GROUND ENGINEERING DESIGN PTY LTD
Consulting Services

18 Sonter Street
Quakers Hill NSW 2763

T 02 9626 6830
M 0401 929 955
E dknotek@groundengineeringdesign.com.au
W www. groundengineeringdesign.com.au

ABN 29 163 931 762

Report
on
Geotechnical Investigation
Residential Subdivision Development
at
94 – 100 Explorers Way St Clair
Prepared for
Silky Property Group

Ref.No 250315DIV

April 2015

Table of Contents

1. Introduction

This report presents the results of Geotechnical Investigation for the residential subdivision development at 94-100 Explorers Way, St Claire. The Investigation was commissioned by Mr David Gerardis of Diversi Consulting on behalf of Silky Property Group and was carried out in accordance with Ground Engineering Design Pty Ltd proposal No. 250315DIV of 29th March 2015. Site layout plan including nominated test pit locations was provided by Diversi Consulting.

2. Investigation Procedure

The site field work included the excavation of a total of three test pits using extendable backhoe equipped with "tiger " teeth. The test pits were excavated at the locations determined by Diversi Consulting. The Excavation was terminated between the depths of 3.7m (TP1) and 4.2m (TP3). The field work was supervised by experienced Geotechnical Engineer who logged the pits, collected disturbed samples at regular depth intervals and carried out hand penetrometer tests to assess the strength of the encountered soil. Dynamic cone penetrometer (DCP) tests were carried out at the location of each test pit to the depth of 2.4m to determine the soil strength and correlate it with the results of hand penetrometer testing.

The locations of test pits are indicated on Figure 1 in Appendix 1. Summary of test pit engineering logs as well as the results of DCP testing are presented in Appendix 2.

3. Results of Site Investigation

3.1 Site Description

The site is of rectangular shape, measuring approximately 139m x 78m.

The Site is bound by Explorers Way to the South, by M4 Motorway to the North and by existing residential development and open spaces to the West and East. The site is sloping towards the north at an angle of approximately 2°.

North eastern corner of the site (100 Explorers Way) is occupied by a double storey residential dwelling. A single level timber board and a single level fibre board dwellings are located in the southern portion of the site. Large metallic gazebo with concrete slab is located north of the existing two storey dwelling at 100 Explorers Way. There are some old concrete slabs in the southern portion of the site. The majority of the site is covered with grass. There is a number of large grown trees located across the site.

There is an existing overland flow path traversing the site, conveying flows from Ashwick Circuit to the existing open space to the west of the site and to M4 Motorway land to the East and North.

3.2 Subsurface Conditions

The 1:100 000 geological sheet indicates the site to be underlain by Middle Triassic formation of the shale of Wianamatta Group, Bringelly subgroup.

The site was found to be underlain by a layer of topsoil – silty clay loan over layer of residual stiff to very stiff clay of high plasticity with lenses of iron indurated gravel, overlying very stiff to hard shaley clay. Layer of firm to stiff silty clay was encountered in test pit TP2, located approximately in the middle of the site. Highly weathered very weak siltstone/fine grained sandstone was encountered at the depth of 4.0 m in test pit TP3. A layer of fill was encountered in test pit TP3 at the location of an old dam which was backfilled during the civil engineering works for the adjacent subdivision.

The subsoil conditions are detailed in the summary of Test Pit Engineering Logs appended to this report and summarised in Table 1 below:-

Table 1 – Summary of Site Subsoil Conditions

Test Pit	Layer Depth (m)					
	Fill	Topsoil	Firm to Stiff Clay	Stiff to very Stiff Clay	Very Stiff to Hard Shaley Clay	Very Weak Siltstone/Fine Grained sandstone
TP1	-	0.0 - 0.3	-	0.3 - 2.5	2.5 - 3.7	-
TP2	-	0.0 - 0.2	0.9 – 1.5	0.2 - 0.9 1.5 -3.7	3.7 - 4.0	-
TP3	0.0 - 0.6	-	-	0.6 - 2.8	2.8 - 4.0	4.0 - 4.2

3.3 Ground Water conditions

All test pits were dry during and shortly after completion of excavation of test pits.

3.4 Laboratory Test Results

Selected samples extracted from the test pits were tested in NATA registered laboratory for field moisture content, Atterberg Limits, Linear Shrinkage, Emerson Class Number, California Bearing Ratio and aggresivity to steel and concrete. The detail laboratory test sheets are given in Appendix 3 and the results are summarized in tables 2 and 3 below.

Table 2 – Results of Mechanical Laboratory Tests

Test Pit No	Depth (m)	Material	W_f (%)	W_L (%)	W_P (%)	PI (%)	LS (%)	CBR (%)	Emerson Class Number
TP1	0.3 - 1.1	Silty Clay	14.2	58	13	45	13	1.5	1.0
	2.5 - 3	Shaley clay	17.5						
TP2	0.2 - 0.6	Silty Clay	23.2					4.0	
	0.6 - 1.0	Silty Clay	26.8	59	17	42	13.5		1.0
	3.0 - 3.3	Shaley clay	21.2						
TP3	0.8	Silty clay	11	53	17	36	11.5	-	-
	3.1	Shaley Clay	21.1						
	4.1	Weathered Siltstone/Fine Grained Sandtone	12						

W_f = Filed Moisture Content

W_L = Liquid Limit

W_P = Plastic Limit

PI – Plasticity Index

LS = Linear Shrinkage

CBR = California Bearing Ratio

The result of Atterberg Limits and Linear Shrinkage Tests indicate clays to be of high plasticity and moderate soil reactivity.

