Moonee Parklands Trust
C/- JW Planning Pty Ltd

Geotechnical and Acid Sulfate Soils Assessment

Lot 1 DP 1097743 and Lot 6 DP 252223, Pacific Hwy, Moonee Beach, NSW.

P1002663JR02V03
March 2013

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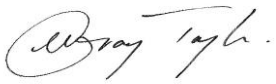
Mr Gray Taylor	Dr Daniel Martens	Mr Gray Taylor	

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All enquiries regarding this project are to be directed to the Project Manager.

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1 Introduction

1.1 Scope of Work

Martens & Associates Pty Ltd has prepared this geotechnical and acid sulfate soils (ASS) assessment for Moonee Parklands Trust C/- JW Planning Pty Ltd to form a Part 3A Environmental Assessment for a proposed residential sub-division yielding up to 160 lots at Lot 1 DP 1097743 and Lot 6 DP252223, Pacific Hwy, Moonee Beach, NSW.

1.1.1 Geotechnical Assessment

The objective of the geotechnical assessment is to determine site geotechnical conditions and any associated limitations which may affect the site and the proposed development. To this extent, the following range of issues has been reviewed as part of the assessment:

- General sub-surface conditions across the site including soil type and rock depth
- Soil and rock strength properties for foundations and pavement design
- Groundwater conditions
- Excavation requirements
- Site classification in accordance with AS 2870 (1996)
- Slope stability and hazard risk assessment

The assessment has been prepared in accordance with the following guidelines:

- Australian Geomechanics Society *Practice Note Guidelines for Landslide Risk Management* (2007).
- Australian Standard 1726 (1993) *Geotechnical Site Investigations*.

1.1.2 Acid Sulfate Soils

The assessment includes a desktop study review of site geomorphic setting and ASS risk maps, detailed site soil landscape investigations and laboratory analysis of collected soil samples.

The objective of the preliminary assessment is to determine the extent of any potential and actual acid sulfate soils on-site, the risk of acid sulfate soils exposure during development works, and to prepare an ASS management plan if required based on soil chemistry test results.

The work is prepared in accordance with the following guidelines:

- NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC, 1998).
- Coffs Harbour City Council (2000) *Local Environmental Plan, Part 4 – Environmental Hazards: Acid Sulfate Soils*.

Site works that potentially affect acid sulfate soils at the site include the construction of building foundations and the construction of services, such as sewer, water supply and stormwater drainage systems.

Final depth of cut/fill earthworks, foundations and service trenches are not confirmed. The assessment has addressed soil layers as deep as 4.0 m below existing ground level in parts, which is sufficient assessment for excavation to 3.0 m depth

1.2 Development Proposal

The development proposal involves the sub-division of land zoned predominantly for residential purposes and part conservation purposes.

The implementation of the concept subdivision is proposed to occur in 4 construction stages beginning in the north west corner. The construction stages will be divided further in into 10 sales stages which may be adjusted in size at the time of release to suit marketing requirements. Preliminary staged works are as follows:

1. Stage 1:
    a. Bulk earthworks for the entire 101 lots to reduce costs and impact on adjoining residents.
    b. The court approved collector road running along the western edge of Moonee Parklands links the approved Glades development to the north with Moonee Beach Village to the south and will be constructed prior to development and release of lots in the Glades development.
    c. Connections to power, water and telecommunication infrastructure to be located within the collector road.
    d. Construction of vehicular access to the proposed sewer pump station as well as to stormwater treatment and detention Basin 1.
    e. Services extended as required and access to the existing residence maintained.
2. Stage 2:
    a. Extension of Roads 4, 5 and 6 with associated services.

3. Stage 3:
    a. Construction of stormwater Basin 2.
    b. Extension of Road 3 & 6 and the partial construction of Road 2 with associated services.
4. Stage 4:
    a. Connection of Road 1 and Road 2 as well as complete Roads 4 & 5 and associated services.

The proposed staging plan aims to provide a cost effective construction sequence that seeks to minimise the impact on any local residents. Whilst subject to possible variation via more detailed construction certificate investigation, design and market considerations as well as land owner circumstances, the proposed staging is practical and logical.

1.3 Comparative Local Studies

In preparation of this report, the following environmental assessments of nearby properties have been reviewed:

- *Geotechnical Assessment: Proposed Sub-division at North Moonee Beach, Pacific Highway, Moonee Beach NSW* (Lots 1 & 2 DP 725785), 16 December 2005 (Coffey Geosciences Pty Ltd).

