



Your Reference: GAA-Clyde (Melways Reference 95G3)

06 December 2012

Growth Area Authority
C/- Beveridge Williams
PO Box 61
Malvern VIC 3144

Attention: Belinda Smith / Andrew Mellet

Dear Belinda / Andrew,

**RE: RESIDENTIAL/COMMERCIAL DEVELOPMENT & TOWN CENTRE, CLYDE CREEK
& THOMPSONS ROAD CLYDE PRELIMINARY GEOTECHNICAL INVESTIGATION &
DESKTOP STUDY**

Please find attached our report on the Preliminary Geotechnical Investigation & Desktop Study for the Residential/Commercial Development & Town Centre project located at Clyde Creek & Thompsons Road, Clyde.

Should you have any queries or comments regarding this report please feel free to contact the undersigned.

Regards

.....
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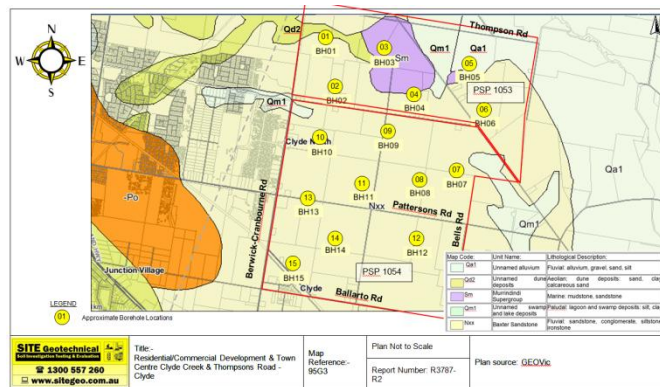


Preliminary Geotechnical Investigation & Desktop Study

Residential/Commercial Development & Town Centre Clyde Creek & Thompsons Road Clyde

06 December 2012
 Report R3787-R2
 (Melways Reference: 95G3)

For
 Growth Area Authority
 C/- Beveridge Williams
 PO Box 61
 Malvern VIC 3144



SUMMARY

This report presents the findings of a Preliminary Geotechnical Investigation & Desktop Study undertaken by Site Geotechnical Pty Ltd for the Residential/Commercial Development & Town Centre project located at Clyde Creek & Thompsons Road, Clyde. Growth Area Authority is managing the preparation of both the Clyde Creek and Thompsons Road Precinct Structure Plans (PSPs) in partnership with the City of Casey Council.

The aim of this report is to provide preliminary geotechnical information for the proposed development. It must be recognized that information provided is limited as the number of boreholes and hours for investigation, inspection and reporting were limited to suit the preliminary nature and that further and ongoing investigations will be required as the project progresses.

Information collected indicates that the two PSPs are located within several geologies. From a geotechnical perspective, the areas located within the geologies Baxter Sandstone, Murrindindi Supergroup, Unnamed dune deposits and Unnamed alluvium are expected to present more favourable geotechnical conditions for design and construction of typical infrastructures. Less favourable geotechnical conditions are expected within the geology of lagoon and swamp deposits. High level of engineering and robust construction designs are expected within lagoon and swamp deposits if structures are planned to be developed within this area.

The areas, within the geological areas of Baxter Sandstone, Murrindindi Supergroup, Unnamed dune deposits and Unnamed alluvium mainly comprising of Silty SAND or Sandy SILT overlying Silty CLAY, are anticipated to be classified as Class M according to AS2870-2011 "Residential slabs and footings". For the areas within or close proximity to the geological area of lagoon and swamp deposits, it is considered that these areas are anticipated to be classified as Class H1 or Class H2.

In some cases, consideration should be given to Class P, engineering designed foundations, should one or more of the following conditions be encountered: areas comprising of soft, loose, collapsing or unstable soils; areas susceptible to landslides, mine subsidence or significant erosion; reactive areas subject to abnormal moisture conditions; areas that cannot be classified in accordance with Clause 2.1.2 of AS2870-2011 or areas containing uncontrolled or controlled fill as identified in clause 2.5.3 of AS2870-2011.

Desktop study indicates former mining activities within PSP 53. Further investigation and engineering consultation will be required to assess specific geotechnical hazards associated with mining activity in the area. Mines are likely to present a risk to public safety. A site specific study will be required to determine the levels of stability and risks and should provide recommendations for design, construction and risk mitigation measures as required.

Further investigation to detect potential geotechnical problems is recommended within the geology of lagoon and swamp deposits if structures are planned to be developed within this area. A buffer zone and/or revegetation zone is likely to be preferred around existing waterways to minimise the potential for erosion, creek bank instabilities and other environmental issues.

Sites in the geological area of lagoon and swamp deposits and low lying areas with creeks are often challenging and usually incur higher construction costs than that of standard 'class M' type sites.

It is noted that there are numerous existing dams across the two PSP sites. Based on existing experience the as built quality of existing farm dams can be quite variable subsequently further investigation would be required to determine if individual dam structures should be converted into part of the wetland system or backfilled using site derived materials. The overall strategy should consider achieving multiple aims.

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1 INTRODUCTION

This report presents the findings of a Preliminary Geotechnical Investigation & Desktop Study undertaken by Site Geotechnical Pty Ltd for the Residential/Commercial Development & Town Centre project located at Clyde Creek & Thompsons Road, Clyde as shown within Appendix A – Engineering Log Location Plan.

The work was commissioned by Beveridge Williams on behalf of Growth Area Authority. The investigation was carried out in accordance with our proposal; reference Q3787, dated 17 January 2012.

2 OBJECTIVES AND SCOPE OF WORKS

The objectives and scope of the investigation work adopted for this particular site investigation, its extent and methods used has been based on site-specific circumstances and information supplied.

2.1 *Field Investigation*

The objectives and scope of the field investigation are to:

- Assess and identify components of existing subsurface (or subgrade) soils including any unusual conditions and groundwater conditions which will include visual and tactile assessment of materials encountered and provide interpretation of these findings within engineering logs generally complying with Australian Standard AS1726,
- SITE Geotechnical is to set out the borehole locations and prepare the engineering logs of the strata encountered as agreed with Beveridge Williams¹.

2.2 *Engineering & Reporting*

The objectives and scope of the engineering and reporting works are to:

- Report and graphically represent engineering log data
- Assessment of findings of the desktop review to include:
 1. Geology description of the precincts.
 2. Assessment of site geology, including construction issues, anticipated bearing capacities and founding mediums.
 3. Provide comments related to expected groundwater levels.
 4. Review and summarise available information collected from previous geotechnical reports within the two precincts and surroundings.
- Provide general comments related to previous experiences in the area.
- Prepare a report presenting the factual findings of the investigation together with comments relating to the design and construction options for the proposed works

¹ The locations were generally located to provide a spread of borehole across the site.

2.3 Presentation

Contained within this preliminary report are summaries of factual findings, interpretative condition and general recommendations. It must be recognized that information provided is limited as the number of boreholes and hours for investigation, inspection and reporting were limited to suit the preliminary nature. It should be recognized that further and ongoing investigations will be required as the project progresses.

The site plans, engineering logs, groundwater observations, together with notes which briefly describe the investigation techniques and their limitations are mentioned throughout the report. More detailed information related to each of these items is attached within the appendices.

3 LOCATION, DESCRIPTION AND WALKOVER SURVEY

Growth Area Authority is managing the preparation of both the Clyde Creek and Thompsons Road Precinct Structure Plans (PSPs) in partnership with the City of Casey Council. Clyde Creek PSP 54 covers an area of approximately 1153 ha and is traversed by the natural watercourse Clyde Creek. The precinct is expected to support a residential community of approximately 15,000 dwellings and Major Town Centre in association with a new Clyde Railway Station. Thompson Road PSP 53 covers an area of approximately 700 ha and is expected to support a residential community of approximately 4,200 dwellings in association with 300 ha of employment land and a Major Town Centre. An approximate location of the two PSPs is presented within Appendix A – Engineering Log Location Plan. The general topography comprises of flat to undulating terrain, with ground cover comprising mainly of grasses with groups of trees mainly confined to fence lines and parts of Clyde Creek and some bare earth areas associated with market gardening and the quarry.

3.1 Surrounding Development

The observed surrounding development is inferred to comprise of:

- A rural farming area, with minimal residential development.
- Existing features related to previous development associated with the areas under investigation indicate that the PSPs areas have been slightly developed in the past with previous development consisting of a market gardening, power lines, quarry, former dairies, single storey dwellings, sheds, animal grazing, dams, gravel and asphalt surfaced roads.

An aerial photograph of the site and surrounds is shown below;

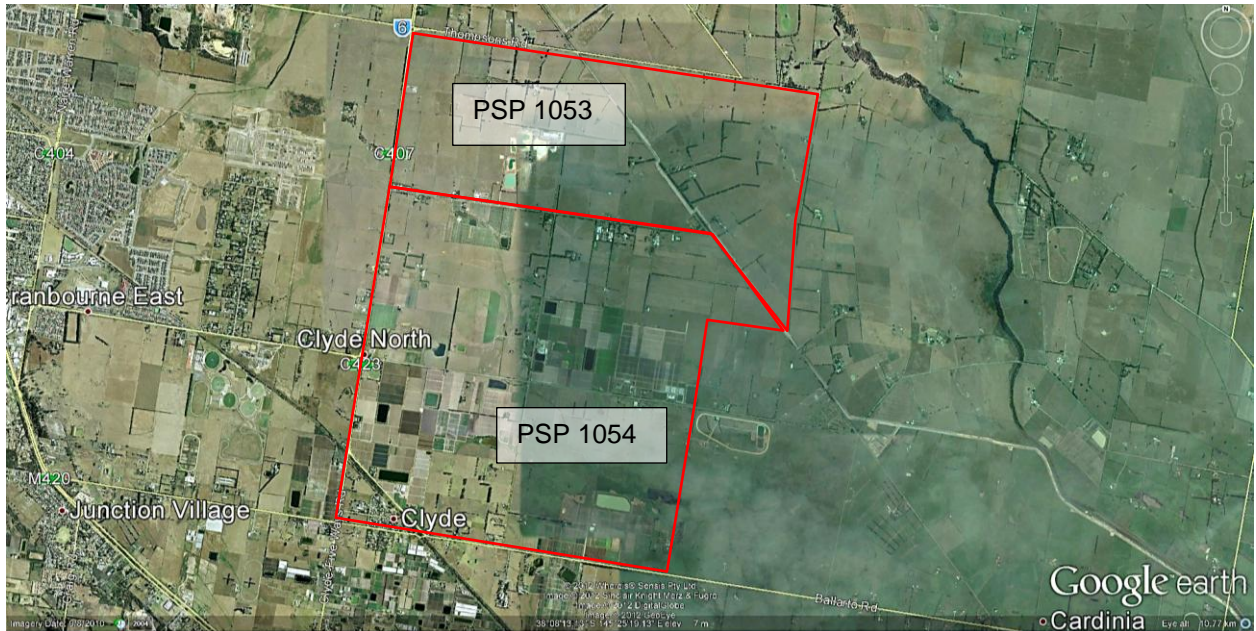


Figure 3-1 Aerial photograph of the site and surroundings

3.2 Vegetation

A sparse cover² of trees was observed within the inferred PSPs boundaries. Trees were observed to be mainly confined to fence lines and parts of Clyde creek.

3.2.1 Comments Related to Slope Stability and Creek Environments

According to Glade et al (2005), Vegetation affects the stability of soils and slopes in two major ways: first, by modifying components of the hydrological cycle largely through the processes of interception, evapotranspiration and infiltration; and second, by contributing strength to the soil via roots. "Removal of vegetation permits an increase in erosion (runoff)...an increase in infiltration during rainy periods (which may include an increase of groundwater level), and an increase in evaporation during dry spells resulting in surface desiccation and cracking" (Hunt, 2007).

According to the Department of Environment and Resource Management of the State of Queensland, rivers and streams are products of their catchments and they are often referred to as dynamic systems. The factors controlling their formation are complex and interrelated. Erosion of creek beds and banks is a natural process. However erosion rates are significantly increased by human activities such as clearing land for agricultural production, and uncontrolled grazing by stock. The key principle in preventing or reducing erosion along creeks is to maintain good ground cover over the surface of the banks. The roots of vegetation growing along and on top of the bank also help to reinforce the soil and reduce the erosion rate, while vegetation growing within the creek channel can also slow water flow and trap sediment (Land & Water Australia, 2007).

² Occurring, growing, or settled at widely spaced intervals (scattered); not thick or dense.

A setback distance from creeks is generally necessary for human development in order to avoid disturbing the creek environment. From a geotechnical perspective, soils encountered within and/or in close proximity to creek environments usually have poor engineering properties including low shear strength and high compressibility. Setback distances from creeks are generally necessary to avoid marginally stable creek banks and soils having poor bearing capacity. A specific study should be carried out for developments in close proximity to creek environments.

It is likely that several culverts or bridge crossings would be required as part of development of the site. Underground assets which may be required to cross these areas will also require special alteration to construction methodology.

3.3 Rock Outcrop

Information obtained from geological maps and engineering logs indicates the investigated section is within the geological areas of Baxter Sandstone (fluvial soils, sandstone, conglomerate, siltstone and ironstone), Murrindindi Supergroup (marine soils, mudstone, sandstone) and Unnamed dune deposits (aeolian soils, dune deposits: sand, clay, calcareous sand) with some pockets of paludal: lagoon and swamp deposits (silt, clay) and Unnamed alluvium (fluvial soils: alluvium, gravel, sand, silt) as it can be seen within Figure 4-1.

