and materials investigations are:

Colluvium – a soil, often including angular rock fragments and boulders, which has been transported downslope predominantly under the action of gravity assisted by water. The principle forming process is that of soil creep in which the soil moves after it has been weakened by saturation. It may be water borne for short distances.

Alluvium – a soil which has been transported and deposited by running water. The larger particles (sand and gravel size) are water worn.

Lateritic soils: soils which have formed in situ under the effects of tropical weathering include all reddish residual and non residual soils which genetically form a chain of material ranging from decomposed rock through clay to sesqui-oxide rich crusts. The term does not necessarily imply any compositional, textural or morphological definition; all distinctions useful for engineering purposes are based on the differences in geotechnical characteristics.

ROCK WEATHERING DEFINITIONS

Extremely Weathered (EW)	Rock substance affected by weathering to the extent that the rock exhibits soil properties, i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly Weathered (HW)	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of the chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately Weathered (MW)	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly Weathered (SW)	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance, usually by limonite, has taken place. The colour and texture of the fresh rock is recognisable.
Fresh (Fr)	Rock substance unaffected by weathering.

The degrees of rock weathering may be gradational. Intermediate stages are described by dual symbols with the prominent degree of weathering first (e.g. EW-HW).

The various degrees of weathering do not necessarily define strength parameters as some rocks are weak, even when fresh, to the extent that they can be broken by hand across the fabric, and some rocks may increase in strength during the weathering process.

Fresh drill cores of some rock types, such as basalt and shale may disintegrate after exposure to the atmosphere due to slaking, desiccation, expansion or contraction, stress relief or a combination of any of these factors.

AN ENGINEERING CLASSIFICATION OF SEDIMENTARY ROCKS

This classification system provides a standardised terminology for the engineering description of the sandstone and shales in the Sydney area, but the terms and definitions may be used elsewhere when applicable. Where other rock types are encountered, such as in dykes, standard geological descriptions are used for rock types and the same descriptions as below are used for strength, fracturing and weathering.

Under this system rocks are classified by Rock Type, Strength, Stratification Spacing, Degree of Fracturing and Degree of Weathering. These terms do not cover the full range of engineering properties. Descriptions of rock may also need to refer to other properties (e.g. durability, abrasiveness, etc) where these are relevant.

ROCK TYPE DEFINITIONS

ROCK TYPE	DEFINITION
Conglomerate:	More than 50% of the rock consists of gravel sized (greater than 2mm) fragments.
Sandstone:	More than 50% of the rock consists of sand sized (0.06 to 2mm) grains.
Siltstone:	More than 50% of the rock consists of silt-sized (less than 0.06mm) granular particles and the rock is not laminated.
Claystone:	More than 50% of the rock consists of silt or clay sized particles and the rock is not laminated.
Shale:	More than 50% of the rock consists of silt or clay sized particles and the rock is laminated.

Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, e.g. clayey sandstone, sandy shale.

STRATIFICATION SPACING

Term	Separation of Stratification Planes
Thinly Laminated	< 6mm
Laminated	6mm to 20mm
Very thinly bedded	20mm to 60mm
Thinly bedded	60mm to 0.2m
Medium bedded	0.2m to 0.6m
Thickly bedded	0.6m to 2m
Very thickly bedded	> 2m

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 known artificial fractures such as drilling breaks.

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

ROCK STRENGTH

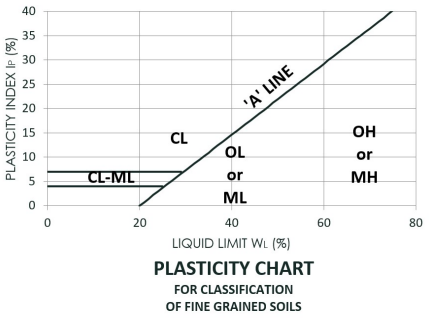
Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics.

Term	Point Load Index Is(50) MPa	Field Guide	Approx qu MPa*
Extremely Weak:	0.03	Easily remoulded by hand to a material with soil properties.	0.7
Very Weak:	0.1	May be crumbled in the hand. Sandstone is “sugary” and friable.	2.4
Weak:	0.3	A piece of core 150mm long x 50mm dia. May be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	7
Medium Strong:	1	A piece of core 150mm long x 50mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.	24
Strong: (SW)	3	A piece of core 150mm long x 50mm dia. core cannot be broken by unaided hands, can be slightly scratched or scored with knife.	70
Very Strong (SW)	10	A piece of core 150mm long x 50mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.	240
Extremely Strong (Fr)	>10	A piece of core 150mm long x 50mm dia. is difficult to break with hand held hammer. Rings when struck with a hammer.	>240

The approximate unconfined compressive strength (qu) shown in the table is based on an assumed ration to the point load index of 24:1. This ratio may vary widely.

