Realty Realizations Pty Ltd
c/o Allen Price and Associates Pty Ltd

Geotechnical Constraints Assessment Lot 61 DP 755971 and Part of Lot 6 DP1065111, Culburra Road, West Culburra, NSW.

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November 2012

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Head Office
6/37 Leighton Place
Hornsby, NSW 2077, Australia
ACN 070 240 890 ABN 85 070 240 890
Phone: +61-2-9476-9999
Fax: +61-2-9476-8767
Email: mail@martens.com.au
Web: www.martens.com.au

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Author(s)	Reviewer(s)	Project Manager	Signature
Nathan Foster	Andrew Norris Dr Daniel Martens	Andrew Norris	

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1 Introduction

1.1 Overview

The report documents the findings of a geotechnical constraints assessment undertaken by Martens & Associates Pty Ltd for Realty Realizations Pty Ltd C/- Allen, Price & Associates to inform a concept plan for a mixed use sub-division at West Culburra.

The purpose of this assessment is to outline the suitability of the subject site for proposed development. Geotechnical information outlined in this report details preliminary geotechnical properties of sub-surface soils, and possible geotechnical constraints at the subject site. Consideration of the factors likely to affect development is addressed via preliminary development constraints planning.

1.2 Field Investigations

Site investigations included the following:

- A general walkover inspection of the site to assess existing site conditions, presence of geotechnical hazards, and document site geomorphology;

- Excavation of twenty-five (25) testing locations via boreholes using a truck-mounted hydraulic drill rig, and test pitting activities using a backhoe; and

- Dynamic Cone Penetrometer (DCP) testing at twenty-five (25) locations to determine soil strength properties, and compliment borehole log data.

Soil samples were collected from locations across the site for the purposes of salinity, ASS, and Atterberg Limit / Linear Shrinkage assessments. Sampling information for the above assessments is outlined Sections 3.

Sub-surface investigation locations are presented in Attachment A.

1.3 Relevant Guidelines/Standards

This report has been prepared in general accordance with the following guidelines/standards:

- Acid Sulfate Soil Management Advisory Committee (1998) *Acid Sulfate Soil Manual*;
- Australian Standard 1289 6.3.2 (1997) *Methods of testing soils for engineering purposes - Soil strength and consolidation tests DCP;*
- Australian Standard 1796 (1993) *Geotechnical Site Investigations*;
- Australian Standard 2870 (1996) *Residential Slabs and Footings*;
- Department of Land and Water Conservation (2002) *Salinity Guidelines; and*
- Department of Land and Water Conservation (2002) *Site Investigations for Urban Salinity.*

2 Site Description

2.1 Site Location

The subject site at Culburra Road, West Culburra comprises the following lots:

- Lot 61 DP 755971;
- Part Lot 5 DP 1065111;
- Part Lot 6 DP 1065111; and
- Part Lot 7 DP 1065111.

The site is located approximately 15 km east-south-east of Nowra and is within the Shoalhaven City Council Local Government Area.

Total site area is approximately 97 ha consisting mostly of undeveloped remnant forest, although part of Lot 5 DP 1065111 and part of Lot 61 DP 755971 have been cleared.

The location of the site in its regional context is presented in Figure 1.

Figure 1: Location of the subject site.

2.2 Physiography and Hydrology

Majority of the site is elevated >5 mAHD above the Crookhaven River estuary. Immediate foreshore areas are moderately steep and transitional between the subject site and the estuary. Relief across the site is approximately 20 m. The landscape is gently undulating with slopes ranging between 2.5 – 5.0 %, with some areas of localised over steepening typically associated with drainage lines.

Site drainage ranges from good to poor across the site, with poor draining areas characteristically associated with lower points of elevation within the landscape. Site drainage likely consists of both infiltration and overland flow (sheet and concentrated).

2.3 Lithology and Soil Landscapes

Reference to the 1:250,000 Wollongong Geological Series Sheet indicates that site is lies upon Wandrawandian Siltstone, a member of the Shoalhaven Group. Wandrawandian Siltstone is dominated by siltstone and silty sandstone lithologies, and is pebbly in parts. Immediate foreshore areas of the site, adjacent to Crookhaven River Estuary consist of Quaternary sedimentary units of gravel, sands, silts, and clays of marine to freshwater environments, and likely overlie Wandrawandian Siltstone in these areas.

Hazelton (1992) indicates that soils within the investigation area belong predominantly to the Greenwell Point Soil Landscape Group. Soils are primarily derived from *in-situ* weathering of the underlying Wandrawandian Siltstone. Soils are characteristically shallow (<50 cm) to moderately deep (50-100 cm) Loams to Yellow Podzolic Soils or Red Solodic Soils.

While not observed during field investigations, soil mapping completed by Hazelton (1992) suggests that the eastern periphery of the site may contain the Seven Mile Soil Landscape group. This soil landscape group is genetically estuarine, and comprises deep (> 1.5 m) Siliceous Sands, Acid Peats, and Humus Podzols.

2.4 Hydrogeology

Groundwater was observed during intrusive investigations at the site, and is summarised in Table 1. A more detailed investigation of groundwater at the site is presented in Martens and Associates report P0902521JR03V01.

Table 1: Groundwater level measurements

GMB ID [1]	GMB Surface Level [2]	23.11.2010 mAHD	24.11.2010 mAHD	25.11.2010 mAHD	26.11.2010 mAHD
1	6	5.38	5.38	5.34	5.31
1a	6	-	4.84	4.93	4.97
2	22	20.8	20.71	20.63	20.59
2a	22	-	Dry	Dry	Dry
3	15	Dry	Dry	Dry	Dry
4	8	Dry	Dry	Dry	Dry
5	8	Dry	Dry	Dry	Dry
6	5	-	-	4.87	4.86

Note:
[1] GMB – groundwater monitoring bore.
[2] Level approximate mAHD based on Allen, Price and Associates survey (Ref: 25405-02)

3 Factors Affecting Development

3.1 Geotechnical

3.1.1 Sub-surface Conditions

Subsurface investigations at the subject indicate that predominantly sandy silts or silty sands (with some organic content) typically overlie medium to high-plasticity clays derived from *in-situ* weathering of the underlying Wandrawandian Siltstone. The soil mantle typically ranges in depths from 1.3 – 1.5 m below ground level (BGL). Extremely to highly-weathered siltstone is encountered below 1.5 mBGL, with rock strength variation ranging from extremely to slightly weathered to depths of 5.5 mBGL. Significant rock outcropping was not observed on the site.

Borehole, test pit and DCP locations are shown on the site plan (Attachment A). Detailed borehole and test pit logs are presented in Attachment B.

Table 2: Indicative soil and rock depth range.

Material Description [1]	Depth [2] (m)
SILTY SAND / SANDY SILT	0.0 – 0.3
CLAY	0.3 – 1.3
EW – SW SILTSTONE (weathering patterns variable down profile)	1.3 - >5.5

Notes:
[1] F = Fresh, SW=Slightly weathered, MW = Moderately weathered, HW = Highly weathered, EW = Extremely weathered. Refer to borehole logs for material description details.
[2] Indicative depth range. Material depth may vary across a site depending on site and local geological conditions. Depth of fill variable across the site. Refer to borehole logs for accurate depths of soil materials at each borehole.

3.1.2 Soil Strength Properties

Preliminary soil strength estimates indicate soils below 0.3 m are likely to have allowable bearing capacities (ABC) ranging between 50 – 200 kPa, providing suitable bearing capacity for standard shallow foundations for residential dwellings. Areas of the site identified to contain soft soils are likely to have ABC <50 kPa.

Further investigation is required at detailed design stage to formally assess ABC and related soil strength properties across the site. We also recommend that additional assessment is conducted to formally identify the distribution of soft soil areas and associated ABC and related soil strength properties which may have implications for development in these areas.

3.1.3 Rock Strength Properties

Initial investigations indicate that the rock weathering front occurs between 1.0-1.5 mBGL across the site, with underlying Wandrawandian Siltstone exhibiting rock strength variations down profile. Based upon preliminary investigations, allowable bearing capacities of weathered rock between 300-600 kPa are likely to be encountered below 1.5 mBGL.

Due to observed variation in rock strength it is recommended that where higher rock strength values are required for structural design purposes, further rock coring, RQD assessment, and point-load testing is conducted.

3.1.4 Atterberg Limits Laboratory Analysis

Atterberg limits laboratory testing was conducted upon representative soil samples collected. Results are presented in Table 3. Analytical laboratory certificates are presented in Attachment E.

Table 3: Laboratory Results for Atterberg Limits and Linear Shrinkage Testing

Sample	LL (%) [1]	PL(%) [2]	PI(%) [3]	Ls (%) [4]	USCS [5]
2842/10/0.5	120	33	87	21.5	CH
2842/10/1.0	54	17	37	15.0	CH
2842/17/0.5	71	17	54	14.0	CH
2842/17/1.0	68	16	52	17.5	CH
2842/20/1.0	92	19	73	17.5	CH

Notes:
[1] Liquid limit.
[2] Plastic Limit.
[3] Plasticity Index.
[4] Linear Shrinkage.
[5] Unified Soil Classification Scheme.

Preliminary laboratory analysis indicates that sub-soils at the site are highly plastic.

Linear shrinkage information relating to site classification for foundation purposes are discussed in Section 4.3.

3.1.5 Soft Soils and Poor Drainage Constraints

Intrusive investigations and site observations indicate typically consistent site geomorphology and subsurface conditions within the subject site. Due to shallow, low-permeability sub-soils, and general low relief, soils across the subject site are likely to exhibit characteristics of poor drainage following incident rainfall.

Localised soft soils were identified during site works, and approximate locations are presented in Attachment A. These areas were observed in drainage depressions or areas of extreme low relief associate with

ridge crests. Due to the preliminary nature of the investigation and limited information available, it is uncertain if soft soil areas are a product of low-permeability sub-soils, perched groundwater, or spring discharge points

3.2 Slope Instability

3.2.1 Assessed Hazards

The slope instability assessment for the subject site has been prepared in accord with Australian Geomechanics (Vol. 42, No.1) "Guidelines for Landslide Susceptibility, Hazard, and Risk Zoning for Landuse Planning".

Observation compiled during the site walkover indicates the following potential slope stability hazards:

1. Soil creep - Soil creep can be an active process on moderate and steep slopes. The process is very slow and shallow seated. While not directly observed during the site walkover, possibility for the existence of soil creep at the site is likely given sufficient relief.

2. Shallow Rotational Slide – Where necessary relief is available, particularly within poor drainage areas of the site. Such failures may occur where the soils become saturated, or the slope is over-steep and failure occurs on defects such as joints or bedding planes.

3.2.2 Slope Instability Risk Assessment

The site instability risk assessment was undertaken in accordance with Australian Geomechanics 2007 Landslide Management guidelines. Results of the analysis are provided in the table below.

Table 4: Slope Instability Risk Assessment and Calculation.

Site Features	Poorly Drained Areas	Balance of Site
Average Grade (%)	10%	5%
Peak Grade (%)	25%	10%
Average soil depth (m)	1.3	<1.3
Peak soil depth (m)	2.0	<1.3
Soil materials	Silty Sand/ Sandy Silt / Clay	Silty Sand/ Sandy Silt / Clay
Soil creep observed	No	No
Permanent Groundwater	Not observed	Not observed
Springs	Possible	Not observed
Instability observations	No	No

Site Features	Poorly Drained Areas	Balance of Site
Instability factors	1.Possible springs within drainage depressions leading to increased poor pressure behind structures if not adequately drained. 2.Locally saturated soil profile without adequate sub-soil drainage.	Site is typically of low relief and limited opportunity for instability.
Soil Creep		
Likelihood	Almost Certain	Barely Credible
Consequence	Low	Very Low
Risk Rating	Low	Very Low
Treatment Required	Yes	Nil
Shallow Rotational Slide		
Likelihood	Possible	Very Low
Consequence	Medium	Very Low
Risk Rating	Moderate	Very Low
Treatment Required	Yes	Nil

3.2.3 Conclusions

It is recommended that further investigation is undertaken to confirm the existence and possible extent of slope instability, particularly in relation to areas of poor drainage, and proposed development areas in proximity to the foreshore protection zone (where required). Within this landscape position, some degree of over steepening was observed in conjunction with shallow groundwater levels overlying sub-horizontal strata.

Development of remaining areas of the site should be undertaken in accordance with good hillside construction practice and sound engineering principles.

3.3 Salinity

3.3.1 Salinity Risk Mapping

Review of salinity hazard mapping (NSW Natural Resource Atlas, 2010) does not indicate salinity hazards associated with the subject site. Although the regional evidence indicates that the site is in a locality of unidentified salinity potential (NSW Natural Resource Atlas, 2010), local variations can occur and the subject site may experience minor salinity potential.

3.3.2 *Observed Site Conditions*

Site investigations did indicate the signs of existing salinity at the site:

- Vegetation growth appeared healthy and uninhibited;
- There were no salt crystals on ground surface;
- There were no bare soil patches with black staining or greasy appearance on site;
- There were no bare patches with obvious white crystals or a 'puffy' soil structure on site;
- There was no dieback of trees from outer canopy on site; and
- Drainage on the site was acceptable, except for poor drainage observed in drainage lines, and following rainfall.

3.3.3 *Soil Testing*

Thirty (30) soil samples from ten (10) of the geotechnical boreholes were submitted to Envirolab Services laboratories for electrical conductivity (EC) testing and soil pH characteristics.

3.3.4 *Soil Salinity and Aggressivity*

Results indicate that the soils at the site are generally non-saline, except soils at BH6 at the far eastern-end of the site which were moderately to very saline throughout the soil profile.

Soil pH conditions will likely impact on exposed concrete foundations / piles within areas of the site, with a concrete exposure classification of mild for soils assessed. BH8 returned a moderate exposure classification at 1.0 mBGL.

Summary of testing results is presented in Attachment D and laboratory analytical certificates are provided in Attachment F.

3.3.5 *Recommendations*

It is recommended that at detailed design stage, detailed soil salinity and aggressivity assessment is completed, with particular emphasis on those proposed eastern development blocks where soil salinity has been indicated during this investigation. Given the extent and magnitude of observed salinity it is concluded that soil salinity shall be readily managed with engineering solutions and shall not prevent development of these areas.

Soil sodicity was not assessed as part this investigation, however site observations indicate areas of poor drainage and low-permeability

across the site. Further investigations should assess Cation Exchange Capacity (CEC) of soils in addition to Emerson Aggregate Class, to ascertain the prevalence of soil sodicity and soil dispersion on site.

3.4 Acid Sulfate Soils

3.4.1 Introduction

A preliminary assessment for the presence of Acid Sulfate Soil (ASS) was undertaken within areas of the site <5 mAHD. ASS soil samples were collected for laboratory analysis during the intrusive investigations of the site.