No exposed areas of rock that is inferred to be continuous with underlying rock were observed. Part of the PSPs areas was observed to have a relatively thick cover of grass³, which limited the rock outcrop observations. However, subsurface investigation revealed mechanical auger refusal at 0.9 m depth within test site 1. This feature suggests the presence of weathered siltstone rock close to where the auger refusal was encountered as test site 01 is within the Baxter Sandstone geology based on information collected from geological maps. The findings from test site 01 are considered consistent with the Baxter Sandstone geology.

Previous experiences within the surroundings indicate that subsurface explorations generally do not encounter auger refusal up to 1.5 m depth, which may infer the nonappearance of rock up to this depth. However it is not discarded that there is a possibility that deep excavations may encounter weathered rock within the Baxter Sandstone and Murrindindi Supergroup geologies. It should be also noted that the presence of a former quarry highlights the potential of rock within the area.

Further geotechnical investigation, which may include boring to greater depths, rock coring and unconfined compressive strength tests, would be required to determine the presence and characteristic of rock within the two PSPs.

³ This reference excludes the areas where the market exists in PSP 54.

3.4 Drainage and Water

Water is a macro factor affecting soil and rocks behaviour. According to Hunt (2007), “Storm intensity, ground saturation, vegetation, frozen ground, the nature of the surficial geologic materials, and slope inclination and other topographic features affect runoff”. Drainage systems have a great influence on the runoff and rainfall infiltrations. An increase of rainfall infiltrations due to improper drainage can lead to an increase of the seepage forces and groundwater levels, which may reduce the resisting or stabilizing forces of the soil. A summary of some of the elements observed during our investigation and previous experiences within the surroundings is presented in order to provide a perspective of the drainage systems of the PSPs areas and its surroundings.

- Several dams and watercourses are present within the area as it can be seen within Figure 4-1.
- Signs of dampness, water seepages, springs or standing water were not observed within the geologies of Baxter Sandstone, Murrindindi Supergroup, Unnamed alluvium and Unnamed dune deposits.
- Signs of dampness and standing water have been observed within the geology of unnamed swamp and lake deposits (Map code Qm1) located towards the northeast and west of PSP 53. As it can be seen within Figure 4-1, part of the north side of PSP 53 is within the geology of unnamed swamp and lake deposits (Map code Qm1), which suggests the potential for groundwater and soft soils within this area.

3.5 Observed Features Related to the Potential of Filled Ground

Fill which has been placed under uncontrolled conditions can lead to settlement and/or differential movement and subsequent distress unless footings including pavements and hardstand areas are engineered designed to accommodate features of filled ground. Excluding the areas where existing structures and development are present⁴, observations across the PSPs areas inferred that the PSPs areas, in general, are likely to have a low probability of presence of fill. These observations are confirmed with the subsurface exploration undertaken, which revealed 14 out of 15 test sites comprising of naturally occurring soils. Test site 15 showed 200 mm of fill which is considered related to the existing development (including previous earthworks) within the vicinity of test site 15. The present fill may be expected in other areas and a more extensive investigation would be required to determine more information related to the presence of fill. The potential presence of fill material was highlighted in visual observations related to:

- What appeared to be unusual changes in topography and landform.
- Underground infrastructure throughout the sites as determined from a “dial before you dig” enquiry prior to undertaking our investigation.
- Appearance of past earthwork activity associated with the existing observed development (including market gardening, quarry, former dairies, single storey dwellings, sheds, animal grazing, dams, power lines, gravel and roads).

⁴ Further information regarding to the existing development can be found within section 3.1 Surrounding Development.

3.6 Mining Activity

Information obtained from Beveridge Williams indicates that a former quarry is located within PSP 53. The following figure shows an extract from a Beveridge Williams plan “Regional Geology and Topography Plan” (Project reference 1101542) dated 20/01/2012 which highlights the approximate locations where extractive industry has occurred. The level of slope stability of the excavated sites is not known at this level of investigation. Further investigation and engineering consultation should be undertaken for developments in close proximity to these mined areas as these areas may represent a hazard to new developments in close proximity. A site specific study would be required to determine the levels of stability and risks and provide recommendations for design, construction and risk mitigation measures if required.

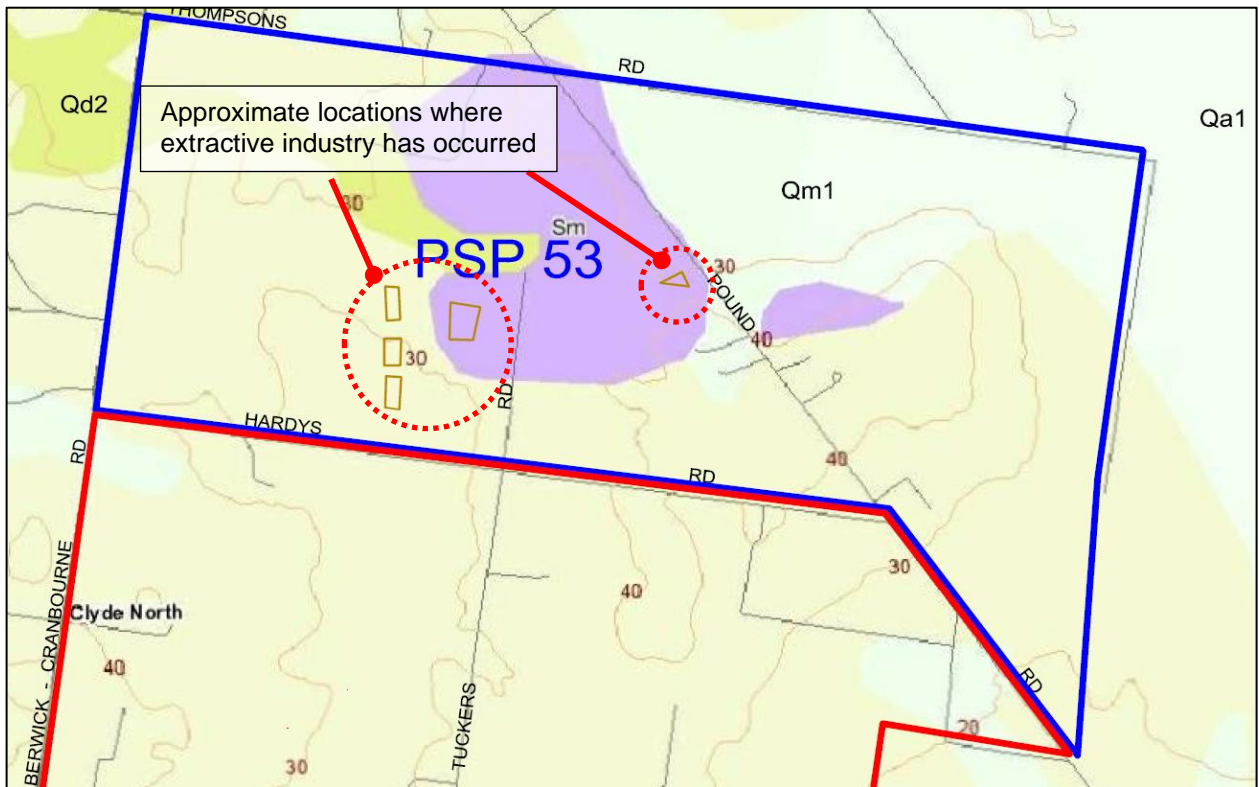


Figure 3-2 Beveridge Williams plan “Regional Geology and Topography Plan” (Project reference 1101542) dated 20/01/2012

4 SUBSURFACE CONDITIONS

4.1 Soil Exploration Program

Geotechnical engineers must deal with two main types of uncertainty: (1) natural variability of geotechnical parameters and (2) systematic uncertainties (Chowdhury, 2010). Geotechnical engineers and geologists deal with materials whose properties and spatial distribution are poorly known and with problems in which loads and resistances are often coupled. Spatial variation in a soil deposit can be characterized in detail, but only with a great number of observations, which normally are not available, particularly at preliminary (initial desktop) study stages. Thus, it is common to model spatial variation by a smooth deterministic trend combined with residuals about that trend, which are described probabilistically (Phoon, 2008). In order to achieve an economic proposal, the scope of works carried out considers the minimum requirements to obtain sufficient data to enable a preliminary geotechnical analysis and assessment.

The aim of this preliminary investigation is to collect and provide the first quantitative information at the site, initial quantitative estimates of engineering properties and type and possible locations of geological anomalies. As part of a preliminary investigation, the location of the test sites was based on a probability approach. The locations of the proposed 15 test sites were spread across the PSPs areas maintaining as practical as possible similar distances between each test site to cover the whole investigated area in a proportional manner. Additionally to this criterion, accessibility constraints were also taken into consideration to locate the borehole locations.

4.2 Geology

Geological information obtained from the Department of Primary Industries indicates that the PSPs areas are within the geological areas of Baxter Sandstone (fluvial soils, sandstone, conglomerate, siltstone and ironstone), Murrindindi Supergroup (marine soils, mudstone, sandstone) and Unnamed dune deposits (aeolian soils, dune deposits: sand, clay, calcareous sand) with some pockets of paludal: lagoon and swamp deposits (silt, clay) and Unnamed alluvium (fluvial soils: alluvium, gravel, sand, silt) as described below:

Geological Polygons 250K

Unique Feature Identifier:	71
Map Code:	Nxx
Old Map Codes:	Npx, Tpx
Unit Type:	Rock
Rank:	Formation
Unit Name:	Baxter Sandstone
Youngest Age:	Neogene (Miocene)
Oldest Age:	Neogene (Pliocene)
Classification or Environment:	Sedimentary (Non-Marine (Fluvial))
Feature Type:	ROCK_UNIT
Subtype:	Sedimentary
Lithological Description:	Fluvial: sandstone, conglomerate, siltstone, ironstone
Area Square Metres:	83156247.22
Hectares:	8315.62
Full Reference:	VANDENBERG, A.H.M., 1997. QUEENSCLIFF SJ 55-9 Edition 2, 1:250 000 Geological Map Series 1:250,000 geological map. Geological Survey of Victoria.

Geological Polygons 250K

Unique Feature Identifier: 155
Map Code: Sm
Old Map Codes: S
Unit Type: Rock
Rank: Supergroup
Unit Name: Murrindindi Supergroup
Youngest Age: Palaeozoic (Devonian)
Oldest Age: Palaeozoic (Silurian)
Classification or Environment: Sedimentary (Marine)
Feature Type: ROCK_UNIT
Subtype: Sedimentary
Lithological Description: Marine: mudstone, sandstone
Area Square Metres: 1134022.15
Hectares: 113.4
Full Reference: VANDENBERG, A.H.M., 1997. QUEENSCLIFF SJ 55-9 Edition 2, 1:250 000 Geological Map Series 1:250,000 geological map. Geological Survey of Victoria.

Geological Polygons 250K

Unique Feature Identifier: 146
Map Code: Qd2
Old Map Codes: Qpd
Unit Type: Rock
Rank: Formation
Unit Name: Unnamed dune deposits
Youngest Age: Quaternary (Pleistocene)
Oldest Age: Quaternary (Pleistocene)
Classification or Environment: Sedimentary (Non-Marine (Aeolian))
Feature Type: ROCK_UNIT
Subtype: Sedimentary
Lithological Description: Aeolian: dune deposits: sand, clay, calcareous sand
Area Square Metres: 2063237.95
Hectares: 206.32
Full Reference: VANDENBERG, A.H.M., 1997. QUEENSCLIFF SJ 55-9 Edition 2, 1:250 000 Geological Map Series 1:250,000 geological map. Geological Survey of Victoria.

Geological Polygons 250K

Unique Feature Identifier: 194
Map Code: Qm1
Old Map Codes: Qrm,Qm

Unit Type: Rock
Rank: Formation
Unit Name: Unnamed swamp and lake deposits
Youngest Age: Quaternary (Holocene)
Oldest Age: Quaternary (Holocene)
Classification or Environment: Sedimentary (Non-Marine (Paludal))
Feature Type: ROCK_UNIT
Subtype: Sedimentary
Lithological Description: Paludal: lagoon and swamp deposits: silt, clay
Area Square Metres: 1099228.71
Hectares: 109.92
Full Reference: VANDENBERG, A.H.M., 1997. QUEENSCLIFF SJ 55-9 Edition 2, 1:250 000 Geological Map Series 1:250,000 geological map. Geological Survey of Victoria.

Geological Polygons 250K

Unique Feature Identifier: 4
Map Code: Qa1
Old Map Codes: Qra,Qa,Qrt,Qc
Unit Type: Rock
Rank: Formation
Unit Name: Unnamed alluvium
Youngest Age: Quaternary (Holocene)
Oldest Age: Quaternary (Holocene)
Classification or Environment: Sedimentary (Non-Marine (Alluvial))
Feature Type: ROCK_UNIT
Subtype: Sedimentary
Lithological Description: Fluvial: alluvium, gravel, sand, silt
Area Square Metres: 112225167.95
Hectares: 11222.52
Full Reference: VANDENBERG, A.H.M., 1997. QUEENSCLIFF SJ 55-9 Edition 2, 1:250 000 Geological Map Series 1:250,000 geological map. Geological Survey of Victoria.

The general naturally occurring soil profile encountered during our subsurface investigation is considered mainly consistent with the geological areas of Baxter Sandstone, Murrindindi Supergroup and Unnamed alluvium; mainly comprising of Silty SAND or Sandy SILT overlying Silty CLAY. Test sites 02 and 10 are considered consistent with the geological area of lagoon and swamp deposits, mainly comprising of soft silts and clays.

An interpretation of the geological area of the two PSP sites is shown below. This map has been obtained from the Department of Primary Industries and indicates that the sites comprise of different geological zones.