Unified Soil Classification System (Metricated)
Data for Description Indentification and Classification of Soils

MAJOR DIVISIONS				DESCRIPTION				FIELD IDENTIFICATION					LABORATORY CLASSIFICATION				
				Group Symbol	Graphic Symbol	TYPICAL NAME	DESCRIPTIVE DATA						% [2] < 0.06mm	PLASTICITY OF FINE FRACTION			NOTES
COARSE GRAINED SOILS	More than 50% by dry mass, less than 60mm is greater than 0.06mm.	GRAVELS	More than 50% of coarse grains are greater than 2.0mm	GW		Well graded gravels and gravel-sand mixtures, little or no fines	Give typical name, indicate approximate percentages of sand and gravel, maximum size, angularity, surface condition and hardness of the coarse grains, local or geological name and other pertinent descriptive information, symbols in parenthesis. For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics. EXAMPLE: Silty Sand, gravelly, about 20% hard, angular gravel particles, 10mm maximum size, rounded and sub angular sand grains coarse to fine, about 15% non-plastic fines with low dry strength, well compacted and moist in place, light brown alluvial sand, (SM)	Determine approximate percentages of material over 60mm size, maximum size, shape, surface texture, hardness of material, geological description. Identify on estimated percentage mass of the various fractions.	COARSE GRAINED SOILS	More than half of the material less than 60mm is larger than 0.06mm	0.06mm is about the smallest particle visible to the naked eye	GRAVELS AND SANDS	GRADATIONS	NATURE OF FINES	DRY STRENGTH	Group Symbol	Use the gradation curve of material passing 60mm for classification of fractions according to criteria given under 'Major Division'.	0-5	-	>4	Between 1 and 3	1. Identify Fines by the method given for fine grained soils. 2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.06mm size) is greater than 5% and less than 12%. Borderline classifications require the use of dual symbols eg SP-SM GW-GC
				GP		Poorly graded gravels and gravel-sand mixtures, little or no fines						GOOD	Wide range in grain size	"Clean" materials (not enough fines to band coarse grains)	None	GW		0-5	-	Fails to comply with above		
		GRAVELLY SOILS		GM		Silty gravels, gravel-sand-silt mixtures						POOR	Predominantly one size or range of sizes			GP		12-50	Below 'A' line and Ip >7	-	-	
				GC		Clayey gravels gravel-sand-clay mixtures						GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are non-plastic (1)	None to medium	GM		12-50	Above 'A' line and Ip > 7	-	-	
		SANDS	More than 50% of coarse grains are greater than 2.0mm	SW		Well graded sands and gravelly sands, little or no fines								Fines are plastic (1)		GC		0-5	-	>6	between 1 and 3	
				SP		Poorly graded sands and gravelly sands, little or no fines						GOOD	Wide range in grain size	"Clean" materials (not enough fines to band coarse grains)	None	SW		0-5	-	Fails to comply with above		
		SANDY SOILS		SM		Silty sand, sand-silt mixtures						POOR	Predominantly one size or range of sizes			SP		12-50	Below 'A' line or Ip < 4	-	-	
				SC		Clayey sands, sand-clay mixtures						GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are non-plastic (1)	None to medium	SM		12-50	Above 'A' line and Ip > 7	-	-	
														Fines are plastic (1)		SC						
FINE GRAINED SOILS	More than 50% by dry mass, less than 60mm is less than 0.06mm	Liquid Limit less than 50%		ML		Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, colour in wet condition, odour if any, local or geological name and r pertinent descriptive information, symbols in parenthesis. For undisturbed soil add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions. EXAMPLE Clayey Silt, brown, low plasticity, small percentage of fine sand, numerous vertical root-holes, firm and dry in place, fill, (ML).		FINE GRAINED SOILS	More than half of the material less than 50mm is less than 0.06mm		SILT AND CLAY FRACTION									
				CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.						Fraction smaller than 0 20mm AS sieve size										
				OL		Organic silts and organic silty clays of low plasticity						DRY STRENGTH	DILATANCY	TOUGHNESS								
		Liquid Limit more than 50%		MH		Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.						None to low	Quick to slow	None		ML		Below 'A' line				
				CH		Inorganic clays of high plasticity, fat clays.						Medium to high	None to very slow	Medium		CL		Above 'A' line				
				OH		Organic clays of medium to high plasticity.						Low to medium	Slow	Low		OL		Below 'A' line				
												Low to medium	Slow to none	Low to medium		MH		Below 'A' line				
												High to very high	None	High		CH		Above 'A' line				
												Medium to high	None to very slow	Low to medium		OH		Below 'A' line				
				Pt		Peat muck and other highly organic soils.		Readily identified by colour, odour, spongy feel and generally by fibrous texture								Pt*	*Effervescence with H2O2					



PLASTICITY CHART
FOR CLASSIFICATION OF FINE GRAINED SOILS

ACT Geotechnical Engineers

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Limitations in the Use and Interpretation of this Geotechnical Report

Our Professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject development and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive borehole and test pit logs, cross- sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory bore holes, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory bore holes and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between conducting this investigation and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and the recommendations considering the changed conditions and time lapse.

The summary bore hole and test pit logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the test holes progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The bore hole and test pit logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. Soil conditions at the other locations may differ from conditions occurring at these bore hole and test pit locations. Also, the passage of time may result in a change in the soil conditions at these test locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, bore holes or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report: nor can our company be responsible for any construction activity on sites other than the specific site referred to in this report.