3.4.2 ASS Risk Map Classification

Review of the NSW Natural Resource Atlas acid sulphate soils risk map (see Figure 2) indicates that perimeter areas of the site, most notably adjacent to Crookhaven River Estuary are classified as Class 2 (works below the ground surface). In consideration of ASS risk to the development, it is noted that a 100 m foreshore set-back distance is required for the proposed development.

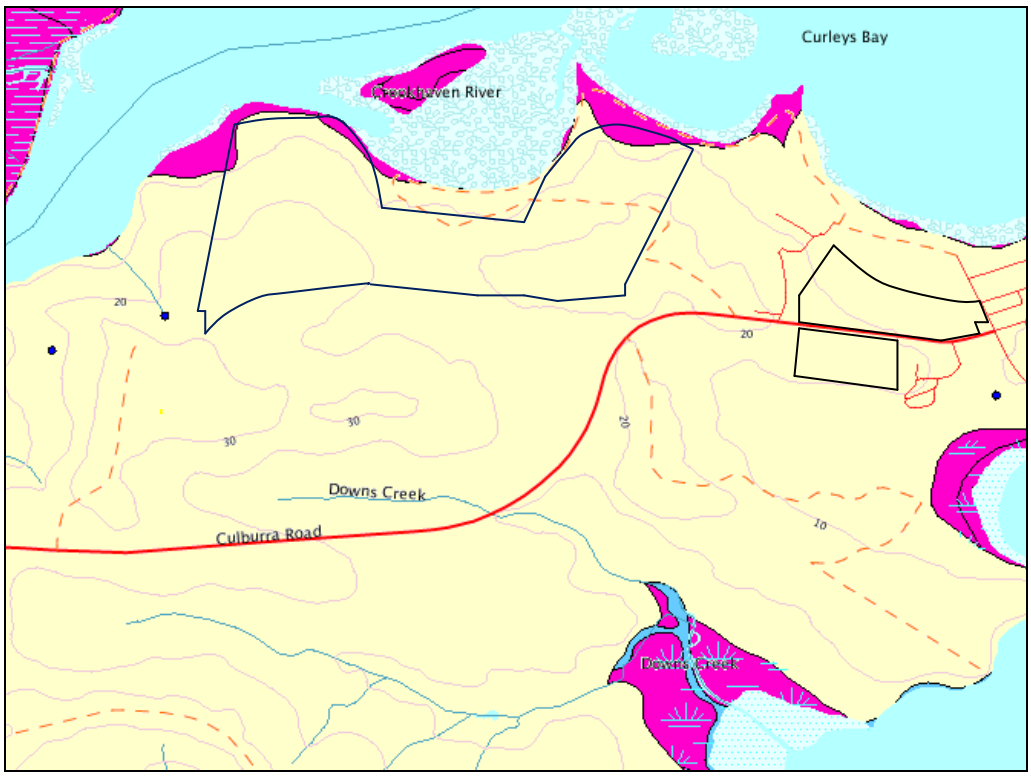

Figure 2: Acid Sulfate Soils Risk Map (NSW Natural Resource Atlas).

3.4.3 Geomorphic Characteristics

Observations compiled during the site inspection and via aerial photography interpretation (API) were compared against various geomorphic characteristics outlined in ASSMAC (1998) indicating likely ASS occurrence (Table 5).

Table 5: Geomorphic site features indicative of ASS and their presence or absence at the site.

Geomorphic Feature	Present on site?
Holocene sediments	Adjacent to Shore
Soil horizons less than 5 m AHD	Adjacent to Shore
Marine / estuarine sediments or tidal lakes	Adjacent to Shore
Coastal wetland; backwater swamps; waterlogged or scaled areas; interdune swales or coastal sand dunes.	Adjacent to Shore
Dominant vegetation is mangroves, reeds, rushes and other swamp or marine tolerant species.	Adjacent to Shore
Geologies containing sulphide bearing material	Possibly
Deep older (Pleistocene) estuarine sediments	Unknown

Due to the characteristic local morphology, areas likely to be associated with ASS prevalence likely exist with the immediate perimeter of the site, bordering Crookhaven River Estuary. Two (2) of the seven geomorphic characteristics listed are present on the site. This indicates a likelihood that ASS may be present.

3.4.4 *Potential Risk Assessment of Proposed Works.*

Table 6 provides a risk assessment based on field investigations undertaken. Due to the preliminary nature of this investigation, and unknown aspects of the proposed development, a number of assumptions have been made in generating the risk assessment in Table **6**. Assumptions have based on observed site conditions and our experience working on similar sites.

Table 6: Risk assessment for proposed works on the site based on Table 3.1 of ASSMAC (1998) and Laboratory results of SPOCUS testing.

Factors Affecting Risk Level	Description	Level of Risk
Volume of material to be disturbed	> 50 tonne (across the whole site)	High
Distance between potential acid sulfate soils and depth of disturbance	Unknown	N/A
Change in surface drainage	Likely to be shallow to mid level drains across the site.	Moderate
Duration of disturbance	> 7 days	High
Likely severity of ASS based on peroxide reaction and final pH_{ox}	Mild	Low
Connection to natural waterbodies or wetlands	Connected to Crookhaven River Estuary and Lake Wollumboola by surface runoff	Moderate

The assessment suggests a "moderate" risk from proposed site works, and as such, a preliminary laboratory testing regime was conducted for the site.

3.4.5 Preliminary Field Screen Testing

Preliminary field screen testing was completed on thirty (30) soil samples to provide an indication as to the presence of potential ASS (PASS) or actual ASS (AASS). Soil samples were analysed from ten (10) boreholes (BH1, BH4, BH5, BH6, BH11, BH13, BH19, BH20, BH21, and BH24), with sampling aimed at:

1) Assessing the soil horizons most likely to contain ASS; and

2) Testing of soil horizons most likely to be impacted as a result of proposed development works.

3.4.6 Cl^- / SO_4^{2-} Groundwater Ratio

Presence of ASS was also assessed by examination of Cl^- / SO_4^{2-} ratio in groundwater, and results are presented in Table 7.

Table 7: ASS groundwater data.

Groundwater bore sampling	Chloride (Cl^-) (mg/L)	Sulfate (SO_4^{2-}) (mg/L)	Cl^- / SO_4^{2-} ratio
GMB01	1,300	330	3.9
GMB02	40	22	1.8
GMB06	6,000	720	8.3

While Cl^- / SO_4^{2-} ratios <2 are a strong indication of ASS presence, Cl^- and SO_4^{2-} concentrations are very low within groundwater at GMB02. Additionally GMB02 is located on a residual soil profile, at an elevation >20 mAHD, indicating that ASS presence is unlikely.

3.4.7 sPOCAS Analysis

Table 8: Results of sPOCAS testing.

Sample ID	Sample Depth (mBGL)	Soil Type	pH_{KCL} [1]	pH_{OX} [2]	TPA (mol H+/t) [3]	TSA (mol H+/t) [4]	S_{POS} (%S oxidisable) [5]
2842/1/1.0	1.0	Clay	3.5	4.1	143	5.0	0.005
2842/5/1.0	1.0	Clay	3.6	4.2	128	<5.0	<0.005
2842/13/0.5	0.5	Clay	4.3	4.0	<5.0	<5.0	0.007
2842/19/0.5	0.5	Clay	3.5	4.0	173	10	0.007
2842/21/0.5	0.5	Clay	3.8	4.2	108	20	0.010
Guideline Limit (Action Criteria)		**Sands**	**-**	**-**	**18**	**18**	**0.03**
		Sandy Loams, Clays and Silts	**-**	**-**	**36**	**36**	**0.06**
		Silty Clays, Clays	**-**	**-**	**62**	**62**	**0.10**

Note: [1] Actual pH; [2] Post peroxide oxidation pH; [3] Total Potential Acidity; [4] Total Sulfidic Acidity; [5] Percentage peroxide oxidisable sulfur.

On the basis of this sPOCUS analysis we conclude the following:

1. Except for 2842/13/0.5, soil acidity is reduced following oxidation;

2. Samples are not considered to be PASS or AASS, however there are a number of soil samples that contain minor acid generating ability when fully oxidised. It unlikely that soil acidity can be attributed to sulfidic acidity, and is most likely a result of pedogenic processes occurring within the soil mantle.

3.4.8 Conclusions and Recommendations

It is considered that soils observed during the investigation are neither AASS nor PASS, but are inherently acidic soils derived from *in-situ* weathering of the underlying siltstone lithology and pedogenic processes.

Should development be considered within the 100 m foreshore set-back distance, adjacent to Crookhaven River estuary, further ASS assessment would be required to evaluate ASS constraints in this area.

4 Development Constraints Planning

4.1 Overview

The following geotechnical constraints are based on slope stability and soil erosion considerations. The constraints are aimed at providing broad guidelines to assist in development planning. It is envisaged that further refinement and delineation of geotechnical constraints, including pavement and foundation designs, will occur with more detailed assessment of separate areas of the site as development proceeds.

4.2 Areas of Suitable for Development

It is considered that the site is generally geotechnically suitable for development, however, it is recommend further investigation is undertaken to identify the distribution and ascertain development suitability of areas of the site characterised by soft soils. It is also recommend more detailed salinity assessment is completed in proposed eastern development areas (considering salinisation values identified in BH6) to establish salinity distribution and consider appropriate constraints planning options.

While no pronounced evidence of land instability was observed at the subject site, should development be considered in steeper areas adjacent to Crookhaven River foreshore, and within the 100 m foreshore set-back distance, a detailed land instability assessment would be required.

4.3 Foundations

Limited site investigation indicates no specific geotechnical constraint relating to foundations at the site, provided foundations are designed by a suitably qualified geotechnical or structural engineer, in accordance with AS2870-1996 "Residential Slabs and Footings".

Based upon depth of clay saprolite and linear shrinkage values (see Table 3), we consider that the site classification to AS2870-1996 "Residential Slabs and Footings" would be predominantly **Class M**, however, we recommend detailed site classification assessment at a later stage.

It is also envisaged where soft soils occur these may require foundation treatment prior to foundation construction (i.e. dewatering, compaction, bridging layers, piles, etc). Laboratory analysis of identified soft soil should be incorporated within further investigations of soft soils, and should include shrink/swell index testing or further linear shrinkage analysis.

4.4 Site Preparation and Clearance

Soil and erosion control planning will be required during and following construction on the subject site, and should be prepared in accordance with Landcom (2004) 'Blue Book'.

4.5 Excavation

It is anticipated that all materials could be excavated by conventional dozer-blade or backhoe bucket at least to a depth between 1.5 – 2.0 mGBL.

Difficult ripping conditions maybe encountered within deeper excavations, as such, allowance should be made for use of hydraulic rock breakers in localised hard bands, or in confined detail excavations such as footings or service trenches.

Where excavations should exceed 1.5m in depth, constructed retaining walls should be considered on a site by site basis and designed by a qualified and experienced engineer.

4.6 Reuse of Materials

The following comments are made regarding suitability of site materials for re-use in filled areas:

- Where site regrading is proposed, all existing topsoil, vegetation, and geotechnically unsuitable materials should be removed to spoil or stockpiled for reuse as landscaping materials only;
- Stripping is expected to be required to depths of about 0.3 m (topsoil layer), but may be significantly deeper where wet, silty soils are encountered;
- Underlying very stiff clays may be carefully stripped as necessary and stockpiled for re-use as general site fill;
- The clayey soils on-site are expected to be moderately reactive (susceptible to volume changes with variation in moisture content) and will need to be placed and compacted to a minimum density ratio of 95% Standard Compaction within ±2% of OMC to minimise reactive soil movements;
- Where excavation of weathered rock is required there may be some oversize material that requires sorting or crushing prior to re-use as engineering fill.

4.7 Filling

Use of engineered fill on the subject site should be undertaken in accordance with sound engineering principles as set out in AS3798 (2007).

Residual clay soils derived from cuts on the site is likely to be suitable as site regrade fill provided good moisture control is supplied during placement and compaction. Topsoil materials are considered geotechnically unsuitable and are regarded as suitable for landscaping use only.

Where site regrading is proposed, the following general course of action should be taken:

- Strip existing topsoil, root affected material and deleterious material to spoil;
- Following stripping the surface should be assessed for trafficability;
- Following stripping, the exposed sub-grade materials should be proof rolled to indicate any wet or deflecting material. Any such areas should be over excavated and backfilled with an approved select material. The area should also be graded to shed water
- Approved fill should be placed and compacted in accordance with AS3798-2007 '*Guidelines for Earthworks for Commercial and Residential Developments'*.

4.8 Pavements

It should be anticipated that some degree of moisture conditioning of sub-grade materials may be necessary prior to compaction and placement of pavement materials. The required time period to prepare the sub-grade is likely to be dependent on the prevailing weather conditions at the time of construction. Based upon preliminary site assessment a provisional CBR value of 3% is likely for pavement calculations at clay sub-grade level.

Where siltstone sub-grades are encountered, the bedrock should be ripped and re-compacted to a minimum depth of 250mm to provide a dense homogenous surface for pavement construction. Ripped and re-compacted weathered rock may be assumed to have a design CBR of 10%, however this should be confirmed with further testing.

Where pavements are required in poor drainage areas, a CBR value <3% is likely, and may require sub-grade improvement or replacement, and involve lime-stabilised sub-grades, use of geofabrics or removal of a nominal depth of soil and replacement with select fill to bridge low-strength material.

It is recommended that a detailed pavement investigation be conducted incorporating CBR laboratory testing, when the alignment, level, and traffic loading of proposed roads are determined.

5 Limitations

The recommendations presented in this report include specific issues to be addressed during the detailed design phase of the project. In the event that any of the recommendations presented in this report are not implemented, the general recommendations may become inapplicable and Martens & Associates accept no responsibility whatsoever for the performance of the project where recommendations are not implemented in full and properly tested, inspected and documented.

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

6 References

Acid Sulfate Soil Management Advisory Committee (1998). *Acid Sulfate Soil Manual*.

Australian Geomechanics Society, Sub-Committee on Landslide Risk Management (March 2000) *Landslide Risk Management Concepts and Guidelines*, Australian Geomechanics 35 (1), p 49 – 92.