The result of Emerson Class Number Tests indicate the soils are of very high dispersivity – instability of soil in contact with water due to the presence of exchangeable sodium between clay platelets.

Table 3 – Results of Chemical Laboratory Tests

Test Pit No	Depth (m)	Material	PH	CL mg/kg	S04 mg/kg
TP1	0.3-1.1	Silty Clay	5.2	< 10	680
PT2	0.6-1.0	Silty Clay	5.1	220	630

CL = Chloride Concentration

SO_4 – Sulphate Concentration

The above results indicate that the site soils are mildly aggressive to concrete and non-aggressive to steel (see AS 2159 – 2009 Piling – Design and Installation)

4. Proposed Development

The property is to be subdivided into 14 Lots, the road accessing the site from Explorers Way will be located approximately in the middle of the subdivision. The lots will include 1 lot allocated to an existing dwelling (100 Explorers Way), 11 standard residential lots and 2 battle-axe lots. The site will be developed by cut and fill operation, an existing overland flow path will be backfilled, flows from Ashwick Circuit will be diverted into storm water pipe drain to be constructed across the site.

We would expect that single and two level brick veneer dwellings will be constructed on the individual lots of the subdivision.

5. Conclusions and Recommendations

5.1 Earthworks

Earthworks should be carried out as per the recommendations detailed below:-

- Strip the existing vegetation

- Strip the existing topsoil and stockpile it for further use in landscaping or remove it from the site.

- Carry out stripping inspection and proof roll the exposed subgrade surface, using smooth drum roller of minimum 10 tons dead weight. The proof rolling is to be carried out under the direction of Geotechnical Engineer. If soft, weak or otherwise unsuitable soil is detected during the testing (heaving occurs) remove it and replace with an approved granular material, compacted to minimum 95% Standard Maximum Dry Density (SMDD).

- Where structural fill is required to elevate the site to design level, place approved material in near horizontal layers of maximum 250mm loose thickness and compact each layer to minimum 98% and maximum 102% SMDD at -1% to +2% of optimum moisture content (OC)

- Compaction testing of the fill should be carried out by NATA registered laboratory and monitored by geotechnical consultant. Testing frequency and level of supervision should be carried out in accordance with the requirements of AS3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments".

- The site clay is considered suitable for re-use as structural fill provided that the above compaction and moisture content limits are adhered to. Pad foot or sheep foot roller should be used in the filling operation to ensure that the required level of compaction is achieved. Since there is a high risk of significant surface erosion due to the very high dispersivity of the site soils, it is recommended that the unpaved surfaces be grassed or other erosion control measures be applied as soon as possible after completion of the filling operation.

- Any imported material to be used as structural fill should to be free of any foreign inclusions, e.g. building waste, organic matter, or any other unsuitable material. The fill should be well graded with maximum particle size not exceeding 75mm. The imported fill should be tested prior to delivery to the site to ensure the suitability for the subject fill application.

- The fill material encountered in test pit TP3 and potentially between test pit locations would be classified as "uncontrolled" fill and would not be suitable to support structures such as building foundations, house slabs and pavements.

- If highly dispersive site clay is used for backfilling of the service trenches, it should be mixed with lime or gypsum to reduce the risk of tunnel erosion alongside the buried service. Alternatively non dispersive soils should be imported for the trench backfill.

- Surface drainage should be maintained during earthworks by maintaining appropriate cross-falls within the site. Surface drainage should be installed to capture and remove surface flows to prevent erosion and softening of the exposed soils. Drying of natural clays or engineered fill during construction should be avoided by regular site watering.

- The excavation of the existing site fill and of natural clay should be readily achieved by using conventional earth moving equipment.

- Maximum temporary fill and excavated batters should not exceed the limits detailed in table 4 below:-

Table 4 – Batter Slope Limits

Material	Maximum Batter Slope	
	Temporary	Permanent
Compacted Fill	1 : 1.15	1 : 2.5
Stiff to Hard Residual Clay	1:1	1:2

- In order to minimize the erosion of the batter surfaces, appropriate erosion protection should be applied as soon as possible after construction of batters (planting of suitable species of vegetation)

5.2 Foundations

5.2.1 Site Classification and Footing Types

Lot classification should be carried out after completion of site preparation works. In view of the results of a total of three sets of Atterberg Limit Tests and Linear Shrinkage Tests (see clause 3.4) and subject to the earthwork preparation method as discussed in clause 5.1, shallow footings comprising raft slabs, waffle slabs or strip and pad footing may be adopted for the proposed residential dwellings. We would expect that the footings may be sized to comply with the requirements for medium to highly reactive sites as per AS2870-2011 - "Residential Slabs and Footings".