  This site is immediately north of the subject site and the geotechnical assessment included limited acid sulfate soils testing.

- *Acid Sulfate Soils Assessment for Residential Sub-division: Lot 1 DP 725785 Pacific Highway Moonee Beach NSW*, 17 July 2007 (Coffey Geotechnics Pty Ltd).

  This study was completed subsequent to the preliminary ASS study included in the site geotechnical assessment. The investigation was limited to an approximately 600 m long section of proposed road within Lot 1 DP 725785.

- *Preliminary Acid Sulfate Soils Assessment: Proposed Community Title Sub-division at Moonee* (Lot 211 DP 1044292 and Lot 101 DP 262330), January 2009 (GHD Pty Ltd).

  This site is approximately 600 m south of the subject site.

2 Site Description

2.1 Location and Site Description

The subject site is located between Pacific Highway and Moonee Creek at Moonee Beach, approximately 12 km north of Coffs Harbour and is within the Coffs Harbour City Council Local Government Area (Figure 1).

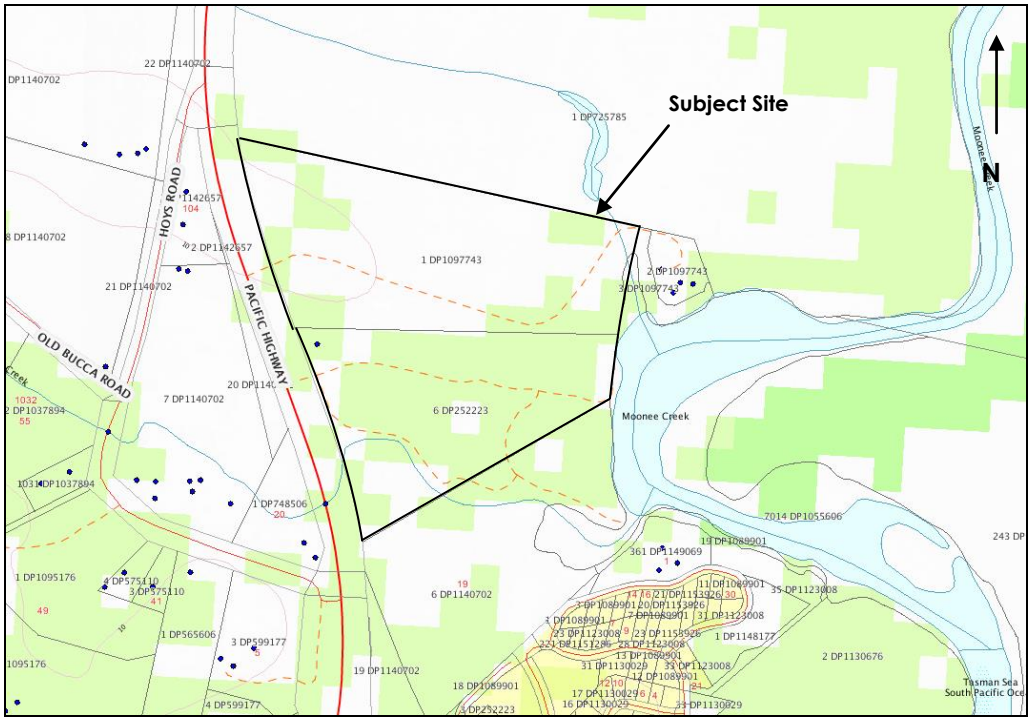

Figure 1: Location of the subject site within its local context (Source: NSW LPMA SixViewer online mapping service, 2010).

Lot 6 has an area of 10.073 ha while Lot 1 is 12.93 ha in area, giving the site a total area of approximately 23 ha. The site is in an area of low density rural development approximately 500 m north of a commercial area and existing residential areas of Moonee Beach. The site is partly cleared with stands of remnant trees remaining. There is a caravan and detachable house in the eastern portion and a caravan and stables in the north-west corner of Lot 6 and unsealed access roads on both properties. Otherwise, the site is undeveloped.