Australian Standard (1997) 1289 6.3.2 *Determination of the Penetration Resistance of a Soil using the 9 kg Dynamic Cone Penetrometer.*

Australian Standard 1796 (1993) *Geotechnical Site Investigations.*

Australian Standard 2159 (2005) *Pliling – Design and Installation.*

Australian Standard 2870 (1996) *Residential Slabs and Footings.*

Australian Standard 2870 Supplement 1 (1996) *Residential Slabs and Footings – Construction – Commentary.*

Australian Standard 3798 (2007) *Guidelines on earthworks for commercial and residential developments.*

Australian Standard 4678 (2002) *Earth Retaining Structures.*

Das, B.M., (1995) *Principles of Foundation Engineering.*

Department of Land and Water Conservation (2002) *Salinity Guidelines.*

Department of Land and Water Conservation (2002) *Site Investigations for Urban Salinity.*

Hazelton P.A *et.al* (2007) *What Do All the Numbers Mean?*

7 Attachment A – Site Plan

KEY:

5 — INVESTIGATION AREA BOUNDARY AND NUMBER

CADASTRAL BOUNDARY

BH28/DCP28 — BOREHOLE/TEST PIT AND DCP LOCATIONS

PRELIMINARY SOFT SOILS AREA

N W E S

PRELIMINARILY DEMARCATED SOFT SOILS AREAS. ADDITIONAL INVESTIGATION REQUIRED TO ASSESS SOFT SOIL DISTRIBUTION AND LIKELY LIKELY WORKS REQUIRED FOR DEVELOPMENT

MODERATE - VERY SALINE SOILS REPORTED THROUGHOUT THE SOIL PROFILE @ BH6. ADDITIONAL SALINITY ASSESSMENT IN RECOMMENDED FOR THE EASTERN PORTION OF THE SITE TO CHARATERISE SALINITY.

BH1/DCP1 BH11/DCP11 BH24/DCP24 BH7/DCP7 TP10 BH13/DCP13 BH4 BH19/DCP19 BH5/DCP5 BH17/DCP17 BH18/DCP18 BH8/DCP8 TP12 BH3/DCP3 TP15 TP16 TP14 TP9 BH2 TP20 TP21 BH6/DCP6 BH23/DCP23 BH22/DCP22

PM 73997 FD PM 74004 FD PWD 677 PM 32621 FD PM 62367 FD SSM 4577 FD PM 73999 FD PM32620

GATE ROAD CULVERT CANAL STREET E

5 (POR. 61) 61 DP 755971

4 3 2 1

6 DP 1065111

7 DP 1065111

(POR. 81) 81 DP 755971

(POR. 90) 90 DP 755971

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CLIENT/ PROJECT
REALTY REALIZATIONS PTY LTD
GEOTECHNICAL CONSTRAINTS ASSESSMENT

THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in m unless otherwise specified.

TITLE
LOT 61 DP 755971 AND PART OF LOT 6 DP 1065111 CULBURRA ROAD, WEST CULBURRA, NSW CONSTRAINTS AND TESTING LOCATION PLAN

PROJECT MANAGER: ANDREW NORRIS
DRAWING NUMBER: P1002842JD02V01

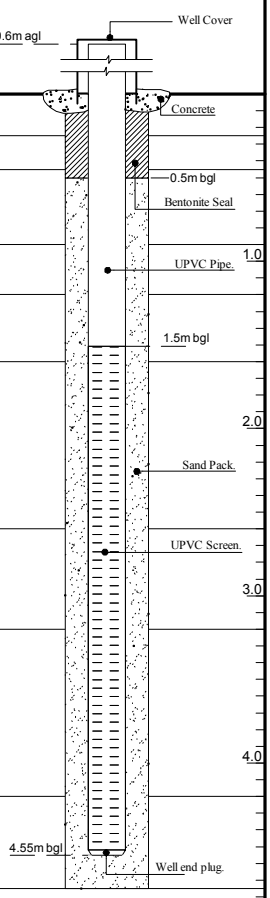
DESIGNED:	NF
DRAWN:	NF
REVIEWED:	AN
DATUM:	mAHD
HORIZONTAL RATIO:	1:500 @ A1 1:1000 @ A3
VERTICAL RATIO:	NA
SHEET	1
OF	1 SHEETS
PAPER SIZE:	A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	GEOTECHNICAL CONTRAINTS ASSESSMENT	28.01.11	NF

8 Attachment B – Borehole and Test Pit Logs

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	22.11.10	**COMPLETED**	22.11.10	**REF**	**BH1**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.1mØ X 4.75m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
A	Nil	N	M	0.25			SC	SILTY CLAYEY SAND – Dark brown, fine grained sands.		L	A	0.2	2842/1/0.2
A	Nil	N	M	0.45			SC	SILTY CLAYEY SAND – Light grey, fine grained sands, minor gravels.		L	A	0.4	2842/1/0.4
A	Nil	N	M	0.6 0.9			CL	SILTY CLAY - Brown/orange, gravels (1-15mm, 35%), tending to clay with gravels decreasing.	F St		A	0.5	2842/1/0.5
A	Nil	N	M	1.0 1.2			CH	CLAY - Grey/orange/red mottled.	VSt		A	1.0	2842/1/1.0
A	Nil	N	M	1.6			CL	SANDY CLAY/EXTREMELY WEATHERED SILTSTONE - Light grey, yellow, cream bands, gravels (approx 5-50mm).	VSt	MD	A	1.5	2842/1/1.5
A	Nil	N	D	2.0 2.6			EW HW	EXTREMELY TO HIGHLY WEATHERED SILTSTONE.		MD D	A A	2.0 2.5	2842/1/2.0 2842/1/2.5
A	Nil	N	D	3.0 3.2			MW	MODERATELY WEATHERED SILTSTONE GRAVELLY CLAY.					
A	Nil	N	M	4.0 4.2			CL EW	CLAY/EXTREMELY WEATHERED SILTSTONE - Grey.	F St		A	3.5	2842/1/3.5
A	Nil	N	D	4.75			MW	MODERATELY WEATHERED SILTSTONE.		D	A	4.5	2842/1/4.5
				5.0 6.0 7.0 8.0 9.0				Borehole terminated at 4.75m on moderately to slightly weathered siltstone.					



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

Quality Sheet No. 4

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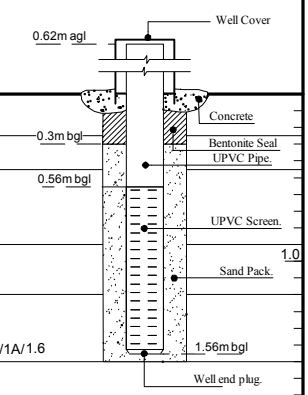
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	23.11.10	**COMPLETED**	23.11.10	**REF**	**BH1A**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.1mØ X 1.6m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
A	Nil	N	M	0.25			SC	SILTY CLAYEY SAND – Dark brown, fine grained sands.		L			
A	Nil	N	M	0.45			SC	SILTY CLAYEY SAND – Light grey, fine grained sands, minor gravels.		L			
A	Nil	N	M	0.6 0.9			CL	SILTY CLAY - Brown/orange, gravels (1-15mm, 35%), tending to clay with gravels decreasing.	F St				
A	Nil	N	M	1.0 1.2			CH	CLAY - Grey/orange/red mottled.	VSt				
A	Nil	N	M	1.6			CL	SANDY CLAY/EXTREMELY WEATHERED SILTSTONE - Light grey, yellow, cream bands, gravels (approx 5-50mm).	VSt	MD	A	1.6	2842/1A/1.6
								Borehole terminated at 1.6m on clay/extremely weathered siltstone.					



2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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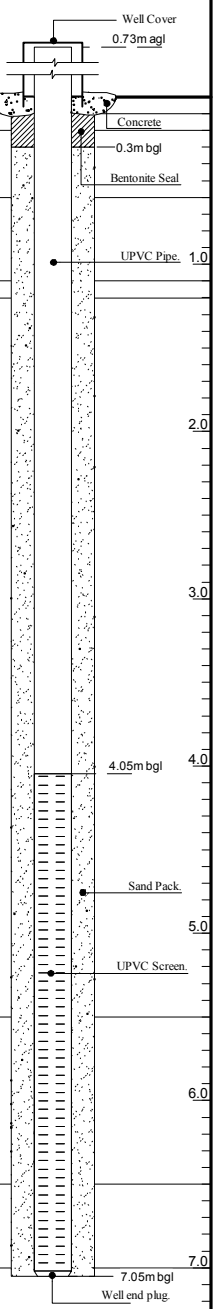
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	22.11.10	**COMPLETED**	22.11.10	**REF**	**BH2**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.1mØ X 7.0m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	3-4%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
A	Nil	N	M	0.1			OL	ORGANIC SILTY CLAY – Dark grey/black.	S				
A	Nil	N	M	0.2			CL	SILTY CLAY – Brown/light brown.	S		A	0.2	2842/2/0.2+B
A	Nil	N	M	0.6			CL	CLAY – Red, moderately plastic, with light brown/grey mottles increassing with depth.	F		A	0.5	2842/2/0.5+Att
A	Nil	N	M	1.0 1.1			CH	CLAY – Red, medium plasticity, grey/brown mottles.	St		A	1.0	2842/2/1.0
A	Nil	N	M	1.2			CH	CLAY - Grey with minor red/brown mottles.	VSt		A	1.2	2842/2/1.2
A	Nil	N	D M	2.0 3.0 4.0 5.0 5.5			CL EW	CLAY - EXTREMELY WEATHERED SILTSTONE - Clay to sandy clay, weathered gravels, grey/red/brown.	VSt		A A A A	1.5 2.0 2.5 4.5	2842/2/1.5 2842/2/2.0 2842/2/2.5 2842/2/4.5
A	Nil	N	M	6.0 6.5			CL	SILTSTONE CLAY - Brown/dark grey, minor gravels, highly weathered siltstone.	St		A	6.0	2842/2/6.0
A	Nil	N	W	7.0			CL EW	CLAY - Dark grey/brown, clay/extremely weathered siltstone.	VSt		A	7.0	2842/2/7.0
				8.0 9.0				Borehole terminated at 7.0m on clays.					



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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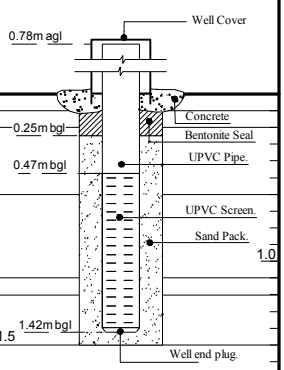
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	23.11.10	**COMPLETED**	23.11.10	**REF**	**BH2A**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.1mØ X 1.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	3-4%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
A	Nil	N	M	0.1			OL	ORGANIC SILTY CLAY – Dark grey/black.	S				
A	Nil	N	M	0.2			CL	SILTY CLAY – Brown/light brown.	S				
A	Nil	N	M	0.6			CL	CLAY – Red, moderately plastic, with light brown/grey mottles increassing with depth.	F				
A	Nil	N	M	1.0 1.1			CH	CLAY – Red, medium plasticity, grey/brown mottles.	St				
A	Nil	N	M	1.2			CH	CLAY - Grey with minor red/brown mottles.	VSt				
A	Nil	N	D M	1.5			CL EW	CLAY TO EXTREMELY WEATHERED SILTSTONE - Clay to sandy clay, weathered gravels, grey/red/brown.	VSt		A	1.5	2842/2A/1.5
								Borehole terminated at 1.5m on extremely weathered siltstone.					



2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
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D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
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Ux Tube sample (x mm)

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S Standard penetration test
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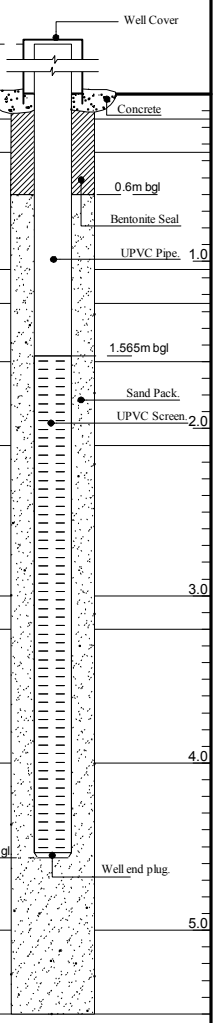
Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	23.11.10	**COMPLETED**	23.11.10	**REF**	**BH3**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.1mØ X 5.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
A	Nil	N	M	0.15			SM	SILTY SAND – Brown/dark brown, minor gravels.		L	A	0.2	2842/3/0.2
A	Nil	N	M	0.35			SP	SAND – Light brown/brown, medium grained sands, gravels (1-5mm, approx 10%).		L			
A	Nil	N	M	0.8 1.0 1.05			CL	CLAY - Yellow/brown/orange, red weathered siltstone bands increasing with depth.	F St		A A	0.5 1.0	2842/3/0.5 2842/3/1.0
A	Nil	N	M	1.25			CL/ HW	SANDY CLAY/HIGHLY WEATHERED SILTSTONE - Orange/grey.	VSt		A	1.2	2842/3/1.2
A	Nil	N	M	1.6			CL HW	CLAY - HIGHLY WEATHERED SILTSTONE - Grey with red/orange mottles, siltstone bands/gravels.	VSt		A	1.5	2842/3/1.5
A	Nil	N	M	2.0 2.1			CL MW EW	CLAY - MODERATELY TO EXTREMELY WEATHERED SILTSTONE - Grey with red/pink mottles.	VSt		A	2.0	2842/3/2.0
A	Nil	N	D	3.0			SC EW	CLAYEY SAND/EXTREMELY WEATHERED SILTSTONE - Grey/pink/red, fine to medium grained sands.	VSt		A	2.5	2842/3/2.5
A	Nil	N	D	3.2			MW	MODERATELY WEATHERED SILTSTONE - Orange brown.					
A	Nil	N	D	4.0			HW/ EW	HIGHLY/EXTREMELY WEATHERED SILTSTONE.			B	4.0	2842/3/4.0
A	Nil	N	D	5.0			MW/ SW	MODERATELY/SLIGHTLY WEATHERED SILTSTONE.					
A	Nil	N	D	5.5			EW/ MW	EXTREMELY/MODERATELY WEATHERED SILTSTONE.					
				6.0 7.0 8.0 9.0				Borehole terminated at 5.5m on moderately weathered siltstone.					



