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Report

Geotechnical and Salinity Investigation
Proposed Residential Subdivision Development
Lot 437 DP 755242 No 1377 Hue Hue Road
Wyee NSW

Prepared for
Topa Property
Suite 7, 114 Majors Bay Road
Concord NSW 2137

Ref: JC21405A-r2(rev)
September 2021

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23rd November 2021

Our Ref: JC21405A-r2(rev)

Topa Property
Suite 7, 114 Majors Bay Road
Concord NSW 2137

Attention: Ms Olga Masella

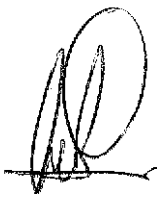
Dear Madam

Re Geotechnical and Salinity Investigation
Proposed Residential Subdivision Development
Lot 437 DP 755242 No 1377 Hue Hue Road, Wyee

We are pleased to submit our Geotechnical and Salinity Investigation report for the proposed residential development at the above address.

Should you have any queries, please contact the undersigned.

Yours faithfully
GeoEnviro Consultancy Pty Ltd



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Director

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Client	Topa Property

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TABLE OF CONTENTS

Section Page

REFERENCES

LIST OF DRAWINGS

LIST OF APPENDICES

1. INTRODUCTION

This report presents the results of our Geotechnical investigation for the site located at Lot 437 DP 755242 No 1377 Hue Hue Road Wyee as shown in Drawing No 1. The investigation was commissioned by Ms Olga Masella of Topa Property. The scope of this assessment was carried out in general accordance with our proposal reference PC21018A dated 9th July 2021.

We understand the proposed development will include subdivision of the site into residential lots and construction of residential roads. We understand the southernmost portion of the site is proposed to be retained as E2 Zoned Land and some drainage infrastructure including basin and stormwater works are proposed.

The purpose of this investigation was to assess the subsurface ground conditions including fill and groundwater conditions and based on the information provided, to provide the following information;

- Subsurface conditions and provide recommendations on geotechnical issues considered relevant to the proposed development as follows;
    - Site preparations, fill construction and earthworks specification to AS3798 -Guidelines on Earthworks for Commercial and Residential Sites.
    - Shoring and retaining wall design parameters including lateral earth pressure coefficients, Ka, Ko and Kp
    - Slope batter design; temporary and permanent
    - Foundation design parameters including suitable footings, allowable bearing capacities and estimated settlement
    - Assessment on soil reactivity to AS2870
    - Recommendations on pavement subgrade preparation and pavement design
- Assessment on soil salinity and aggressiveness for durability design.

This investigation was carried out in conjunction with our Preliminary Site Investigation Report and details of this assessment are compiled in our report referenced JC21405A-r1 dated September 2021.

2. SCOPE OF WORK

2.1 Geotechnical Assessment

The scope of work for geotechnical investigation included;

- Excavation of test pits across the site at accessible locations.
- Hand penetrometer testing on the clayey soil to assess the strength.
- Soil classification and assessment of insitu soil.
- Soil sampling and laboratory analysis in our NATA accredited laboratory to assess soil properties and characteristics.
- Preparing a report providing comments and general guidelines on issues such as earthworks, site preparation, suitable foundation systems and indicative site classifications to AS2870.

2.2 Salinity Assessment

The salinity assessment was performed in general conformance with our understanding of the guidelines prepared by the Department of Land and Water Conservation (Reference 3) and the Salinity Code of Practice prepared by Western Sydney Regional Organisation Council (Reference 4). The scope of work conducted consisted of:

- Excavation of test pits using a rubber tyre backhoe.
- Soil sampling of the topsoil and at changes in the soil texture at lower depths at selected test pit locations.
- Laboratory analysis to aid assessment of physical and chemical properties

3. SITE INFORMATION

3.1 Site Location

The Subject Site is located on the southern side of Hue Hue Road and is referred to as No 1377 Hue Hue Road Wyee. The site is irregular in shape with a 150m frontage to Hue Hue Road by about 400m to the rear of the site. Total site area is approximately 4.5 hectares. Refer to Drawing No 1 for site locality.

The site is within the jurisdiction of Lake Macquarie Council. The site is situated within a semi-rural area with adjoining properties consisting mainly of semi-rural residential properties. A completed subdivision development with newly constructed houses occupies the adjoining eastern properties. Mannering Creek is situated immediately to the rear of the site.

3.2 Site Topography

The site is situated on the upper slopes of a hill with Hue Hue Road following a ridgeline. Ground surface slopes down to the rear of the site to Mannering Creek at angles of between 4 to 8 degrees. Based on Google Earth, the site is situated at about 25m to 35m above sea level.

3.3 Ground Cover and Salinity Indicators

The site ground cover consists of predominantly of grassy areas with dense trees towards the southern portion of the site. The site generally appeared to have areas of potential water logging, in particular to the southern portion of the site adjacent Manning Creek.

The area surrounding the dam/water hole in the middle of the site appeared dry however there is a potential for localised springs to be in this area.

There were no obvious signs and indicators of salinity impacts such salt crystals on the surface, salt attacks and markings on existing building footings and vegetation distress.

3.4 Soil Landscape and Geological Setting

The 1:100,000 Soil Landscape Map of Gosford-Lake Macquarie (Reference 1) prepared by the Soil Conservation Services of NSW indicates the northern portion of the site to consist of erosional soil belonging to the Doyalson landscape group (do). This soil landscape group occurs on broad crests/ridges with gentle inclined slopes. The Doyalson Landscape Group is typically characterised to have localised shallow soils, sodic/dispersive in nature with low wet strength and very acidic.

The southern portion of the site to consist of alluvial soil belonging to the Wyong Landscape Group (wy) on poorly drained deltaic flood plains and alluvial flats of the Quaternary sediments on the Central Coast Lowlands. The Wyong Landscape Group is typically characterised to have seasonal waterlogging with localised stream bank erosion, foundation hazard, localised acid sulphate potential, strongly acid, very low fertility and saine soils. Refer to Drawing No 2 for the soil landscape map.

The 1:100,000 Geological Map of Gosford-Lake Macquarie (Reference 2) indicates the site to be situated predominantly on bedrock of the Tuggerah Formation consisting of grey to green-grey laminite, red-brown claystone and siltstone, interbedded with fine to medium grained green-grey sandstone.

3.5 Existing Site Conditions and Description

A site visit was carried out on the 11th August 2021 by an environmental engineer to observe existing site features and identify obvious or suspected areas of potential contamination. Reference should be made to Drawing No 1 for site locality and features plan.

At the time of the investigation, the site was mainly used for residential purposes with some dwellings and sheds towards the north-western corner of the site. There was a horse stabling area to the central western portion of the site with some containers and sheds. The majority of the site was vacant with grass cover except the rear portion of the site which was densely covered with trees.

The rear southern portion of the site was heavily vegetated with trees and bushes and Mannings Creek runs across the southmost corner of the site. Refer to Drawing No 1. We understand that the southernmost portion of the site is proposed to be retained as E2 Zoned Land and some drainage infrastructure including basin and stormwater works are proposed.

Site Feature	Description
A	Single-storey fibro dwelling with a timber and metal carport.
B	Single-storey weatherboard dwelling with a timber and metal carport.
C	Fibro dwelling used as a storage shed/workshop.
D	Single-storey fibro dwelling with an attached metal carport and metal garden shed at the rear.
E	20 foot shipping container.
F	Horse stables with a storage container, metal and timber sheds, horse float/trailer and metal horse round yard/pen.
G	Sunken dam.
H	Sunken dam full of water (Possible Spring?)
I	Cleared area used for horse training.
J	Mannings Creek

4. INVESTIGATION METHODOLOGY

4.1 Fieldwork

Field investigation included excavation of test pits on the 11th August 2021. A total of twelve test pits (TP 1 to TP 12) were excavated across the site using mainly a rubber tyred backhoe. The test pit locations are shown on Drawing No 4.

The test pits were excavated to depths varying from 1.4m to 3.1m below existing ground surface. The test pits were observed for groundwater during and upon completion of the excavation. The field results together with details of the strata encountered are presented in Table A.

To assess the strength of the subsurface soil, hand penetrometer tests were carried on the test pit walls. The test pits were observed for groundwater during and upon completion of the excavation. The field results together with details of the strata encountered are presented in Table A.

4.2 Laboratory Analysis

"Undisturbed" U_{50} soil samples and disturbed samples were taken from the site to our NATA accredited laboratory for Shrink-Swell Index and Atterberg Limit tests to assess the soil reactivity and other physical soil properties. Bulk samples were taken from the site for California Bearing Ratio (CBR) tests to assess pavement subgrade characteristics for pavement design.

To assess the likely impact of soil salinity on the proposed development, the following laboratory analysis was carried out;

- pH
- Electrical Conductivity (Ec)
- Chloride (Cl)
- Sulphate (S04)
- Resistivity

Salinity soil analysis was performed by Envirolab Services Pty Ltd, a laboratory accredited by the National Association of Testing Authorities (NATA). Disturbed soil samples were also taken to our NATA accredited laboratory for Emerson Class and Particle Size Distribution testing. The laboratory test reports for Geotechnical properties are attached in Appendix B and Appendix C of this report.

5. SUBSURFACE CONDITIONS

Reference should be made to the attached Table A in Appendix A for a summary of subsurface profiles encountered from the test pit investigation and Drawing No 4 for test pit location plan. The following is a summary of the subsurface profiles encountered in the test pits;

Topsoil

Topsoil was encountered on the surface of all test pits consisting of Sandy Silt and Clayey Silt of low liquid limit. The topsoil was found to have thickness ranging from 200mm to 400mm.

Some Sandy Silt was encountered below the topsoil in TP 2, 7 and 8 with thickness ranging from 200mm to 250mm.

Natural Soil

Natural soil was encountered below the topsoil in all test pits consisting predominantly of medium to high plasticity Silty Clay over the majority of the site with relatively more sandy soil on the southern portion of the site. Some Sandy Clay/Clayey Sand of low to medium plasticity was encountered in TP 6 and 7 and some Gravelly Clayey Sand was encountered in TP 8, 9 and 10.

The natural soil on the southern portion of the site was found to have high moisture (ie moist to wet) and weak (ie Stiff) based on TP 1, 3 and 4 with interbedded sand and siltstone encountered at lower depths of between 1.9m and 2.8m below existing ground surface.

In the other test pits on the northern portion of the site, the natural clay was generally found to be stiff to very stiff. Relatively weak bands of clays were also encountered in TP 7 at between 0.5 and 1.60m and this clay was found to high moisture content. We note that TP 7 was excavated within close proximity to the existing dam and the slight water seepage encountered may be derived from a natural spring.

Bedrock

Bedrock consisting of Siltstone/Claystone and Sandstone was encountered in TP 5 and 9 to 12 at depths ranging from 1.2m to 1.9m below existing ground surface.

Groundwater

All test pits were found to be dry during and shortly after the test pit investigation except in TP 1 near Manning Creek to the rear where some seepage was encountered within the natural Sand layer at about 2.7m depth. Some minor groundwater seepage was also encountered in TP 7 at about 1.5m below existing ground surface.

6. RESULTS OF THE INVESTIGAITON

6.1 Geotechnical

6.1.1 Principal of Lot Classification

Most natural clay soils have sufficient bearing capacities to support typical residential loads. Most distress to residential structures occurs due to reactive soil movements rather than settlement movements.

AS2870 establishes a classification system whereby reactive sites are classified based on the reactive soil movements anticipated. Other foundation conditions such as the presence of fill material, may affect the site classification. Appendix D of this report provides a comprehensive explanation of site classification.

The purpose of the classification is to allow the design of an economical footing system that will limit cracking of footings, floor slabs and masonry walls to an extent normally considered acceptable. The performance expectations associated with the design guidelines are presented in Appendix A of AS 2870. It is fundamental when applying the following site classifications to residential footing design that these performance expectations are acceptable to the house owners.

6.1.2 Laboratory Test Results

California Bearing Ratio

The following is a summary of the CBR test results;

Sample	Maximum Dry Density t/m^3	Optimum Moisture Content %	Field Moisture Content %	CBR %
TP 1 (0.5-0.8m)	1.73	18.5	15	3.5
TP 2 (0.4-0.7m)	1.60	22.5	19	5
TP 5 (0.4-0.7m)	1.41	29.5	35.5	3
TP 6 (0.5-0.8m)	1.75	17	19.5	8
TP 11 (0.4-0.7m)	1.42	29.5	32.5	3.5

The laboratory test results indicate the subgrade to have CBR values ranging from 3.5% to 8.0%.

Shrink/Swell Index

"Undisturbed" U_{50} samples were tested for Shrink/Swell Index to aid assessment of soil reactivity to moisture variation and the summary of results are as follows;

Sample	Shrinkage %	Swell %	Shrink/Swell Index %/pF
TP 1 (0.4-0.8m)	1.7	1.4	1.3
TP 4 (0.5-0.9m)	2.0	0.0	1.1
TP 8 (0.5-0.9m)	8.1	0.1	4.5
TP 12 (0.3-0.6m)	7.6	0.1	4.2

Based on the laboratory results, the natural soil was assessed to have a moderate to high reactivity to moisture variation.