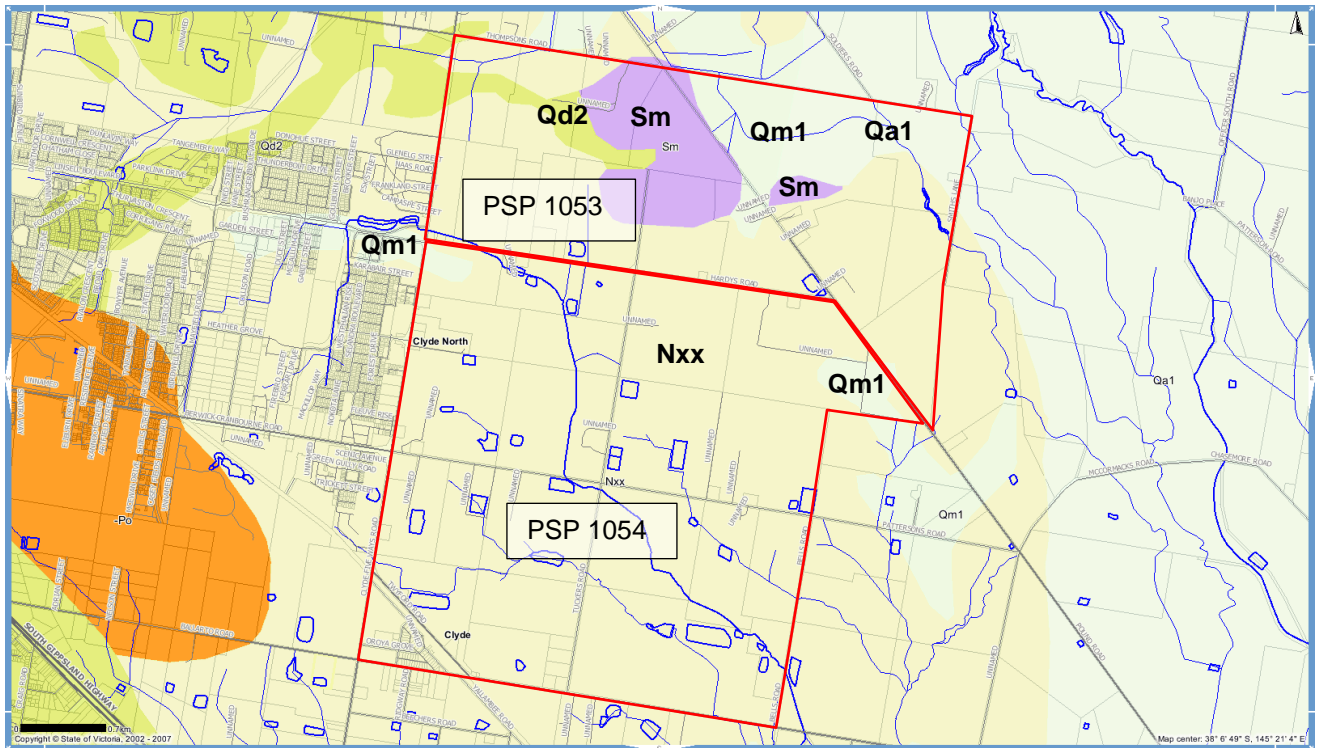







Figure 4-1 Geological area of the PSPs areas and its surrounding, and watercourses (in blue)

Map Code:	Unit Name:	Lithological Description:
 Qa1	Unnamed alluvium	Fluvial: alluvium, gravel, sand, silt
 Qd2	Unnamed dune deposits	Aeolian: dune deposits: sand, clay, calcareous sand
 Sm	Murrindindi Supergroup	Marine: mudstone, sandstone
 Qm1	Unnamed swamp and lake deposits	Paludal: lagoon and swamp deposits: silt, clay
 Nxx	Baxter Sandstone	Fluvial: sandstone, conglomerate, siltstone, ironstone

Review of the geological map and comparison with borehole data collected and recorded indicates that geological maps provide a reasonably good guide to the likely soil types which may be encountered.

4.3 Ground Data Disclosed from Engineering Logs

4.3.1 Interpretative Soil Strata Condition

The general underlying soil profile mainly consistent with the geological area of Baxter Sandstone comprises of:

- Layer 1 – FILL (SM) Silty SAND
- Layer 2 – (SM) Silty SAND / (ML) SILT
- Layer 3 – (CH) Silty CLAY
- Layer 4 – (SC) Clayey SAND
- Layer 5 – Auger refusal

Detailed engineering logs are attached within Appendix B. Figure 4-2 General Profile, below represents a general graphical summary of the underlying soil profiles encountered.

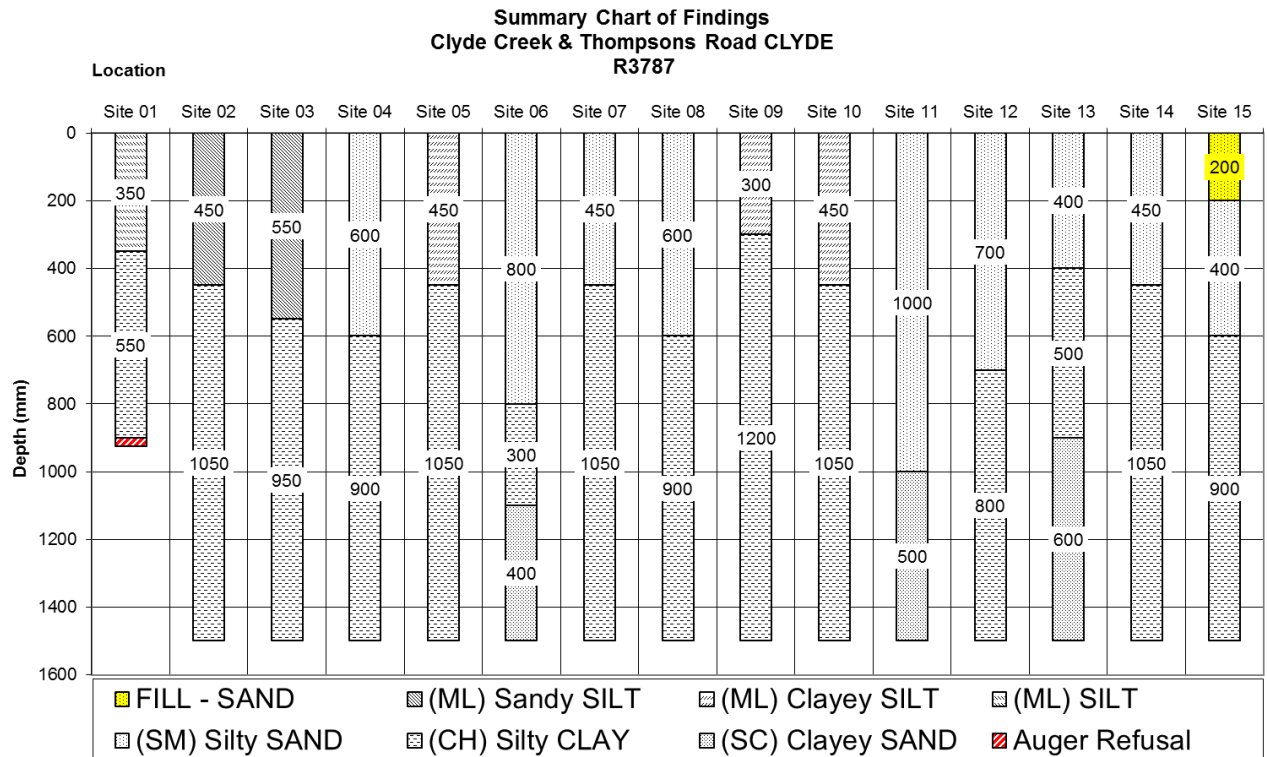


Figure 4-2 General Profile

Approximate locations of the test sites are presented within Appendix A – Engineering Log Location Plan. The table below presents the GPS coordinates of each of the test sites.

Test Site	Coordinates	
01	38°05'39.9"	145°20'12.2"
02	38°06'08.8"	145°20'20.7"
03	38°05'46.2"	145°20'54.1"
04	38°06'12.0"	145°20'16.0"
05	38°05'54.5"	145°21'55.0"
06	38°06'20.3"	145°22'6.1"
07	38°06'55.0"	145°21'46.3"
08	38°06'59.9"	145°21'20.0"
09	38°06'33.0"	145°20'57.2"
10	38°06'36.9"	145°20'10.1"
11	38°07'2.7"	145°20'39.5"
12	38°07'33.8"	145°21'18.1"
13	38°07'10.7"	145°20'0.8"
14	38°07'32.6"	145°20'19.9"
15	38°07'47.9"	145°19'50.3"

Table 4-1 GPS coordinates of test sites

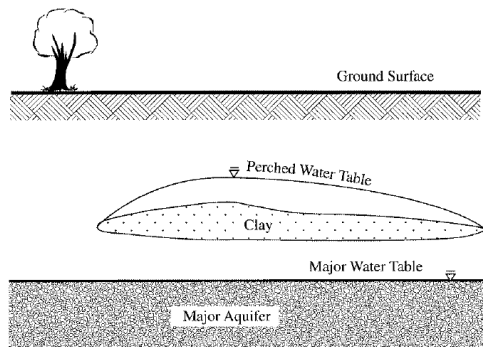
The locations of test sites were recorded using a hand held GPS device with limited accuracy. Should higher levels of accuracy be required, test sites may need to be surveyed.

4.3.2 Interpretative Subgrade

Layer, Unit / Thickness	Description	Comments
Layer 1, Thickness ranging from 0.00m to 0.20m	FILL (SM) Silty SAND	<p>The presence of fill is normally regarded with caution as it is often associated with high variation in strength and density and potential for differential settlement. Non-engineered fills (fills with no engineering treatment during deposition) may settle variably, have poor bearing capacity and may also suffer significant movements due to causes other than the imposed loading.</p> <p>The extent to which non-engineered fill will be suitable as foundation material depends largely on its age, composition, uniformity, properties and the method by which the material was placed. Therefore with these factors unknown it is recommended that all footings (i.e. edge beams, internal beams and load support thickenings) are founded into the naturally occurring soils through the filling. Alternatively footings should be engineer designed to accommodate the filled ground.</p>
Layer 2, Thickness ranging from 0.30m to 1.00m	(SM) Silty SAND / (ML) SILT	<p>Poor to good foundation support may be generally found within these materials as these materials were described as soft, firm and medium dense.</p> <p>These materials may be susceptible to pockets of seasonal or perched water tables above the underlying clay horizon which may cause soil weakening.</p> <p>Should a seasonal or perched water table be encountered during construction it is likely to cause construction difficulties (including trench collapse for example). To minimise the potential influences from excessive moisture caused by a perched water table an appropriately installed subsurface drain should be installed or considered.</p> <p>Where these soils are encountered close to the surface, it is often preferred to found footings, infrastructures and pavements into the underlying (firm or stiff) cohesive clay soils where practical.</p>
Layer 3 and 4,	(CI) Silty CLAY / (SC) Clayey SAND	Fair to good subgrade is generally anticipated, as these soils have been described as firm, stiff and dense. Poor subgrade support conditions are expected within low lying areas and the geological areas of swamp deposits.
Layer 5	Auger refusal	Auger refusal using a hydraulic drilling rig was encountered during drilling at site 01. This feature suggests the presence of rock close to where the auger refusal was encountered. Where rock or auger refusal is encountered, difficulty may be experienced in obtaining a reliable guide as to possible excavation difficulties. Hence, if more accurate information is required regarding excavation characteristics, it may be necessary to undertake some trial pits and/or further investigation.

4.4 Groundwater

Water exists in different forms and in different places and for widely varying times in the hydrologic cycle. Groundwater or soil moisture content depends on several factors such as permeability, infiltration rate, plant use, hydraulic gradient and surface runoff and evapotranspiration (Delleur, 1999).



Observations during the undertaking of engineering logs revealed evidence of groundwater in the time the excavations were left open where the upper silts and sands were frequently observed to be moist to wet. This feature may be related to subsurface runoff, produced by rainfall infiltration. This can create a seasonal or perched water table above the underlying clay horizon.

Figure 4-3 A perched aquifer (Delleur, D; 1999)

Some construction difficulties could be experienced if excavations are undertaken particularly after heavy and/or sustained rain.

This adjacent photograph, from another project within the Baxter Sandstone geological area, highlights the soil weakening that can occur within sands or silts above clay horizon during wetter times of the year or after heavy rainfall.

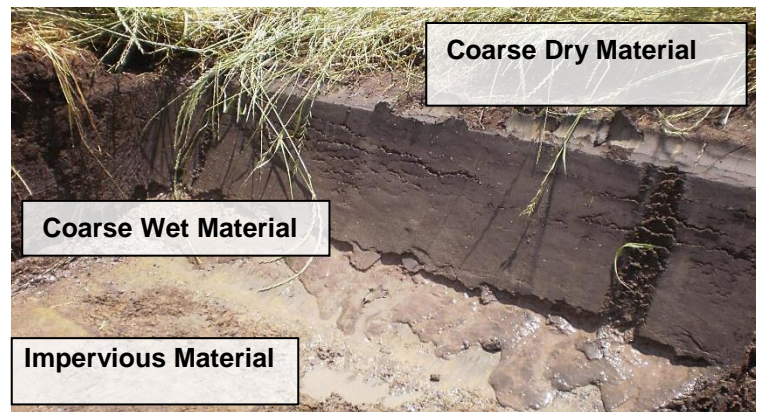


Figure 4-4, Site inspection photograph from a site within the same logical area (reference R2469). Note the effects of a seasonal or perched water table above the clay horizon

Should further or more detailed information regarding groundwater wish to be obtained a specific groundwater investigation including surveying, the installation of monitoring wells, periodic monitoring, and groundwater bore licensing (where required) should be carried out.

It is understood that Beveridge Williams is undertaking a Preliminary Environmental Contamination Assessment for Clyde Creek & Thompsons Road, Clyde (PSP 53 & PSP 54). Further groundwater information from an environmental and chemical perspective may be sought from Beveridge Williams or further investigation works.