Where uncontrolled fill of thickness greater than 0.5 m is encountered (northern part of the site - backfilled dam or potentially other locations) classification "P" would be appropriate and dwellings should be founded on the natural soils underlying the fill. Bored piers, excavated piers, screw piles or blade piles are recommended for such an application.

A layer of firm clay was encountered in TP_2 at the depth between 0.9m and 1.5m below the existing surface. We recommend that the dwellings located within this area be founded on pier/pile foundations and the foundation load be transferred into the stiff to very stiff clay underlying the firm strata.

5.2.2 Foundation Design Parameters

Allowable bearing pressures for various types of soils and footings are detailed in table number 5 below:-

Table 5 – Allowable Design Bearing Pressures

Type of Footing	Soil Type				
	Firm to Stiff Clay (kPa)	Stiff Clay (kPa)	Very Stiff Clay (kPa)	Very Stiff to Hard Shaley Clay (kPa)	Very Weak Siltstone/Fine Grained Sanstone (kPa)
High Level Footings	75	100	150	-	-
Bored/Excavated Piers Screw Piles Blade Piles	-	200	250	350	700

Modules of subgrade reactions k = 15.0 MPa/m can be considered for the design of slabs founded on stiff/very stiff clay subgrade.

Exposed foundations should be inspected by geotechnical engineer to assess the strength of the foundation soil and to confirm the bearing pressure adopted in the footing design.

5.3 Pavements

Based on the results of the laboratory testing, the pavement should be designed for CBR value of 1.5%. Confirmation of CBR value should be carried out after exposing to subgrade level.

- Pavement subgrade should be proof rolled with smooth drum roller of minimum dead weight of 10 tons and compacted to minimum 100% and maximum 102% of SMDD within the top 300mm below the subgrade surface.

- Road base and sub base material should be compacted to not less than 98% of Modified Maximum Dry Density (MMDD)

- The following pavement material should be used for the pavement construction:

    - Wearing course AC(10), binder class 170 – typically 40mm thick.
    - Base course D6B 20 – typically 100mm thick
    - Sub-base course DGS 40 or recycled DGS 40 or crushed sandstone minimum CBR value of 35%.

- In order to improve the pavement subgrade conditions and to reduce the thickness of the pavement, the top 300mm surface layer may be lime stabilised. This would reduce shrink/swell and dispersion potential of the subgrade soil and would result in a thinner pavement.

5.4 Retaining Structures

Both cut and fill should be either battered or retained. The parameters to be adopted in the design of retaining structures are detailed in table 6 below:-

Table 6 – Parameters for Design of Retaining Walls

Material	K_0	K_a	K_p	Bulk Density KN/m^3
Compacted Fill	0.6	0.4	2	19
Residual Clay	0.5	0.35	2.5	20

- γ = soil density (kN/m^3)
- k_a = coefficient of active earth pressure
- k_0 = coefficient of earth pressure at rest
- k_p = coefficient of passive earth pressure

Permanent drains should be installed behind the rear face of retaining wall or hydrostatic ground water pressure should be considered in the design. Surcharge due to adjacent structures, batters and vehicle live loads should be included in the design.

Cantilever retaining structures or walls being propped at one level only should be designed for the following triangular distribution of earth pressure.

$P = \gamma hk + pk$

Where:

- $K = k_a$ for flexible structures
- $K = k_0$ for rigid structures
- p = design surcharge pressure (kp_a)

Structures propped at several levels should be designed for trapezoidal distribution of earth pressure as detailed in table 7 below.

Table 7 – Trapezoidal Earth Pressure Distribution

Depth (m)	Earth Pressure (kPa)
O	K x p
0.25H	K (0.8ɣH +p)
0.75H	K (0.8ɣH+P)
1	K x P

H = Depth of retention

5.5 Site Maintenance and Drainage

The developed site should be maintained as per recommendations of CSIRO publication "Foundation Maintenance and Footing Performance, A Home Owners Guide", which details site maintenance practices to minimize foundation movement to keep cracking within acceptable limits.

Subsurface drainage should be installed and maintained to minimize over land flow. All collected storm water, ground water and roof run off should be discharged into the storm water disposal system.

6.0 Limitations

This report has been prepared for Silky Property Group. It remains the property of Ground Engineering Design Pty Ltd (GED) subject to payment of all fees due to assessment.

This report can be reproduced in full and with prior permission of GED. It must be read in conjunction with all attachments without separation of individual pages or sections.