Atterberg Limits

The following is a summary of the Atterberg Limit test results;

Sample	Liquid Limit %	Plastic Limit %	Plasticity Index %	Linear Shrinkage %	Natural Moisture Content %
TP 1 (0.9-1.0m)	37	15	22	11	14
TP 4 (0.5-0.6m)	42	19	23	12	21
TP 8 (1.6-1.7m)	56	24	32	15	25
TP 12 (0.4-0.5m)	72	31	41	19	33

Based on the laboratory results, the Atterberg Limit indicates the natural soil to generally be medium to highly plastic.

6.2 Salinity

6.2.1 Guidelines

Salinity refers to the presence of excess salt in the environment and is able to occur if salts which are naturally found in soil or groundwater mobilise, allowing capillary rise and evaporation to concentrate the salt at the upper subsurface soil profile. Such movements are caused by changes in the natural water cycle. In urban areas, the processes which causes salinity are intensified by the increased volumes of water added to the natural system from irrigation of gardens, lawn and parks and from leaking infrastructures (eg pipes, sewer, stormwater, etc) and pool.

Saline soil may have adverse impact on development such as;

- Damage to buildings and houses caused by deterioration of bricks, mortar and concrete when salt drawn up into capillaries of bricks and mortar expands resulting in spalling.
- Deterioration of concrete kerbs and gutters as a result of chemical reaction between concrete and sulphates.
- High chloride content in the soil may result in corrosion of steel reinforcement and buried metal structures.
- Damage to underground pipes and infrastructures.
- Water logging of ground surface due to sealing effect of sodic and dispersive soil.
- Loss of vegetation cover and plants due to high salt content resulting in retardation of plants.

In recognition of the potential adverse impact of salinity to development, the Western Sydney Regional Organisation of Councils Ltd has a Salinity Code of Practice (Reference 5) to address the issue of salinity. It was acknowledged in the Code that salinity problems can change substantially over time and it is difficult to predict exactly where salinity will occur and how it will respond to the changing environment conditions.

For assessment of soil salinity and aggressiveness, the Department of Land and Water Conservation has prepared a guideline entitled "Site Investigation for Urban Salinity" (Reference 6). The fundamental criterion for assessing soil salinity is based on Electrical Conductivity.

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

Soil dispersion relates to stability of the soil in the presence of water. The following is a measure of soil dispersion;

Emerson Class No	**Dispersibility**
1	Very High
2	High
3	Moderate to High
4	Moderate
5 and 6	Slight
7 and 8	Negligible/Aggregated

Sodic soils are dispersible and are vulnerable to erosion and tunnelling. Sodicity is a measure of Exchangeable Sodium Percentage (ESP) and Cation Exchangeable Capacity (CEC). The following is a measure of soil sodicity;

ESP (%)	**Rating**
Less than 5	Non-Sodic
5 to 15	Sodic
Greater than 15	Highly Sodic

The measure of Cation Exchangeable Capacity is as follows;

CEC ($cmol^+/kg$)	**Rating**
Less than 6	Very Low
6 to 12	Low
12 to 25	Moderate
25 to 40	High
Greater than 40	Very High

In addition to the above, the presence of Sulphate and Chloride in the soil has the potential to cause high soil aggressivity to concrete and steel structures, in particular if the structures are in direct contact with the soil. The following is a measure of soil aggressivity to concrete based on the AS 2159-2009 "Piling – Design and Installation" (Reference 7).

Sulfates (expressed as SO_4)		**pH**	**Chloride in Groundwater ppm**	**Soil Conditions A***	**Soil Conditions B#**
In Soil ppm	**In Groundwater ppm**				
<5000	<1000	>5.5	<6000	Mild	Non-aggressive
5000-10 000	1000-3000	4.5-5.5	6000-12 000	Moderate	Mild
10 000-20 000	3000-10 000	4-4.5	12 000-30 000	Severe	Moderate
>20 000	>10 000	<4	>30 000	Very Severe	Severe

Approximate 104ppm of SO4=80ppm of SO3
* Soil condition A = High permeability soils (eg sands and gravels) which is below groundwater
# Soil conditions B = Low permeability soils (eg silts and clays) and all soils above groundwater

The following is a measure of soil aggressivity to steel piles based on the AS 2159-2009 "Piling – Design and Installation" (Reference 7).

pH	**Chlorides (Cl)**		**Resistivity ohm.cm**	**Soil Conditions A***	**Soil Conditions B#**
	In Soil ppm	**In Groundwater ppm**			
>5	<5000	<1000	>5000	Non-aggressive	Non-aggressive
4-5	5000-20 000	1000-10 000	2000-5000	Mild	Non-aggressive
3-4	20 000-50 000	10 000-20 000	1000-2000	Moderate	Mild
<3	>50 000	>20 000	<1000	Severe	Moderate

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

In addition to the above, the AS 3750-2018 "Concrete Structures" (Referenced 8) outlines an exposure classification for concrete in sulphate soils as follows;

Exposure Conditions			**Exposure Classification**	
Sulphate (expressed as SO3)		**pH**	**Soil Conditions A***	**Soil conditions B#**
In Soil ppm	**In Groundwater ppm**			
<5000	<1000	>5.5	A2	A1
5000-10 000	1000-3000	4.5-5.5	B1	A2
10 000-20 000	3000-10 000	4-4.5	B2	B1
>20 000	>10 000	<4	C2	B2

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

6.2.2 Laboratory Test Results

The following is a summary of the laboratory test results;

Sample	Depth (m)	pH	ECe dS/m	Cl mg/kg	SO4 mg/kg	Resistivity ohm cm
TP 1	0.00-0.10	5.9	0.24			
	0.90-1.00	4.9	2.47	290	71	
	2.70-2.80	6.2	4.60	530	50	2200
TP 2	0.00-0.10	5.4	0.29			
	0.50-0.60	5.1	0.75	67	39	
	1.80-1.90	4.9	1.70	170	88	5000
	2.50-2.60	5.3	0.72	73	20	
TP 3	0.10-0.20	5.3	0.44			
	0.70-0.80	5.3	1.02	99	55	8500
	2.10-2.20	5.3	2.47	320	69	
TP 4	0.00-0.10	5.6	2.10			
	0.50-0.60	5.4	1.53	130	120	
	1.90-2.00	5.8	2.04	200	150	4100
TP 5	0.00-0.10	5.8	0.36			
	0.40-0.50	5.5	0.54	39	64	13000
	1.30-1.40	5.1	1.12	89	92	
TP 6	0.10-0.20	5.6	0.21			
	0.60-0.70	5.4	0.28	<10	36	
	2.30-2.40	4.9	0.35	22	32	22000
TP 7	0.00-0.10	5.8	0.43			
	0.80-0.90	6.1	0.58	55	20	16000
	1.90-2.00	5.9	0.49	39	23	
TP 8	0.00-0.10	5.8	0.37			
	0.60-0.70	5.2	1.11	76	110	
	1.60-1.70	5.3	1.36	150	77	5800

Note: ECe – Electrical Conductivity (dS/m)
Cl – Chloride (mg/kg)
SO4 – Sulphate (mg/kg)
CEC – Cation Exchange Capacity
ESP – Exchangeable Sodium Percentage

Sample	Depth (m)	pH	ECe dS/m	Cl mg/kg	SO4 mg/kg	Resistivity ohm cm
TP 9	0.00-0.10	6.1	0.21			
	0.40-0.50	5.8	0.38	10	34	26000
	1.40-1.50	5.7	0.41	20	39	
TP 10	0.00-0.10	6.3	0.37			
	0.50-0.60	5.6	0.79	20	100	
	1.20-1.30	5.6	0.55	20	56	18000
TP 11	0.10-0.20	5.8	0.32			
	0.60-0.70	5.5	0.50	24	70	14000
	1.50-1.60	5.7	0.43	20	54	
TP 12	0.00-0.10	5.5	0.46			
	0.40-0.50	5.2	1.19	120	110	
	0.90-1.00	5.5	0.21	64	63	9600

Note: ECe – Electrical Conductivity (dS/m) Cl – Chloride (mg/kg)
SO4 – Sulphate (mg/kg) CEC – Cation Exchange Capacity
ESP – Exchangeable Sodium Percentage

Emerson Class

Sample	Class	Dispersiveness
TP 1 (0.9-1.0m)	2	High
TP 2 (0.5-0.6m)	6	Slight
TP 3 (2.1-2.2m)	2	High
TP 4 (0.5-0.6m)	2	High
TP 5 (1.3-1.4m)	1	Very High
TP 6 (0.6-0.7m)	5	Slight
TP 7 (0.8-0.9m)	6	Slight
TP 8 (1.6-1.7m)	2	High
TP 9 (1.4-1.5m)	5	Slight
TP 10 (0.5-0.6m)	5	Slight
TP 11 (1.5-1.6m)	3	Moderate to High
TP 12 (0.4-0.5m)	6	Slight

Particle Size Distribution

Sample	Clay & Silt (%)	Sand (%)	Gravel (%)
TP 1 (0.9-1.0m)	78	22	0
TP 5 (1.3-1.4m)	71	23	6
TP 9 (1.4-1.5m)	25	64	11

7. ASSESSMENT AND RECOMMENDATIONS

7.1 Geotechnical Assessment

7.1.1 Site Preparation and Earthworks

The site was found to be underlain by two soil landscape units consisting of erosional soil of the Doyalson Landscape (do) ground on the northern side and alluvial soil of the Wyong Landscape (wy) group on the southern side.

The alluvial soil on the southern portion of the site was found to have poor foundation properties with high moisture (ie moist to wet) and weak (ie Stiff) sandy soil whilst the northern portion of site was found to have relatively better foundation material with Stiff to Very Stiff clayey soil. There may be some localised soft and weak foundation material caused by subsurface ground water inflows (eg springs).

Based on the results of the investigation, we anticipate that earthworks will be required to improve the foundation for the proposed residential development and redevelopment of the alluvial portion of the site is expected to be constrained by wet and soft soil with shallow groundwater.

For the northern portion of the site (Doyalson Landscape - do) we anticipate the site preparation for the proposed residential subdivision development to include;

- Drainage improvement works should be undertaken as early as possible prior to earthworks to allow time for the site to drain and dry up. This should include diversion of the drainage depression water coming into the site from the north western corner and pumping the water on the downstream side of the existing dam.
- Dewatering and desilting of the existing dam and construction of deep subsoil drains or trench drains to intercept the ground water. Where possible subsoil drains be installed along future or proposed service trenches so that it would not interfere with earthworks or future building construction works.
- Stripping of topsoil/fil and excavation of any “uncontrolled” fill to expose natural soil.
- Inspection of the exposed natural surface for any soft or wet areas and additional subsoil drains may be installed in areas where required.

- Rolling and compacting of the exposed areas using a minimum 8 passes of a 10 tonne vibrating roller to identify any soft or heaving areas. We note the majority of the site was found to have poor ground conditions and with successful implementation of drainage improvement measures, rolling with a heavy compactor may be sufficient to densify the insitu natural clay and sand.
- Any persisting soft or heaving areas observed during rolling should be excavated and replaced with a select granular fill such as ripped sandstone having a maximum particle size of 75mm.
- All structural fill required to elevate the site to design level should be controlled and compacted in layers not exceeding 250mm thickness compacted to a minimum 95% Standard Maximum Dry Density at ±2% Optimum Moisture.

We understand that the southern alluvial (Wyong Landscape – wy) portion of the site is proposed to be retained as E2 Zoned Land and some drainage infrastructure including basin and stormwater works are proposed. There is insufficient geotechnical information from this investigation to provide a suitable ground improvement strategy should this portion be redeveloped (e.g. infrastructure works). Additional geotechnical investigation involving deeper borehole drilling and ground water monitoring will be required in order to further assess the ground conditions.

Our general comments on suitable bearing material and reusability of onsite soil with respect to shallow foundation construction are as follows;

- The topsoil encountered on the surface in the majority of the test pits are not considered suitable to support permanent structures such as pavements, slabs and buildings and therefore should be excavated and removed. The topsoil and may be reused in future landscaping areas (eg earth mounds and footpaths) subject to the removal of any foreign material or signs of contamination.
- All insitu fill encountered during construction would be classified as "Uncontrolled" fill in accordance with the definition outlined in AS 3798 and is therefore not suitable to support permanent structures such as pavements, slabs and buildings with shallow footings.
- Fill containing foreign inclusion (eg rubbish and building waste) or chemical contaminants are not considered suitable for reuse without treatment or remedial works. Fill containing high organic and topsoil material (eg Silt) is not suitable for reuse

- The underlying natural clay and shale are generally considered suitable for reuse as structural fill provided the fill is well graded with maximum particle size of not greater than 75mm.

Earthworks should be closely monitored by a geotechnical consultant and should include field density testing of fill at an appropriate frequency and level of supervision as detailed in AS3798 - 2007.