4.4.1 Probable Groundwater Levels

Information collected from the Department of Sustainability and Environment indicates that the groundwater levels within the two PSPs would typically range approximately from 5 to 10 m. Previous geotechnical investigation undertaken by Site Geotechnical within Grices Road close to Pound Road, Clyde North revealed that shallower groundwater levels can be encountered in areas within or close proximity to the geological area of lagoon and swamp deposits. Previous geotechnical investigations (reports R2379B and R3128) revealed that the groundwater was encountered at depths between 0.6 m and 2.9 m, which corresponds to levels between approximately RL 23.3 m and RL 21.0 m. The predominant geology of these investigated areas is lagoon and swamp deposits bordering Murrindindi Supergroup and Baxter Sandstone. Consequently, it is inferred that shallower groundwater levels (i.e. groundwater levels shallower than 5 m depth) could be expected in areas within or close proximity to the geological area of lagoon and swamp deposits and creek environments.

5 GEOTECHNICAL ASSESSMENT FOR FOUNDATIONS

The following initial geotechnical assessment would provide a general interpretation of the geotechnical behaviour of the soil profile encountered in order to provide potential geotechnical solutions that may be used for the proposed project.

5.1 General Assessment for Residential Slabs and Footings – Construction

The purpose of the site classification is to assess the subsurface conditions and therefore enable a structural engineer to determine the most appropriate foundations / floor slabs (i.e. the site classification will assist in the determination of the appropriate dimensions for house footings and/or floor slabs).

Site Classification has been carried out closely following the Australian Standards:

- AS2870-2011: "Residential Slabs and Footings—construction" and
- AS1726-1993: "Geotechnical site investigations"

5.2 Site Classification

Taking into account that all foundations will be founded into natural soil, the underlying soil profile encountered during our field investigation, the geology and climatic zone of the area, it can be stated that:

1. The areas, **within the geological areas of Baxter Sandstone, Murrindindi Supergroup, Unnamed dune deposits and Unnamed alluvium** mainly comprising of Silty SAND or Sandy SILT overlying Silty CLAY, are considered to have an expected level of site movement consistent with that of:
 - **Class M**, which includes moderately reactive sites with seasonal differential surface movement anticipated to be moderately reactive, which can experience moderate ground movements from moisture changes, with typical surface movement anticipated to be between 20mm to 40mm with reference to AS2870-2011 “Residential slabs and footings – Construction”.

This site classification is expected to be representative of the majority of the investigated areas.

2. For the areas **within or close proximity to the geological area of lagoon and swamp deposits**, it is considered that these areas have an expected level of site movement consistent with that of:
 - **Class H1 to Class H2**, which includes highly reactive sites with seasonal differential surface movement anticipated to be highly reactive, which can experience high ground movements from moisture changes, with typical surface movement anticipated to be between 40mm to 75mm with reference to AS2870-2011 “Residential slabs and footings – Construction”.

It should be noted that for individual building sites, a specific site investigation should be undertaken by a qualified engineer or engineering geologist experienced in the field of geomechanics for soil classification, related to slab and footing construction.

3. In some cases, consideration should be given to **Class P**, engineering designed foundations, should one or more of the following conditions be encountered:
 - a. Areas comprising of soft, loose, collapsing or unstable soils.
 - b. Areas susceptible to landslides, mine subsidence or significant erosion.
 - c. Reactive areas subject to abnormal moisture conditions and areas that cannot be classified in accordance with Clause 2.1.2 of AS2870-2011.
 - d. The area contains uncontrolled or controlled fill as identified in clause 2.5.3 of AS2870-2011.

Factors prior, during or after construction can lead to a site classification of Class P. According to the AS2870-2011 Clause 1.3.3, factors such as: presence or potential removal of trees near the building site; removal of an existing building or structure likely to have significantly modified the soil moisture conditions under the footprint of the footing system of the building; unusual moisture conditions caused by drains, channels, ponds, dams, effluent disposal areas or tanks, which are to be maintained or removed from the site; or failure to provide adequate site drainage during construction can lead this site to a Class P classification.

Standard type classifications such as Class A, Class S, Class M, Class H1, Class H2 and Class E require normal moisture conditions. These classifications assume the site maintenance complies with Appendix B of AS2870-2011.

Within reactive soils, the designer may consider increasing the stiffness of the footing system, if trees are planned to be planted (or retained) within close proximity to footings, to allow for potential abnormal moisture conditions that trees may cause. Appendix H "Guide to Design of Footings for Trees" from the AS2870-2011 provides a method for design when trees are located close to proposed foundations.

The following figure presents a rough indication of the probable areas of the different site classifications. The area covering PSP 53 is enclosed by a solid purple line. The area covering PSP 54 is enclosed by a solid black line. The area covering the probable Class M sites is enclosed by a dot blue line and the areas covering the probable Class H1, Class H2 and Class P sites is enclosed by a dashed red line.

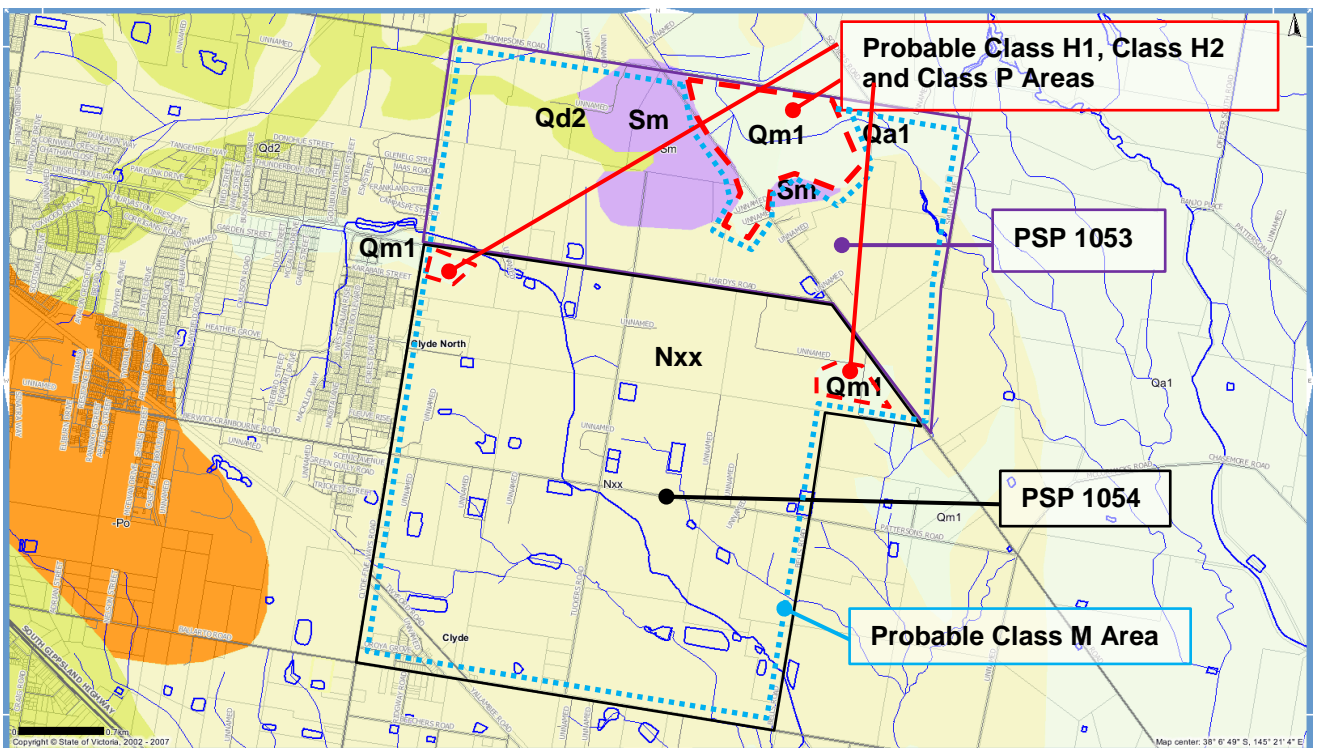







Figure 5-1 Geological area of the site and its surrounding, and watercourse (in blue)

Map Code:	Unit Name:	Lithological Description:	Probable Site Classification
 Qa1	Unnamed alluvium	Fluvial: alluvium, gravel, sand, silt	Class M
 Qd2	Unnamed dune deposits	Aeolian: dune deposits: sand, clay, calcareous sand	Class M
 Sm	Murrindindi Supergroup	Marine: mudstone, sandstone	Class M
 Qm1	Unnamed swamp and lake deposits	Paludal: lagoon and swamp deposits: silt, clay	Class H1, Class H2 and Class P
 Nxx	Baxter Sandstone	Fluvial: sandstone, conglomerate, siltstone, ironstone	Class M

Further testing including additional boreholes, sampling and laboratory testing may provide further information related to the reactivity of soils within the two PSP.

5.3 Effect of Site Works on Classification

Where effect of site works have not been taken into account, the classification shall be reconsidered if-

- a) The depth of cut on an S, M, H1, H2 or E site exceeds the lesser of 0.25Hs or 0.5m; or
- b) the depth of fill would result in a P classification in accordance with Clause 2.5.3. of AS2870-2011 or as mentioned within Section 5.4 below.

5.4 General Effect of Fill on Classification

5.4.1 Shallow Controlled Fill

The classification of a site with shallow controlled fill (which has been placed and compacted in layers by compaction equipment within a defined moisture range to a defined density requirement and tested by a testing authority or other means of compaction validation / verification including penetrometer testing for sands) up to 0.8m deep for sand and 0.4m deep for material other than sand shall be the same as the natural site, prior to filling.

5.4.2 Deep Controlled Fill

The classification of a site with controlled sand fill (which has been placed and compacted in layers by compaction equipment within a defined moisture range to a defined density requirement by a testing authority or other means of compaction validation) deeper than 0.8 m shall not require a more severe Class than the natural site classification, but may be used to justify by engineering principles a less severe reactive site classification. The effect of the fill on the settlement of the underlying soil shall be taken into account. The classification of a site with controlled fill of material other than sand and deeper than 0.4 m shall be Class P unless reclassification can be validated through following engineering principles (refer to AS2870-2011, clause 2.5.3 (c) regarding reclassification).

5.4.3 Shallow Uncontrolled Fill

The classification of a site with uncontrolled fill up to 0.8 m deep for sand and 0.4 m deep for material other than sand shall be Class P, unless all footings (i.e. edge beams, internal beams and load support thickenings) are founded on natural soil through the filling.

5.4.4 Deep Uncontrolled Fill

The classification of a site with uncontrolled fill deeper than 0.8 m for sand and 0.4 m for material other than sand shall be Class P.

5.5 Preliminary Assessment of Soil Parameters for Foundations

The following table presents estimated soil parameters. Drained and undrained conditions may be considered for geotechnical analyses. Effective stress shear parameters represent a drained condition for long-term assessments where, effective stresses are used for calculation. Total stress shear parameters represent an undrained condition for short-term stability analyses where total stresses are used for calculation⁵.

Layer	Consistency / Relative Density	Unit Weight γ (kN/m ³)	Drained Conditions		Undrained Conditions		Deformation Parameters		
			Effective Angle of Friction ϕ' (°)	Effective Cohesion c' (kPa)	Angle of Friction ϕ (°)	Undrained Cohesion c_u (kPa)	Vertical Short Term 'Elastic' Modulus E_v (MPa)	Vertical Long Term 'Elastic' Modulus E_v (MPa)	Poisson μ
(ML) SILT	Soft	16.0-17.0	20-24	0	18-20	0	<10	<8	0.30-0.40
(ML) SILT	Firm	17.0-18.0	24-26	0	20-22	0	10-12	8-10	0.30-0.40
(SM) Silty SAND	Medium dense	18.0-19.0	30-34	0	22-25	0	15-25		0.30-0.35
(SC) Clayey SAND	Medium dense	18.0-19.0	26-28	0-3	15-20	0-3	10-20		0.30-0.40
(CH) Silty CLAY	Soft	16.0-17.0	22-24	0	0	12-25	2-7	1-5	0.40-0.50
(CH) Silty CLAY	Firm	17.0-18.0	24-26	0-5	0	25-50	5-12	4-8	0.40-0.50
(CH) Silty CLAY	Stiff	17.5-18.5	26-28	5-10	0	50-100	10-25	7-20	0.40-0.50

Table 5-1 Probable soil profile and estimated soil parameters⁶

⁵ Drained and undrained conditions represent the two boundary conditions of the soil behaviour. The real soil failing mechanism is likely to be between a drained condition and an undrained condition. This will basically depend on the loading rate and soil permeability.

⁶ It should be noted that values for clayey sand should be used with care as its values are obtained from the combination of the sand and clay correlations.

The following parameters may be assumed for compacted backfill materials.

Type of Material	Comment	Unit Weight γ (kN/m ³)	Drained Conditions	
			Effective Angle of Friction ϕ' (°)	Effective Cohesion c' (kPa)
Good: Gravelly sands, compacted sands, controlled crushed sandstone and gravel fills (Class I), dense well-graded sands	Controlled fill-Class I	20.0-21.0	34-36	0
Average: Stiff sandy clays, gravelly clays, compact clayey sands and sandy silts, compacted clay fill (Class II)	Controlled fill-Class II	19.0-20.0	28-30	0-5

Table 5-2 Estimated soil parameters for class I⁷ and class II⁸ backfill materials

The foregoing values are based on well-known correlations. These values should not be overemphasized. Natural materials such as soils can present large variability. The variability of a soil parameter should be considered before assessing its relevance (Look, 2007). In addition, there are other factors that need to be considered for soil and rock parameter selection. These factors are: geological and geotechnical background information, possible modes of failure, ranges of in situ and imposed stresses, potential variability of the parameter values and the sensitivity of the design to these variabilities, extent of the zone of influence governing the soil behaviour, influence of workmanship on artificially placed or improved soils, effects of construction activities on the properties of the in situ soil, etc (clause 7.3.4. of AS 5100.3-2004).