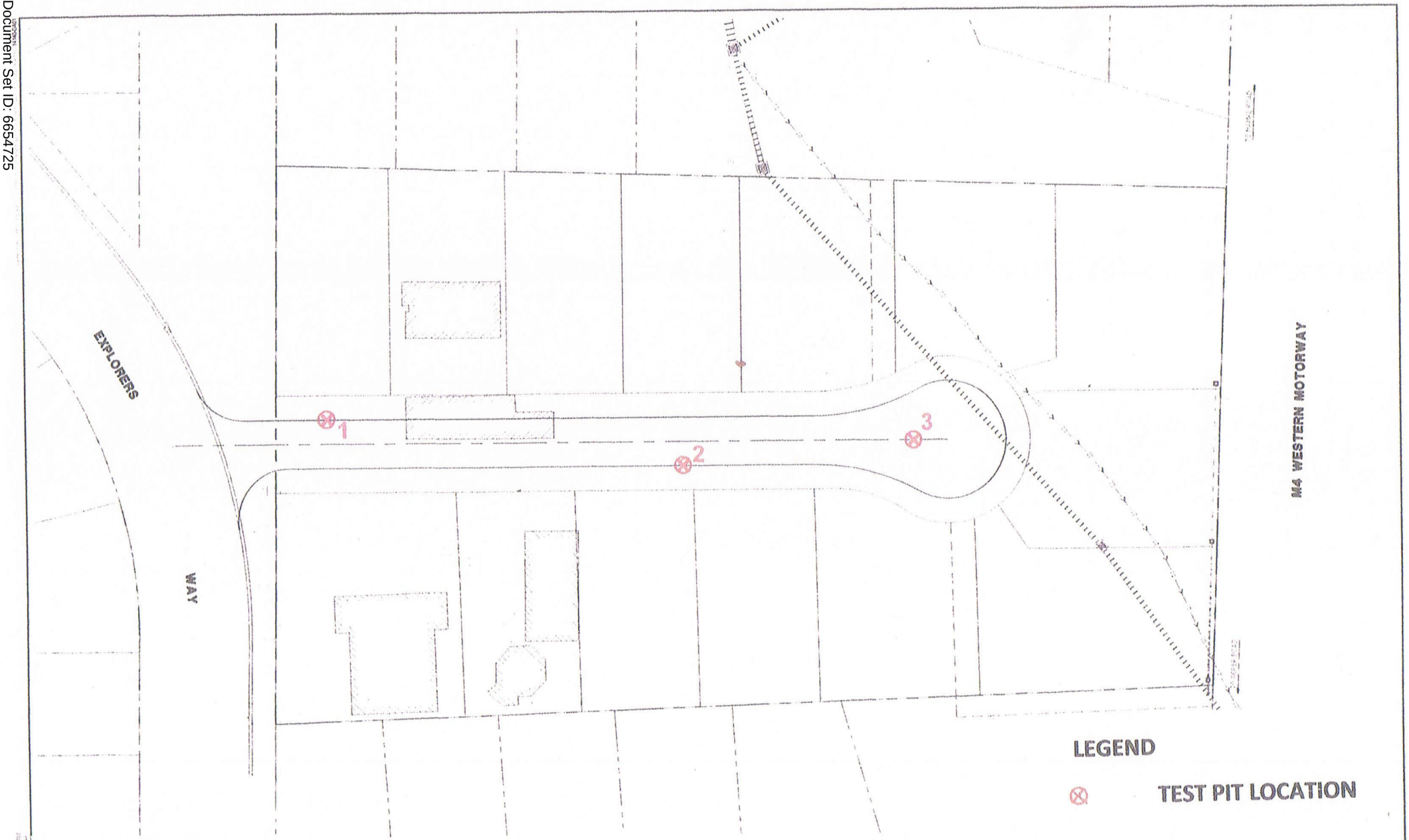
The information provided in this report is indicative of the subsurface conditions on the site only at the specific test location and to the depths investigated at the time of the work was carried out. Subsurface conditions may change due to variability of geological processes or as a result of human activities.

If you have any queries regarding this report please do not hesitate to contact the undersigned.

Daniel Knotek | Director
Ground Engineering Design Pty Ltd

Appendix A

Figure 1 – Test Pit Location Plan



Ground Engineering Design Pty Ltd

18 Sonter Street Quakers Hill NSW

T:(02)9626 6830 M:0401 929 955

E:dknotek@groundengineeringdesign.com.au

Client: Silky Property Group

Proposed Residential Subdivision

94-100 Explorers Way St Clair

Ref.No 230315DIV

Figure 1

Location of Test Pits

Appendix B

Summary of Test Pit Engineering Logs and Dynamic Cone Penetration Test Results

Table A – Summary of Test Pit Engineering Logs

Client: Silky Property Group **Job No. 250315 DIV**

Project: Proposed Residential Subdivision

At: 94-100 Explorers Way St Clair NSW **Date: 15th April 2015**

Test Pit No	RL (m)	Depth (m)		Soil/Rock Description	Hand Penetrometer Reading (kPa)
		From	To		
1	56.23	0.0	0.3	Topsoil: Silty load brown, moist	
		0.3	1.1	Silty clay, high plasticity, red brown with some grey, St-Vst, Mc<PL	250 250 400
		1.1	2.5	Silty clay, medium to high plasticity, grey brown with some red brown, Vst-H Mc<P Contains ironstone gravel	400 400 >400
		2.5	3.7	Shaley clay, high plasticity, pale grey, Vst-H, Mc<PL Contains lenses of iron induration	400 450 450
2	55.01	0.0	0.2	Topsoil: Silty loam brown,	
		0.2	0.6	Silty clay, high plasticity, brown and red brown, St, Mc>PL	200 250
		0.6	1.0	Silty clay, high plasticity, brown with some grey, stiff, Mc>PL	110 150 150
		1.0	2.2	Clay, high plasticity, light grey with yellow brown F St, Mc>PL	100 110 120
		2.2	3.7	As above, but Vst-H, Mc<PL contains ironstone from 2.8m	220 250 350 400
		3.7	4.0	Shaley clay, medium to high plasticity, pale grey, contains ironindurated lenses, H, Mc<PL	>400 >400