7.1.2 Retaining Walls and Support

Cut and fill should be adequately retained or battered. For walls propped by a floor slab, thus limiting deflection, an "at-rest" lateral earth pressure coefficient (K_o) should be adopted in the design. For retaining walls designed to "yield", an "active" lateral earth pressure coefficient (K_a) may be adopted in the design. We recommend the following;

Material	K_o	K_a	Bulk Density
Compacted Fill	0.65	0.35	17.5kN/m^3
Natural Clay	0.5	0.33	19.0kN/m^3
Weathered Shale	0.25	0.15	22.0kN/m^3

Permanent subsurface drains should be provided at the back of the retaining wall, or full hydrostatic ground water pressure should be assumed in the design. Surcharge due to adjacent structures, sloping backfill or construction loads should be taken into account in the design if applicable.

All unretained cut and fill should be battered to not steeper than 1 Vertical to 2 Horizontal.

7.1.3 Preliminary Lot Classification and Footings

Lot classification should be carried out after site preparation as described in the above Section 7.2.1. Subject to the earthworks as previously described, shallow footings consisting of stiffened raft slabs, waffle slabs or strip and pad footings may be adopted for the proposed residential dwellings. Shallow footings founded on natural very stiff natural clay or fill compacted as specified above may be proportioned to an allowable bearing capacity of 100kPa.

The insitu clayey soil was assessed to be moderately to highly reactive and as the site is generally underlain by relatively thick clay profiles, preliminary lot classification may be based on Class 'H1' (Highly Reactive) for lots with soil profiles less than 1.5m thick and Class 'H2' (Highly Reactive) for soil profiles greater than 1.5m thick.

Based on current test results, the southern alluvial portion of the site should be classified as Class 'P' (Problem). A final lot classification should be carried out upon completion of site preparation or bulk earthworks

7.1.4 Pavement Design

We understand that the proposed development will include construction of residential roads. Our test pit investigation revealed the site to be generally underlain by topsoil overlying varying natural soil including Silty Clay, Sand, Gravelly Silty Clay and Gravelly Clayey Sand. Some Siltstone/Claystone and Sandstone bedrock was encountered in TP 5 and 9 to 12 at depths ranging from 1.2m to 1.9m below existing ground surface.

Based on the hand penetrometer test results, the natural clayey soil was found to have varying consistency ranging from stiff to hard and varying moisture ranging from dry to moist. Weak (ie stiff and wet) clays and sand were encountered in TP 1, 3, 4, 7 and 12 at varying depths.

Based on the foregoing, we expect pavement construction to require some significant subgrade improvements and reworking. We recommend pavement subgrade preparation to include the following;

- Site clearing and drainage improvement by construction of dish drains and earth mounds to divert stormwater runoffs.
- Stripping of topsoil and topsoil/fill and excavation of any "uncontrolled" fill.
- Boxing of subgrade to proposed design level
- Proof rolling of the base of the excavation with a heavy vibrating roller (minimum 10 tonne).
- Any soft areas identified during rolling should be excavated and replaced with ripped sandstone fill. We note that moist to wet and weak (ie stiff) clay was encountered in TP 1, 3, 4, 7 and 12 and this material may be excavated and moisture conditioned by drying and reuse on the site.
- The depth of excavation may be reduced by construction of a bridging layer and this may involve excavation up to about 1.0m below design subgrade level, placement of a layer of geosynthetic material placement of a select granular fill about 500mm thick and compacting a target 95% Standard Maximum Dry Density (SMDD). The bridging layer should be proof rolled using a minimum 10 tonne roller and should heaving persist, we recommend additional select subgrade material be placed and compacted to achieve 95% SMDD. Additional geosynthetic material may be used to provide additional stability. We recommend subgrade preparation be supervised by a suitably qualified geotechnical engineer.
- The excavated clay material may be reused as fill beneath pavements subject to moisture reconditioning. Alternatively, imported good quality fill such as ripped sandstone having a maximum particle size of 75mm may be used.

- The fill material should be compacted in layers not exceeding 250mm loose thickness compacted to a minimum 95% Standard Maximum Dry Density (SMDD) at close to Optimum Moisture Content.
- The upper 300mm of the fill material forming the pavement subgrade should be compacted to a minimum 100% SMDD.
- The subgrade preparation and pavement construction should be closely monitored by a geotechnical consultant and should include field density testing of the pavement material at an appropriate frequency and level of supervision as detailed in AS 3798 - 2007.

Our laboratory test results indicate the pavement subgrade to have CBR values ranging from 3.5% to 8.0%.

For preliminary pavement design, we recommend a design CBR value of 3.0% be adopted. Confirmation of CBR value may be carried out after exposing to subgrade level.

In the absence of design traffic loading for the proposed roads, the following pavement design options may be adopted based on assumed design traffic loadings (ie Equivalent Standard Axle (ESA);

Material	**Assumed ESA**		
	5×10^4	**3×10^5**	**2×10^6**
Asphaltic Concrete (AC10)	50mm	50mm	50mm
Single Coat Flush Seal	-	-	-
DGB20 Base Course	150mm	150mm	150mm
Crushed Sandstone Subbase Course	240mm	320mm	360mm
Total	**440mm**	**520mm**	**560mm**

The final pavement thickness design should be carried out based on Austroads publication, "Pavement Design – A Guide to the Structural Design of Road Pavements", and Austroads Pavement Research Group publication, Report No 21, "A Guide to the Design of New Pavements for Light Traffic".

The pavement design assumes the subgrade and pavement materials to be compacted to the following Minimum Dry Density Ratios (AS1289 5.1.1, 5.2.1);

Pavement Material	**Compaction Level**	**Compactive Effort**
Base Course	98%	Modified
Sub-Base Course	98%	Modified

7.2 Salinity Assessment

The proposed development is likely to include some cut and fill to regrade the site for future residential lots and roadways. The laboratory test results indicate the incite soil to be generally Non to Slightly Saline with ECe values ranging from 0.21 to 2.47 dS/m. Some Moderately Saline soil was encountered in TP 1 (2.7-2.8m) with Ece value of 4.6 dS/m.

The Emerson test results indicate the insitu soil was generally found to be Slightly to Very Highly Dispersive.

The subsurface soil was found to have low concentrations of Sulphate and a minimum pH value of 4.9, therefore the soil is considered to be Mildly aggressive to buried concrete structures and therefore the site may be classified as "Class A2" in accordance to AS 3750-2018 "Concrete Structures" (Reference 7).

The subsurface soil was found to have low concentrations of Chloride, with a minimum pH value of 4.9 and the lowest resistivity of 2200ohms/cm, the site was assessed to be Non aggressive to buried steel structures based on AS 2159 (Reference 6).

For the proposed development, the following are our suggested management strategies;

7.2.1 Excavation and Filling

- Excavations in excess of 1.0m should be battered to a 1 vertical to a 1 horizontal. Excavated stockpile material may either be treated immediately on site using 3% by weight of lime, otherwise capped with non-porous clay soils greater than 0.5m thick. Alternatively excavated material may be removed off-site to a landfill for treatment and disposal.

- Gypsum should be mixed into filling containing sodic soils and cuts where sodic soils are exposed on slopes to improve soil structure and to minimise erosion potential.

- Any material removed from the site should be carried out by a licensed contractor. This material should be sealed and contained using appropriate lining and capping material.

- Exposure and disturbance of subsoil material must be reduced by minimising cut and fill. Time of exposure of bare ground (without vegetation) should be kept to a minimum. If extended periods of rain are forecast, the bare ground should be covered with stable fill such as ripped sandstone or stabilised with lime proportioned to 3% by weight.

- Stormwater runoff from upstream should be diverted away from excavation areas by the use of bunding.

- Filling areas are to be graded, revegetated and adequate surface drainage infrastructure installed as soon as practical to avoid excessive infiltration, minimise salt leaching, soil erosion and ponding of water on-site.

- All imported fill should be verified by sampling and testing to ensure the material is non to slightly saline. Moderately to highly saline soil is not acceptable. Supporting information and documentation should be supplied verifying that the subject material complies. The addition of salts in the materials, fill or water used during construction must be limited.

- Reversing or mixing the soil profile when undertaking cut and fill activities must be avoided. Soils must be replaced in their original order. Excavations deeper than 1m should be backfilled in the same order, alternatively this material may be treated by using lime or used in fill at depths more than 1m from finished level.

- Batter slopes should be compacted with control of the moisture content to optimum moisture content plus 2 per cent (OMC +2%) or otherwise over-filled, compacted and then trimmed back to the final alignment to minimise infiltration through the exposed filling batters and the potential resulting flushing of salts from the filling. If the latter is to be carried out, the outer zone (3 metres) of the fill should be placed at OMC +2%.

7.2.2 Infrastructure and Drainage

- Trenching for underground services should be carried out in such a manner that there is minimal rotation and vertica1l displacement of the original soil profile as the lower soil profile is more erodible.

- Pipes used for stormwater drainage should be sealed to minimise the risk of leakage. Drainage, sewerage and water infrastructure is to be regularly maintained and repaired to prevent leakages.

- Concrete of suitable strength and reinforcement cover is to be used for drainage structures and wherever contact with water and increased soil moisture is expected.

- Watering or irrigation practices are to be managed to avoid excessive infiltration and water logging.

- Natural drainage patterns and infiltration rates must be maintained as far as practicable. Drainage should not be designed to discharge to groundwater or salinity affected areas that is likely to cause increased water logging adjacent to the road or that concentrated surface runoff.

- Direct runoff from paved areas into lined stormwater drains rather than along grassed channels as necessary.

- Groundwater extraction must not occur on the site.

7.2.3 Stormwater

- During construction, hay bales and other temporary erosion control devices should be placed at appropriate locations in areas where concentrated flows are expected and suitable dish drains should be constructed to retard flow and trap silt particles during heavy runoff. Temporary detention ponds in construction sites should be regularly monitored for water quality and cloudy water should be treated by flocculation with gypsum. This is critical before a storm event.

- Surface drains should be provided along the top of batter slopes or greater than 2.5 metres height to reduce the potential for concentrated flows of water flows slopes which may cause scour. Well graded subsoil should be provided at the base of all slopes where there are road pavements below the slope to reduce the risk of water logging.

- Line or locate any ponds higher in the landscape to avoid recharge where proximity to the water table is likely to create groundwater mounding.

- Ensure an appropriate ratio of hard (impermeable) and permeable surfaces to avoid rainwater runoff infiltrating the ground in large volumes at any given location.

7.2.4 Vegetation

- Native vegetation must be retained or restored on site where possible. Revegetation of the site may involve treatment of topsoil material and planting appropriate salt-tolerant water efficient plant species (trees, shrubs, and grasses).

7.2.5 Building Materials

- In seepage and discharge areas or areas with a high potential sulphate, resistant building materials must be used. Sulphate resistant materials should be used for underground services, roads and paving.

- For all building materials, the manufacturer's advice must be complied with regarding durability and correct use. Exposure of building materials to corrosive elements in soils should be minimised. Appropriate construction techniques such as suspended slab or piering to encourage ventilation and prevent soil moisture from being forced up the walls of the structure should be used.

7.2.6 Roads

- Roads must have well designed sub surface drainage. A waterproof seal must be used on roads to minimise evaporation and the concentration of salt.

- Roads and shoulder areas must be designed to drain surface water such that there is no excessive concentration of runoff or ponding which may result in water logging or additional recharge or groundwater. Road shoulders must also be sealed.

- Materials and waters used in the construction of roads and fill embankments should be selected to contain minimal or no salt. Where it is difficult a capping layer of either topsoil or sandy materials should be placed to reduce capillary rise, act as a drainage layer and also reduce the potential for dispersive behaviour in the sodic soils.

- Roads should not intercept known salt affected or water logged areas, and should be designed in a manner that does not impede the sub-soil flow or creates hydraulic pressure causing groundwater discharge.

- Avoid or minimise the use of on site stormwater detention except where in accordance with a stormwater management strategy adopted for the Precinct.

7.2.7 Residential and Other Buildings

- A high impact waterproof membrane, (not just a vapour proof membrane), should be lain under house slabs. The waterproof membrane must be extended to the outside face of the external edge beam up to the finishing ground level, as detailed in the Building Code of Australia (BCA).

- For masonry building construction, the damp proof course must consist of polyethylene or poly-ethylene coated metal and correctly placed in accordance with BCA. Ground levels immediately adjacent to masonry walls must be kept below the damp proof course.

- Appropriate infrastructure should be in place to manage urban water cycle and this includes all water flows such as water supply, stormwater and wastewater. Relevant design considerations are outlined in "Evaluating Options for Water Sensitive Urban Design (WSUD) - a national guide" Joint Steering Committee for Waster Sensitive Cities, July 2009.

- For slab on ground construction, a layer of bedding sand at least 50mm thick should be laid under the slab to allow free drainage of water and to prevent pooling of water potentially carrying salts.

- Concrete floor slabs must comprise of Class 32MPa concrete or sulphate resisting Type SR cement with a water cement ratio of 0.5. Similar concrete should be used for bored piers or footings.

- Slabs must be vibrated and cured for a minimum 3 days

- The mini um cover to reinforcement should be 30mm from a membrane in contact with the ground.

- The minimum cover to reinforcement should be 50mm for strip footings and beams.

- Admixtures for waterproofing and /or corrosion prevention may be used.