5.5.1 Review of Typical Soil Values from Previous Geotechnical Investigations within the Area and Surroundings

Local data and experiences become an important element in the assessment process of a site. The following table summarises the typical values encountered within previous geotechnical investigations.

Parameter	Unit	Common Range			Comment
		Minimum	Maximum	Typical Value	
Salinity for Silty CLAY (CH)	dS/m	0.7	6.0	2-4	Non-saline to moderately saline
pH for Silty CLAY (CH)	N/A	6	8	6.5-7.5	Non-aggressive for Steel and Concrete Piles
Permeability for Silty CLAY (CH)	m/s	2E-11	1E-10	4.00E-10	Relatively impervious

Table 5-3 Typical Geotechnical Parameters for Soils Encountered within the Area and Surroundings

⁷ According to AS 4678-2002, soil rock or other inert material that has been placed at a site in a controlled fashion and under appropriate supervision to ensure the resultant material is consistent in character, placed and compacted to an average density equivalent to 98% (and no test result below 95%) of the maximum dry density (standard compactive effort) for the material when tested in accordance with AS 1289.5.1.1.

⁸ According to AS 4678-2002, soil rock or other inert material that has been placed at a site in specified layers in controlled fashion to ensure that the resultant material is consistent in character placed and compacted to an average density equivalent to 95% (and no test result below 92%) of the maximum dry density (standard compactive effort) for the material when tested in accordance with AS 1289.5.1.1.

Dryland salinity has been recorded in the area between Bacchus Marsh, Anakie and Lara, on the Bellarine Peninsula, and in low lying areas near Pakenham and Cranbourne in the south east of Melbourne. Dryland salinity is caused by the replacement of deep-rooted native vegetation with shallow rooted pastures and crops. This results in a rising of the water table because of the reduced water usage by the vegetation. The following image illustrates the sites of recorded dryland salinity and areas susceptible to salinity in the Port Phillip region.

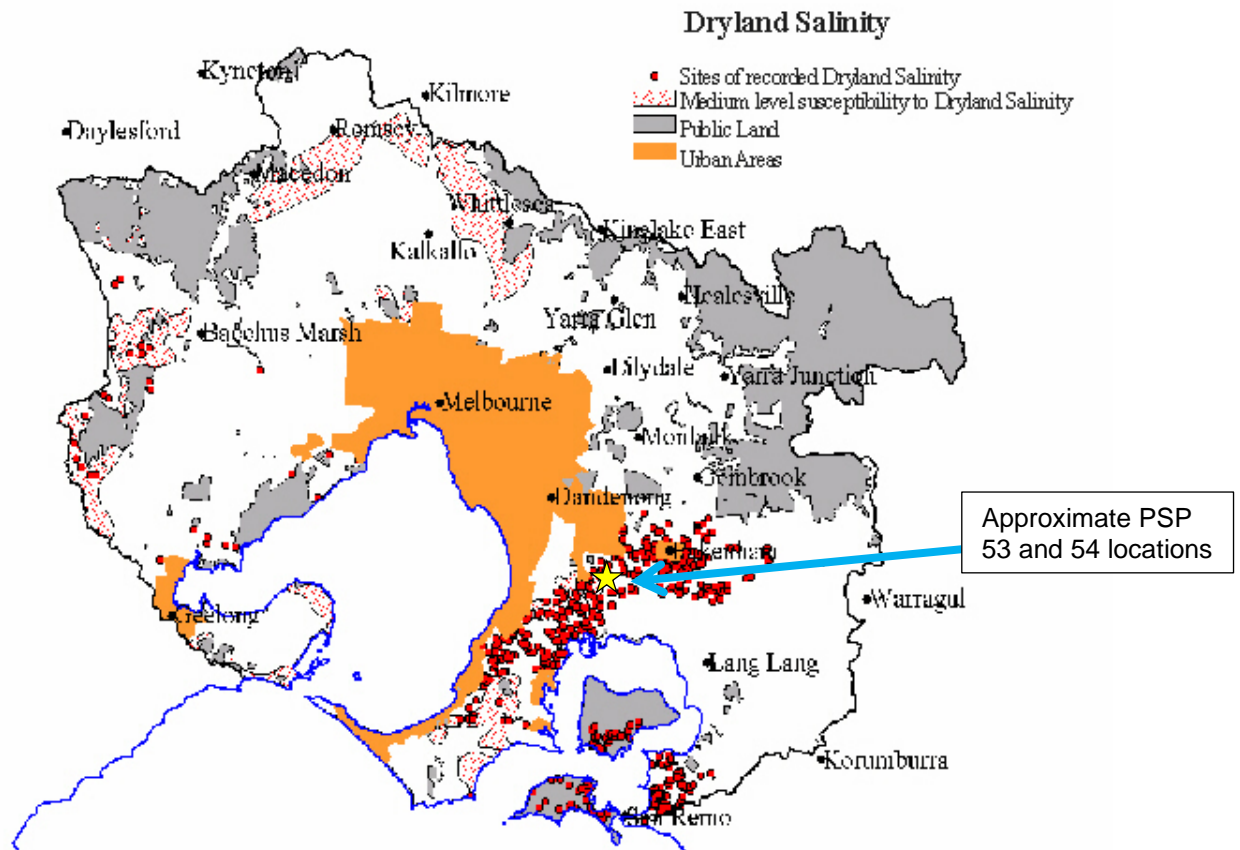


Figure 5-2 Sites of recorded dryland salinity and areas susceptible to salinity in the Port Phillip region (Source Department of Primary Industry⁹)

For information purposes, obvious visual evidence of salinity was not observed during our site inspection. However, a specific environmental investigation should be undertaken as the tests required for such assessments are out of the scope of this geotechnical investigation. A specific environmental investigation should assess the potential for dryland salinity as information collected from the Department of Primary Industry highlights a potential salinity for as shown within the previous figure.

⁹ <http://www.dpi.vic.gov.au/forestry/private-land-forestry/on-farm-benefits/environmental-benefits-of-farm-forestry-in-the-port-phillip-region>

5.1 Presumptive Bearing Capacities for Foundations

The geotechnical design of foundations and retaining walls involves a series of assumptions and calculations that usually create a repetitive iterative process. Bearing capacity calculations depend on the width of the foundation, type of foundation (deep or shallow), allowable settlement, angle of inclination of the load, load eccentricity, pressure generated by the retained soil, etc; therefore, basic preliminary geotechnical analyses have been undertaken to assess the geotechnical behaviour of the on-site soils. The following values are not intended to be used for the final foundation design. Instead, the aim of the foregoing value is to create a perspective of the geotechnical behaviour of the on-site soils, which can be used for preliminary assessments. The final foundation design should be based on the specific project data (e.g. wind load, earthquake load, live and dead loads, etc).

5.1.1 Preliminary Shallow Foundations Analysis

Basic geotechnical analyses have been undertaken to assess the shear strength of the in situ soils. As a guide, the adjacent bullet points present presumptive vertical bearing capacities for continuous (strip) or square footings that can be used for assessing the soil at different depths.

- 50-100 kPa at 0.5 m depth.
- 100-150 kPa at 1.0 m depth.
- 150-180 kPa at 1.5 m depth.
- 180-220 kPa at 2.0 m depth.

5.1.2 Preliminary Deep Foundation Analysis

Geotechnical design of piles depends on several factors such as construction material, method of construction, type of loads, soil characteristics, pile spacing and configuration, and so on. Therefore, detailed bearing capacity recommendations cannot be given at this stage, where specific information related to the project has not been made, as they may not accurately represent the actual behaviour of the foundation.

Driven, bored and screw piles may be considered. Each type of pile has its advantages and disadvantages relating to constructability and geotechnical-structural behaviour, which should be evaluated within the design. It is recommended that a specific geotechnical analysis is undertaken for the proposed project foundation design.

5.2 Aggressive Soils

According to AS 2870-2011, the footing system should be protected from saline soils, acid sulphate soils and/or aggressive groundwater by providing isolation or the application of the concrete strength and detailing requirements of Clause 5.5.3 of AS 2870-2011. For information purposes, obvious visual evidence of salinity was not observed during our preliminary investigation. A specific environmental investigation should be undertaken to accurately assess the potential for dryland salinity. Specific comments related to acid sulphate soils and/or aggressive groundwater cannot be made within this report as the tests required for such assessments are out of the scope of this geotechnical investigation and a specific environmental investigation will be required to assess these environmental/chemical elements¹⁰.

5.3 Earthworks within Existing Dams

Several dams were observed. It is inferred that some dams will be filled. The following comments provide general guidelines that should be considered for dam filling.

5.3.1 General requirements for dam filling

Soils encountered within dams are anticipated to generally provide low subgrade support. It is recommended that the dam subgrade is excavated until a naturally occurring firm and dense layer is reached. The excavated subgrade should be compacted to a minimum density ratio of 95% AS1289 5.1.1 (Standard Compaction) as poor ground support may lead to excessive deformation or settlement. The dam should be backfilled with an adequate and suitable material. Where practical the backfill material should closely resemble the surrounding naturally occurring soil profile. The requirements for the backfill will depend on the proposed use and a specific assessment should be undertaken for every case.

¹⁰ It is understood that Beveridge Williams is undertaking a Preliminary Environmental Contamination Assessment for Clyde Creek & Thompsons Road, Clyde (PSP 53 & PSP 54). Further information from an environmental and chemical perspective may be sought from information collected and recorded within Beveridge Williams report 1101542.

6 GEOTECHNICAL ASSESSMENT FOR PAVEMENTS

The following initial geotechnical assessment would provide a general interpretation of the geotechnical behaviour of the soil profile encountered in order to provide potential geotechnical solutions that may be used for the proposed project.

6.1.1 Review of Typical Soil Vales from Previous Geotechnical Investigations within the Area and Surroundings

Local data and experiences become an important element in the assessment process of a site. The following table summarises the typical values encountered within previous geotechnical investigations.

Parameter	Unit	Common Range		
		Minimum	Maximum	Typical Value
C.B.R. for Silty CLAY (CH)	%	1.5	4.0	2-3
Stabilized C.B.R. for Silty CLAY (CH) with Lime and Cement Additive	%	15.0	35.0	15 ¹¹

Table 6-1 Typical Geotechnical Parameters for Soils Encountered within the Area and Surroundings

6.2 Summary of Interpretative Subgrade Conditions & Characteristics

The predominant subgrade was found to comprise of a lower layer of high plasticity silty clay overlain by silts and silty sands. These upper silts and silty sands may be susceptible to a seasonal or perched water table above the underlying clay horizon which may cause weakening. The presence of a seasonal or perched water table above the clay horizon is likely to cause construction difficulties. It is often preferred to remove these materials and found the pavement or proposed fill materials on the underlying clays to minimise construction delays, where practical. Overall the underlying clay soils indicate to have relatively fair to good conditions for construction.

The surface silts can be hard setting during drier months of the year however susceptible to severe loss in strength after heavy rain or wetter times of the year. To minimise the potential influences from excessive moisture caused by a perched water table an appropriately installed subsurface drain should be installed or considered. Careful planning and good construction procedures should lead to good subgrade conditions for construction.

¹¹ Lime Stabilisation may be used to improve the strength and/or reduce the swell potential of clay at or below subgrade level. In most cases the Design C.B.R. given to a soil layer shall not exceed 15%.

6.3 Fill Material & Placement for Construction

Previous experiences indicate that the areas within the geologies of Baxter Sandstone, Murrindindi Supergroup, Unnamed dune deposits and Unnamed alluvium generally require a low level of subgrade improvement, which typically incorporates the use of subgrade stabilisation (utilising lime and cement) of clay/cohesive subgrade material. Table 6-1 presents the typical C.B.R. improvement that can be achieved in the materials within these geologies. The areas within lagoon and swamp deposits generally require a high level of subgrade improvement, which typically incorporates the use of subgrade stabilisation (utilising lime and cement) or drainage blankets in excessively wet areas. As with most development sites within close proximity of creeks or in low lying swampy areas the subgrade conditions within these areas are often associated with poor subgrade conditions and construction difficulties. Figure 5-1 and Appendix A – Engineering Log Location Plan illustrate the approximate locations of the above-mentioned geologies.

Proven methods of constructing adequate working platforms within clays of high plasticity include the construction of a subgrade which incorporates the use of subgrade stabilisation (utilising lime and cement), drainage blankets or the use of highly or extremely weathered rock. All these treatments can offer two basic functions including the provision of low plasticity material cover over expansive subgrades to minimise potential environmental effects (where these materials are applied for the full depth) and to provide a subgrade with additional strength consequently providing an adequate working platform to allow construction to proceed (particularly within road reserve areas where a reasonably high degree of construction trafficking may be required for the delivery of fill materials). The use of low expansive materials within filling could also lead to a reduction in the overall pavement thickness being accepted by council. The following sections provide a description of potential alternatives for subgrade improvements.

6.3.1 In Situ Subgrade Stabilisation (With Lime & Cement)

Previous experience with similar cohesive clay subgrade materials¹² to those found during this investigation has found that in situ stabilisation with 3% Lime and 3% Cement would be appropriate to increase the mechanical properties of the subgrade. If the soils are found to be marginally wet at the time of construction, or do not consist of cohesive material, consideration should be given to increasing the lime content to 4% (if above optimum moisture content) or replacing the lime with cement (if low to medium reactivity cohesive material is encountered).