Test Pit No	RL (m)	Depth (m)		Soil/Rock Description	Hand Penetrometer Read (kPa)
3	54.05	0.0	0.6	Fill: Silty clay/loam, dark brown, moist, contains steel plate, aluminium can	
		0.6	1.5	Silty clay, high plasticity, brown red and grey, Vst-H Mc<PL	>400 >400
		1.5	2.8	Clay, high plasticity, pale grey with yellow brown, iron induration at 2.2m, Vst Mc≤Pl	250 250 250
		2.8	3.0	Shaley clay, high plasticity, pale grey, contains ironstone lenses, H, Mc<P	>400 >400
		3.0	4.0	As above but Vst, Mc>PL	250 300 300
		4.0	4.2	Siltstone/Fine grained sandstone, brown, highly weathered, very weak	

Table B – Results of Dynamic Cone Penetrometer (DCP) Tests

Depth (m)		DCP Test Number		
From	To	1	2	3
0.0	0.1	7	1	3
0.1	0.2	4	3	4
0.2	0.3	4	2	8
0.3	0.4	2	4	9
0.4	0.5	2	4	6
0.5	0.6	2	4	6
0.6	0.7	4	5	6
0.7	0.8	4	5	6
0.8	0.9	4	4	11
0.9	1.0	6	2	12
1.0	1.1	8	2	11
1.1	1.2	12	2	14
1.2	1.3	14	2	14
1.3	1.4	10	2	8
1.4	1.5	19	2	7
1.5	1.6	16	3	10
1.6	1.7	18	4	11
1.7	1.8	14	3	8
1.8	1.9	13	4	10
1.9	2.0	17	3	8
2.0	2.1	14	12	6
2.1	2.2	18	11	7
2.2	2.3	15	9	10
2.3	2.4		11	
2.4	2.5			

Appendix C

Laboratory Test Results

Determination of Moisture Content of a Soil

Client:	Ground Engineering Design Pty Ltd	Job No: 1829
Project:	94-100 Explorers Way	Report Date: 23/04/2015
Project Location:	St Clair	Report Number: 1829-ST-4-1
Test Methods:	AS 1289.2.1.1	

Laboratory Number:	2448	2448	2448	2448
Sample Location:	TP1 2.5m-3.0m	TP2 3.0m-3.3m	TP3 3.1m	TP3 4.1m
Sampled By:	Client	Client	Client	Client
Date Sampled:	15-Apr-15	15-Apr-15	15-Apr-15	15-Apr-15
Material Description:	Shaley CLAY: pale grey	Shaley CLAY: light grey / yellow brown	Shaley CLAY: pale grey	Siltstone: brown
Moisture Content (%):	17.5	21.2	21.1	12.0

Laboratory Number:				
Sample Location:				
Sampled By:				
Date Sampled:				
Material Description:				
Moisture Content (%):				

Notes:

Alliance Geotechnical Pty Ltd | NATA Accreditation: 15100
Website: www.allgeo.com.au | Email: office@allgeo.com.au
Mobile: 0400 545 805 | Office Phone: (02) 9623 1588
Office Fax: (02) 9623 2688 | PO Box 1028 St Marys NSW 1790

Alliance Geotechnical
ENGINEERING | ENVIRONMENTAL | TESTING
Your On-Site Geotechnical & Environmental Specialists

Manage the earth, eliminate the risk
Phone Us Today – 9675 1777

PO Box 1028 St Marys NSW 1790 Ph: (02) 9675 1777 Fax: (02) 9675 1888 Email: office@allgeo.com.au Web: www.allgeo.com.au

Plasticity Index Test Report

Client Name:	Ground Engineering Design Pty Ltd	Project Number:	1829
Client Address:	18 Sonter Street, Quakers Hill NSW 2763	Report Number:	1829-ST-2-1
Project Name:	94-100 Explorers Way	Report Date:	23/04/2015
Project Location:	St Clair	Page Number:	1 of 1
Test Methods:	AS1289 ☒ 1.1 ☒ 2.1.1 ☒ 3.1.1 ☐ 3.1.2 ☒ 3.2.1 ☒ 3.3.1 ☒ 3.4.1		

Laboratory Number:	2448
Sample Identification:	TP1 0.3 – 1.1m
Date Sampled:	15/04/2015
Sampled By:	Client
Material Description:	Silty CLAY: red brown, some grey
Preparation Method:	Dry Sieved
Sample History:	Oven Dried
Shrinkage Mould Length (mm):	250