- Salt tolerant masonry and mortar must be used below the damp proof course

- Constant monitoring of water pipes to detect any leakages and the repair of damaged pipes as soon as possible after detection

- Use Copper or non-metallic pipes instead of galvanised iron

- Ensure any underground services are provided with adequate corrosion protection.

- On sites where excavation and fill exceeds 1m, Council may require suspended slab or pier and beam construction as an alternative to 'slab on ground' construction. This may occur on sloping sites as this will minimise exposure to potentially corrosive soils and reduce the potential cut and fill on site which could alter subsurface flows.

- Other measures that can be considered to improve the durability of concrete in saline environments should be considered. These include reducing the water cement ratio (hence increasing strength), minimising cracks and joins in plumbing on or near the concrete, reducing turbulence of any water flowing over the concrete and using a quality assurance supplier.

- It is essential in all masonry buildings that a brick damp course be properly installed so that it cannot be bridged either internally or externally. This will prevent moisture moving into brick work and up the wall.

- As there are various exposure classifications and durability ratings for the wide range of masonry available, reference should be made to the supplier in choosing suitable bricks of at least exposure quality. Water proofing agents can also be added to mortar to further restrict potential water movement. Bricks that are not susceptible to damage from salt water should be used. These are generally less permeable, do not contain salts during their construction and have good internal strength so that they can withstand any stress imposed on them by any salt encrustation.

- Design and construction to be carried out in accordance with relevant Australian Standards, Building Codes and current 'Industry Best Practice' in regard to urban salinity.

- Service connections and stormwater runoffs should be checked to avoid leaky pipes which may affect off site areas lower down the slope and increase groundwater recharge resulting in increases in groundwater levels.

7.2.8 Detention Ponds and Playing Fields

- All excavation works should be minimised by staging the construction into small areas to prevent salinity from developing. Very saline soil is not recommended for use as building platform fill. This material may be buried beneath proposed roadways away from where underground services will be laid. Very saline soil should be placed at depths greater than 1.5m below design level and covered with non to slightly saline fill.

- Surplus saline soil from construction works may be reused in playing fields. A revegetation scheme which includes introduction of salt tolerant plants should be in place. Amenities buildings, light poles, fences and other associated structures should be appropriately designed to reduce adverse impacts of the saline soil. A capping layer of non saline material with a minimum thickness of 1.5m may be adopted to reduce the impacts of salinity.

- Detention ponds should be constructed to minimise build up of salts in the groundwater system via infiltration through the base of the ponds. This may be achieved by lining the ponds with synthetic HDPE liners. Clay liners may be considered if justification can be provided on the material selection process and proposed construction methodology. If using a clay lining, the possibility that on site clays may be saline should be investigated before they are used for this purpose. In these situations an impermeable geotech fabric may be preferable.

- Sodic and dispersive soils can be managed by the addition of lime. Capping of sodic and dispersive soils within the embankments is recommended for protection against erosion.

- Spillways should be provided in pond embankments to reduce the potential for concentrated flows of water down slopes causing scour.

- Where mass concrete is required in or around the ponds, a minimum concrete strength of 32 MPa is recommended to limit the corrosive effects of the underlying and surrounding soils. Concrete or masonry elements of lower strength may be susceptible to long term adverse effects of the aggressive or saline soils.

- Utilise native and deep rooted vegetation in order to minimise soil erosion and limit the rising of the water table.

8. LIMITATIONS

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

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

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

The statements presented in these documents are intended to advise you of what should be your realistic expectations of this report, and to present you with recommendations on how to minimise the risks associated with the ground works for this project. The document is not intended to reduce the level of responsibility accepted by GeoEnviro Consultancy Pty Ltd, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing. Attached in Appendix E are documents entitled “Explanatory Notes” in conjunction with which this report must be read, as it details important limitations regarding the investigation undertaken and this report.

C:\\21JOB\405\A\JC21405A-r2(rev)

REFERENCES

1. *1:100,000 Soil Landscape Map of Gosford-Lake Macquarie – Department of Environment, Climate Change and Water; Soil Landscape Series – Sheet 9131-9231*
2. *1:100,000 Geological Map of Gosford-Lake Macquarie – Geological Survey of New South Wales – Sheet 9131 & part sheet 9231*
3. *Department of Land and Water Conservation – "Site Investigation for Urban Salinity".2002*
4. *Salinity Hazard Report for Catchment Action Plan upgrade – Hunter-Central Rivers CMA – NSW Government Department of Primary Industries - 2013*
5. *What do all the numbers mean? A guide for the interpretation of soil test results. – Department of Conservation and Land Management, 1992*
6. *Australian Standard, AS 2159-2009 "Piling – Design and Installation", 2009*
7. *Australian Standard, AS 3750-2018 "Concrete Structures".*
8. *Australian Standard, AS 2870-2011 "Residential Slabs and Footings".*

Site Feature	Description
A	Single-storey fibro dwelling with a timber and metal carport.
B	Single-storey weatherboard dwelling with a timber and metal carport.
C	Fibro dwelling used as a storage shed/workshop.
D	Single-storey fibro dwelling with an attached metal carport and metal garden shed at the rear.
E	20 foot shipping container.
F	Horse stables with a storage container, metal and timber sheds, horse float/trailer and metal horse round yard/pen.
G	Sunken dam.
H	Sunken dam.
I	Cleared area used for horse training.
J	Mannering Creek

Legend

A Site Feature

GeoEnviro Consultancy Pty Ltd
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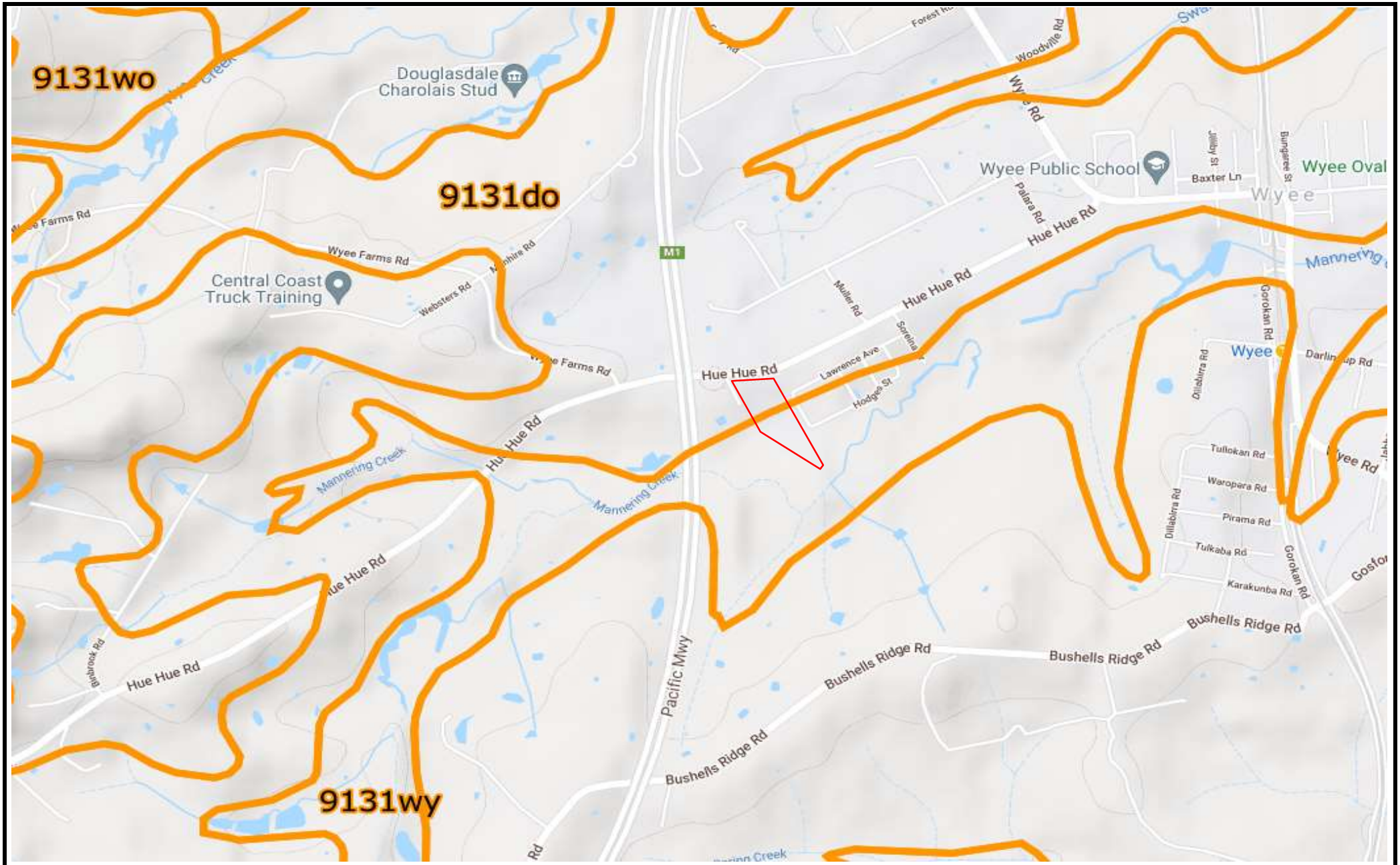
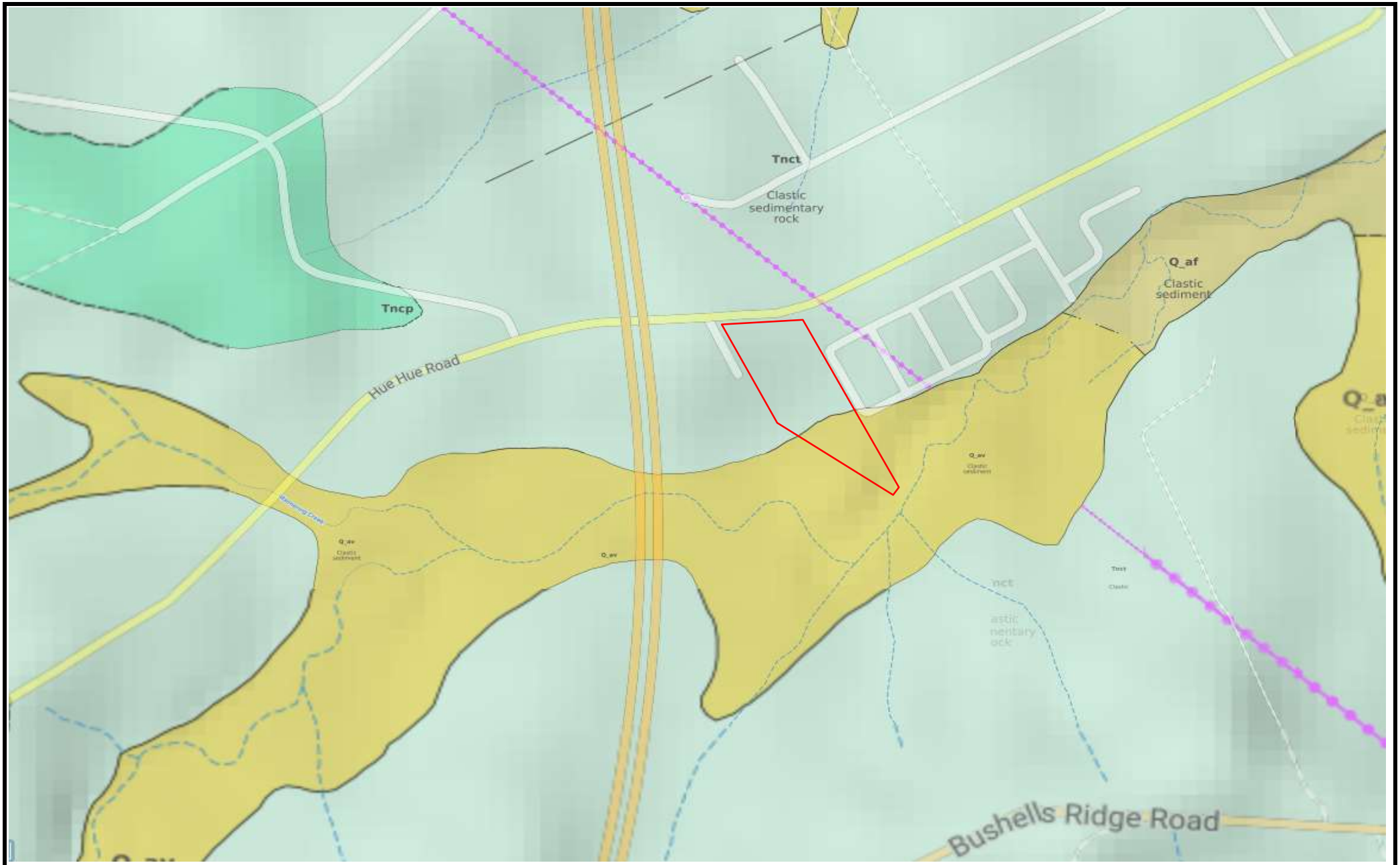
Drawn By:	Date: 30/8/21	**Topa Property**	
Checked By: SL	Date: 30/8/21	**No 1377 Hue Hue Road Wyee**	
Revision By:	Date:	**Site Locality and Site Features Plan**	
Scale: Not to Scale	A3	**Project No: JC21405A**	**Drawing No: 1**