2.2 Field Investigations

Site investigations were undertaken 26 – 28 July 2010 for a range of engineering services. Locations of sub-surface investigations are shown

on the site plan (Attachment A). The geotechnical and acid sulfate soils component of field work included the following:

- Walkover inspection of the site assess existing site conditions and local topography, geology, soil conditions and vegetation;
- Excavation of 14 boreholes to between 0.6 – 9.2 m depth using a hydraulic auger to allow for the characterisation of underlying soils and geology;
- Dynamic Cone Penetration (DCP) testing at 13 borehole locations to determine indicative strengths of sub-surface materials in accordance with AS 1289.6.3.2 (1997);
- Installation of groundwater monitoring wells at 8 borehole locations (BH1, BH2, BH3, BH4, BH6, BH7, BH8 and BH13);
- Collection of 4 bulk soil samples from 4 boreholes for the purposes of CBR testing (Californian Bearing Ratio);
- Collection of 5 bulk soil samples from 3 boreholes for the purposes of testing shrink/swell properties; and
- Collection of seventy-five soil samples from thirteen boreholes for potential acid sulfate soils testing.

2.3 Topography and Drainage

The site is located in an area of gently to moderately undulating hills and flatter low-lying alluvial plains associated with Moonee Creek. Site elevation ranges between approximately 19 mAHD in the west and 2 mAHD along the banks of Moonee Creek in the east with slopes of up to 8 degrees (14%) in the west and relatively flat (generally less than 5%) across low-lying areas in the east.

2.4 Geology

The Coffs Harbour 1:250,000 Geological Sheet (NSW Dept. of Mines, 1970) identifies the site as being on the boundary of Coramba Beds (comprising mudstone, siltstone and greywacke with minor intervals of volcanic rock), and Quaternary alluvium (comprising silt, clay, fluvial sand, marine sand and gravel).

Borehole investigations to 9.2 m depth below ground level did not encounter fresh bedrock. Extremely – moderately weathered claystone bedrock (with clay properties) was encountered at boreholes 5, 8 and 9, as shown by the borehole excavation logs. These boreholes were situated on the lower slopes in the north-west of the site at higher elevations than those on the low-lying alluvial floodplains further east.

Penetration testing extended to maximum 2.7 m depth below ground level and terminated in stiff clays.

2.5 Soil Profile

2.5.1 Soil Landscapes Map

The Soil Landscapes of the Coffs Harbour 1:100,000 Sheet identifies the site as having soils mainly of the Newports Creek soil landscape, as well as Ulong soil landscape on the lower slopes in the west of the site (Table 1 and Table 2). Total soil depth is typically up to 2.5 m or more across the lower slopes and floodplains.

Table 1: Soil profile summary of Newports Creek soil landscape: low-lying alluvial floodplains (Milford, H.B., 1999).

Layer	Depth Range of soil layer (m)	Description
np1	0.0 – 0.30	Dark brown, weakly pedal clay loam.
np2	0.30 – 0.80	Greyish, yellow-brown, whole-coloured light clay.
np3	0.80 – 1.60	Yellowish-brown, mottled Pleistocene clay.
np4	1.60 – >2.50	Grey, mottled Pleistocene clay.

Table 2: Soil profile summary of Ulong soil landscape: lower slopes (Milford, H.B., 1999).

Layer	Depth Range of soil layer (m)	Description
ul5	0.0 – 0.30	Dark brown, weakly pedal clay loam.
ul2	0.30 – 1.10	Reddish-brown, pedal clay loam.
ul3	1.10 – 2.10	Reddish-brown clay to silty clay.
ul4	2.10 – 3.10	Reddish-brown, pedal, mottled, light to medium silty clay.

2.5.2 Local Soil Studies

A geotechnical study completed for the property immediately north of the subject site (Lots 1 & 2 DP 725785) (Coffey Geosciences Pty Ltd, 2005) included nine test pits to depths of 2.0 m and six boreholes to depths between 4.3 m and 5.0 m. The property has similar surface

levels and topography to the subject site. The study found the stratigraphy to be as per Table 3.

Sub-surface conditions were categorised into two geological zones as follows:

- Zone 1 – Topsoil overlying residual soils and weathered rock; and
- Zone 2 – Topsoil overlying alluvial soils of variable depth, with residual soils underlying the alluvial soils in some test pits.

Table 3: Summary of soil profile observed at Lots 1 & 2 DP 725785, Moonee Beach (Coffey Geosciences Pty Ltd, 16 December 2005).