Linear Shrinkage Observations:	Curling

Sample Moisture Content (%)	**14.2**
Liquid Limit (%)	**58**
Plastic Limit (%)	**13**
Linear Shrinkage (%)	**13.0**
Plastic Index (%)	**45**

Comments:	

We give you the right information to make the right decisions

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Accredited for compliance with ISO/IEC 17025

Approved Signatory: Simon Thomas

Alliance Geotechnical Pty Ltd | NATA Accreditation: 15100
Website: www.allgeo.com.au | Email: office@allgeo.com.au
Mobile: 0407 551 455 | Office Phone: (02) 9675 1777
Office Fax: (02) 9675 1888 | PO Box 1028 St Marys NSW 1790

Alliance Geotechnical
ENGINEERING | ENVIRONMENTAL | TESTING
Your On-Site Geotechnical & Environmental Specialists

Manage the earth, eliminate the risk
Phone Us Today – 9675 1777

PO Box 1028 St Marys NSW 1790 Ph: (02) 9675 1777 Fax: (02) 9675 1888 Email: office@allgeo.com.au Web: www.allgeo.com.au

Plasticity Index Test Report

Client Name:	Ground Engineering Design Pty Ltd	Project Number:	1829
Client Address:	18 Sonter Street, Quakers Hill NSW 2763	Report Number:	1829-ST-2-2
Project Name:	94-100 Explorers Way	Report Date:	23/04/2015
Project Location:	St Clair	Page Number:	1 of 1
Test Methods:	AS1289 ☒ 1.1 ☒ 2.1.1 ☒ 3.1.1 ☐ 3.1.2 ☒ 3.2.1 ☒ 3.3.1 ☒ 3.4.1		

Laboratory Number:	2448
Sample Identification:	TP2 0.6 – 1.0m
Date Sampled:	15/04/2015
Sampled By:	Client
Material Description:	Silty CLAY: brown mottled with some grey
Preparation Method:	Dry Sieved
Sample History:	Oven Dried
Shrinkage Mould Length (mm):	250

Linear Shrinkage Observations:	Curling

Sample Moisture Content (%)	**26.8**
Liquid Limit (%)	**59**
Plastic Limit (%)	**17**
Linear Shrinkage (%)	**13.5**
Plastic Index (%)	**42**

Comments:	

We give you the right information to make the right decisions

NATA
TECHNICAL COMPETENCE

Accredited for compliance with ISO/IEC 17025

Approved Signatory: Simon Thomas

Alliance Geotechnical Pty Ltd | NATA Accreditation: 15100
Website: www.allgeo.com.au | Email: office@allgeo.com.au
Mobile: 0407 551 455 | Office Phone: (02) 9675 1777
Office Fax: (02) 9675 1888 | PO Box 1028 St Marys NSW 1790

Alliance Geotechnical
ENGINEERING | ENVIRONMENTAL | TESTING
Your On-Site Geotechnical & Environmental Specialists

Manage the earth, eliminate the risk
Phone Us Today – 9675 1777

PO Box 1028 St Marys NSW 1790 Ph: (02) 9675 1777 Fax: (02) 9675 1888 Email: office@allgeo.com.au Web: www.allgeo.com.au

Plasticity Index Test Report

Client Name:	Ground Engineering Design Pty Ltd	Project Number:	1829
Client Address:	18 Sonter Street, Quakers Hill NSW 2763	Report Number:	1829-ST-2-3
Project Name:	94-100 Explorers Way	Report Date:	23/04/2015
Project Location:	St Clair	Page Number:	1 of 1
Test Methods:	AS1289 ☒ 1.1 ☒ 2.1.1 ☒ 3.1.1 ☐ 3.1.2 ☒ 3.2.1 ☒ 3.3.1 ☒ 3.4.1		

Sample Number:	2448
Sample Identification:	TP3 0.8m
Date Sampled:	15/04/2015
Sampled By:	Client
Material Description:	Silty CLAY: brown red and grey
Preparation Method:	Dry Sieved
Sample History:	Oven Dried
Shrinkage Mould Length (mm):	250

Linear Shrinkage Observations:	Curling

Sample Moisture Content (%)	**11.1**
Liquid Limit (%)	**53**
Plastic Limit (%)	**17**
Linear Shrinkage (%)	**11.5**
Plastic Index (%)	**36**

Comments:	

We give you the right information to make the right decisions

NATA
TECHNICAL COMPETENCE

Accredited for compliance with ISO/IEC 17025

Approved Signatory: Simon Thomas

Alliance Geotechnical Pty Ltd | NATA Accreditation: 15100
Website: www.allgeo.com.au | Email: office@allgeo.com.au
Mobile: 0407 551 455 | Office Phone: (02) 9675 1777
Office Fax: (02) 9675 1888 | PO Box 1028 St Marys NSW 1790

Determination of Emerson Class Number of a Soil

Client:	Ground Engineering Design Pty Ltd	Job No: 1829
Project:	94-100 Explorers Way	Report Date: 23/04/2015
Project Location:	St Clair	Report Number: 1829-ST-3-1
Test Methods:	AS1141.3.8.1	