GeoEnviro Consultancy Pty Ltd Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia Tel: (02) 9679 8733 Fax: (02) 9679 8744	**Drawn By:**	**Date: 30/8/21**	**Topa Property** **No 1377 Hue Hue Road Wyee** **Soil Landscapes Map**
	Checked By: SL	**Date: 30/8/21**	
	Revision By:	**Date:**	
	Scale: Not to Scale	**A3**	**Project No: JC21405A** / **Drawing No: 2**



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Drawn By:	Date: 30/8/21	**Topa Property**	
Checked By: SL	Date: 30/8/21	**No 1377 Hue Hue Road Wyee**	
Revision By:	Date:	**Geological Map**	
Scale: Not to Scale	A3	**Project No: JC21405A**	**Drawing No: 3**

Site Feature	Description
A	Single-storey fibro dwelling with a timber and metal carport.
B	Single-storey weatherboard dwelling with a timber and metal carport.
C	Fibro dwelling used as a storage shed/workshop.
D	Single-storey fibro dwelling with an attached metal carport and metal garden shed at the rear.
E	20 foot shipping container.
F	Horse stables with a storage container, metal and timber sheds, horse float/trailer and metal horse round yard/pen.
G	Sunken dam.
H	Sunken dam.
I	Cleared area used for horse training.
J	Mannering Creek

Legend

Test Pit

GeoEnviro Consultancy Pty Ltd
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Drawn By:	Date: 30/8/21	**Topa Property**
Checked By: SL	Date: 30/8/21	**No 1377 Hue Hue Road Wyee**
Revision By:	Date:	**Test Pit Location Plan**
Scale: Not to Scale	A3	Project No: JC21405A / Drawing No: 4

APPENDIX A

Table A: Summary of Soil Profile

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Table A : Summary of Test Pit Profile

Client: Topa Property — Job Number: JC21405A

Project: Proposed Residential Subdivision Development — Logged By: AT

Location: No 1377 Hue Hue Road Wyee — Date: 11/8/21

Test Pit Number	Depth (m) From	Depth (m) To	Material Description
1	0.00	0.35	Topsoil: Sandy Silt: low liquid limit, grey with fine to medium grained sand, dry to moist
	0.35	2.60	(CL-CI) Silty Clay: low to medium plasticity, grey brown with heavy ironstaining and some fine grained sand, moist to wet PP 160kPa
	2.60	3.10	(SP) Sand: fine to medium grained, grey with ironstaining and some siltstone gravel, moist to wet , Groundwater Seepage at 2.7m
2	0.00	0.20	Topsoil: Sandy Silt: low liquid limit, grey with fine to medium grained sand, moist
	0.20	0.40	Clayey Silt: low liquid limit, grey, moist
	0.40	2.30	(CL-CI) Silty Clay: low to medium plasticity, grey brown with heavy ironstaining and some fine grained sand, dry to moist, hard PP>600kPa
	2.30	2.90	(CL-CI) Gravelly Silty Clay: low to medium plasticity, grey brown red with ironstone gravel, dry to moist
3	0.00	0.40	Topsoil: Sandy Silt: low liquid limit, grey with fine to medium grained sand, moist
	0.40	1.90	(CL-CI) Silty Clay: low to medium plasticity, grey brown with heavy ironstaining and some fine grained sand, moist, very stiff to hard PP=380-600kPa
	1.90	2.80	As above but dark grey, moist, stiff PP=170-220 kPa
	2.80	3.00	As above but with interbedded sand and siltstone bands, moist , appears medium densere
4	0.00	0.40	Topsoil: Sandy Silt: low liquid limit, brown with fine to medium grained sand, moist
	0.40	1.90	(CL-CH) Silty Clay: medium to high plasticity, grey brown with heavy ironstaining and some bands ofr sand, moist to wet, stiff to very stiff PP=160-210kPa
	1.90	3.00	As above but dark grey with interbedded sand and siltstone , moist, very stiff PP=310-350kPa
5	0.00	0.30	Topsoil: Sandy Silt: low liquid limit, brown with fine to medium grained sand, moist
	0.30	1.00	(CH) Silty Clay: high plasticity, light brown, moist, very stiff PP=310kPa
	1.00	1.40	(CI) Silty Clay: medium plasticity, grey with ironstone gravel, moist
	1.40	1.60	Siltstone/Claystone: grey (near refusal)
6	0.00	0.40	Topsoil: Sandy Silt: low liquid limit, brown with fine to medium grained sand,, moist
	0.40	1.80	(SC/CI) Sandy Clay: low to medium plasticity, light brown red with heavy ironstaining, moist, very stiff PP=260-320kPa
	1.80	2.80	(CI) Silty Clay: medium plasticity, grey with abundant ironstone, dry, very stiff PP=360-400kPa
7	0.00	0.25	Topsoil: Sandy Silt: low liquid limit, brown with fine to medium grained sand,, moist
	0.25	0.50	Sandy Silt: low liquid limit, grey, moist
	0.50	1.60	(SC/CI) Clayey Sand/Sandy Clay: low to medium plasticity, light brown red with heavy ironstaining, moist to wet , stiff to very stiff PP=140-210kPa, slight groundwater seepage at 1.5m
	1.60	2.90	As above but grey red with ironstone gravel, moist
			Notes:
			MC = Moisture Content.
			PL = Plastic Limit.
			PP = Pocket Penetrometer.

GeoEnviro Consultancy Pty Ltd
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Table A : Summary of Test Pit Profile

Client: Topa Property — Job Number: JC21405A

Project: Proposed Residential Subdivision Development — Logged By: AT

Location: No 1377 Hue Hue Road Wyee — Date: 11/8/21

Test Pit Number	Depth (m) From	Depth (m) To	Material Description
8	0.00	0.20	Topsoil: Sandy Silt: low liquid limit, brown with fine to medium grained sand,, moist
	0.20	0.40	Sandy Silt: low liquid limit, grey, moist
	0.40	1.10	(CL-CI) Silty Clay: low to medium plasticity, grey brown with heavy ironstaining and some fine grained sand, moist, very stiff PP=270kPa
	1.10	2.50	(CH) Silty Clay: high plasticity, grey with some ironstone gravel, dry to moist, very stiff PP=280-310kPa
	2.50	3.00	As above but with abundant ironstone gravel, dry to moist
9	0.00	0.30	Topsoil: Sandy Silt: low liquid limit, brown with fine to medium grained sand,, moist
	0.30	1.90	(SP) Gravelly Clayey Sand: fine to coarse grained, grey brown red with sandstone gravel and bands, moist
	1.90	2.00	Sandstone (refusal)
10	0.00	0.25	Topsoil: Clayey Silt: low liquid limit, brown with sand, moist
	0.25	1.40	(SP) Gravelly Clayey Sand: fine to coarse grained, grey brown red with sandstone gravel and bands, moist
	1.40	1.90	Sandstone (refusal)
11	0.00	0.30	Topsoil: Clayey Silt: low liquid limit, brown with sand, moist
	0.30	1.10	(CH) Silty Clay: high plasticity, light brown, dry to moist, very stiff PP=300-320kPa
	1.10	1.80	(CI) Silty Clay: medium plasticity, grey with siltstone/claystone bands, dry, hard PP=410Kpa
	1.80	2.30	Siltstone/Claystone: grey (near refusal)
12	0.00	0.25	Topsoil: Clayey Silt: low liquid limit, brown with sand, moist
	0.25	0.70	(CH) Silty Clay: high plasticity, light brown, moist, stiff to very stiff PP=190-280kPa
	0.70	1.10	(CI) Silty Clay: medium plasticity, grey, moist, very stiff PP=240kPa
	1.10	1.20	As above but with siltstone/claystone bands, dry to moist
	1.20	1.40	Siltstone/Claystone: grey (refusal)

Notes:
MC = Moisture Content.
PL = Plastic Limit.
PP = Pocket Penetrometer.

APPENDIX B

Laboratory Test Reports – Geotechnical

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

Test Results - California Bearing Ratio

Client / Address:	Topa Property	Job No:	JC21405A
Project:	Proposed Residential Subdivision Development	Date:	10/09/2021
Location:	1377 Hue Hue Road Wyee	Report No:	R01A

SAMPLE INFORMATION Test Methods	AS 1289 1.1, 1.2.1 (6.5.4)				
Lab Reference No.	SR14620	SR14623	SR14628	SR14630	SR14638
Date Sampled / Received	11-Aug-21	11-Aug-21	11-Aug-21	11-Aug-21	11-Aug-21
Date Tested	06-Sep-21	06-Sep-21	06-Sep-21	06-Sep-21	06-Sep-21
Sample Identification	TP 1 (0.5-0.8m)	TP 2 (0.4-0.7m)	TP 5 (0.4-0.7m)	TP 6 (0.5-0.8m)	TP 11 (0.4-0.7m)
Laboratory Specimen Description	Silty Clay: brown	Silty Clay: brown	Silty Clay: brown	Silty Clay: brown	Silty Clay: brown
Preparation of the test sample					
Liquid Limit Preformed Yes / No	No	No	No	No	No
Visual / Tactile Assessment Yes / No	Yes	Yes	Yes	Yes	Yes
Sample Curing Time	96 h (4 days)	96 h (4 days)	96 h (4 days)	96 h (4 days)	96 h (4 days)
TEST RESULTS					
Laboratory Compaction & Moisture Content - Test Methods AS1289 5.1.1 Mould A and AS1289 2.1.1					
Maximum Dry Density t/m3	1.73	1.60	1.41	1.75	1.42
Optimum Moisture Content %	18.5	22.5	29.5	17.0	29.5
Field Moisture Content %	15.0	19.0	35.5	19.5	32.5
% Of Oversize 19mm	-	-	-	-	-
Replacement of Oversize (See note B)	-	-	-	-	-
California Bearing Ratio - Test Method AS1289 6.1.1					
CBR Test: Dry Density t/m3	Before Soaking	1.73	1.60	1.42	1.77	1.42
	After Soaking	1.71	1.59	1.38	1.77	1.40
CBR Test: Density Ratio %	Before Soaking	100.0	100.0	100.5	101.0	100.0
	After Soaking	99.0	99.5	97.5	100.5	98.0
CBR Test: Moisture Content %	Before Soaking	18.5	22.5	30.0	17.0	30.0
	After Soaking	20.5	25.0	34.5	18.5	34.0
CBR Test: Number of Days Soaked		4	4	4	4	4
CBR Test: Surcharge kg		4.5	4.5	4.5	4.5	4.5
CBR Test: Moisture Content After Test %	Top 30mm	22.0	26.0	37.0	19.0	37.0
	Whole Sample	20.0	25.0	34.5	18.0	34.0
Swell After Soaking %		1.1	0.2	2.9	0.2	1.6
Penetration mm		2.5	2.5	2.5	5.0	2.5
CBR Value %		3.5	5.0	3.0	8.0	3.5

Notes: (A) Test specimen was compacted to a target dry density of 100 percent standard (AS 1289 5.1.1)

(B) If specified the percentage of oversize retained on the 19mm may be replaced by an equal portion of –19mm to +4.75mm

Remarks

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 10/9/21

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

Test Results - Shrink/Swell Index

Client / Address:	Topa Property	Job No:	JC21405A
Project:	Proposed Residential Subdivision Development	Date:	10/09/2021
Location:	1377 Hue Hue Road Wyee	Report No:	R02A

Test Procedure: AS 1289 7.1.1

Sample Identification	TP 1 (0.4-0.8m)	TP 4 (0.5-0.9m)	TP 8 (0.5-0.9m)	TP 12 (0.3-0.6m)
Sample Register No	SR14621	SR14626	SR14633	SR14640
Sample Date	11-Aug-21	11-Aug-21	11-Aug-21	11-Aug-21
Test Date	25-Aug-21	25-Aug-21	25-Aug-21	25-Aug-21
Sample Procedure	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)

Test Results

Test Procedure	AS 1289 2.1.1	AS 1289 2.1.1	AS 1289 2.1.1	AS 1289 2.1.1
Moisture Content				
Initial %	17.0	18.0	38.0	37.0
Final %	20.5	23.5	40.0	41.0

Test Procedure	AS 1289 7.1.1	AS 1289 7.1.1	AS 1289 7.1.1	AS 1289 7.1.1
Estimated UCS				
Before Test kPa	600	160	180	240
After Test kPa	520	150	180	240
Swell %	1.4	0.0	0.1	0.1
Shrinkage %	1.7	2.0	8.1	7.6
Shrink/Swell Index %/pF	1.3	1.1	4.5	4.2
Material Description				

Remarks

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 10/9/21

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

Test Results - Atterberg Limits

Client / Address:	Topa Property	Job No:	JC21405A
Project:	Proposed Residential Subdivision Development	Date:	10/09/2021
Location:	1377 Hue Hue Road Wyee	Report No:	R03A