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
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St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
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MD Medium Dense
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VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
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DCP Dynamic cone penetrometer
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WS Water sample

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

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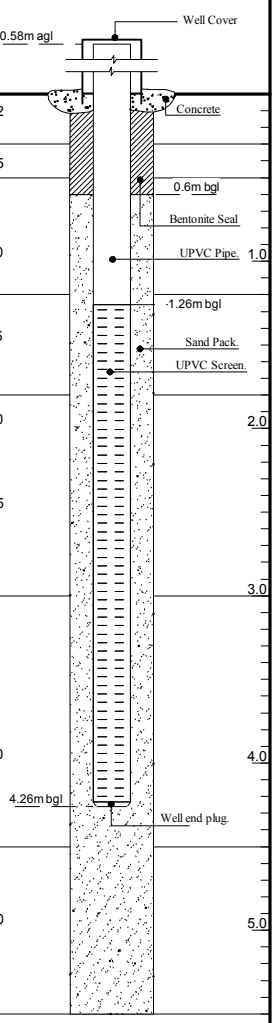
Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	23.11.10	**COMPLETED**	23.11.10	**REF**	**BH4**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.1mØ X 5.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
A	Nil	N	M	0.3			SM	SILTY SAND – Brown, gravels (1-10mm, approx 10%).		L	A	0.2	2842/4/0.2
A	Nil	N	M	0.5			CL	CLAY - Brown/orange, mottles increasing with depth, gravels (1-10mm, approx 10%).	S		A	0.5	2842/4/0.5
A	Nil	N	M	1.0 1.2			CL	CLAY - Grey/brown/red mottles, minor gravels.		F	A	1.0	2842/4/1.0
A	Nil	N	M	1.8			CL HW	CLAY - HIGHLY WEATHERED SILTSTONE - Grey with red/orange mottles, siltstone bands/gravels.	VSt		A	1.5	2842/4/1.5
A	Nil	N	M	2.0 3.0			CL MW EW	CLAY - MODERATELY TO EXTREMELY WEATHERED SILTSTONE - Grey with red/pink mottles.	VSt		A A	2.0 2.5	2842/4/2.0 2842/4/2.5
A	Nil	N	D	4.0 4.5			SC EW	CLAYEY SAND/EXTREMELY WEATHERED SILTSTONE - Grey/pink/red/orange, fine to medium grained sands.	VSt		B	4.0	2842/4/4.0
A	Nil	N	D	5.0 5.5			EW/ MW	EXTREMELY/MODERATELY WEATHERED SILTSTONE - Grey/red/pink/orange.			A	5.0	2842/4/5.0
				6.0 7.0 8.0 9.0				Borehole terminated at 5.5m on extremely/moderately weathered siltstone.					



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

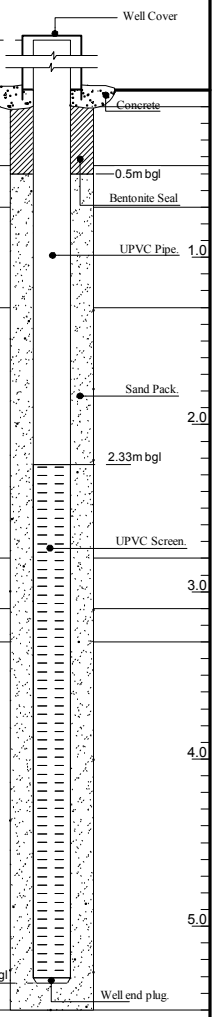
EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	23.11.10	**COMPLETED**	23.11.10	**REF**	**BH6**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.1mØ X 5.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
A	Nil	N	M	0.1			CL	SILTY SANDY CLAY – Dark grey/brown.	S				
A	Nil	N	M	0.45			CL	SILTY SAND CLAY – Brown/light brown.	S		A A	0.2 0.5	2842/6/0.2 2842/6/0.5
A	Nil	N	M	0.7			CL	CLAY - Red/orange with light brown mottles increasing with depth, minor gravels (1-10mm, approx 5%).	St				
A	Nil	N	M	1.0 1.3			CH	CLAY - Grey/cream with red/brown mottles, moderately plastic, gravels (1-5mm, approx 20%).	St		A	1.0	2842/6/1.0
A	Nil	N	M	2.0 2.8			CL HW	CLAY - HIGHLY WEATHERED SILTSTONE - Light grey with red mottles, siltstone gravels bands increasing with depth.	VSt		A A A	1.5 2.0 2.5	2842/6/1.5 2842/6/2.0 2842/6/2.5
A	Nil	N	M	3.0 3.1			CL MW	SANDY CLAY - MODERATELY WEATHERED SILTSTONE - Light brown, gravels (1-50mm, approx 15%).	VSt		B	3.0	2842/6/3.0
A	Nil	N	D	3.3			CL/ HW	CLAY/HIGHLY WEATHERED SILTSTONE - Light grey.	VSt				
A	Nil	N	W	4.0 5.0 5.5			CL EW	CLAY - EXTREMELY WEATHERED SILTSTONE - Dark brown/dark grey with bands of grey clay.	VSt		A B A	3.5 4.5 5.5	2842/6/3.5 2842/6/4.5 2842/6/5.5
				6.0 7.0 8.0 9.0				Borehole terminated at 5.5m on extremely weathered siltstone.					



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**TP9**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Backhoe	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.4m X 2.0m X 2.5m depth	**NORTHING**	NA	**ASPECT**	Sourth	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
BH	Nil	N	M	0.1			SM	ORGANIC SILTY SAND – Dark grey/brown.		L			
BH	Nil	N	M	0.35			SM	SILTY SAND – Light grey/grey, gravels (1-5mm, 10%).		L	B	0.2	2842/9/0.2
BH	Nil	N	M	0.6 0.9			CL	CLAY - Orange/brown mottled, moderately plastic.	F St		B	0.5	2842/9/0.5
BH	Nil	N	M	1.0 1.4			CL	CLAY - Grey/red/orange mottled, moderately plastic.	VSt		B	1.0	2842/9/1.0 1.0
BH	Nil	N	M	2.0			CL/HW	CLAY/HIGHLY WEATHERED SILTSTONE - Grey/pink/red/orange, siltstone gravels bands, tending to extremely weathered siltstone at 1.8m.	VSt		B B	1.5 2.0	2842/9/1.5 2842/9/2.0 2.0
BH	Nil	N	M	2.5			MW	MODERATELY WEATHERED SILTSTONE - With grey/orange/red mottling.	VSt				
				3.0				Test pit terminated at 2.5m on moderately weathered siltstone.					3.0
				4.0									4.0
				5.0									5.0
				6.0									6.0
				7.0									7.0
				8.0									8.0
				9.0									9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

Quality Sheet No. 4

martens

MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Excavation

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**TP10**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Backhoe	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.4m X 2.0m X 2.0m depth	**NORTHING**	NA	**ASPECT**	North West	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
BH	Nil	N	M	0.1			SM	ORGANIC SILTY SAND – Dark grey/brown.		L			
BH	Nil	N	M	0.3			SM	SILTY SAND – Light grey/grey, gravels (1-5mm, 10%).		L	B	0.2	2842/10/ 0.2
BH	Nil	N	M	0.5			CL	CLAY - Orange/brown mottled, moderately plastic.	F St		B	0.5	2842/10/ 0.5
BH	Nil	N	M	0.8 1.0			CL	CLAY - Grey/red/orange mottled, moderately plastic.	VSt		B	1.0	2842/10/ 1.0 1.0
BH	Nil	N	M	1.3 2.0			CL/EW	CLAY/EXTREMELY WEATHERED SILTSTONE - Grey minor mottles, moderately weathered siltstone bands, tending to moderately weathered siltstone.	VSt		B B	1.5 2.0	2842/10/ 1.5 2842/10/ 2.0 2.0
				3.0				Test pit terminated at 2.0m on moderately/slightly weathered siltstone.					3.0
				4.0									4.0
				5.0									5.0
				6.0									6.0
				7.0									7.0
				8.0									8.0
				9.0									9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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Engineering Log - Excavation

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**TP12**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Backhoe	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.4m X 2.0m X 2.2m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
BH	Nil	N	M	0.1			SM	ORGANIC SILTY SAND – Dark grey/brown.		L			
BH	Nil	N	M	0.3			SM	SILTY SAND – Light grey/grey, gravels (1-5mm, 10%).		L	B	0.2	2842/12/ 0.2
BH	Nil	N	M	0.5			CL	CLAY - Orange/brown mottled, moderately plastic.	F St		B	0.5	2842/12/ 0.5
BH	Nil	N	M	0.7 1.0			CL	CLAY - Grey/red/orange mottled, moderately plastic.	VSt		B	1.0	2842/12/ 1.0
BH	Nil	N	M	1.3			CL/ EW	CLAY/EXTREMELY WEATHERED SILTSTONE - Grey minor mottles, moderately weathered siltstone bands, tending to moderately weathered siltstone.	VSt		B	1.5	2842/12/ 1.5
				2.0 2.2				Test pit terminated at 2.2m on moderately weathered siltstone.					
				3.0									
				4.0									
				5.0									
				6.0									
				7.0									
				8.0									
				9.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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6/37 Leighton Place
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Phone: (02) 9476 9999 Fax: (02) 9476 8767
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Engineering Log - Excavation

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**TP14**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Backhoe	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.4m X 2.0m X 1.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
BH	Nil	N	M	0.1			SM	ORGANIC SILTY SAND – Dark grey/brown.		L			
BH	Nil	N	M	0.25			SM	SILTY SAND – Light grey/grey, gravels (1-5mm, 10%).		L	B	0.2	2842/14/ 0.2
BH	Nil	N	M	0.35			CL	CLAY - Orange/brown mottled, moderately plastic.	F St		B	0.5	2842/14/ 0.5
BH	Nil	N	M	0.8			CL	CLAY - Light grey/grey with brown/orange mottled.	VSt				
BH	Nil	N	M	1.0			EW	EXTREMELY WEATHERED SILTSTONE BANDS.	VSt		B	1.0	2842/14/ 1.0
BH	Nil	N	M	1.5			MW	MODERATELY WEATHERED SILTSTONE - Grey, minor mottles.	VSt		B B	1.2 1.5	2842/14/ 1.2 2842/14/ 1.5
				2.0				Test pit terminated at 1.5m on moderately weathered siltstone.					
				3.0									
				4.0									
				5.0									
				6.0									
				7.0									
				8.0									
				9.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

Quality Sheet No. 4

martens

MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Excavation

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**TP15**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Backhoe	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.4m X 2.0m X 2.7m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
BH	Nil	N	M	0.1			SM	ORGANIC SILTY SAND – Dark grey/brown.		L			
BH	Nil	N	M	0.2			SM	SILTY SAND – Light grey/grey, gravels (1-5mm, 10%).		L	B	0.2	2842/15/ 0.2
BH	Nil	N	M	0.6			CL	CLAY - Orange/brown mottled, moderately plastic.	F St		B	0.5	2842/15/ 0.5
BH	Nil	N	M	1.0			CL	CLAY - Grey/red/orange mottled, moderately plastic.	VSt		B B	1.0 1.5	2842/15/ 1.0 2842/15/ 1.5
BH	Nil	N	M	2.0			CL/ HW	CLAY/HIGHLY WEATHERED SILTSTONE - Grey/pink/red, siltstone gravels bands, tending to extremely weathered siltstone past 2.3m.	VSt		B B B	2.0 2.5 2.6	2842/15/ 2.0 2842/15/ 2.5 2842/15/ 2.6
				2.7				Test pit terminated at 2.7m on extremely weathered siltstone.					
				3.0									
				4.0									
				5.0									
				6.0									
				7.0									
				8.0									
				9.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

Quality Sheet No. 4

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6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Excavation

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**TP16**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Backhoe	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.4m X 2.0m X 2.4m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
BH	Nil	N	M	0.1			SM	ORGANIC SILTY SAND – Dark grey/brown.		L			
BH	Nil	N	M	0.4			SM	SILTY SAND – Light grey/grey, gravels (1-5mm, 10%).		L	B	0.2	2842/16/ 0.2
BH	Nil	N	M	0.6 0.9			CL	CLAY - Light brown/grey mottles, moderately plastic.	F St		B	0.5	2842/16/ 0.5
BH	Nil	N	M	1.0 1.2			CL	CLAY - Grey with minor red/orange mottles, minor gravels, moderately plastic, mottles increasing with depth.	VSt		B	1.0	2842/16/ 1.0 1.0
BH	Nil	N	M	2.0 2.4			CL HW	CLAY - HIGHLY WEATHERED SILTSTONE - Grey with minor red/orange mottles, minor gravels, moderately plastic, mottles increasing with depth, siltstone bands/gravels (1-10mm, approx 20%), tending to extremely weathered siltstone.	VSt		B B B	1.5 2.0 2.4	2842/16/ 1.5 2842/16/ 2.0 2.0 2842/16/ 2.4
				3.0 4.0 5.0 6.0 7.0 8.0 9.0				Test pit terminated at 2.4m on extremely weathered siltstone.					3.0 4.0 5.0 6.0 7.0 8.0 9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Excavation

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**TP20**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Backhoe	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.4m X 2.0m X 2.2m depth	**NORTHING**	NA	**ASPECT**	North West	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
BH	Nil	N	M	0.2			SM	SILTY SAND – Dark grey/grey.		L	B	0.2	2842/20/ 0.2
BH	Nil	Y	W	0.35			SM	SILTY CLAYEY SAND – Brown/light brown.		L			
BH	Nil	Y	W	0.45 0.55			CL	CLAY - Orange/brown, minor gravels, moderately plastic.	F St		B	0.5	2842/20/ 0.5
BH	Nil	N	M	1.0			CH	CLAY - Red/grey, minor gravels, orange mottled, moderately to highly plastic.	VSt		B B B	1.0 1.5 2.0	2842/20/ 1.0 2842/20/ 1.5 2842/20/ 2.0
				2.2				Test pit terminated at 2.2m on clays.					
				3.0									
				4.0									
				5.0									
				6.0									
				7.0									
				8.0									
				9.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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6/37 Leighton Place
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Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Excavation

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**TP21**
PROJECT	Engineering Services	**LOGGED**	GT	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	None	**PROJECT NO.**	P1002842
EQUIPMENT	Backhoe	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.4m X 2.0m X 2.6m depth	**NORTHING**	NA	**ASPECT**	North West	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
BH	Nil	N	M	0.12			CL	SILTY SANDY CLAY – Dark grey/brown.	S				
BH	Nil	N	M	0.5			CL	SILTY SAND CLAY – Brown/light brown.	S		B B	0.2 0.5	2842/20/ 0.2 2842/20/ 0.5
BH	Nil	N	M	0.8			CL	CLAY - Red/orange with light brown mottles increasing with depth, minor gravels (1-10mm, approx 5%).	St				
BH	Nil	N	M	1.0 1.6			CH	CLAY - Grey/cream with red/brown mottles, moderately plastic, gravels (1-5mm, approx 20%).	St		B B	1.0 1.5	2842/20/ 1.0 2842/20/ 1.5
BH	Nil	N	M	2.0 2.6			CL HW	CLAY - HIGHLY WEATHERED SILTSTONE - Light grey with red mottles, siltstone gravels bands increasing with depth.	VSt		B B	2.0 2.6	2842/20/ 2.0 2842/20/ 2.6
				3.0 4.0 5.0 6.0 7.0 8.0 9.0				Test pit terminated at 2.6m on moderately weathered siltstone.					