Laboratory Number:	2448
Sample Location:	St Clair
Sampled By:	Client
Source of Material:	TP1 0.3 – 1.1m
Date Sampled:	15/04/2015
Material Description:	Silty CLAY: red brown, some grey
Water Type Used:	Distilled
Water Temperature:	21°C

Emerson Class Number:	**1**

Notes:

NATA
WORLD RECOGNISED
ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory: Simon Thomas

Alliance Geotechnical Pty Ltd | NATA Accreditation: 15100
Website: www.allgeo.com.au | Email: office@allgeo.com.au
Mobile: 0400 545 805 | Office Phone: (02) 9623 1588
Office Fax: (02) 9623 2688 | PO Box 1028 St Marys NSW 1790

Determination of Emerson Class Number of a Soil

Client:	Ground Engineering Design Pty Ltd	Job No: 1829
Project:	94-100 Explorers Way	Report Date: 23/04/2015
Project Location:	St Clair	Report Number: 1829-ST-3-2
Test Methods:	AS1141.3.8.1	

Sample Number:	2448
Sample Location:	St Clair
Sampled By:	Client
Source of Material:	TP2 0.6 – 1.0m
Date Sampled:	15/04/2015
Material Description:	Silty CLAY: brown mottled with some grey
Water Type Used:	Distilled
Water Temperature:	21°C

Emerson Class Number:	**1**

Notes:

Alliance Geotechnical Pty Ltd | NATA Accreditation: 15100
Website: www.allgeo.com.au | Email: office@allgeo.com.au
Mobile: 0400 545 805 | Office Phone: (02) 9623 1588
Office Fax: (02) 9623 2688 | PO Box 1028 St Marys NSW 1790

Alliance Geotechnical Pty Ltd
ENGINEERING | ENVIRONMENTAL | TESTING

We give you the right information to make the right decisions

PO Box 1028 St Marys NSW 1790 Ph: (02) 9675 1777 Fax: (02) 9675 1888 Website: www.allgeo.com.au

CALIFORNIA BEARING RATIO (CBR) TEST REPORT

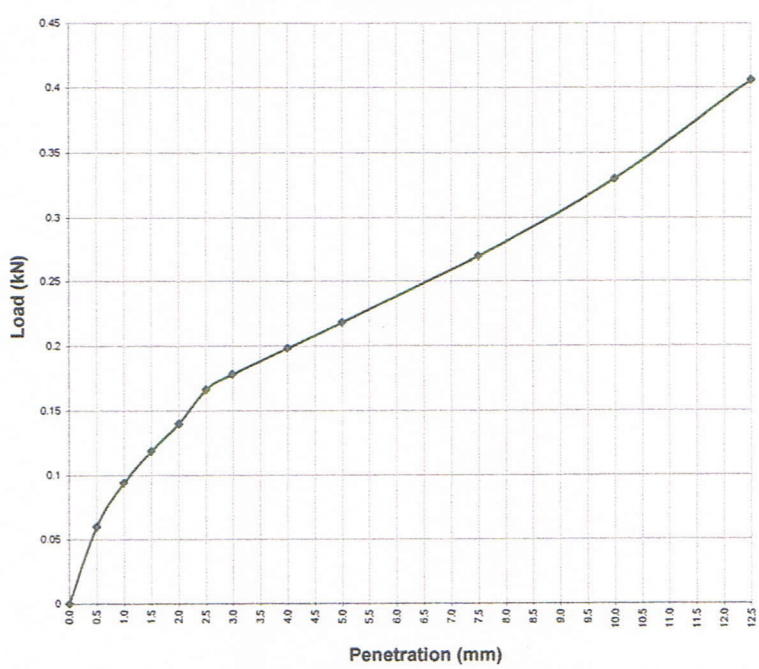
Client Name:	Ground Engineering Design Pty Ltd	Job Number:	1829
Client Address:	18 Sonter Street, Quakers Hill NSW 2763		
Project Name:	94-100 Explorers Way	Report Number:	1829-ST-1-2
Project Location:	St Clair	Date Reported:	27-Apr-15
Sample Location:	TP1 Depth 0.3m to 1.1m	Date Sampled:	15-Apr-15
Sample Description:	Silty CLAY: red brown, some grey	Lab Number:	2448
Test Methods:	AS 1289 6.1.1, 2.1.1, 5.1.1	Date Tested:	25-Apr-13

Maximum Dry Density (t/m³)	1.8	Optimum Moisture (%)	17.0	Field Moisture (%)	14.2

Before Soak			
Dry Density at Moulding (t/m³)	1.76	Moisture Content at Moulding (%)	16.6
Laboratory Density Ratio (%)	98	Laboratory Moisture Ratio (%)	98
Mass Retained on 19.0mm Sieve (%)	0.0	Surcharge (kg)	4.5
Excluded from Test	N/A	Days Soaked	4

After Soak			
Top 30mm - Moisture Content (%)	26.0	Dry Density after Soaking (t/m³)	1.70
Remainder - Moisture Content (%)	17.5	Swell (%)	3.6