Soil Unit	Observed Depth Range (m)	Description
Topsoil	0.0 – 0.30	Sands and clays, fine to coarse grained sand, low to medium plasticity fines, dark brown.
Alluvial soil	0.10 – >5.00	Sandy clay and sand, medium plasticity clay, fine to medium grained sand, brown and grey/orange.
Residual soil	0.00 – >5.00	Clay and sandy clay, high plasticity, red/orange-brown and grey/red, sand is fine to medium grained.
Extremely – highly weathered Claystone	0.70 – >1.70	Clayey gravel, fine to coarse grained, grey/orange, medium plasticity fines.

2.5.3 Site Observations

Borehole investigations indicate that the site soil profile generally consists of stiff – very stiff, moderately plastic grey clays with up to 1.5 m of sand overlying clays in some parts of the site, as summarised in Table 4. The data shows that sandy deposits are thicker at lower elevations and absent on the lower slopes in the north-west of the site (above approximately 5 mAHD). Detailed bore logs are provided in Attachment B.

Table 4: Summary of soil profile observed at Lot 1 DP 1097743 and Lot 6 DP 252223, Moonee Beach.

Borehole	Elevation (mAHD)	Topographic Unit	Depth of SAND[1] (m)	Depth of CLAY[2] (m)
BH1	3.5	Low-lying alluvial plain	1.5	>7.0
BH2	2.8	Low-lying alluvial plain	0.9	>5.5
BH3	3.4	Low-lying alluvial plain	0.45	>5.5
BH4	3.6	Low-lying alluvial plain	0.1 (organic silt)	>7.0
BH5	11.5	Lower hill slopes	N/A	3.0 (then E/W claystone to 5.5)
BH6	7.0	Lower hill slopes	N/A	>8.5
BH7	1.1	Low-lying alluvial plain	1.2	>4.2
BH8	6.0	Lower hill slopes	N/A	9.2
BH9	18.5	Lower hill slopes	N/A	>2.5
BH10	11.0	Lower hill slopes	N/A	>2.0
BH11	2.9	Low-lying alluvial plain	0.9	>2.5
BH12	4.5	Low-lying alluvial plain	0.1 (organic silt)	>2.5
BH13	1.6	Low-lying alluvial plain	N/A	>5.0
BH14	14.5	Lower hill slopes	N/A	>0.6

Notes: [1] Silty sand, sand, clayey sand, loose, fine – medium grained. [2] Grey, stiff – very stiff, moderately plastic.

2.6 Groundwater

2.6.1 Bore Search

A review of the former NSW Department of Natural Resources groundwater bore database revealed that there are at least six bores with available water level data located within approximately 1 km of

the subject site (Figure 2). Standing water level data from the database is shown in Table 5.