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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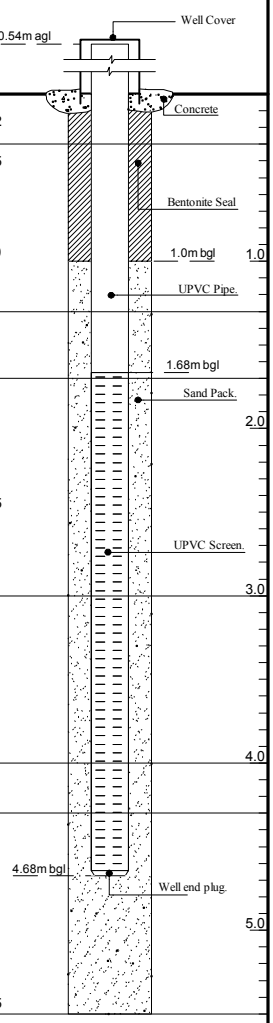
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Excavation

CLIENT	**Allen Price & Associates Pty Ltd**	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH5**
PROJECT	**Engineering Services**	**LOGGED**	JSF	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Cullburra Road, West Cullburra**	**GEOLOGY**	Siltstone	**VEGETATION**	Eucalypts	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 5.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	5%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
A	Nil	N	M	0.3			OL	ORGANIC SANDY SILT – Dark brown.	S		A	0.2	2842/5/ 0.2
A	Nil	N	M	1.0 1.3			CL	CLAY - Orange/brown mottles, firm grading stiff, tending grey with minor brown and red mottles at depth.	F-St		A A	0.5 1.0	2842/5/ 0.5 2842/5/ 1.0
A	Nil	N	D	1.7			EW	EXTREMELY WEATHERED SILTSTONE - Orange/grey mottled, dry.			A	1.5	2842/5/ 1.5
A	Nil	N	D	2.0 3.0			MW	MODERATELY WEATHERED SILTSTONE - Orange/grey mottled, dry.			A	2.5	2842/5/ 2.5
A	Nil	N	D	4.0			EW	EXTREMELY WEATHERED SILTSTONE - Orange/grey mottled, dry.					
A	Nil	N	D	4.3			SW	SLIGHTLY WEATHERED SILTSTONE.					
A	Nil	N	D	5.0 5.5			MW	MODERATELY WEATHERED WITH EXTREMELY WEATHERED SILTSTONE BANDS.			B	5.5	2842/5/ 5.5
				6.0 7.0 8.0 9.0				Borehole terminated at 5.5m on moderately weathered siltstone.					



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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6/37 Leighton Place
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Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH7**
PROJECT	Engineering Services	**LOGGED**	JSF	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Grass	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 2.5m depth	**NORTHING**	NA	**ASPECT**	North West	**SLOPE**	4%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.1			OL	ORGANIC SANDY SILT – Dark brown.	S				
A	Nil	N	M	0.3			SC	CLAYEY SAND - Brown, moist (almost wet), loose.		L	A	0.2	2842/7/0.2
A	Nil	N	M	1.0 1.2			CL	CLAY - Orange/brown mottles, firm grading stiff, tending grey with minor brown and red mottles at depth.	F		A A	0.5 1.0	2842/7/0.5 2842/7/1.0
A	Nil	N	D	1.6			EW	EXTREMELY WEATHERED SILTSTONE - Grey, clay like properties.			A	1.5	2842/7/1.5
A	Nil	N	D	2.0 2.5			MW	MODERATELY WEATHERED WITH EXTREMELY WEATHERED SILTSTONE BANDS.					Borehole left open and checked 2 hours after drillinh and found dry.
				3.0 4.0 5.0 6.0 7.0 8.0 9.0				Borehole terminated at 2.5m on moderately weathered siltstone.					

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH8**
PROJECT	Engineering Services	**LOGGED**	JSF	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Grass	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 2.5m depth	**NORTHING**	NA	**ASPECT**	North West	**SLOPE**	5%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.1			OL	ORGANIC SANDY SILT – Dark brown.	S				
A	Nil	N	M	0.3			SC	CLAYEY SAND - Brown, moist (almost wet), loose.		L	A	0.2	2842/7/0.2
A	Nil	N	M	1.0 1.3			CL	CLAY - Orange/brown mottles, firm grading stiff, tending grey with minor brown and red mottles at depth.	F		A A	0.5 1.0	2842/7/0.5 2842/7/1.0
A	Nil	N	D	1.6			EW	EXTREMELY WEATHERED SILTSTONE - Grey, red mottles, clay like properties.			A	1.5	2842/7/1.5
A	Nil	N	D	1.9			EW	EXTREMELY WEATHERED SILTSTONE - Orange, clay like properties.					
A	Nil	N	D	2.0 2.5			MW	MODERATELY WEATHERED SILTSTONE - Grey.			A	2.0	2842/7/2.0 Borehole dry after 2 hours.
								Borehole terminated at 2.5m on moderately weathered siltstone.					

3.0 4.0 5.0 6.0 7.0 8.0 9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
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Engineering Log - Borehole

CLIENT	**Allen Price & Associates Pty Ltd**	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH11**
PROJECT	**Engineering Services**	**LOGGED**	JSF	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Cullburra Road, West Cullburra**	**GEOLOGY**	Siltstone	**VEGETATION**	Eucalypts	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 2.0m depth	**NORTHING**	NA	**ASPECT**	North East	**SLOPE**	4%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.2			OL	ORGANIC SANDY SILT – Dark brown.	S		A	0.2	2842/11/ 0.2
A	Nil	N	M	1.0 1.3			CL	CLAY - Orange/brown mottles, firm grading stiff, tending grey with minor brown and red mottles at depth.	F-St		A A	0.5 1.0	2842/11/ 0.5 2842/11/ 1.0
A	Nil	N	D	1.8			EW	EXTREMELY WEATHERED SILTSTONE - Grey with mottled.			A	1.5	2842/11/ 1.5
A	Nil	N	D	2.0			MW	MODERATELY WEATHERED SILTSTONE - Grey with mottled.					
								Borehole terminated at 2.0m on moderately weathered siltstone.					

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

Quality Sheet No. 4

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6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH13**
PROJECT	Engineering Services	**LOGGED**	JSF	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Eucalypts	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 2.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	6%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.25			ML	ORGANIC SILTY/CLAYEY SAND - Dark brown, moist.	S		A	0.2	2842/13/ 0.2
A	Nil	0.4 ▽ N	M	0.4			CL	SANDY CLAY - Light brown, moist.	F				
A	Nil		W	0.7			CL	GRAVELLY CLAY - Brown, wet (perched), gravels (5- 10mm, 10-40%), minor sand.	S-F		A	0.5	2842/13/ 0.5
A	Nil	N	M	1.0 1.3			CL	CLAY - Brown and orange mottled, firm to stiff, moist.	F-St		A	1.0	2842/13/ 1.0
A	Nil	N	M	1.7			EW	EXTREMELY WEATHERED SILTSTONE - Brown/grey mottled, dry side of moist.			A	1.5	2842/13/ 1.5
A	Nil	N	M	2.0 2.5			MW	MODERATELY WEATHERED SILTSTONE - Light grey.			A	2.0	2842/13/ 2.0
				3.0 4.0 5.0 6.0 7.0 8.0 9.0				Borehole terminated at 2.5m on moderately weathered siltstone.					

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
▽ Water level
◁ Water outflow
▷ Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH17**
PROJECT	Engineering Services	**LOGGED**	JSF	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Eucalypts	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 2.5m depth	**NORTHING**	NA	**ASPECT**	North West	**SLOPE**	5%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.3			ML	ORGANIC SILTY/CLAYEY SAND - Dark brown, moist.		L	A	0.2	2842/17/ 0.2
A	Nil	N	M	1.0			CL	CLAY - Orange/brown mottles, firm grading stiff, tending grey with minor brown and red mottles at depth.	F		A A	0.5 1.0	2842/17/ 0.5 2842/17/ 1.0
A	Nil	N	M	1.4 2.0			CL	CLAY - Grey with minor red mottled, firm to stiff, moist, sand in profile from 1.8m, grades to SANDY CLAY - Grey, with red mottles, moist, stiff.	St		A A	1.5 2.0	2842/17/ 1.5 2842/17/ 2.0
				2.5							A	2.5	2842/17/ 2.5
								Borehole terminated at 2.5m on sandy clay.					
				3.0									
				4.0									
				5.0									
				6.0									
				7.0									
				8.0									
				9.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	**Allen Price & Associates Pty Ltd**	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH18**
PROJECT	**Engineering Services**	**LOGGED**	JSF	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Cullburra Road, West Cullburra**	**GEOLOGY**	Siltstone	**VEGETATION**	Eucalypts	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 2.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.3			OL	ORGANIC SANDY SILT – Dark brown.	S		A	0.2	2842/18/ 0.2
A	Nil	N	M	1.0			CL	CLAY - Orange/brown mottles, firm grading stiff, tending grey with minor brown and red mottles at depth.	F-St		A A A	0.5 1.0 1.5	2842/18/ 0.5 2842/18/ 1.0 2842/18/ 1.5
A	Nil	N	D	2.0			EW	EXTREMELY WEATHERED SILTSTONE - Clay like properties, grey with red mottles, stiff to very stiff.	St-VSt		A	2.0	2842/18/ 2.0
A	Nil	N	D	2.5			MW	MODERATELY WEATHERED SILTSTONE - Grey.			A	2.5	2842/18/ 2.5
				3.0				Borehole terminated at 2.5m on moderately weathered siltstone.					
				4.0									
				5.0									
				6.0									
				7.0									
				8.0									
				9.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	**Allen Price & Associates Pty Ltd**	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH19**
PROJECT	**Engineering Services**	**LOGGED**	JSF	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Cullburra Road, West Cullburra**	**GEOLOGY**	Siltstone	**VEGETATION**	Eucalypts	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 2.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	2-3%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.1		x x x	OL	ORGANIC SANDY SILT – Dark brown.	S				
											A	0.2	2842/19/ 0.2
											A	0.5	2842/19/ 0.5
A	Nil	N	M	1.0			CL	CLAY - Orange/brown mottles, firm grading stiff, tending grey with minor brown and red mottles at depth.	F-St		A	1.0	2842/19/ 1.0 1.0
				1.6							A	1.5	2842/19/ 1.5
A	Nil	N	D	2.0			EW	EXTREMELY WEATHERED SILTSTONE - Red and grey mottles, clay like properties, highly weathered layers from 2.0m.			A	2.0	2842/19/ 2.0 2.0
				2.5							A	2.5	2842/19/ 2.5
								Borehole terminated at 2.5m on moderately weathered siltstone.					
				3.0									3.0
				4.0									4.0
				5.0									5.0
				6.0									6.0
				7.0									7.0
				8.0									8.0
				9.0									9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	**Allen Price & Associates Pty Ltd**	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH22**
PROJECT	**Engineering Services**	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Cullburra Road, West Cullburra**	**GEOLOGY**	Siltstone	**VEGETATION**	Grass	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 2.5m depth	**NORTHING**	NA	**ASPECT**	North East	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
A	Nil	N	M	0.3			OL	ORGANIC SILT – Dark brown, gravels (5-10mm, 30%).	S		A	0.2	2842/22/ 0.2	
A	Nil	N	M	0.8			CL	CLAY - Variable colours (grey, red, yellow, brown).	F		A	0.5	2842/22/ 0.5	
A	Nil	N	D	1.0 1.2			EW	EXTREMELY WEATHERED FINE GRAINED SILTSTONE - Reddish brown.			A	1.0	2842/22/ 1.0	1.0
A	Nil	N	D	1.9			EW	EXTREMELY WEATHERED FINE GRAINED SILTSTONE - Grey.			A	1.5	2842/22/ 1.5	
A	Nil	N	D	2.0 2.5			EW	EXTREMELY WEATHERED FINE GRAINED SILTSTONE - Grey, strength decreasing.			A A	2.0 2.5	2842/22/ 2.0 2842/22/ 2.5	2.0
				3.0				Borehole terminated at 2.5m on extremely weathered siltstone.						3.0
				4.0										4.0
				5.0										5.0
				6.0										6.0
				7.0										7.0
				8.0										8.0
				9.0										9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH23**
PROJECT	Engineering Services	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Grass	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 1.0m depth	**NORTHING**	NA	**ASPECT**	North East	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.2			OL	ORGANIC SILT – Dark brown, gravels (5-10mm, 30%).	S		A	0.2	2842/23/ 0.2
A	Nil	N	M	0.3			CL	CLAY - Grey.	S				
A	Nil	N	M	0.9			CL	CLAY - Variable colours (grey, red, yellow, brown).	S		A	0.5	2842/23/ 0.5
A	Nil	N	D	1.0			EW	EXTREMELY WEATHERED FINE GRAINED SILTSTONE - Reddish brown. Borehole terminated at 1.0m on extremely weathered siltstone.			A	1.0	2842/23/ 1.0

2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Allen Price & Associates Pty Ltd	**COMMENCED**	24.11.10	**COMPLETED**	24.11.10	**REF**	**BH24**
PROJECT	Engineering Services	**LOGGED**	JSF	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Cullburra Road, West Cullburra	**GEOLOGY**	Siltstone	**VEGETATION**	Eucalypts	**PROJECT NO.**	P1002842
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	0.95mØ X 2.6m depth	**NORTHING**	NA	**ASPECT**	North East	**SLOPE**	5%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.2			OL	ORGANIC SANDY SILT – Dark brown.	S		A	0.2	2842/24/ 0.2
											A	0.5	2842/24/ 0.5
				1.0							A	1.0	2842/24/ 1.0
A	Nil	N	M				CL	CLAY - Orange/brown mottles, firm grading stiff, tending grey with minor brown and red mottles at depth.	St-VSt				
											A	1.5	2842/24/ 1.5
				2.0							A	2.0	2842/24/ 2.0
				2.3									
A	Nil	N	D	2.6			EW	EXTREMELY WEATHERED SILTSTONE - Grey with red mottles, clay like properties.			A	2.5	2842/24/ 2.5
								Borehole terminated at 2.6m on extremely weathered siltstone.					
				3.0									
				4.0									
				5.0									
				6.0									
				7.0									
				8.0									
				9.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

9 Attachment C – DCP Test Data

Dynamic Cone Penetrometer Test Log Summary

martens consulting engineers since 1989

6 / 37 Leighton Place, Hornsby, NSW 2159. Ph: (02) 9476 9999 Fax: (02) 9476 8767.