CBR GRAPH



CBR Value
(%)
1.5
Penetration (mm)
2.5

Alliance Geotechnical Pty Ltd
Approved Signatory: Simon Thomas
Office Phone: (02) 9675 1777 | Email: office@allgeo.com.au
Office Fax: (02) 9675 1888 | PO Box 1028 St Marys NSW 1790

Alliance Geotechnical Pty Ltd
ENGINEERING | ENVIRONMENTAL | TESTING

We give you the right information to make the right decisions

PO Box 1028 St Marys NSW 1790 Ph: (02) 9675 1777 Fax: (02) 9675 1888 Website: www.allgeo.com.au

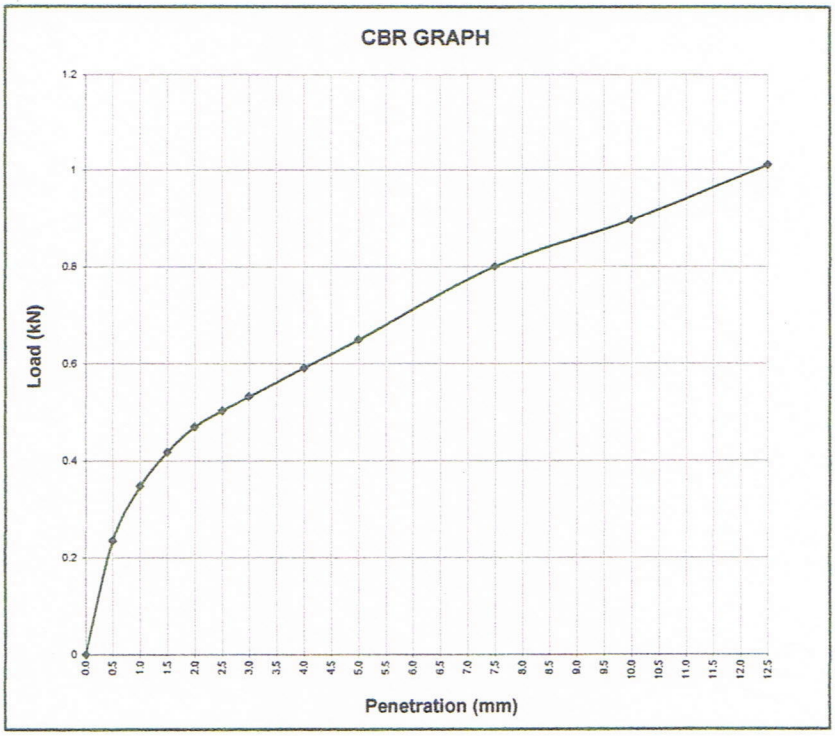
CALIFORNIA BEARING RATIO (CBR) TEST REPORT

Client Name:	Ground Engineering Design Pty Ltd	Job Number:	1829
Client Address:	18 Sonter Street, Quakers Hill NSW 2763		
Project Name:	94-100 Explorers Way	Report Number:	1829-ST-1-1
Project Location:	St Clair	Date Reported:	27-Apr-15
Sample Location:	TP2 Depth 0.2m to 0.6m	Date Sampled:	15-Apr-15
Sample Description:	Silty CLAY: brown/red brown	Lab Number:	2448
Test Methods:	AS 1289 6.1.1, 2.1.1, 5.1.1	Date Tested:	25-Apr-13

Maximum Dry Density (t/m³)	1.72	Optimum Moisture (%)	19.5	Field Moisture (%)	23.2

Before Soak			
Dry Density at Moulding (t/m³)	1.72	Moisture Content at Moulding (%)	20.1
Laboratory Density Ratio (%)	100	Laboratory Moisture Ratio (%)	103
Mass Retained on 19.0mm Sieve (%)	0.0	Surcharge (kg)	4.5
Excluded from Test	N/A	Days Soaked	4

After Soak			
Top 30mm - Moisture Content (%)	23.7	Dry Density after Soaking (t/m³)	1.69
Remainder - Moisture Content (%)	21.1	Swell (%)	1.9



CBR Value
(%)
4.0
Penetration (mm)
2.5

Alliance Geotechnical Pty Ltd
Approved Signatory: Simon Thomas
Office Phone: (02) 9675 1777 | Email: office@allgeo.com.au
Office Fax: (02) 9675 1888 | PO Box 1028 St Marys NSW 1790

eurofins | mgt

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Alliance Geotechnical
3/155 Glendenning Road
Glendenning
NSW 2761

Attention: **Michael Dunesky**

Report **454314-S**
Project name ST CLAIR
Received Date Apr 16, 2015

Client Sample ID			**TP1-0.3-1.1**	**TP2-0.6-1.0**
Sample Matrix			**Soil**	**Soil**
Eurofins | mgt Sample No.			**S15-Ap12366**	**S15-Ap12367**
Date Sampled			**Apr 16, 2015**	**Apr 16, 2015**
Test/Reference	LOR	Unit		
Chloride	10	mg/kg	< 10	680
pH (1:5 Aqueous extract)	0.1	pH Units	5.2	5.1
Sulphate (as SO4)	10	mg/kg	220	630
% Moisture	0.1	%	14	19