Sample Identification	TP 1 (0.9-1.0m)	TP 4 (0.5-0.6m)	TP 8 (1.6-1.7m)	TP 12 (0.4-0.5m)
Sample Register No	SR14622	SR14627	SR14634	SR14641
Sample Date	11-Aug-21	11-Aug-21	11-Aug-21	11-Aug-21
Test Date	1-Sep-21	30-Aug-21	1-Sep-21	30-Aug-21
Sample Procedure	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)
Test Results				
Test Procedure:	AS 1289 3.1.2	AS 1289 3.1.2	AS 1289 3.1.2	AS 1289 3.1.2
Liquid Limit (%)	37	42	56	72
Test Procedure:	AS 1289 3.2.1	AS 1289 3.2.1	AS 1289 3.2.1	AS 1289 3.2.1
Plastic Limit (%)	15	19	24	31
Test Procedure:	AS 1289 3.3.1	AS 1289 3.3.1	AS 1289 3.3.1	AS 1289 3.3.1
Plasticity Index (%)	22	23	32	41
Test Procedure:	AS 1289 3.4.1	AS 1289 3.4.1	AS 1289 3.4.1	AS 1289 3.4.1
Linear Shrinkage (%)	11.0	12.0	15.0	18.5
Test Procedure:	AS 1289 2.1.1	AS 1289 2.1.1	AS 1289 2.1.1	AS 1289 2.1.1
Natural Moisture Content %	14.0	21.0	25.0	32.5
Material Description				

Remarks

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 10/9/21

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

Atterberg Limits & Particle Size Distribution

Client / Address:	Topa Property	Job No:	JC21405A
Project:	Proposed Residential Subdivision Development	Date:	10-Sep-2021
Location:	1377 Hue Hue Road Wyee	Report No:	R04A

Lab Reference No:	SR14622	Sample Identification:	TP 1 (0.9-1.0m)
Sample Date:	11/08/2021	Test Date:	1/09/2021

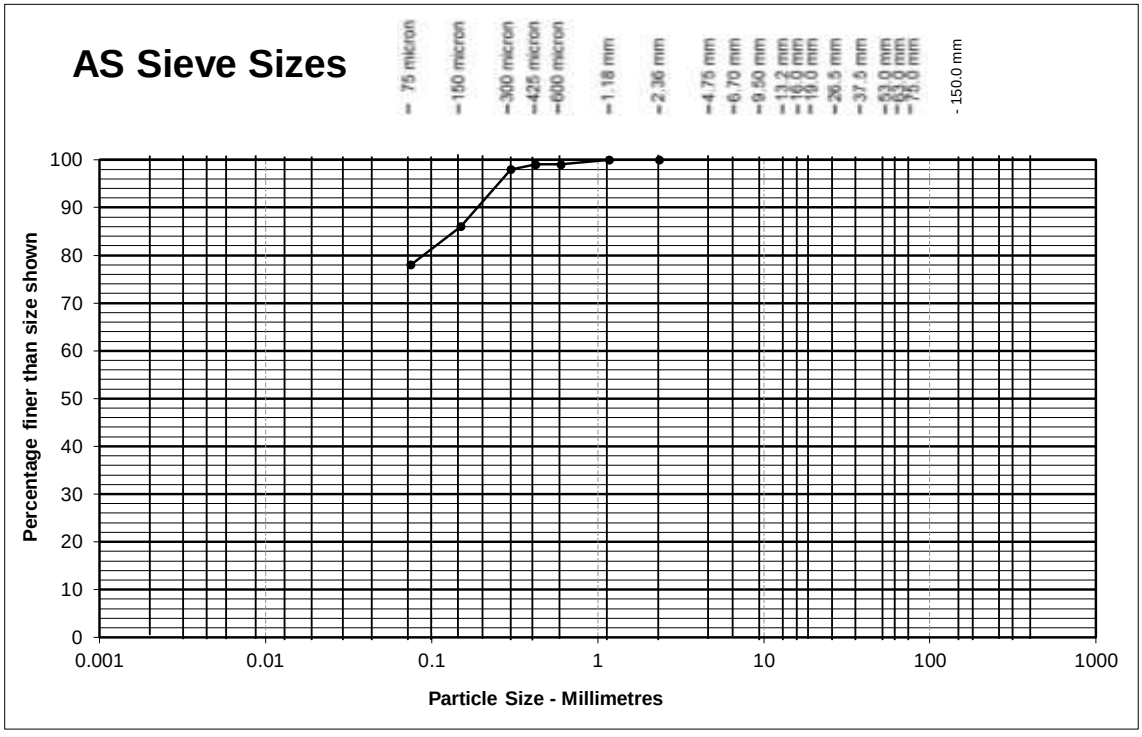
Laboratory Specimen Description:

Test Method	Test Results	Test Procedure
Liquid Limit (%)	-	AS 1289 3.1.1
Plastic Limit (%)	-	AS 1289 3.2.1
Plasticity Index (%)	-	AS 1289 3.3.1
Linear Shrinkage (%)	-	AS 1289 3.4.1
Natural Moisture %	-	AS 1289 2.1.1
Sample History:	-	
Preparation Method.	-	
Condition of linear shrinkage.	-	
Linear shrinkage mould length.	-	

ND = not determined NO = not obtainable NP = non plastic

Test Procedure AS1289 2.1.1, 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
63 mm		
53 mm		
37.5 mm		
26.5 mm		
19 mm		
16 mm		
13.2 mm		
9.5 mm		
6.7 mm		
4.75 mm		
2.36 mm	100	
1.18 mm	100	
600 um	99	
425 um	99	
300 um	98	
150 um	86	
75 um	78	



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	

Remarks:

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 10/9/21

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
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Atterberg Limits & Particle Size Distribution

Client / Address:	Topa Property	Job No:	JC21405A
Project:	Proposed Residential Subdivision Development	Date:	10-Sep-2021
Location:	1377 Hue Hue Road Wyee	Report No:	R05A

Lab Reference No:	SR14629	Sample Identification:	TP 5 (1.3-1.4m)
Sample Date:	11/08/2021	Test Date:	1/09/2021

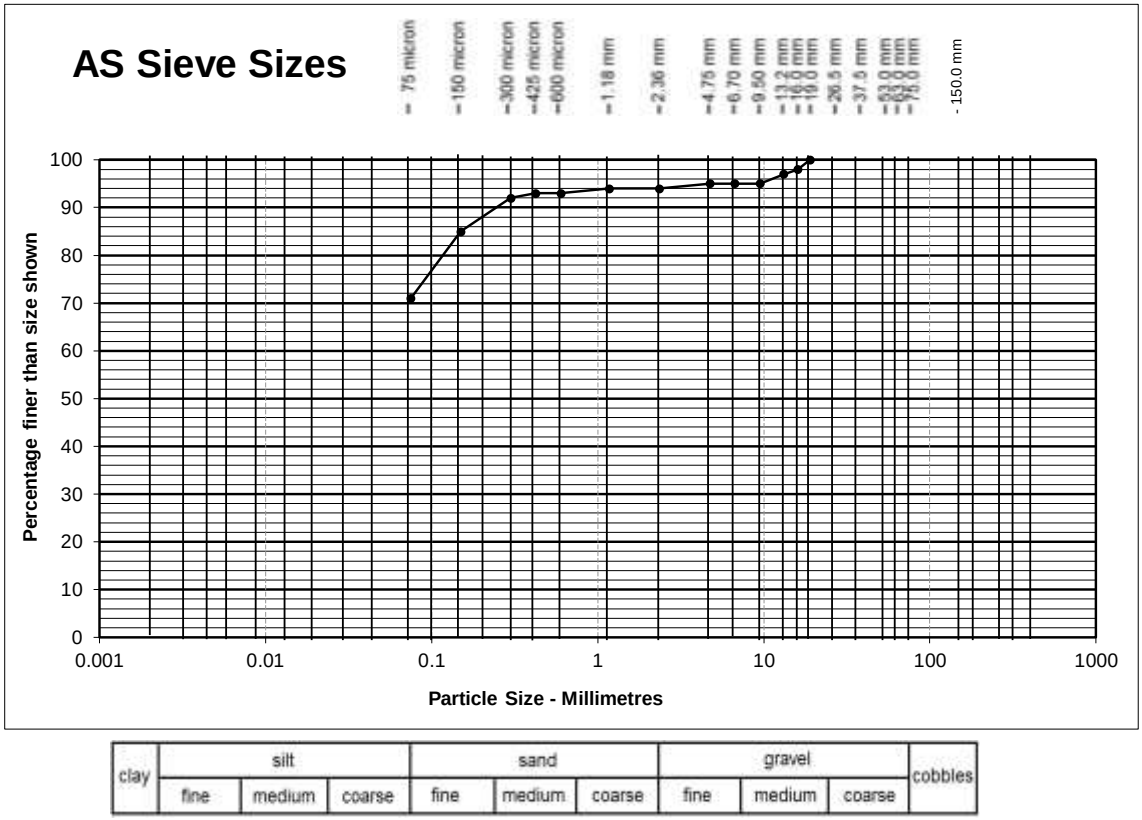
Laboratory Specimen Description:

Test Method	Test Results	Test Procedure
Liquid Limit (%)	-	AS 1289 3.1.1
Plastic Limit (%)	-	AS 1289 3.2.1
Plasticity Index (%)	-	AS 1289 3.3.1
Linear Shrinkage (%)	-	AS 1289 3.4.1
Natural Moisture %	-	AS 1289 2.1.1
Sample History:	-	
Preparation Method.	-	
Condition of linear shrinkage.	-	
Linear shrinkage mould length.	-	

ND = not determined NO = not obtainable NP = non plastic

Test Procedure AS1289 2.1.1, 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
63 mm		
53 mm		
37.5 mm		
26.5 mm		
19 mm	100	
16 mm	98	
13.2 mm	97	
9.5 mm	95	
6.7 mm	95	
4.75 mm	95	
2.36 mm	94	
1.18 mm	94	
600 um	93	
425 um	93	
300 um	92	
150 um	85	
75 um	71	



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	

Remarks:

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 10/9/21

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

Atterberg Limits & Particle Size Distribution

Client / Address:	Topa Property	Job No:	JC21405A
Project:	Proposed Residential Subdivision Development	Date:	10-Sep-2021
Location:	1377 Hue Hue Road Wyee	Report No:	

Lab Reference No:	SR14636	Sample Identification:	TP 9 (1.4-1.5m)
Sample Date:	11/08/2021	Test Date:	1/09/2021

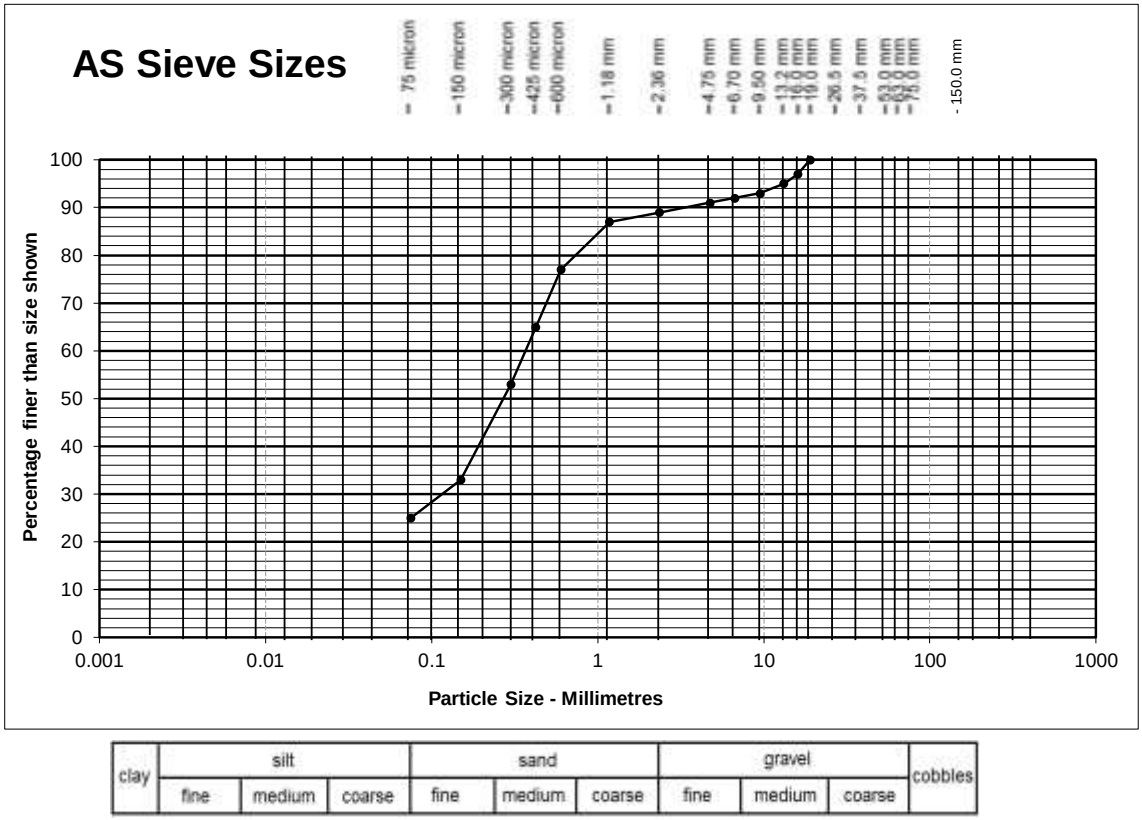
Laboratory Specimen Description:

Test Method	Test Results	Test Procedure
Liquid Limit (%)	-	AS 1289 3.1.1
Plastic Limit (%)	-	AS 1289 3.2.1
Plasticity Index (%)	-	AS 1289 3.3.1
Linear Shrinkage (%)	-	AS 1289 3.4.1
Natural Moisture %	-	AS 1289 2.1.1
Sample History:	-	
Preparation Method.	-	
Condition of linear shrinkage.	-	
Linear shrinkage mould length.	-	

ND = not determined NO = not obtainable NP = non plastic

Test Procedure AS1289 2.1.1, 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
63 mm		
53 mm		
37.5 mm		
26.5 mm		
19 mm	100	
16 mm	97	
13.2 mm	95	
9.5 mm	93	
6.7 mm	92	
4.75 mm	91	
2.36 mm	89	
1.18 mm	87	
600 um	77	
425 um	65	
300 um	53	
150 um	33	
75 um	25	



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	

Remarks:

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 10/9/21

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

Emerson Class Number

Client / Address:	Topa Property	Job No:	JC21405A
Project:	Proposed Residential Subdivision Development	Date:	10-Sep-2021
Location:	1377 Hue Hue Road Wyee	Report No:	R06A

Sample Identification	TP 1 (0.9-1.0m)	TP 2 (0.5-0.6m)	TP 3 (2.1-2.2m)	TP 4 (0.5-0.6m)	TP 5 (1.3-1.4m)
Sample Register No	SR14622	SR14624	SR14625	SR14627	SR14629
Sample Date	11-Aug-21	11-Aug-21	11-Aug-21	11-Aug-21	11-Aug-21
Test Date	08-Sep-21	08-Sep-21	08-Sep-21	08-Sep-21	08-Sep-21
Sample Procedure	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)
Test Procedure	AS 1289 1.1, 1.2.1, 3.8.1				

Test Results

Air Dried crumbs					
Time in water:	3:47	3:47	3:47	3:45	3:46
Time dispersion starts:	5:00	-	4:45	4:20	4:20
Remoulded Soil					
Time in water	-	7:38	-	-	-
Time dispersion starts	-	-	-	-	-
Type of water	Distilled	Distilled	Distilled	Distilled	Distilled
Temp. of water	16°	16°	16°	16°	16°
Emerson Class Number					
Class No.	2	6	2	2	1

Remarks

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

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 10/9/21

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

Emerson Class Number

Client / Address:	Topa Property	Job No:	JC21405A
Project:	Proposed Residential Subdivision Development	Date:	10-Sep-2021
Location:	1377 Hue Hue Road Wyee	Report No:	R07A

Sample Identification	TP 6 (0.6-0.7m)	TP 7 (0.8-0.9m)	TP 8 (1.6-1.7m)	TP 9 (1.4-1.5m)	TP 10 (0.5-0.6m)
Sample Register No	SR14631	SR14632	SR14634	SR14636	SR14637
Sample Date	11-Aug-21	11-Aug-21	11-Aug-21	11-Aug-21	11-Aug-21
Test Date	08-Sep-21	08-Sep-21	08-Sep-21	08-Sep-21	08-Sep-21
Sample Procedure	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)
Test Procedure	AS 1289 1.1, 1.2.1, 3.8.1				

Test Results

Air Dried crumbs					
Time in water:	3:46	3:46	3:46	3:47	3:45
Time dispersion starts:	-	-	5:00	-	-
Remoulded Soil					
Time in water	7:47	7:43	-	7:34	7:48
Time dispersion starts	-	-	-	-	-
Type of water	Distilled	Distilled	Distilled	Distilled	Distilled
Temp. of water	16°	16°	16°	16°	16°
Emerson Class Number					
Class No.	5	6	2	5	5

Remarks

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 10/9/21

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

Emerson Class Number

Client / Address:	Topa Property			Job No:	JC21405A
Project:	Proposed Residential Subdivision Development			Date:	10-Sep-2021
Location:	1377 Hue Hue Road Wyee			Report No:	R08A
Sample Identification	TP 11 (1.5-1.6m)	TP 12 (0.4-0.5m)			
Sample Register No	SR14639	SR14641			
Sample Date	11-Aug-21	11-Aug-21			
Test Date	08-Sep-21	08-Sep-21			
Sample Procedure	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)			
Test Procedure	AS 1289 1.1, 1.2.1, 3.8.1				
Test Results					
Air Dried crumbs					
Time in water:	3:45	3:45			
Time dispersion starts:	-	-			
Remoulded Soil					
Time in water	7:49	8:02			
Time dispersion starts	8:02	-			
Type of water	Distilled	Distilled			
Temp. of water	16°	16°			
Emerson Class Number					
Class No.	3	6			
Remarks					

Accredited for compliance with ISO/IEC 17025 - Field of Testing.

The results of the tests, calibrations and/or measurements included in this documents are traceable to Australian/national standards

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 10/9/21

APPENDIX C

Laboratory Test Reports – Salinity

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

CERTIFICATE OF ANALYSIS 276104

Client Details

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

Sample Details

Your Reference	**JC21405A, Wyee**
Number of Samples	37 Soil
Date samples received	18/08/2021
Date completed instructions received	18/08/2021

Analysis Details

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

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

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

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	25/08/2021
Date of Issue	24/08/2021

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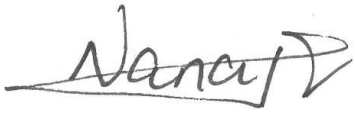
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		276104-1	276104-2	276104-3	276104-4	276104-5
Your Reference	UNITS	TP 1	TP 1	TP 1	TP 2	TP 2
Depth		0.00-0.10	0.90-1.00	2.70-2.80	0.00-0.10	0.50-0.60
Type of sample		Soil	Soil	Soil	Soil	Soil
Date Sampled		11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
Date prepared	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Date analysed	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units	5.9	4.9	6.2	5.4	5.1
Electrical Conductivity 1:5 soil:water	µS/cm	24	290	460	29	88
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	290	530	[NA]	67
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	71	50	[NA]	39
Resistivity in soil*	ohm m	[NA]	[NA]	22	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		276104-6	276104-7	276104-8	276104-9	276104-10
Your Reference	UNITS	TP 2	TP 2	TP 3	TP 3	TP 3
Depth		1.80-1.90	2.50-2.60	0.10-0.20	0.70-0.80	2.10-2.20
Type of sample		Soil	Soil	Soil	Soil	Soil
Date Sampled		11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
Date prepared	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Date analysed	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units	4.9	5.3	5.3	5.3	5.3
Electrical Conductivity 1:5 soil:water	µS/cm	200	85	44	120	290
Chloride, Cl 1:5 soil:water	mg/kg	170	73	[NA]	99	320
Sulphate, SO4 1:5 soil:water	mg/kg	88	20	[NA]	55	69
Resistivity in soil*	ohm m	50	[NA]	[NA]	85	[NA]

Misc Inorg - Soil						
Our Reference		276104-11	276104-12	276104-13	276104-14	276104-15
Your Reference	UNITS	TP 4	TP 4	TP 4	TP 5	TP 5
Depth		0.00-0.10	0.50-0.60	1.90-2.00	0.00-0.10	0.40-0.50
Type of sample		Soil	Soil	Soil	Soil	Soil
Date Sampled		11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
Date prepared	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Date analysed	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units	5.6	5.4	5.8	5.8	5.5
Electrical Conductivity 1:5 soil:water	µS/cm	210	180	240	36	77
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	130	200	[NA]	39
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	120	150	[NA]	64
Resistivity in soil*	ohm m	[NA]	[NA]	41	[NA]	130

Misc Inorg - Soil						
Our Reference		276104-16	276104-17	276104-18	276104-19	276104-20
Your Reference	UNITS	TP 5	TP 6	TP 6	TP 6	TP 7
Depth		1.30-1.40	0.10-0.20	0.60-0.70	2.30-2.40	0.00-0.10
Type of sample		Soil	Soil	Soil	Soil	Soil
Date Sampled		11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
Date prepared	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Date analysed	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units	5.1	5.6	5.4	4.9	5.8
Electrical Conductivity 1:5 soil:water	µS/cm	140	21	31	44	43
Chloride, Cl 1:5 soil:water	mg/kg	89	[NA]	<10	22	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	92	[NA]	36	32	[NA]
Resistivity in soil*	ohm m	[NA]	[NA]	[NA]	220	[NA]

Misc Inorg - Soil						
Our Reference		276104-21	276104-22	276104-23	276104-24	276104-25
Your Reference	UNITS	TP 7	TP 7	TP 8	TP 8	TP 8
Depth		0.80-0.90	1.90-2.00	0.00-0.10	0.60-0.70	1.60-1.70
Type of sample		Soil	Soil	Soil	Soil	Soil
Date Sampled		11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
Date prepared	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Date analysed	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units	6.1	5.9	5.8	5.2	5.3
Electrical Conductivity 1:5 soil:water	µS/cm	64	54	37	130	170
Chloride, Cl 1:5 soil:water	mg/kg	55	39	[NA]	76	150
Sulphate, SO4 1:5 soil:water	mg/kg	20	23	[NA]	110	77
Resistivity in soil*	ohm m	160	[NA]	[NA]	[NA]	58

Misc Inorg - Soil						
Our Reference		276104-26	276104-27	276104-28	276104-29	276104-30
Your Reference	UNITS	TP 9	TP 9	TP 9	TP 10	TP 10
Depth		0.00-0.10	0.40-0.50	1.40-1.50	0.00-0.10	0.50-0.60
Type of sample		Soil	Soil	Soil	Soil	Soil
Date Sampled		11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
Date prepared	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Date analysed	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units	6.1	5.8	5.7	6.3	5.6
Electrical Conductivity 1:5 soil:water	µS/cm	21	38	41	37	79
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	10	20	[NA]	20
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	34	39	[NA]	100
Resistivity in soil*	ohm m	[NA]	260	[NA]	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		276104-31	276104-32	276104-33	276104-34	276104-35
Your Reference	UNITS	TP 10	TP 11	TP 11	TP 11	TP 12
Depth		1.20-1.30	0.10-0.20	0.60-0.70	1.50-1.60	0.00-0.10
Type of sample		Soil	Soil	Soil	Soil	Soil
Date Sampled		11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
Date prepared	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
Date analysed	-	20/08/2021	20/08/2021	20/08/2021	20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units	5.6	5.8	5.5	5.7	5.5
Electrical Conductivity 1:5 soil:water	µS/cm	55	32	72	54	46
Chloride, Cl 1:5 soil:water	mg/kg	20	[NA]	24	20	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	56	[NA]	70	54	[NA]
Resistivity in soil*	ohm m	180	[NA]	140	[NA]	[NA]

Misc Inorg - Soil			
Our Reference		276104-36	276104-37
Your Reference	UNITS	TP 12	TP 12
Depth		0.40-0.50	0.90-1.00
Type of sample		Soil	Soil
Date Sampled		11/08/2021	11/08/2021
Date prepared	-	20/08/2021	20/08/2021
Date analysed	-	20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units	5.2	5.5
Electrical Conductivity 1:5 soil:water	µS/cm	170	100
Chloride, Cl 1:5 soil:water	mg/kg	120	64
Sulphate, SO4 1:5 soil:water	mg/kg	110	63
Resistivity in soil*	ohm m	[NA]	96

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	276104-3
Date prepared	-			20/08/2021	2	20/08/2021	20/08/2021		20/08/2021	20/08/2021
Date analysed	-			20/08/2021	2	20/08/2021	20/08/2021		20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	4.9	4.9	0	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	2	290	270	7	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	290	280	4	81	#
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	71	71	0	90	84
Resistivity in soil*	ohm m	1	Inorg-002	<1	21	160	170	6	[NT]	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	276104-22
Date prepared	-			[NT]	11	20/08/2021	20/08/2021		20/08/2021	20/08/2021
Date analysed	-			[NT]	11	20/08/2021	20/08/2021		20/08/2021	20/08/2021
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	11	5.6	5.6	0	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	11	210	190	10	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	21	55	47	16	81	73
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	21	20	22	10	89	118
Resistivity in soil*	ohm m	1	Inorg-002	[NT]	31	180	200	11	[NT]	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	21	20/08/2021	20/08/2021		[NT]	[NT]
Date analysed	-			[NT]	21	20/08/2021	20/08/2021		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	21	6.1	6.1	0	[NT]	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	21	64	57	12	[NT]	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	31	20	10	67	[NT]	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	31	56	51	9	[NT]	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	31	20/08/2021	20/08/2021		[NT]	[NT]
Date analysed	-			[NT]	31	20/08/2021	20/08/2021		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	31	5.6	5.6	0	[NT]	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	31	55	51	8	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

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

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

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

Report Comments

MISC_INORG_DRY
Percent recovery is not applicable due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

pH /EC: Samples were analysed out of the recommended holding time for this analysis.