Further information relating to in situ stabilisation should be obtained from stabilisation specialists and contractors to determine the most appropriate additive and construction method for the conditions at the time of construction. Stabilisation of materials which are well above optimum moisture content or considered as wet at the time of construction or are non-cohesive (low clay content) may not be considered suitable for stabilisation.

¹² The support gained from sand materials is highly dependent on drainage conditions. Well drained sands often exhibit relatively good subgrade support while saturated or over-wet sands can be troublesome when it comes to construction and require specific recommendations.

Successful Lime Stabilisation has been commonly adopted within clay type subgrade materials, which are similar to that found during our investigation.

6.3.2 Site Derived Materials for General Filling

Site derived or locally imported materials placed on a suitably prepared surface are likely to be suitable if drainage and construction conditions remain favourable. The upper silts are not likely to be considered as suitable as structural fill, however likely suitable for topsoiling. The risks related to potential construction delays and construction problems are anticipated to be higher should construction take place during wetter times of the year or after heavy rainfall. Most of the materials encountered during our investigation are anticipated suitable for filling purposes (excluding some materials as further described within the Australian Standard; AS 3798, Section 4, Materials).

Where it is impracticable to achieve compaction of the prepared surface, a working platform generally comprising of material having reasonably higher strength (weathered rock material, for example), end-dumped and spread in sufficient depth to allow the passage of earthmoving equipment with minimal surface deflection, may provide a suitable foundation for subsequent filling.

6.3.3 Sand Replacement (Drainage Blanket)

Drainage blankets incorporate the use of a free draining lower subbase or subgrade improvement layer, which may be an effective means to remove water that may infiltrate beneath the pavement. Section 3.3.3 of *AUSTROADS – A Guide to the Structural Design of Road Pavements (2004)* provides a brief specification of 'drainage blanket' material indicating that it may consist of an open graded 20mm crushed rock (having no more than 3% of material finer than 75 microns), produced by blending size 20, 14 and 10mm aggregates with coarse washed sand.

Generally 'drainage blanket' material should consist of either natural sand, gravel, crushed rock or a blend of these materials. The following specification should be used as a guide:

- Minimum Soaked CBR \geq 10%
- Plasticity Index \leq 6
- Practical minimum thickness of 500mm
- Grading meeting the following:

Sieve Size	Percentage By Mass Passing
75.0mm	100
37.5mm	85-100
10.0mm	45-100
5.0mm	25-85
0.6mm	8-45
0.075mm	0-10

Where drainage blankets are placed on fine grained subgrades it is recommended that a geotextile be used as a separation layer between the drainage blanket and the subgrade to limit contamination of the drainage blanket. It should be noted that the above parameters should be used as a guide and should not prevent the use of material which has established good past performance. It should be noted that the filling above drainage blanket material with cohesive soils is not preferred due to the abnormal moisture conditions this type of soil layering would likely create.

The specification provided for drainage blanket material does not need to be strictly followed, basically it is intended that the granular material (which may include sand) allows water to pass freely to minimise pore water pressure during construction and provide a suitable working platform. Past performance measures may be acceptable alternatively criteria such as the material having a Hydraulic Conductivity of greater than 5×10^{-3} cm/s, (>180mm/hr), preferably falling within the pervious range could be accepted. The more pervious the material, the less the risk for construction delays. It may be worth setting up a trial section to convince contractors, council and the client before accepting proposed drainage blanket materials on a large scale. The following table may be used as a comparative guide to relative permeability values and descriptions.

K (cm/s)	10 ²	10 ¹	10 ⁰ =1	10 ⁻¹	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁷	10 ⁻⁸	10 ⁻⁹	10 ⁻¹⁰
Relative Permeability	Pervious			Semi-Pervious				Impervious					
Unconsolidated Sand & Gravel	Well Sorted Gravel	Well Sorted Sand or Sand & Gravel		Very Fine Sand, Silt, Loam									
Unconsolidated Clay & Organic				Peat	Layered Clay		Fat / Unweathered Clay						
Consolidated Rocks	Highly Fractured Rocks		Oil Reservoir Rocks		Fresh Sandstone		Fresh Limestone, Dolomite		Fresh Granite				

Table 6-2 Comparative guide to relative permeability values and descriptions

6.4 Subgrade Strength & Moisture Susceptibility

An in situ field CBR value greater than 5.0% is often required to provide an adequate working platform for earthwork and pavement construction (particularly heavy plant and equipment) to achieve adequate compaction and support. Small changes in moisture content can change subgrade support conditions considerably.

Should subgrade conditions be considered unfavourable at the time of construction (i.e. in situ field CBR < 5.0%), consideration will need to be given to providing a working platform.

6.5 General Guide to Good Site Preparation for Placing Fill

The performance of earthworks relies on good construction practices for both short term and long term performance. The following guidelines (although not exhaustive) provide general information which will assist in good construction:

- a) Top soil containing grass roots or other organic material should be removed from the area on to which filled soils are expected to be placed.
- b) Removal of weak materials and other unsuitable material as defined within section 4.2 of AS3798 will be required prior to placing controlled fill.
- c) The fill area should be protected from wind and / or water erosion
- d) Construction equipment should be supported on material with an allowable bearing pressure of at least 50kPa, it has often been found that material having a CBR value of less than 5.0% at the time of construction will often cause construction problems. Where soil conditions are considered unfavourable for the placement of filling consideration should be given to providing a working platform which allows construction to proceed.
- e) Fill construction should be adequately compacted and retained or battered and protected from erosion.
- f) Adequate drainage of the site will assist construction and avoid softening or weakening of foundation materials. It should be noted that leaving excavations open during prolonged dry weather can also have a long term effect on fill performance.
- g) Fill material should be placed in near-horizontal layers of uniform thickness, deposited systematically across the fill area. The thickness of each compacted layer should not exceed 200mm where practical.

Detailed guidelines in relation to fill placement are provided within “AS3798 - Guidelines on earthworks for commercial and residential developments”, Site Geotechnical can assist in providing further guidelines applicable to this project if requested.

6.6 Design Subgrade CBR Value

Taking into account the soil profiles encountered, the anticipated soil type and drainage conditions together with field and laboratory soaked CBR values, design CBR values of 2% and 3% are commonly adopted for pavements founded into the naturally occurring silty CLAYS (CH) and SILTS (ML). These values are consistent with typical presumptive subgrade design values provided within Table 5.4 of Austroads, Pavement Design – A Guide to the Structural Design of Road Pavements -2004.

Typical pavement structures are generally designed and constructed in areas within the geologies of Baxter Sandstone, Murrindindi Supergroup, Unnamed dune deposits and Unnamed alluvium. More robust pavement structures are generally designed and constructed in areas within lagoon and swamp deposits. Figure 5-1 and Appendix A – Engineering Log Location Plan illustrate the approximate locations of the above-mentioned geologies.

7 CONCLUSION

The preliminary geotechnical investigation undertaken has briefly characterized the subsurface profile, the strength and stiffness of the different layers encountered and probable groundwater conditions. The information collected up to date can be used for preliminary analyses. From a geotechnical perspective, the areas located within the geologies Baxter Sandstone, Murrindindi Supergroup, Unnamed dune deposits and Unnamed alluvium are expected to present more favourable geotechnical conditions for design and construction of typical infrastructures. Less favourable geotechnical conditions are expected within the geology of lagoon and swamp deposits. High level of engineering and robust construction designs are expected within lagoon and swamp deposits if structures are planned to be developed within this area.

The areas, within the geological areas of Baxter Sandstone, Murrindindi Supergroup, Unnamed dune deposits and Unnamed alluvium mainly comprising of Silty SAND or Sandy SILT overlying Silty CLAY, are anticipated to be classified as Class M. For the areas within or close proximity to the geological area of lagoon and swamp deposits, it is considered that these areas are anticipated to be classified as Class H1 to Class H2. These site classifications are expected to be representative of the majority of the investigated areas. However, it should be noted that for individual building sites, a specific site investigation should be undertaken by a suitably qualified engineer or engineering geologist.

In some cases, consideration should be given to Class P, engineering designed foundations, should one or more of the following conditions be encountered: areas comprising of soft, loose, collapsing or unstable soils; areas susceptible to landslides, mine subsidence or significant erosion; reactive areas subject to abnormal moisture conditions; areas that cannot be classified in accordance with Clause 2.1.2 of AS2870-2011 or areas containing uncontrolled or controlled fill as identified in clause 2.5.3 of AS2870-2011.

At this level of investigation, apparent and significant geotechnical hazards were not encountered during this preliminary geotechnical investigation. Desktop study indicates former mining activities within PSP 53. The level of slope stability of the excavated sites is not known at this level of investigation. Further investigation and engineering consultation should be undertaken for developments in close proximity to these mined areas as these areas may represent a hazard to new developments in close proximity. A site specific study will determine the levels of stability and risks and will provide recommendations for design, construction and risk mitigation measures if required.

Further investigation to detect potential geotechnical problems is recommended within the geology of lagoon and swamp deposits if structures are planned to be developed within this area. Some buffers and revegetation may be preferred around existing waterways to minimise the potential for erosion, creek bank instabilities and other environmental issues. Further geotechnical assessment is likely to be required to assess the existing condition of the dams observed within the two PSPs sites.

Information collected from the Department of Sustainability and Environment indicates that the groundwater levels within the two PSPs would typically range approximately from 5 to 10 m. Previous geotechnical investigation undertaken by Site Geotechnical within Grices Road close to Pound Road, Clyde North revealed that shallower groundwater levels can be encountered in areas within or close proximity to the geological area of lagoon and swamp deposits. Our previous geotechnical investigations (reports R2379B and R3128) revealed that the groundwater was encountered at depths between 0.6 m and 2.9 m, which corresponds to levels between approximately RL 23.3 m and RL 21.0 m. The predominant geology of these investigated areas is lagoon and swamp deposits bordering Murrindindi Supergroup and Baxter Sandstone. Consequently, it is inferred that shallower groundwater levels (i.e. groundwater levels shallower than 5 m depth) could be expected in areas within or close proximity to the geological area of lagoon and swamp deposits.

8 BIBLIOGRAPHY

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9 VALIDATION

Collection of information and its appraisal, should continue during any construction works, to confirm or otherwise the assumed ground model. In most cases this is undertaken by an experienced contractor, building / construction surveyor, superintendent, clerk of works or engineer. In some cases it is preferred that the geotechnical consultant assesses and monitors the ground conditions (which may also include compaction control testing) during construction, particularly in light of potentially poor or variable ground conditions or unexpected findings.

10 IMPORTANT INFORMATION

Ownership of the data collected and recorded by Site Geotechnical and any specialist testing remains with Site Geotechnical Pty Ltd until all amount owing to Site Geotechnical Pty Ltd by the client are fully discharged.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. Copyright in this report is the property of Site Geotechnical Pty Ltd. The client and / or its representatives alone shall have a license to use this report. This report shall not be reproduced except in full.

Soil and rock exploration and testing have inherent uncertainties. Thus your attention is drawn to limitations inherent in the extrapolation of the limited subsurface information obtained from the site, which is further discussed within Appendix C – Important Information About Your Geotechnical Engineering Report.

Should you have any queries or comments regarding this report please feel free to contact the undersigned.

Regards

.....
Report reviewed by:-

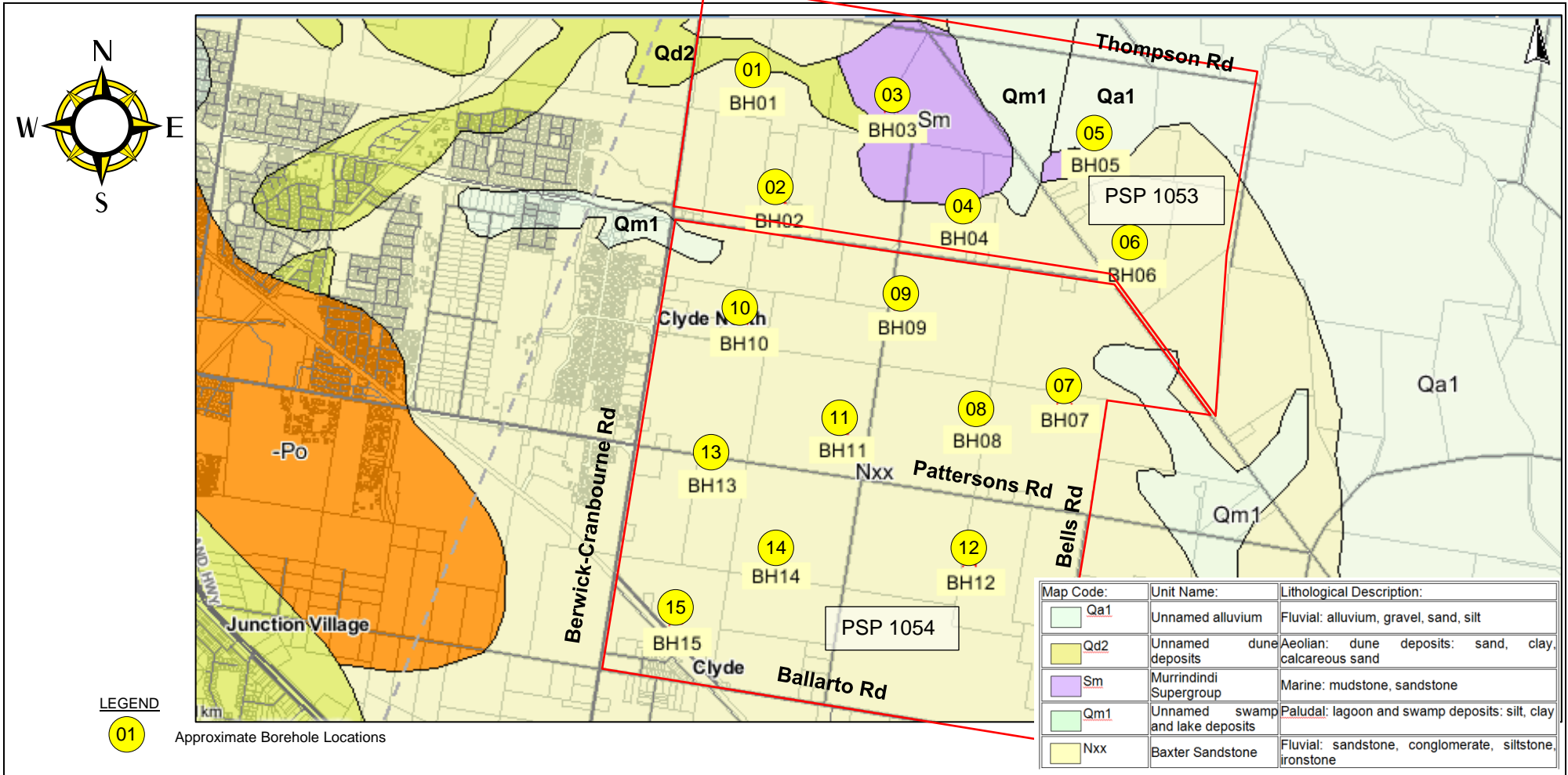
Frank Tostovrsnik B.E. (Civil) Hons.
Managing Director & Senior Geotechnical
Engineer