Site	Culburra Mixed Use Subdivision	DCP Group Reference	P1002842
Client	Allen Price and Associates		22/11 - 25/11/10
Logged by	BR/GT/JF		
Checked by	DM		
Comments			

TEST DATA

Depth Interval (m)	DCP 1	DCP 6	DCP 3	DCP 23	DCP 22	DCP 5	DCP 19	DCP18	DCP17	DCP24	DCP11	DCP7	DCP8	Design
0.15	1	1	1	2	2	1	2	3	1	3	2	1	1	1
0.30	2	4	1	2	2	2	3	3	1	4	4	1	2	1
0.45	2	7	3	3	3	4	4	3	2	7	4	2	3	2
0.60	1	10	6	2	7	4	3	4	2	25	8	4	3	1
0.75	3	12	6	2	8	4	4	7	3	10	6	3	4	2
0.90	3	16	5	6	30	7	4	6	3	14	4	3	4	3
1.05	3	22	6	35		7	5	6	3	12	5	7	4	3
1.20	21	23	10			9	6	7	5	10	5	12	5	5
1.35		27	22			10	7	7	8	15	4	35	5	4
1.50		28	11			20	10	12	9	16	4		10	4
1.65		43	13				12	11	9	14	7		17	7
1.80		35	15				16	5	8	12	6		30	5
1.95		12	18				13	4	10	16	29			4
2.10		14	21				18	16	10	14				10
2.25		15	28				18	30	13	14				13
2.40		18					19		17	17				17
2.55		24					21		22	19				19
2.70		29					30		23	21				21
2.85									19					19
3.00									16					16
3.15									18					18
3.30									13					13
3.45									15					15
3.60									12					12
3.75									16					16
3.90									25					25
4.05									30					30
4.20									31					31
4.35									45					45

10 Attachment D – Salinity and Aggressivity Results Table

Sample ID	Borehole	Sample Depth (m)	Soil Type	EC(1:5) (dS/m)	Multiplier	ECe (dS/m)	Salinity Rating[1]	Ph	Concrete Exposure Classification 2
2842/1/0.5	1	0.5	Sand	0.057	17	0.969	Non-saline	5.1	Non-aggressive
2842/1/1.0	1	1	Clay	0.097	8	0.776	Non-saline	5	Non-aggressive
2842/1/1.5	1	1.5	Clay	0.08	8	0.64	Non-saline	8.1	Non-aggressive
2842/2/0.2	2	0.2	Silty Clay	0.023	8.5	0.1955	Non-saline	5.5	Non-aggressive
2842/2/0.5	2	0.5	Clay	0.043	8	0.344	Non-saline	4.7	Mild
2842/2/1.5	2	1.5	Clay	0.023	8	0.184	Non-saline	5	Non-aggressive
2842/24/0.2	24	0.2	Sandy Silt	0.021	14	0.294	Non-saline	5.3	Non-aggressive
2842/24/1.0	24	1	Clay	0.055	8	0.44	Non-saline	4.8	Mild
2842/24/1.5	24	1.5	Clay	0.058	8	0.464	Non-saline	4.8	Mild
2842/24/2.0	24	2	Clay	0.058	8	0.464	Non-saline	4.9	Mild
2842/13/0.2	13	0.2	Silty Sand	0.033	14	0.462	Non-saline	5.1	Non-aggressive
2842/13/0.5	13	0.5	Clay	0.024	8	0.192	Non-saline	5.5	Non-aggressive
2842/13/1.0	13	1	Clay	0.066	8	0.528	Non-saline	5.2	Non-aggressive
2842/3/0.2	3	0.2	Sand	0.035	17	0.595	Non-saline	5.3	Non-aggressive
2842/3/0.5	3	0.5	Sandy	0.056	8.5	0.476	Non-saline	5.2	Non-aggressive
2842/3/1.0	3	1	Sandy	0.052	8.5	0.442	Non-saline	4.9	Mild
2842/4/1.0	4	1	Clay	0.063	8	0.504	Non-saline	4.8	Mild
2842/4/1.5	4	1.5	Clay	0.068	8	0.544	Non-saline	4.7	Mild
2842/4/2.0	4	2	Clay	0.076	8	0.608	Non-saline	4.6	Mild
2842/18/0.2	18	0.2	Silty Sand	0.018	14	0.252	Non-saline	5.3	Non-aggressive
2842/18/0.5	18	0.5	Clay	0.034	8	0.272	Non-saline	5.1	Non-aggressive
2842/18/1.0	18	1	Clay	0.044	8	0.352	Non-saline	4.9	Mild
2842/19/0.2	19	0.2	Clay	0.03	8	0.24	Non-saline	5.5	Non-aggressive
2842/19/0.5	19	0.5	Clay	0.051	8	0.408	Non-saline	4.9	Mild
2842/19/1.5	19	1.5	Clay	0.083	8	0.664	Non-saline	4.7	Mild
2842/22/0.2	22	0.2	Organic	0.021	10	0.21	Non-saline	5.7	Non-aggressive
2842/22/0.5	22	0.5	Clay	0.058	8	0.464	Non-saline	5.3	Non-aggressive
2842/6/0.2	6	0.2	Sandy	0.48	8.5	4.08	Moderately	4.7	Mild
2842/6/0.5	6	0.5	Clay	1.2	8	9.6	Very Saline	4.5	Mild
2842/6/2.5	6	2.5	Clay	0.71	8	5.68	Moderately	6.1	Non-aggressive

Notes:

[1] Salinity Rating based on the Department of Conservation and Land Management (1992), *What Do All The Numbers Mean* and Table 6.2 of Department of Land and Water Conservation (2002), *Site Investigations for Urban Salinity.*

[2] From Australian Standard 2159 (1995) Table 6.3 – *Exposure Classification for Steel Piles.*

11 Attachment E – Geotechnical Laboratory Analytical Certificates

Sydney Laboratory
57 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

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GHD GEOTECHNICS

Material Test Report

Report No: SYD105754
Issue No: 1

Client: Martens Consulting Engineers
Unit 6 / 37 Leighton Place
Hornsby NSW 2077

Project: 2116124 P1002842

NATA 679

This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO IEC 17025
Laboratory Accreditation No. 679

D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 17/12/2010

Sample Details

Sample ID	SYD10-8001
Client Sample ID	
Date Sampled	26/11/2010
Specification	
Location	
Sampled By	Sampled by client
Boring No.	TP10
Depth	0.5
Soil Description	CLAY: Yellow brown (CH)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	21.5	
Mould Length (mm)		254	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	120	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	33	
Plasticity Index (%)	AS 1289.3.3.1	87	

Comments

N/A

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GHD GEOTECHNICS

Sydney Laboratory
57 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD105755
Issue No: 1

Client: Martens Consulting Engineers
Unit 6 / 37 Leighton Place
Hornsby NSW 2077

Project: 2116124 P1002842

Sample Details

Sample ID	SYD10-8002
Client Sample ID	
Date Sampled	26/11/2010
Specification	
Location	
Sampled By	Sampled by client
Boring No.	TP10
Depth	1.0
Soil Description	CLAY: Grey (CH)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	15.0	
Mould Length (mm)		125	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	54	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	37	

Comments

N/A

Sydney Laboratory
57 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

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Material Test Report

Report No: SYD105752
Issue No: 1

Client: Martens Consulting Engineers
Unit 6 / 37 Leighton Place
Hornsby NSW 2077

Project: 2116124 P1002842

NATA 679

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D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 17/12/2010

Sample Details

Sample ID	SYD10-7999
Client Sample ID	
Date Sampled	26/11/2010
Specification	
Location	
Sampled By	Sampled by client
Boring No.	TP17
Depth	0.5
Soil Description	CLAY: brown (CH)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	14.0	
Mould Length (mm)		254	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	71	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	54	

Comments

N/A

Sydney Laboratory
57 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

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GHD GEOTECHNICS

Material Test Report

Report No: SYD105753
Issue No: 1

Client: Martens Consulting Engineers
Unit 6 / 37 Leighton Place
Hornsby NSW 2077

Project: 2116124 P1002842

NATA 679

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D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 17/12/2010

Sample Details

Sample ID	SYD10-8000
Client Sample ID	
Date Sampled	26/11/2010
Specification	
Location	
Sampled By	Sampled by client
Boring No.	TP17
Depth	1.0
Soil Description	CLAY: Grey/brown (CH)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	17.5	
Mould Length (mm)		125	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	68	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	52	

Comments

N/A

Sydney Laboratory
57 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

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GHD GEOTECHNICS

Material Test Report

Report No: SYD105751
Issue No: 1

Client: Martens Consulting Engineers
Unit 6 / 37 Leighton Place
Hornsby NSW 2077

Project: 2116124 P1002842

Sample Details

Sample ID	SYD10-7998
Client Sample ID	
Date Sampled	26/11/2010
Specification	
Location	
Sampled By	Sampled by client
Boring No.	TP20
Depth	1.0
Soil Description	CLAY: mottled red/grey (CH)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	17.5	
Mould Length (mm)		254	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	92	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	73	

Comments

N/A

12 Attachment F – Acid Sulfate Soil and Salinity Laboratory Analytical Certificates

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

CERTIFICATE OF ANALYSIS 48959

Client:
Martens & Associates Pty Ltd
6/37 Leighton Place
Hornsby
NSW 2077

Attention: Ben Rose

Sample log in details:

Your Reference:	**P1002842JC01V01, Culburra**
No. of samples:	3 Waters, 60 Soils
Date samples received:	30/11/10
Date completed instructions received:	30/11/10

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by:	7/12/10
Date of Preliminary Report:	01/12/2010
Issue Date:	7/12/10

NATA accreditation number 2901. This document shall not be reproduced except in full.
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.
Tests not covered by NATA are denoted with *.

Results Approved By:

Kasjan Paciuszkiewicz
Chemist

Nick Sarlamis
Inorganics Supervisor

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-4	48959-5	48959-6	48959-7	48959-8
Your Reference	----------	2842/1	2842/1	2842/1	2842/2	2842/2
Depth	----------	0.5	1.0	1.5	0.2	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.1	5.0	8.1	5.5	4.7
Electrical Conductivity 1:5 soil:water	µS/cm	57	97	80	23	43

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-9	48959-10	48959-11	48959-12	48959-13
Your Reference	----------	2842/2	2842/24	2842/24	2842/24	2842/24
Depth	----------	1.5	0.2	1.0	1.5	2.0
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.0	5.3	4.8	4.8	4.9
Electrical Conductivity 1:5 soil:water	µS/cm	23	21	55	58	58

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-14	48959-15	48959-16	48959-17	48959-18
Your Reference	----------	2842/13	2842/13	2842/13	2842/3	2842/3
Depth	----------	0.2	0.5	1.0	0.2	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.1	5.5	5.2	5.3	5.2
Electrical Conductivity 1:5 soil:water	µS/cm	33	24	66	35	56

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-19	48959-20	48959-21	48959-22	48959-23
Your Reference	----------	2842/3	2842/4	2842/4	2842/4	2842/18
Depth	----------	1.0	1.0	1.5	2.0	0.2
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	4.9	4.8	4.7	4.6	5.3
Electrical Conductivity 1:5 soil:water	µS/cm	52	63	68	76	18

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-24	48959-25	48959-26	48959-27	48959-28
Your Reference	----------	2842/18	2842/18	2842/19	2842/19	2842/19
Depth	----------	0.5	1.0	0.2	0.5	1.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.1	4.9	5.5	4.9	4.7
Electrical Conductivity 1:5 soil:water	µS/cm	34	44	30	51	83

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-29	48959-30	48959-31	48959-32	48959-33
Your Reference	----------	2842/22	2842/22	2842/6	2842/6	2842/6
Depth	----------	0.2	0.5	0.2	0.5	2.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.7	5.3	4.7	4.5	6.1
Electrical Conductivity 1:5 soil:water	µS/cm	21	58	480	1,200	710

sPOCAS field test						
Our Reference:	UNITS	48959-34	48959-35	48959-36	48959-37	48959-38
Your Reference	----------	2842/1	2842/1	2842/1	2842/11	2842/11
Depth	----------	0.5	1.0	1.5	0.5	1.0
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	5.4	5.1	5.1	5.3	4.7
pH_{FOX} (field peroxide test)*	pH Units	4.5	4.1	4.2	4.4	3.8
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	48959-39	48959-40	48959-41	48959-42	48959-43
Your Reference	----------	2842/24	2842/24	2842/24	2842/24	2842/13
Depth	----------	0.5	1.0	1.5	2.0	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	5.1	5.0	5.1	5.2	5.3
pH_{FOX} (field peroxide test)*	pH Units	4.0	4.0	4.1	4.2	4.2
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	48959-44	48959-45	48959-46	48959-47	48959-48
Your Reference	----------	2842/13	2842/4	2842/4	2842/4	2842/4
Depth	----------	1.0	0.5	1.0	1.5	2.0
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	5.4	5.3	4.9	4.8	4.9
pH_{FOX} (field peroxide test)*	pH Units	4.4	4.3	4.0	4.0	4.0
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	48959-49	48959-50	48959-51	48959-52	48959-53
Your Reference	----------	2842/4	2842/19	2842/19	2842/19	2842/5
Depth	----------	2.5	0.5	1.0	1.5	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	4.5	5.1	4.8	4.9	5.5
pH_{FOX} (field peroxide test)*	pH Units	3.8	4.2	3.9	3.9	4.5
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	48959-54	48959-55	48959-56	48959-57	48959-58
Your Reference	----------	2842/5	2842/6	2842/6	2842/6	2842/6
Depth	----------	1.0	0.5	1.0	1.5	2.0
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	5.2	4.5	4.7	5.0	5.2
pH_{FOX} (field peroxide test)*	pH Units	4.1	3.6	4.0	4.5	4.4
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	48959-59	48959-60	48959-61	48959-62	48959-63
Your Reference	----------	2842/6	2842/6	2842/21	2842/21	2842/20
Depth	----------	2.5	3.0	0.5	1.0	1.5
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	5.8	5.6	5.2	5.3	5.0
pH_{FOX} (field peroxide test)*	pH Units	5.7	5.3	4.1	4.7	4.2
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