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

SAMPLE RECEIPT ADVICE

Client Details

Client	Geoenviro Consultancy Pty Ltd
Attention	Solern Liew

Sample Login Details

Your reference	JC21405A, Wyee
Envirolab Reference	276104
Date Sample Received	18/08/2021
Date Instructions Received	18/08/2021
Date Results Expected to be Reported	25/08/2021

Sample Condition

Samples received in appropriate condition for analysis	Yes
No. of Samples Provided	37 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	15
Cooling Method	Ice Pack
Sampling Date Provided	YES

Comments

Sample 19 - depth on COC is 2.30-2.40 and jar labelled as 2.30-2.70 assumed correct

Please direct any queries to:

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

Analysis Underway, details on the following page:

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

Sample ID	Misc Inorg - Soil
TP 1-0.00-0.10	✓
TP 1-0.90-1.00	✓
TP 1-2.70-2.80	✓
TP 2-0.00-0.10	✓
TP 2-0.50-0.60	✓
TP 2-1.80-1.90	✓
TP 2-2.50-2.60	✓
TP 3-0.10-0.20	✓
TP 3-0.70-0.80	✓
TP 3-2.10-2.20	✓
TP 4-0.00-0.10	✓
TP 4-0.50-0.60	✓
TP 4-1.90-2.00	✓
TP 5-0.00-0.10	✓
TP 5-0.40-0.50	✓
TP 5-1.30-1.40	✓
TP 6-0.10-0.20	✓
TP 6-0.60-0.70	✓
TP 6-2.30-2.40	✓
TP 7-0.00-0.10	✓
TP 7-0.80-0.90	✓
TP 7-1.90-2.00	✓
TP 8-0.00-0.10	✓
TP 8-0.60-0.70	✓
TP 8-1.60-1.70	✓
TP 9-0.00-0.10	✓
TP 9-0.40-0.50	✓
TP 9-1.40-1.50	✓
TP 10-0.00-0.10	✓
TP 10-0.50-0.60	✓
TP 10-1.20-1.30	✓
TP 11-0.10-0.20	✓

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

Sample ID	Misc Inorg - Soil
TP 11-0.60-0.70	✓
TP 11-1.50-1.60	✓
TP 12-0.00-0.10	✓
TP 12-0.40-0.50	✓
TP 12-0.90-1.00	✓

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

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.
Please contact the laboratory immediately if observed settled sediment present in water samples is to be included in the extraction and/or analysis (exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS analysis where solids are included by default.
TAT for Micro is dependent on incubation. This varies from 3 to 6 days.

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 9679 8733 Fax: (02) 9679 8744

Laboratory Test Request/Chain of Custody Record

Job Details
Job Number: JC21405A
Client:
Project:
Location: 1377 Hue Hue Road Wyee

Sample Date: 11/8/21
Sampled By: AT
Project Manager: SL
Store Location:

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

Sampling Details			Sample Type		Test Required (\) / Test Performed(X)																				
Location	Depth From	Depth To	Soil	Water	Combination 5	Combination 5a	Combination 12a		Heavy Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)	OCP	PCB	TRH	BTEX	PAH	Asbestos		Aggressivity (pH, EC, Cl, SO_4)	pH	EC	Cl / SO_4	Resistivity	CEC / ESP				Keep Sample
1 TP 1	0.00	0.10	DG														/	/							
2 TP 1	0.90	1.00	DG														/								
3 TP 1	2.70	2.80	DG														/				/				
4 TP 2	0.00	0.10	DG														/	/	/						
5 TP 2	0.50	0.60	DG														/								
6 TP 2	1.80	1.90	DG														/				/				
7 TP 2	2.50	2.60	DG														/								
8 TP 3	0.10	0.20	DG														/	/	/						
9 TP 3	0.70	0.80	DG														/				/				
10 TP 3	2.10	2.20	DG														/								
11 TP 4	0.00	0.10	DG														/	/	/						
12 TP 4	0.50	0.60	DG														/								
13 TP 4	1.90	2.00	DG														/				/				
14 TP 5	0.00	0.10	DG														/	/	/						
15 TP 5	0.40	0.50	DG														/				/				
16 TP 5	1.30	1.40	DG														/								

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 276104
Date Received: 18/8/21
Time Received: 1145
Received By: CH
Temp: Cool/Ambient
Cooling: Ice/Icepack 15°C
Security: Intact/Broken/None

Relinquished by				Received By			
Laboratory	Name	Signature	Date	Laboratory	Name	Signature	Date
GeoEnviro Consultancy	Adrian Tejada		16/08/2021	ECSYD	Christine		18/08/21

Legend

DB Disturbed Sample (Bulk, Plastic bag)	U50 Undisturbed Sample, 50mm Tube	Y Keep Sample
DS Disturbed Sample (Small, Plastic bag)	U75 Undisturbed Sample, 75mm Tube	N Discard Sample
DG Disturbed Sample (Glass Jar)	WG Water Sample, Amber Glass Jar	
STP Standard Penetration Test Sample	WP Water Sample, Plastic Bottle	

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 9679 8733 Fax: (02) 9679 8744

Laboratory Test Request/Chain of Custody Record

Job Details
Job Number: JC21405A
Client:
Project:
Location: 1377 Hue Hue Road Wyee

Sample Date: 11/8/21
Sampled By: AT
Project Manager: SL
Store Location:

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

Sampling Details				Sample Type		Test Required (\) / Test Performed(X)																				
Location		Depth (m)		Soil	Water	Combination 5	Combination 5a	Combination 12a		Heavy Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)	OCP	PCB	TRH	BTEX	PAH	Asbestos		Aggressivity (pH, EC, Cl, SO_4)	pH	EC	Cl / SO_4	Resistivity	CEC / ESP				Keep Sample
		From	To																								
17	TP 6	0.10	0.20	DG															X	X						
18	TP 6	0.60	0.70	DG														X								
19	TP 6	2.30	2.40	DG														X				X				
20	TP 7	0.00	0.10	DG															X	X						
21	TP 7	0.80	0.90	DG														X				X				
22	TP 7	1.90	2.00	DG														X								
23	TP 8	0.00	0.10	DG															X	X						
24	TP 8	0.60	0.70	DG														X								
25	TP 8	1.60	1.70	DG														X				X				
26	TP 9	0.00	0.10	DG															X	X						
27	TP 9	0.40	0.50	DG														X				X				
28	TP 9	1.40	1.50	DG														X								
29	TP 10	0.00	0.10	DG															X	X						
30	TP 10	0.50	0.60	DG														X								
31	TP 10	1.20	1.30	DG														X				X				

Relinquished by				Received By			
Laboratory	Name	Signature	Date	Laboratory	Name	Signature	Date
GeoEnviro Consultancy	Adrian Tejada		16/08/2021	ECSSYD	Christine		18/08/21

Legend
DB Disturbed Sample (Bulk, Plastic bag)
DS Disturbed Sample (Small, Plastic bag)
DG Disturbed Sample (Glass Jar)
STP Standard Penetration Test Sample
U50 Undisturbed Sample, 50mm Tube
U75 Undisturbed Sample, 75mm Tube
WG Water Sample, Amber Glass Jar
WP Water Sample, Plastic Bottle
Y Keep Sample
N Discard Sample

#276104

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 9679 8733 Fax: (02) 9679 8744

Laboratory Test Request/Chain of Custody Record

Job Details
Job Number: JC21405A
Client:
Project:
Location: 1377 Hue Hue Road Wyee

Sample Date: 11/8/21
Sampled By: AT
Project Manager: SL
Store Location:

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

Sampling Details				Sample Type		Test Required (\) / Test Performed(X)																				
Location		Depth (m)		Soil	Water	Combination 5	Combination 5a	Combination 12a		Heavy Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)	OCP	PCB	TRH	BTEX	PAH	Asbestos		Aggressivity (pH, EC, Cl, SO_4)	pH	EC	Cl / SO_4	Resistivity	CEC / ESP				Keep Sample
		From	To																								
32	TP 11	0.10	0.20	DG														/	/							
33	TP 11	0.60	0.70	DG														/				/				
34	TP 11	1.50	1.60	DG														/								
35	TP 12	0.00	0.10	DG															/	/						
36	TP 12	0.40	0.50	DG														/								
37	TP 12	0.90	1.00	DG														/				/				

Relinquished by				Received By			
Laboratory	Name	Signature	Date	Laboratory	Name	Signature	Date
GeoEnviro Consultancy	Adrian Tejada		16/08/2021	ECS SYD.	Christine		18/08/21

Legend
DB Disturbed Sample (Bulk, Plastic bag)
DS Disturbed Sample (Small, Plastic bag)
DG Disturbed Sample (Glass Jar)
STP Standard Penetration Test Sample
U50 Undisturbed Sample, 50mm Tube
U75 Undisturbed Sample, 75mm Tube
WG Water Sample, Amber Glass Jar
WP Water Sample, Plastic Bottle
Y Keep Sample
N Discard Sample

ES276104

APPENDIX D

A Brief Explanation of Site Classification

A BRIEF EXPLANATION OF SITE CLASSIFICATION

1. Introduction

The intention of the Australian Standard 2870-2011, "Residential Slabs and Footings" is to provide guidance on footing design for residential buildings with a particular emphasis on reactive clay sites. Footing design and construction involves the following steps:

- site classification
- selection of an appropriate footing system
- structural design
- construction in accordance with the required design details and construction methods
- proper site maintenance after construction

The classification assessed in this report is the first step in providing an economical footing system for a residence which will limit cracking of footings, floor slabs and masonry walls to an extent normally considered acceptable. (Performance expectations are explained in AS 2870- 2011). It is necessary that each subsequent step be diligently observed to achieve acceptable performance.

It is imperative when applying the site classifications presented in this report to residential footing design, that these performance expectations are acceptable to the home owner.

2. What is a Reactive Soil?

A reactive soil undergoes appreciable volume change when its moisture content changes. This causes ground surface movements which can result in fooling movements. The extent of ground movement that can occur depends on the clay mineralogy, the depth of clay in the soil profile, the depth of potential moisture variation in the soil and the change in soil suction that occurs from dry to wet soil conditions. AS2870 provides a classification system to quantify the range of ground surface movements anticipated (defined as having less than 5% chance of being exceeded in the design life of the structure).

3. How are Sites Classified in the Sydney Region

Experiment and observation within the Sydney Region indicates a high variability in the potential for reactive movements, which is not clearly related to soil association, terrain location or visual appearance and may not be accurately predicted by simple soil tests. Intense, complex and expensive testing is required at a site to accurately predict its potential for reactive behaviour. To avoid this, a simplified classification procedure for the Sydney region has been devised which is based on the depth of clay in the soil profile. This procedure is detailed in AS2870 – 2011.

4. What is a Class P Site?

Footing design may need to consider other factors beside reactive soils. Such factors include the presence of filling, the presence of compressible or collapsible soils, or the need to consider slope stability aspects. When these or other factors need to be considered the site may be classified P. The footing "solution" for Class P sites requires special engineering consideration. On many sites the "solution may the straight forward and may not necessarily incur major cost increases.

5. Filled Sites

The most common "problem" associated with residential lots is the presence of fill, compacted or otherwise, overlying the natural soils. If the fill is uncompacted, or if there are no records of adequate compaction, a piered footing system is usually adopted which penetrates the fill and found on natural ground.

AS2870 - 2011 indicates that a compacted fill site may be given a less severe classification than P if assessed in accordance with engineering principles. Subdivision developments often include areas of compacted filling which will usually have been required to have been compacted to the relevant Council Specifications. Adequately compacted filling will usually provide sufficient bearing capacity for residential footing loads, but the clay in the fill will also experience reactive soil movements. Depending on the moisture content at which the fill is placed and the compaction which has been achieved, reactive soil movements may exceed those experienced by the natural soil from which the fill has been derived. As a result, classification of compacted fill sites sometimes needs to be conservative.

6. Site Classifications should be Project Specific

Many Councils require that all lots within a new subdivision be classified prior to subdivision approval. This practice precludes a consideration of the impact of site preparation works on the classification. Sites which are not level are often cut and filled to provide a level platform for floor slab construction. AS2870 specifies that the classification shall be reconsidered if:

(a) the depth of cut exceeds 500mm, or
(b) the depth of compacted fill exceeds 400mm for clay (or 800mm for sand).

Where the classification provided in this report is carried out prior to the site development details being known it is a condition of this report that plans for future development of the block be reviewed by a geotechnical engineer to assess the impact of proposed site works and also the impact of work which may have occurred on adjacent sites since the date of this classification. Altering the site classification may be required in some cases.

7. Site Maintenance

The classifications presented in this report have been assessed for moisture variations caused by climatic and "normal" garden conditions. More severe moisture variation can be caused by other common factors, such as removing or planting trees, leaking plumbing, irrigation systems etc. Guidelines to appropriate site maintenance are provided in CSIRO 10-91 "A Guide to Home Owners on Foundation Maintenance and Footing Performance". Most Damage to residences on reactive sites is due to poor site maintenance. Footings designed to AS2870 may not perform satisfactorily if sites are not properly maintained.

APPENDIX E

Explanatory Notes

EXPLANATORY NOTES

Introduction

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The test results are reported in the following form:

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

  as 4, 6, 7
  N = 13

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

  as 15,30/40mm

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Site Inspection

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

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