.....
Report written by:-

Pablo Toro B.E. (Civil)
Civil Engineer

06 December 2012

APPENDIX A – ENGINEERING LOG LOCATION PLAN



SITE Geotechnical
 Soil Investigation Testing & Evaluation

1300 557 260
www.sitegeo.com.au

Title:-
 Residential/Commercial Development & Town
 Centre Clyde Creek & Thompsons Road -
 Clyde

Map
 Reference:-
 95G3

Plan Not to Scale
 Report Number: R3787-
 R2

Plan source: GEOVic

APPENDIX B – ENGINEERING LOGS

APPENDIX C – IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

INTRODUCTION

The purpose of this document is related to subsurface conditions, and to address the variable nature of soil and rock materials when used as a foundation or construction material. This information should be of benefit to Owners, Developers, Geotechnical, Design and Construction personnel.

Early recognition of geotechnical problems during the design stage is still the best way to reduce the risk of geotechnical construction problems and thereby bid prices. This normally means conducting an adequate desktop study and subsurface investigation in advance of final design for a particular project. The complete disclosure of available subsurface information in the contract documents is also an important factor in both preventing contractor claims and in obtaining fair bids for the work to be performed. Matters which could influence the project may include, however may not be limited to, easements, site features, slope stability, acid sulphate soils (ASS), mining subsidence and earthquakes. Undertaking a desktop study, such as a review of management overlays, may recognise potential problems associated with the site which may require particular attention. The amount of desktop study and subsurface information actually presented and the method of presentation in the geotechnical report can vary depending on client requirements and the complexity of the project.

It should be noted that not all the information provided here is necessarily relevant to all types of our reports and that Geoenvironmental concerns are not covered.

ENGINEERING REPORTS

Professional judgments and recommendations are presented in this report. They are based partly on evaluation of the technical information gathered, partly on historical reports (where obtained) and partly on our general experience with subsurface conditions in the area. It should be noted that the borings may not represent potentially unfavourable subsurface conditions between borings. If during construction soil conditions are encountered that vary from those discussed in this report or other reports or if design loads and/or configurations change, we should be notified immediately in order that we may evaluate effects, if any, on foundation performance. The recommendations presented in this report are applicable only to this specific site. The data provided should not be used for other purposes, where the report has been prepared for a specific design proposal as the information and interpretation may not be relevant. Nevertheless Site Geotechnical will be pleased to review the report and the sufficiency of the investigation work for other purposes, and discuss any further information which may be required.

ENGINEERING LOGS

The engineering logs are an interpretation of the subsurface condition, and their reliability will depend to some extent on the frequency of sampling and the method of excavation. The descriptions of the soils found closely follow those outlined in AS1726-1993, Geotechnical Site Investigations.

FILL

The presence of fill materials can often be determined by the visual inspection of foreign objects (i.e. building rubble) or by distinctly unusual smell, texture or colour. Where natural soils similar to those at the site are used for fill, it may be difficult to readily determine the extent of fill, and test pits are often preferred over boreholes to determine their extent. The presence of fill is normally regarded with caution as it is often associated with high variation in strength and density and potential for differential settlement which can often be associated with higher construction costs to minimise its effect to a particular project unless it can be proven and/or documented that the fill materials have been placed under controlled conditions.

POTENTIAL FOR DIFFERING SITE CONDITIONS

Subsurface conditions at a particular site are the result of natural geologic processes modified in time by physical events, such as erosion, or by man.

Site Geotechnical Pty Ltd routinely provides subsurface information to their clients in good faith to permit a general appraisal of below ground conditions. However unanticipated latent ground conditions can and do occur.

SHOULD DIFFERING SITE CONDITIONS BE ENCOUNTERED

During the progress of the work, if subsurface or physical conditions are encountered at the site differing materially from those indicated in the geotechnical report or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for the project are encountered at the site, the party discovering such conditions shall promptly notify Site Geotechnical Pty Ltd in writing of the specific differing conditions before the site is disturbed and before the affected work is performed.

Changes in ground such as filling, nearby construction or by natural events such as flooding which has occurred after the engineering logs were completed, are an example of a differing site condition at or above ground level, in which case Site Geotechnical should be contacted before applying the report to determine if it is still relevant. A minor amount of additional investigation could prevent major problems. Site Geotechnical Pty Ltd will not be responsible for any financial losses (consequential or otherwise) that may result from required changes and / or revised report recommendations.

KEEP IN TOUCH WITH YOUR CONSULTANT (SITE GEOTECHNICAL PTY LTD)

Recommendations provided within our report are not necessarily final. It is often found with the passage of time that more information is gathered related to a specific site or project and it is often beneficial to have a geotechnical engineer available to undertake construction observations and undertake meetings with design members and contractors to minimise misinterpretation and risk related to geotechnical issues.

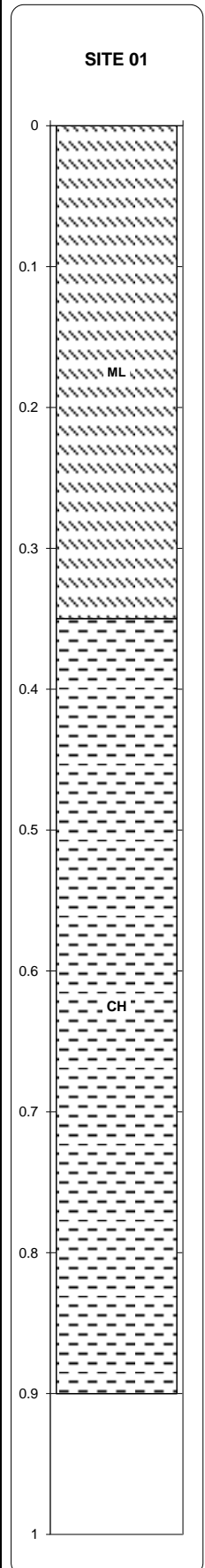
ENGINEERING LOG

CLIENT: Growth Area Authority	REPORT NUMBER: 3787-01-BL
ADDRESS: C/- PO Box 61, Malvern VIC 3144	
PROJECT: Residential/Commercial Development & Town Centre	PAGE: 1 of 1
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978	RELATIVE LEVEL (SURFACE): Not Determined
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling	JOB NUMBER: 3787
TEST SITE NUMBER.: 01 (as shown on the location of test sites plan)	

Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments
		From	To		
0.000					Surfacing Comprises of Grass
0.350	ML, SILT trace SAND, Of low plasticity, Grey, Moist , Firm, Becoming Paler and Gravelly with depth,				
0.900	CH, Silty, CLAY trace SAND, Of high plasticity, Brown mottled Orange, Moist , Stiff, Becoming Orange, Moist to Dry and Friable at 0.800m,				
END	Auger Refusal on inferred Siltstone				



Engineering Log - Field Classification Graphical Summary





END OF LOG: 08-May-2012	LABORATORY RESULTS	FIELD RESULTS
TOTAL DEPTH OF HOLE: 0.9 m	MC - Moisture Content (%) - AS 1289.2.1.1	DCP - Estimated Field CBR (%) - AS 1289.6.3.2
DEPTH TO GROUNDWATER: Not Determined	CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1	SV - Shear Vane (kPa)
LOGGED BY: James Wooding	PI - Plasticity Index (%) - AS 1289.3.3.1	PP - Pocket Penetrometer (kPa)
ENTERED BY: James Wooding	UCS - Unconfined Compressive Strength (kPa) - AS 5101.4	SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1
	LCS - Laboratory Classification of Soil - AS 1726 A2	

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 Phone: 1300 557 260 | Fax: 5975 0310 | <http://www.sitegeo.com.au>




ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-02-BL		PAGE: 1 of 1	
ADDRESS: C/- PO Box 61, Malvern VIC 3144							
PROJECT: Residential/Commercial Development & Town Centre				RELATIVE LEVEL (SURFACE):		Not Determined	
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978							
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				JOB NUMBER:		3787	
TEST SITE NUMBER.: 02 (as shown on the location of test sites plan)							
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments	<div style="text-align: center;">SITE 02</div>	
		From	To				
0.000	Surfacing Comprises of Grass						
0.450	ML, Sandy, SILT Of low plasticity, Grey, Moist , Soft, Becoming Wet at 0.300m and Paler with depth,						
1.500	CH, Silty, CLAY with SAND, Of high plasticity, Grey mottled Orange Brown, Moist , Firm, Becoming Paler with depth,						
END							
							
							
END OF LOG: 08-May-2012		LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER: Not Determined		CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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Soil Investigation Testing & Evaluation



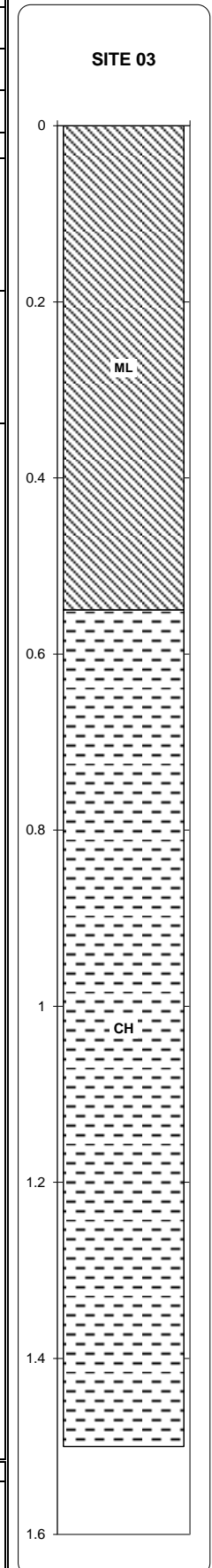
ENGINEERING LOG

CLIENT: Growth Area Authority	REPORT NUMBER: 3787-03-BL
ADDRESS: C/- PO Box 61, Malvern VIC 3144	PAGE: 1 of 1
PROJECT: Residential/Commercial Development & Town Centre	RELATIVE LEVEL (SURFACE): Not Determined
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978	JOB NUMBER: 3787
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling	
TEST SITE NUMBER.: 03 (as shown on the location of test sites plan)	

Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments
		From	To		
0.000					Surfacing Comprises of Grass
0.550	ML, Sandy, SILT Of low plasticity, Brown, Moist , Firm, Becoming Paler, Clayey and Moist to Wet with depth,				
1.500	CH, Silty, CLAY trace SAND, Of high plasticity, Orange Brown mottled Grey, Moist , Firm, Becoming Stiff at 1.300m and Paler with depth,				
END					



Engineering Log - Field Classification Graphical Summary





END OF LOG: 08-May-2012	LABORATORY RESULTS	FIELD RESULTS
TOTAL DEPTH OF HOLE: 1.5 m	MC - Moisture Content (%) - AS 1289.2.1.1	DCP - Estimated Field CBR (%) - AS 1289.6.3.2
DEPTH TO GROUNDWATER: Not Determined	CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1	SV - Shear Vane (kPa)
LOGGED BY: James Wooding	PI - Plasticity Index (%) - AS 1289.3.3.1	PP - Pocket Penetrometer (kPa)
ENTERED BY: James Wooding	UCS - Unconfined Compressive Strength (kPa) - AS 5101.4	SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1
	LCS - Laboratory Classification of Soil - AS 1726 A2	

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-04-BL		<p style="text-align: center;">SITE 04</p>	
ADDRESS: C/- PO Box 61, Malvern VIC 3144				PAGE: 1 of 1			
PROJECT: Residential/Commercial Development & Town Centre				RELATIVE LEVEL (SURFACE):			
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				Not Determined			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				JOB NUMBER: 3787			
TEST SITE NUMBER.: 04 (as shown on the location of test sites plan)							
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments		
		From	To				
0.000					Surfacing Comprises of Grass		
0.600	SM, Silty, Fine SAND Of low plasticity, Grey, Moist , Medium Dense, Becoming Paler and Moist to Wet with depth,						
1.500	CH, Silty, CLAY with SAND, Minor iron stone gravel throughout Of high plasticity, Orange mottled Red, Grey, Moist , Stiff, Becoming Stiff at 1.300m and Paler with depth,						
END							
							