Miscellaneous Inorganics				
Our Reference:	UNITS	48959-1	48959-2	48959-3
Your Reference	----------	2842/GMB01/ 25.11.2010	2842/GMB02/ 25.11.2010	2842/GMB06/ 26.11.2010
Depth	----------	-	-	-
Type of sample		Water	Water	Water
Date prepared	-	30/11/2010	30/11/2010	30/11/2010
Date analysed	-	30/11/2010	30/11/2010	30/11/2010
Electrical Conductivity	µS/cm	4,900	250	18,000
Total Dissolved Solids (grav)	mg/L	2,900	180	13,000
pH	pH Units	5.2	5.1	5.6
Nitrate as N in water	mg/L	0.01	0.1	<0.005
Hardness	mg$CaCO_3$ /L	280	8	2,600
NOx as N in water	mg/L	0.02	0.1	0.007
Ammonia as N in water	mg/L	0.3	0.02	0.1
Total Nitrogen in water	mg/L	0.7	0.4	0.3
Phosphorus - Total	mg/L	<0.05	<0.05	<0.05
Phosphate as P in water	mg/L	<0.05	<0.05	<0.05
Silicon*- Dissolved	mg/L	36	36	15
Strontium - Dissolved	mg/L	0.2	<0.01	1.2
Titanium - Dissolved	mg/L	<0.02	<0.02	<0.02

Ion Balance Our Reference: Your Reference Depth Type of sample	UNITS ---------- ----------	48959-1 2842/GMB01/ 25.11.2010 - Water	48959-2 2842/GMB02/ 25.11.2010 - Water	48959-3 2842/GMB06/ 26.11.2010 - Water
Date prepared	-	30/11/2010	30/11/2010	30/11/2010
Date analysed	-	30/11/2010	30/11/2010	30/11/2010
Calcium - Dissolved	mg/L	10	0.6	130
Potassium - Dissolved	mg/L	8.0	0.6	13
Sodium - Dissolved	mg/L	950	38	3,400
Magnesium - Dissolved	mg/L	62	1.6	560
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<0.1	<0.1	<0.1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	23	7	46
Carbonate Alkalinity as $CaCO_3$	mg/L	<0.1	<0.1	<0.1
Total Alkalinity as $CaCO_3$	mg/L	23	7	46
Sulphate, SO4	mg/L	330	22	720
Chloride, Cl	mg/L	1,300	40	6,000
Ionic Balance	%	3.5	3.1	3.9

All metals in water-dissolved				
Our Reference:	UNITS	48959-1	48959-2	48959-3
Your Reference	----------	2842/GMB01/ 25.11.2010	2842/GMB02/ 25.11.2010	2842/GMB06/ 26.11.2010
Depth	----------	-	-	-
Type of sample		Water	Water	Water
Date prepared	-	2/12/2010	2/12/2010	2/12/2010
Date analysed	-	2/12/2010	2/12/2010	2/12/2010
Aluminium-Dissolved	µg/L	260	39	210
Boron-Dissolved	µg/L	200	70	40
Barium-Dissolved	µg/L	71	7	93
Beryllium-Dissolved	µg/L	<0.5	<0.5	0.6
Cadmium-Dissolved	µg/L	1.9	1	3.2
Cobalt-Dissolved	µg/L	52	<1	67
Chromium-Dissolved	µg/L	<1	<1	<1
Copper-Dissolved	µg/L	3	<1	7
Iron-Dissolved	µg/L	1,800	11	13
Manganese-Dissolved	µg/L	950	7	1,100
Molybdenum-Dissolved	µg/L	<1	<1	<1
Nickel-Dissolved	µg/L	38	<1	67
Vanadium-Dissolved	µg/L	<1	<1	<1
Zinc-Dissolved	µg/L	100	42	140
Arsenic-Dissolved	µg/L	2	<1	9
Mercury-Dissolved	µg/L	<0.4	<0.4	<0.4
Lead-Dissolved	µg/L	15	<1	3
Selenium-Dissolved	µg/L	<1	<1	<1

Method ID	Methodology Summary
LAB.1	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
LAB.2	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA2510 20th ED and Rayment & Higginson.
LAB.63	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.
LAB.18	Total Dissolved Solids - determined gravimetrically by drying the sample, in accordance with APHA 20th ED, 2540-C.
LAB.55	Nitrate - determined colourimetrically based on EPA353.2. Soils are analysed following a water extraction.
Metals.20 ICP-AES	Determination of various metals by ICP-AES.
LAB.57	Ammonia - determined colourimetrically based on EPA350.1, Soils are analysed following a water extraction.
LAB.66	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
LAB.60	Phosphate water extractable - determined colourimetrically based on EPA365.1
LAB.6	Alkalinity - determined titrimetrically in accordance with APHA 20th ED, 2320-B.
LAB.81	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 21st ED, 4110-B.
LAB.41	Gravimetric determination of the total solids content of water.
Metals.22 ICP-MS	Determination of various metals by ICP-MS.
Metals.21 CV-AAS	Determination of Mercury by Cold Vapour AAS.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			6/12/2010	48959-4	6/12/2010 || 6/12/2010	LCS-1	6/12/2010
Date analysed	-			6/12/2010	48959-4	6/12/2010 || 6/12/2010	LCS-1	6/12/2010
pH 1:5 soil:water	pH Units		LAB.1	[NT]	48959-4	5.1 || 5.1 || RPD: 0	LCS-1	100%
Electrical Conductivity 1:5 soil:water	µS/cm	1	LAB.2	<1.0	48959-4	57 || 53 || RPD: 7	LCS-1	107%

QUALITY CONTROL sPOCAS field test	UNITS	PQL	METHOD	Blank
pH_F (field pH test)*	pH Units		LAB.63	[NT]
pH_{FOX} (field peroxide test)*	pH Units		LAB.63	[NT]

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			30/11/2010	[NT]	[NT]	LCS-W1	30/11/2010
Date analysed	-			30/11/2010	[NT]	[NT]	LCS-W1	2/12/2010
Electrical Conductivity	µS/cm	1	LAB.2	<1.0	[NT]	[NT]	LCS-W1	104%
Total Dissolved Solids (grav)	mg/L	5	LAB.18	<5	[NT]	[NT]	LCS-W1	106%
pH	pH Units		LAB.1	[NT]	[NT]	[NT]	LCS-W1	102%
Nitrate as N in water	mg/L	0.005	LAB.55	<0.005	[NT]	[NT]	LCS-W1	91%
Hardness	$mgCaCO_3/L$	3	Metals.20 ICP-AES	<3	[NT]	[NT]	[NR]	[NR]
NOx as N in water	mg/L	0.005	LAB.55	<0.005	[NT]	[NT]	LCS-W1	91%
Ammonia as N in water	mg/L	0.005	LAB.57	<0.005	[NT]	[NT]	LCS-W1	93%
Total Nitrogen in water	mg/L	0.1	LAB.66	<0.1	[NT]	[NT]	LCS-W1	86%
Phosphorus - Total	mg/L	0.05	Metals.20 ICP-AES	<0.05	[NT]	[NT]	LCS-W1	97%
Phosphate as P in water	mg/L	0.005	LAB.60	<0.005	[NT]	[NT]	LCS-W1	101%
Silicon*- Dissolved	mg/L	0.2	Metals.20 ICP-AES	<0.2	[NT]	[NT]	LCS-W1	100%
Strontium - Dissolved	mg/L	0.01	Metals.20 ICP-AES	<0.01	[NT]	[NT]	LCS-W1	90%
Titanium - Dissolved	mg/L	0.02	Metals.20 ICP-AES	<0.02	[NT]	[NT]	LCS-W1	96%

QUALITY CONTROL Ion Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			30/11/2010	[NT]	[NT]	LCS-W1	30/11/2010
Date analysed	-			30/11/2010	[NT]	[NT]	LCS-W1	30/11/2010
Calcium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	91%
Potassium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	103%
Sodium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	100%
Magnesium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	92%
Bicarbonate Alkalinity as $CaCO_3$	mg/L	0.1	LAB.6	<0.1	[NT]	[NT]	LCS-W1	104%
Carbonate Alkalinity as $CaCO_3$	mg/L	0.1	LAB.6	<0.1	[NT]	[NT]	[NR]	[NR]
Total Alkalinity as $CaCO_3$	mg/L	0.1	LAB.6	<0.1	[NT]	[NT]	LCS-W1	104%
Sulphate, SO4	mg/L	1	LAB.81	<1.0	[NT]	[NT]	LCS-W1	108%
Chloride, Cl	mg/L	1	LAB.81	<1.0	[NT]	[NT]	LCS-W1	94%
Ionic Balance	%		LAB.41	[NT]	[NT]	[NT]	[NR]	[NR]

QUALITY CONTROL All metals in water-dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			2/12/2010	48959-1	2/12/2010 || 2/12/2010	LCS-W1	02/12/2010
Date analysed	-			2/12/2010	48959-1	2/12/2010 || 2/12/2010	LCS-W1	02/12/2010
Aluminium-Dissolved	µg/L	10	Metals.22 ICP-MS	<10	48959-1	260 || 260 || RPD: 0	LCS-W1	103%
Boron-Dissolved	µg/L	5	Metals.22 ICP-MS	<5	48959-1	200 || 190 || RPD: 5	LCS-W1	83%
Barium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	71 || 67 || RPD: 6	LCS-W1	99%
Beryllium-Dissolved	µg/L	0.5	Metals.22 ICP-MS	<0.5	48959-1	<0.5 || <0.5	LCS-W1	80%
Cadmium-Dissolved	µg/L	0.1	Metals.22 ICP-MS	<0.1	48959-1	1.9 || 2.0 || RPD: 5	LCS-W1	100%
Cobalt-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	52 || 52 || RPD: 0	LCS-W1	96%
Chromium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	<1 || <1	LCS-W1	95%
Copper-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	3 || 3 || RPD: 0	LCS-W1	91%
Iron-Dissolved	µg/L	10	Metals.22 ICP-MS	<10	48959-1	1800 || 1800 || RPD: 0	LCS-W1	91%
Manganese-Dissolved	µg/L	5	Metals.22 ICP-MS	<5	48959-1	950 || 950 || RPD: 0	LCS-W1	91%

QUALITY CONTROL All metals in water-dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Molybdenum-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	<1 || <1	LCS-W1	99%
Nickel-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	38 || 38 || RPD: 0	LCS-W1	89%
Vanadium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	<1 || <1	LCS-W1	95%
Zinc-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	100 || 100 || RPD: 0	LCS-W1	95%
Arsenic-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	2 || 2 || RPD: 0	LCS-W1	90%
Mercury-Dissolved	µg/L	0.4	Metals.21 CV-AAS	<0.4	48959-1	<0.4 || <0.4	LCS-W1	100%
Lead-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	15 || 15 || RPD: 0	LCS-W1	96%
Selenium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	<1 || <1	LCS-W1	92%

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	48959-14	6/12/2010 || 6/12/2010	LCS-2	6/12/2010
Date analysed	-	48959-14	6/12/2010 || 6/12/2010	LCS-2	6/12/2010
pH 1:5 soil:water	pH Units	48959-14	5.1 || 5.0 || RPD: 2	LCS-2	100%
Electrical Conductivity 1:5 soil:water	µS/cm	48959-14	33 || 34 || RPD: 3	LCS-2	106%

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	48959-25	6/12/2010 || 6/12/2010
Date analysed	-	48959-25	6/12/2010 || 6/12/2010
pH 1:5 soil:water	pH Units	48959-25	4.9 || 5.0 || RPD: 2
Electrical Conductivity 1:5 soil:water	µS/cm	48959-25	44 || 54 || RPD: 20

Report Comments:
Phosphate:PQL raised due to sample matrix.

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job
Asbestos counting was analysed by Approved Counter:	@ERROR
Asbestos counting was authorised by Approved Signatory:	@ERROR

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

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

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

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

CERTIFICATE OF ANALYSIS 48959-A

Client:
Martens & Associates Pty Ltd
6/37 Leighton Place
Hornsby
NSW 2077

Attention: Ben Rose

Sample log in details:

Your Reference:	**P1002842JC01V01, Culburra**
No. of samples:	Additional Testing on 5 Soils
Date samples received:	30/11/10
Date completed instructions received:	02/12/10

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by:	9/12/10
Date of Preliminary Report:	Not Issued
Issue Date:	10/12/10

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

Results Approved By:

Matt Mansfield
Approved Signatory

sPOCAS Our Reference: Your Reference Depth Type of sample	UNITS ---------- ----------	48959-A-35 2842/1 1.0 Soil	48959-A-43 2842/13 0.5 Soil	48959-A-50 2842/19 0.5 Soil	48959-A-54 2842/5 1.0 Soil	48959-A-61 2842/21 0.5 Soil
Date prepared	-	7/12/2010	7/12/2010	7/12/2010	7/12/2010	7/12/2010
Date analysed	-	7/12/2010	7/12/2010	7/12/2010	7/12/2010	7/12/2010
pH $_{kcl}$	pH units	3.5	4.3	3.5	3.6	3.8
TAA pH 6.5	moles H^+/t	138	27	163	125	87
s-TAA pH 6.5	%w/w S	0.22	0.044	0.26	0.20	0.14
pH $_{Ox}$	pH units	4.1	4.0	4.0	4.2	4.2
TPA pH 6.5	moles H^+/t	143	<5.0	173	128	108
s-TPA pH 6.5	%w/w S	0.23	<0.01	0.28	0.20	0.17
TSA pH 6.5	moles H^+/t	5.0	<5.0	10	<5.0	20
s-TSA pH 6.5	%w/w S	<0.01	<0.01	0.016	<0.01	0.032
ANC$_E$	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
a-ANC$_E$	moles H^+/t	<5	<5	<5	<5	<5
s-ANC$_E$	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
S$_{KCl}$	%w/w S	0.012	<0.005	0.011	0.035	0.097
S$_P$	%w/w	0.018	0.008	0.018	0.038	0.11
S$_{POS}$	%w/w	0.005	0.007	0.007	<0.005	0.010
a-S$_{POS}$	moles H^+/t	<5.0	<5.0	<5.0	<5.0	5.9
Ca$_{KCl}$	%w/w	0.009	<0.005	0.016	0.014	0.014
Ca$_P$	%w/w	0.008	0.005	0.017	0.014	0.014
Ca$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg$_{KCl}$	%w/w	0.037	0.008	0.029	0.031	0.074
Mg$_P$	%w/w	0.036	0.009	0.031	0.032	0.074
Mg$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
SRAS	%w/w	0.006	<0.005	<0.005	0.005	0.013
S$_{HCl}$	%w/w S	0.017	<0.005	0.011	0.029	0.084
S$_{NAS}$	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
a-S$_{NAS}$	moles H^+/t	<5	<5	<5	<5	<5
s-S$_{NAS}$	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	143	32	167	127	93
Liming rate	kg $CaCO_3$/t	11	2.4	13	9.6	7.0
a-Net Acidity without ANCE	moles H^+/t	NA	NA	NA	NA	NA
Liming rate without ANCE	kg $CaCO_3$/t	NA	NA	NA	NA	NA

Method ID	Methodology Summary
LAB.64	sPOCAS determined using titrimetric and ICP-AES techniques. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			7/12/2010	48959-A-35	7/12/2010 || 7/12/2010	LCS	7/12/2010
Date analysed	-			7/12/2010	48959-A-35	7/12/2010 || 7/12/2010	LCS	7/12/2010
pH $_{kcl}$	pH units		LAB.64	5.9	48959-A-35	3.5 || 3.4 || RPD: 3	LCS	101%
TAA pH 6.5	moles H^+/t	5	LAB.64	<5	48959-A-35	138 || 138 || RPD: 0	LCS	103%
s-TAA pH 6.5	%w/w S	0.01	LAB.64	<0.01	48959-A-35	0.22 || 0.22 || RPD: 0	LCS	100%
pH $_{Ox}$	pH units		LAB.64	3.6	48959-A-35	4.1 || 4.1 || RPD: 0	LCS	106%
TPA pH 6.5	moles H^+/t	5	LAB.64	<5.0	48959-A-35	143 || 140 || RPD: 2	LCS	88%
s-TPA pH 6.5	%w/w S	0.01	LAB.64	<0.01	48959-A-35	0.23 || 0.22 || RPD: 4	LCS	88%
TSA pH 6.5	moles H^+/t	5	LAB.64	<5.0	48959-A-35	5.0 || <5.0	LCS	85%
s-TSA pH 6.5	%w/w S	0.01	LAB.64	<0.01	48959-A-35	<0.01 || <0.01	LCS	84%
ANC_E	% $CaCO_3$	0.05	LAB.64	<0.05	48959-A-35	<0.05 || <0.05	[NR]	[NR]
a-ANC_E	moles H^+/t	5	LAB.64	<5	48959-A-35	<5 || <5	[NR]	[NR]
s-ANC_E	%w/w S	0.05	LAB.64	<0.05	48959-A-35	<0.05 || <0.05	[NR]	[NR]
S_{KCl}	%w/w S	0.005	LAB.64	<0.005	48959-A-35	0.012 || 0.010 || RPD: 18	LCS	103%
S_P	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.018 || 0.017 || RPD: 6	LCS	86%
S_{POS}	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.005 || 0.007 || RPD: 33	LCS	82%
a-S_{POS}	moles H^+/t	5	LAB.64	<5.0	48959-A-35	<5.0 || <5.0	LCS	83%
Ca_{KCl}	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.009 || 0.009 || RPD: 0	LCS	74%
Ca_P	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.008 || 0.009 || RPD: 12	[NR]	[NR]
Ca_A	%w/w	0.005	LAB.64	<0.005	48959-A-35	<0.005 || <0.005	LCS	82%
Mg_{KCl}	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.037 || 0.036 || RPD: 3	LCS	91%
Mg_P	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.036 || 0.036 || RPD: 0	[NR]	[NR]
Mg_A	%w/w	0.005	LAB.64	<0.005	48959-A-35	<0.005 || <0.005	[NR]	[NR]
SRAS	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.006 || 0.008 || RPD: 29	[NR]	[NR]
S_{HCl}	%w/w S	0.005	LAB.64	<0.005	48959-A-35	0.017 || 0.017 || RPD: 0	LCS	78%
S_{NAS}	%w/w S	0.005	LAB.64	<0.005	48959-A-35	<0.005 || 0.006	[NR]	[NR]
a-S_{NAS}	moles H^+/t	5	LAB.64	<5	48959-A-35	<5 || <5	[NR]	[NR]
s-S_{NAS}	%w/w S	0.01	LAB.64	<0.01	48959-A-35	<0.01 || <0.01	[NR]	[NR]
a-Net Acidity	moles H^+/t	10	LAB.64	<10	48959-A-35	143 || 145 || RPD: 1	LCS	83%

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Liming rate	kg $CaCO_3$ /t	0.75	LAB.64	<0.75	48959-A-35	11 || 11 || RPD: 0	LCS	84%
a-Net Acidity without ANCE	moles H^+/t	10	LAB.64	<10	48959-A-35	NA || NA	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$ /t	0.75	LAB.64	<0.75	48959-A-35	NA || NA	[NR]	[NR]

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job
Asbestos counting was analysed by Approved Counter:	@ERROR
Asbestos counting was authorised by Approved Signatory:	@ERROR

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

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

Laboratory Acceptance Criteria

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

13 Attachment G – Notes About This Report

Information

Important Information About Your Report

Subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Martens to help you interpret and understand the limitations of your report. Not all of course, are necessarily relevant to all reports, but are included as general reference.

Engineering Reports - Limitations

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

Engineering Reports – Project Specific Criteria

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

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

Engineering Reports – Recommendations

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

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

Engineering Reports – Use For Tendering Purposes

Where information obtained from this investigation is provided for tendering purposes, Martens recommend that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. Attention is drawn to the document 'Guidelines for the Provision of Geotechnical Information in Tender Documents', published by the Institution of Engineers, Australia.

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

Engineering Reports – Data

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

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

Engineering Reports – Other Projects

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

Subsurface Conditions - General

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects, relevant standards and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions - the potential for will depend partly on test point (eg. excavation or borehole) spacing and sampling frequency which are often limited by project imposed budgetary constraints.

- Changes in guidelines, standards and policy or interpretation of guidelines, standards and

policy by statutory authorities.

- The actions of contractors responding to commercial pressures.

- Actual conditions differing somewhat from those inferred to exist, because no professional, no matter how qualified, can reveal precisely what is hidden by earth, rock and time.

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

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

Subsurface Conditions - Changes

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

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

Subsurface Conditions - Site Anomalies

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

Report Use By Other Design Professionals

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

Subsurface Conditions - Geoenvironmental Issues

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

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

Responsibility

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

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

Site Inspections

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

Soil Data

Explanation of Terms (1 of 3)

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Definitions

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

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726 and the S.A.A Site Investigation Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

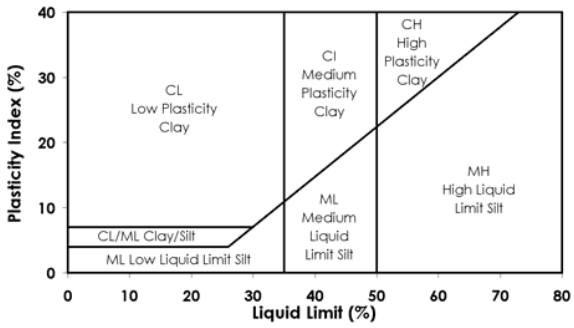
Particle Size

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

Division	Subdivision	Size
BOULDERS		>200 mm
COBBLES		60 to 200 mm
GRAVEL	Coarse	20 to 60 mm
	Medium	6 to 20 mm
	Fine	2 to 6 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties

Plasticity properties can be assessed either in the field by tactile properties, or by laboratory procedures.



Moisture Condition

Dry — Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist — Soil feels cool and damp and is darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet — As for moist but with free water forming on hands when handled.

Consistency of Cohesive Soils

Cohesive soils refer to predominantly clay materials.

Term	C_u (kPa)	Approx SPT "N"	Field Guide
Very Soft	<12	2	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	2 to 4	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	4 – 8	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	8 – 15	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	15 – 30	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	> 200	> 30	The surface of the soil can be marked only with the thumbnail.
Friable	-		Crumbles or powders when scraped by thumbnail

Density of Granular Soils

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

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

Minor Components

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

Term	Assessment	Proportion of Minor component In:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: < 5 % Fine grained soils: < 15 %
With some	Presence easily detectable by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 – 12 % Fine grained soils: 15 – 30 %

Soil Data

Explanation of Terms (2 of 3)

martens consulting engineers

Soil Agricultural Classification Scheme

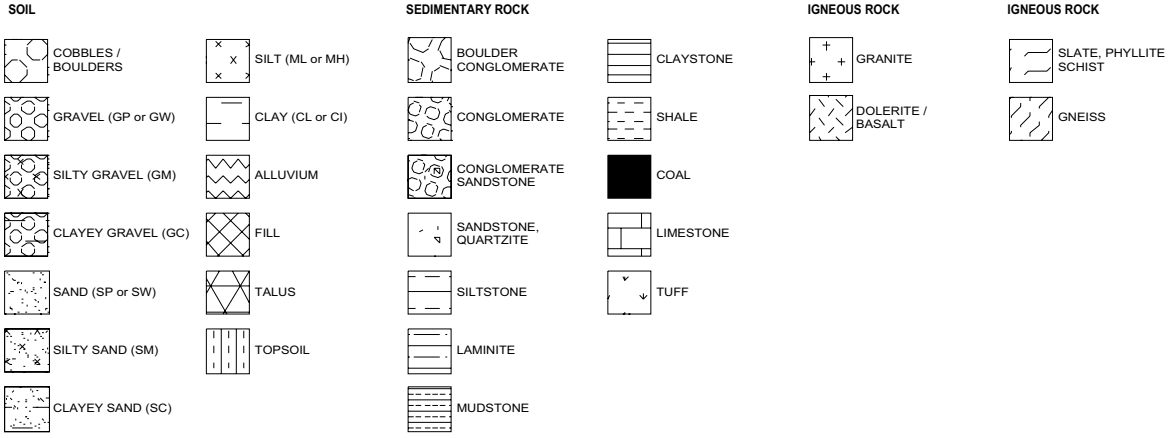
In some situations, such as where soils are to be used for effluent disposal purposes, soils are often more appropriately classified in terms of traditional agricultural classification schemes. Where a Martens report provides agricultural classifications, these are undertaken in accordance with descriptions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

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

Soil Data

Explanation of Terms (3 of 3)

Symbols for Soil and Rock



Unified Soil Classification Scheme (USCS)

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)					USCS	Primary Name
COARSE GRAINED SOILS More than 50 % of material less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm.	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Gravel
				Predominantly one size or a range of sizes with more intermediate sizes missing	GP	Gravel
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	GM	Silty Gravel
				Plastic fines (for identification procedures see CL below)	GC	Clayey Gravel
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of intermediate sizes missing.	SW	Sand
				Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Sand
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	SM	Silty Sand
				Plastic fines (for identification procedures see CL below)	SC	Clayey Sand

FINE GRAINED SOILS More than 50 % of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEDURES ON FRACTIONS < 0.2 MM					
	DRY STRENGTH (Crushing Characteristics)	DILATANCY	TOUGHNESS	DESCRIPTION	USCS	Primary Name
	None to Low	Quick to Slow	None	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	ML	Silt
	Medium to High	None	Medium	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays	CL	Clay
	Low to Medium	Slow to Very Slow	Low	Organic slits and organic silty clays of low plasticity	OL	Organic Silt
	Low to Medium	Slow to Very Slow	Low to Medium	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	MH	Silt
	High	None	High	Inorganic clays of high plasticity, fat clays	CH	Clay
	Medium to High	None	Low to Medium	Organic clays of medium to high plasticity	OH	Organic Silt
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture				Pt	Peat

Low Plasticity – Liquid Limit W_L < 35 % Medium Plasticity – Liquid limit W_L 35 to 60 % High Plasticity - Liquid limit W_L > 60 %

Rock Data

Explanation of Terms (1 of 2)

Definitions

Descriptive terms used for Rock by Martens are given below and include rock substance, rock defects and rock mass.

Rock Substance — In geotechnical engineering terms, rock substance is any naturally occurring aggregate of minerals and organic matter which cannot, unless extremely weathered, be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Rock substance is effectively homogeneous and may be isotropic or anisotropic.

Rock Defect — Discontinuity or break in the continuity of a substance or substances.

Rock Mass — Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

Degree of Weathering

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

Term	Symbol	Definition
Residual Soil	Rs	Soil derived from the weathering of rock. The mass structure and substance fabric are no longer evident. There is a large change in volume but the soil has not been significantly transported.
Extremely weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - ie. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decrease compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original rock substance is no longer recognisable.
Moderately weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	Fr	Rock substance unaffected by weathering

Rock Strength

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

Term	Is (50) MPa	Field Guide	Symbol
Extremely weak	< 0.03	Easily remoulded by hand to a material with soil properties.	EW
Very weak	0.03 - 0.1	May be crumbled in the hand. Sandstone is 'sugary' and friable.	VW
Weak	0.1 - 0.3	A piece of core 150mm long x 50mm diameter may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	W
Medium strong	0.3 - 1	A piece of core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife.	MS
Strong	1 - 3	A piece of core 150mm long x 50mm diameter cannot be broken by unaided hands, can be slightly scratched or scored with a knife.	S
Very Strong	3 - 10	A piece of core 150mm long x 50mm diameter may be broken readily with hand held hammer. Cannot be scratched with pen knife.	VS
Extremely strong	> 10	A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer.	ES

Rock Data

Explanation of Terms (2 of 2)

martens consulting engineers

Degree of Fracturing

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

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

Test Methods

Explanation of Terms (1 of 2)

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Sampling

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

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

Undisturbed samples may be taken by pushing a thin-walled sample tube into the soils and withdrawing a soil sample in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Other sampling methods may be used. Details of the type and method of sampling are given in the report.

Drilling Methods

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

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

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

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

Large Diameter Auger (eg. Pengo) - the hole is advanced by a rotating plate or short spiral auger, generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling - the hole is advanced by pushing a 100mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength *etc.* is only marginally affected.

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

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

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

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

Standard Penetration Tests

Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in AS 1289 Methods of Testing Soils for Engineering Purposes - Test F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

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

as 4, 6, 7
N = 13

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

as 15, 30/40 mm.

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

CONE PENETROMETER TESTING AND INTERPRETATION

Cone penetrometer testing (sometimes referred to as Dutch Cone - abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in AS 1289 - Test F4.1.

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

As penetration occurs (at a rate of approximately 20mm per second) the information is output on continuous chart

Test Methods

Explanation of Terms (2 of 2)

recorders. The plotted results given in this report have been traced from the original records.

The information provided on the charts comprises:
Cone resistance - the actual end bearing force divided by the cross sectional area of the cone - expressed in MPA.
Sleeve friction - the frictional force of the sleeve divided by the surface area - expressed in kPa.
Friction ratio - the ratio of sleeve friction to cone resistance - expressed in percent.

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

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

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

q_c (Mpa) = (0.4 to 0.6) N (blows/300mm)

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

q_c = (12 to 18) c_u

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes *etc*. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

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

Perth sand penetrometer - a 16 mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS 1289 - Test F 3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
Cone penetrometer (sometimes known as the Scala Penetrometer) - a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS 1289 - Test F 3.2). The test was developed initially for pavement sub-grade investigations, with correlations of the test results with California bearing ratio published by various Road Authorities.

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

TEST PIT / BORE LOGS
The test pit / bore log(s) presented herein are an engineering and/or geological interpretation of the sub-surface conditions and their reliability will depend to some extent on frequency of sampling and the method of excavation / drilling. Ideally, continuous undisturbed sampling or excavation / core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

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

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

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

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