							
END OF LOG:	08-May-2012	LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE:	1.5 m	MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER:	Not Determined	CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY:	James Wooding	PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY:	James Wooding	UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-05-BL		<p style="text-align: center;">SITE 05</p>	
ADDRESS: C/- PO Box 61, Malvern VIC 3144				PAGE: 1 of 1			
PROJECT: Residential/Commercial Development & Town Centre				RELATIVE LEVEL (SURFACE):			
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				Not Determined			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				JOB NUMBER: 3787			
TEST SITE NUMBER.: 05 (as shown on the location of test sites plan)							
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments		
		From	To				
0.000					Surfacing Comprises of Grass		
0.450	ML, Clayey, SILT trace SAND, Of medium plasticity, Grey, Moist , Soft, Becoming Paler and Moist to Wet with depth,						
1.500	CH, Silty, CLAY Iron Stone Gravel throughout Of high plasticity, Grey mottled Orange, Moist , Firm, Becoming Stiff at 0.800m and Orange mottled Red, Grey with depth,						
END							
END OF LOG: 08-May-2012		LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER: Not Determined		CBR ₍₆₀₎ - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-06-BL		<p style="text-align: center;">SITE 06</p>	
ADDRESS: C/- PO Box 61, Malvern VIC 3144				PAGE: 1 of 1			
PROJECT: Residential/Commercial Development & Town Centre				RELATIVE LEVEL (SURFACE):			
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				Not Determined			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				JOB NUMBER: 3787			
TEST SITE NUMBER.: 06 (as shown on the location of test sites plan)							
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments		
		From	To				
0.000					Surfacing Comprises of Grass		
0.800	SM, Silty, Fine SAND Of low plasticity, Brown, Moist, Medium Dense, Becoming Paler and Moist to Wet with depth,						
1.100	CH, Silty, CLAY with SAND, Of high plasticity, Orange mottled Grey, Brown, Moist, Stiff,						
1.500	SC, Clayey, Fine SAND Of medium plasticity, Red mottled Orange, Moist, Dense,						
END	 						
END OF LOG: 08-May-2012		LABORATORY RESULTS			FIELD RESULTS		
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1			DCP - Estimated Field CBR (%) - AS 1289.6.3.2		
DEPTH TO GROUNDWATER: Not Determined		CBR ₍₉₀₎ - Laboratory Soaked CBR (%) - AS 1289.6.1.1			SV - Shear Vane (kPa)		
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1			PP - Pocket Penetrometer (kPa)		
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4			SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1		
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-07-BL		<p style="text-align: center;">SITE 07</p>	
ADDRESS: C/- PO Box 61, Malvern VIC 3144				PAGE: 1 of 1			
PROJECT: Residential/Commercial Development & Town Centre				RELATIVE LEVEL (SURFACE):			
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				Not Determined			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				JOB NUMBER: 3787			
TEST SITE NUMBER.: 07 (as shown on the location of test sites plan)							
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments		
		From	To				
0.000					Surfacing Comprises of Bare Earth		
0.450	SM, Silty, Fine SAND Of low plasticity, Pale Brown, Moist , Medium Dense, Becoming Dense at 0.250m and Paler with depth,						
1.500	CH, Silty, CLAY with SAND, Of high plasticity, Orange mottled Grey, Red, Moist , Stiff,						
END							
							
							
END OF LOG: 08-May-2012		LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER: Not Determined		CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority			REPORT NUMBER: 3787-08-BL			<p style="text-align: center;">SITE 08</p>	
ADDRESS: C/- PO Box 61, Malvern VIC 3144			PAGE: 1 of 1				
PROJECT: Residential/Commercial Development & Town Centre			RELATIVE LEVEL (SURFACE):				
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978			Not Determined				
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling			JOB NUMBER: 3787				
TEST SITE NUMBER.: 08 (as shown on the location of test sites plan)							
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments		
		From	To				
0.000	Surfacing Comprises of Bare Earth						
0.600	SM, Silty, Fine SAND Medium Sand throughout Of low plasticity, Brown, Moist, Medium Dense, Becoming Paler and Moist to Wet with depth,						
1.500	CH, Silty, CLAY Of high plasticity, Orange mottled Grey, Moist, Stiff, Becoming Red mottled Orange, Grey and Sandy with depth,						
END							
END OF LOG:	08-May-2012	LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE:	1.5 m	MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER:	Not Determined	CBR ₍₆₀₎ - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY:	James Wooding	PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY:	James Wooding	UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-09-BL			
ADDRESS: C/- PO Box 61, Malvern VIC 3144							
PROJECT: Residential/Commercial Development & Town Centre				PAGE: 1 of 1			
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				RELATIVE LEVEL (SURFACE):			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				Not Determined			
TEST SITE NUMBER.: 09 (as shown on the location of test sites plan)				JOB NUMBER: 3787			
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments	<div style="text-align: center;">SITE 09</div>	
		From	To				
0.000						Surfacing Comprises of Grass	
0.300	ML, Clayey, SILT with SAND, Of low plasticity, Brown, Moist , Soft, Becoming Paler and Moist to Wet with depth,						
1.500	CH, Silty, CLAY trace SAND, Of high plasticity, Grey mottled Orange, Brown, Moist , Firm, Becoming Paler with depth,						
END							
 							
END OF LOG: 08-May-2012		LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER: Not Determined		CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					



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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-10-BL			
ADDRESS: C/- PO Box 61, Malvern VIC 3144							
PROJECT: Residential/Commercial Development & Town Centre				PAGE: 1 of 1			
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				RELATIVE LEVEL (SURFACE):			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				Not Determined			
TEST SITE NUMBER.: 10 (as shown on the location of test sites plan)				JOB NUMBER: 3787			
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments	<div style="text-align: center;">SITE 10</div>	
		From	To				
0.000						Surfacing Comprises of Grass	
0.450	ML, Clayey, SILT trace GRAVEL, Of low plasticity, Grey, Moist , Soft, Becoming Paler with depth,					<div style="text-align: center;">ML</div>	
1.500	CH, Silty, CLAY trace SAND, Of high plasticity, Orange Brown mottled Grey, Moist , Soft, Becoming Firm at 0.800m and mottled red with depth,						
END						<div style="text-align: center;">CH</div>	
							
							
END OF LOG: 08-May-2012		LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER: Not Determined		CBR (lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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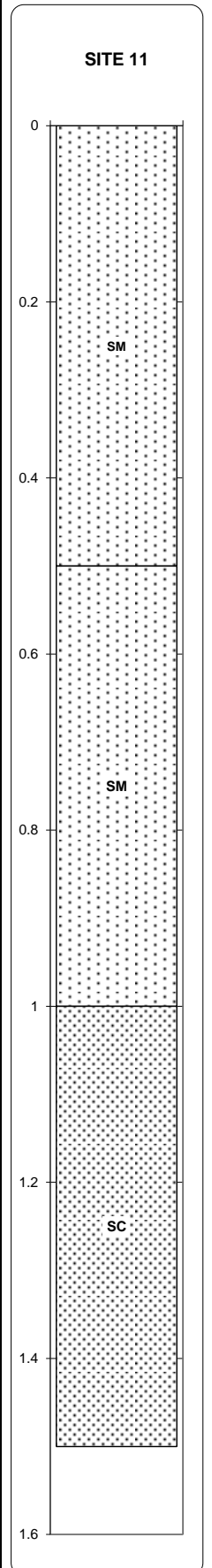


ENGINEERING LOG

CLIENT: Growth Area Authority	REPORT NUMBER: 3787-11-BL
ADDRESS: C/- PO Box 61, Malvern VIC 3144	PAGE: 1 of 1
PROJECT: Residential/Commercial Development & Town Centre	RELATIVE LEVEL (SURFACE):
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978	Not Determined
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling	JOB NUMBER:
TEST SITE NUMBER.: 11 (as shown on the location of test sites plan)	3787

Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments
		From	To		
0.000					Surfacing Comprises of Grass
0.500	SM, Silty, Fine SAND Of low plasticity, Grey, Moist , Medium Dense,				
1.000	SM, Silty, Fine SAND Of low plasticity, Brown, Moist , Medium Dense, Becoming Pale Brown and Moist to Wet with depth,				
1.500	SC, Clayey, Fine SAND Medium Sand throughout Of medium plasticity, Red mottled Pale Brown, Moist , Dense,				
END					

Engineering Log - Field Classification Graphical Summary





END OF LOG: 08-May-2012	LABORATORY RESULTS	FIELD RESULTS
TOTAL DEPTH OF HOLE: 1.5 m	MC - Moisture Content (%) - AS 1289.2.1.1	DCP - Estimated Field CBR (%) - AS 1289.6.3.2
DEPTH TO GROUNDWATER: Not Determined	CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1	SV - Shear Vane (kPa)
LOGGED BY: James Wooding	PI - Plasticity Index (%) - AS 1289.3.3.1	PP - Pocket Penetrometer (kPa)
ENTERED BY: James Wooding	UCS - Unconfined Compressive Strength (kPa) - AS 5101.4	SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1
	LCS - Laboratory Classification of Soil - AS 1726 A2	

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-12-BL		<p style="text-align: center;">SITE 12</p>	
ADDRESS: C/- PO Box 61, Malvern VIC 3144				PAGE: 1 of 1			
PROJECT: Residential/Commercial Development & Town Centre				RELATIVE LEVEL (SURFACE):			
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				Not Determined			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				JOB NUMBER: 3787			
TEST SITE NUMBER.: 12 (as shown on the location of test sites plan)							
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments		
		From	To				
0.000					Surfacing Comprises of Bare Earth		
0.700	SM, Silty, Fine SAND Of low plasticity, Brown, Moist , Medium Dense, Becoming Paler with depth,						
1.500	CH, Silty, CLAY with SAND, Of high plasticity, Orange mottled Red, Moist , Stiff, Becoming Very Sandy with depth,						
END							
							
							
END OF LOG: 08-May-2012		LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER: Not Determined		CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-13-BL			
ADDRESS: C/- PO Box 61, Malvern VIC 3144							
PROJECT: Residential/Commercial Development & Town Centre				PAGE: 1 of 1		<div style="text-align: center;">SITE 13</div>	
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				RELATIVE LEVEL (SURFACE):			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				Not Determined			
TEST SITE NUMBER: 13 (as shown on the location of test sites plan)				JOB NUMBER: 3787			
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments		
		From	To				
0.000					Surfacing Comprises of Bare Earth		
0.400	SM, Silty, Fine SAND with GRAVEL, Of low plasticity, Brown, Moist , Medium Dense, Becoming Paler with depth,					0.2 SM	
0.900	CH, Silty, CLAY with SAND, Of high plasticity, Orange mottled Grey, Red, Moist , Firm, Becoming Stiff at 0.600m,					0.6 CH	
1.500	SC, Clayey, Fine SAND Of low plasticity, Red, Moist , Dense, Becoming Orange with depth,					1.2 SC	
END	 						
END OF LOG: 09-May-2012		LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER: Not Determined		CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-14-BL			
ADDRESS: C/- PO Box 61, Malvern VIC 3144							
PROJECT: Residential/Commercial Development & Town Centre				PAGE: 1 of 1		<div style="text-align: center;">SITE 14</div>	
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				RELATIVE LEVEL (SURFACE):			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				Not Determined			
TEST SITE NUMBER.: 14 (as shown on the location of test sites plan)				JOB NUMBER: 3787			
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments		
		From	To				
0.000						Surfacing Comprises of Bare Earth	
0.450	SM, Silty, Fine SAND Of low plasticity, Grey, Moist, Medium Dense, Becoming Paler and Clayey with depth,						
1.500	CH, Silty, CLAY with SAND, Of high plasticity, Orange mottled Grey, Moist, Soft, Becoming Paler with depth,						
END							
END OF LOG: 08-May-2012		LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER: Not Determined		CBR _(lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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ENGINEERING LOG						Engineering Log - Field Classification Graphical Summary	
CLIENT: Growth Area Authority				REPORT NUMBER: 3787-15-BL		<p style="text-align: center;">SITE 15</p>	
ADDRESS: C/- PO Box 61, Malvern VIC 3144				PAGE: 1 of 1			
PROJECT: Residential/Commercial Development & Town Centre				RELATIVE LEVEL (SURFACE):			
LOCATION: Clyde Creek and Thompsons Road, Clyde VIC 3978				Not Determined			
METHOD: AS1289.1.2.1.6.5.3 Sampling from in-situ material - Power Auger Drilling				JOB NUMBER: 3787			
TEST SITE NUMBER: 15 (as shown on the location of test sites plan)							
Depth (m)	Field Description of Materials (as per AS 1726 - Appendix A)	Sample		Sample I.D.	Comments		
		From	To				
0.000					Surfacing Comprises of Bare Earth		
0.200	SM, Silty, Fine SAND FILL, Of low plasticity, Grey, Moist , Loose,						
0.600	SM, Silty, Fine SAND trace CLAY, Of low plasticity, Dark Grey, Moist , Medium Dense, Becoming Paler and Clayey with depth,						
1.500	CH, Silty, CLAY trace SAND, Of high plasticity, Dark Grey mottled Orange, Moist , Firm, Becoming Paler with depth,						
END							
END OF LOG: 08-May-2012		LABORATORY RESULTS		FIELD RESULTS			
TOTAL DEPTH OF HOLE: 1.5 m		MC - Moisture Content (%) - AS 1289.2.1.1		DCP - Estimated Field CBR (%) - AS 1289.6.3.2			
DEPTH TO GROUNDWATER: Not Determined		CBR (lab) - Laboratory Soaked CBR (%) - AS 1289.6.1.1		SV - Shear Vane (kPa)			
LOGGED BY: James Wooding		PI - Plasticity Index (%) - AS 1289.3.3.1		PP - Pocket Penetrometer (kPa)			
ENTERED BY: James Wooding		UCS - Unconfined Compressive Strength (kPa) - AS 5101.4		SPT - Standard Penetration Test - "N" Value is the number of blows for last 300mm - AS 1289.6.3.1			
		LCS - Laboratory Classification of Soil - AS 1726 A2					

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