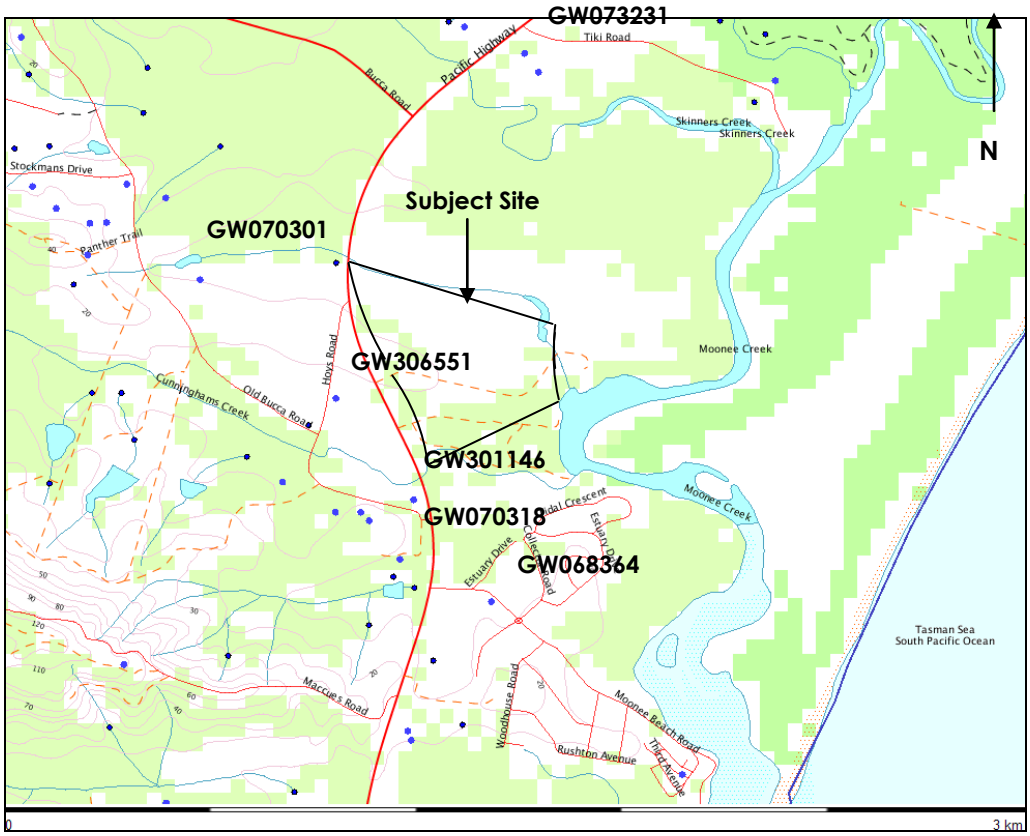

Figure 2: Local groundwater bores (from NSW DNR database).

Table 5: DNR groundwater details – Moonee Beach NSW.

Bore #	Approx. Distance from site (km)	Approx. Ground Elevation (mAHD) [1]	Standing Water Level (m b.g.l)	Approx. Groundwater Level (mAHD)
301146	0.05	8	7.0	1.0
306551	0.15	8	5.0	3.0
073231	0.83	3	5.0	-2.0
070318	0.23	10	9.0	1.0
068364	0.38	9	4.0	5.0
070301	0.45	10	3.5	6.5

Note: [1]Elevation is +/- 5 m without further survey.

2.6.2 *Monitoring Observations*

Results of groundwater monitoring are summarised in Table 6 with respect to different areas of the site. Refer to Martens report P1002663JR02V02 (February, 2013) for further groundwater monitoring detail. Borehole locations are shown on the site plan (Attachment A).

Table 6: Summary of water level data observed during borehole drilling: Lot 1 DP 1097743 and Lot 6 DP 252223, Moonee Beach NSW

	GMB							
	1	**2**	**3**	**4**	**6**	**7**	**8**	**13**
Minimum	0.697	2.111	2.766	2.456	3.904	0.696	4.116	-1.775 [1]
Mean	1.488	2.443	3.186	3.128	4.265	0.948	4.465	1.097
Maximum	3.380	2.695	3.396	3.668	4.640	1.275	5.011	1.680
Range	2.683	0.584	0.63	1.212	0.736	0.579	0.895	3.455
Minimum Depth to GW	0.202	0.022	-0.023	-0.047	2.268	-0.004	0.681	-0.069
Mean Depth to GW	2.094	0.274	0.187	0.493	2.643	0.323	1.227	0.514
Ground Level	3.582	2.717	3.373	3.621	6.908	1.271	5.692	1.611

Notes: [1.] Level occurred due to GMB being purged dry. [2.] GW = groundwater level.

3 Geotechnical Assessment

3.1 Site Classification

Preliminary site classification in accordance with AS 2870 (2011) is provided in Table 7 based on the depth of clay in the soil profile and groundwater levels. The relatively shallow groundwater table on the low-lying alluvial plains generally reduces site classification. Linear shrinkage laboratory testing of site soils has not been completed and, if undertaken, could possibly reduce site classification in certain parts of the site and at certain depths of the soil profile.

Table 7: Preliminary Site Classification.

Topographic Unit	Depth of Clay	Depth to Water Table (mBGL)	Preliminary Site Classification (AS 2870)
Low-lying alluvial plain (<5 mAHD)	> 7.0 m	Generally < 2.5	H1
Lower Hill Slopes (>5 mAHD)	Up to 9.2 m	Generally > 2.5	H2

3.2 Site Stability Observations

Field investigations found no evidence of subsidence or recent gross slope instability on-site. Waterlogged soils will need to be considered as a significant factor affecting site development (Section 3.5).

3.3 Soil and Rock Strength

Preliminary soil strength properties for the primary soil types at the site have been estimated using *in-situ* DCP testing. Results are summarised in Table 8 and a detailed DCP log sheet is provided as Attachment C.

Table 8: Preliminary soil strength properties based on *in-situ* DCP testing

Soil Type	Depth BGL (m)[4]	C_u[1] (kPa)	ϕ[2]	ABC[3] (kPa)
SAND (silty sand, sand, clayey sand, loose, fine – medium grained)	0.0 – 1.0	-	28	90
	1.0 – 1.5	-	30	180
CLAY (grey, stiff – very stiff, moderately plastic) / E/W CLAYSTONE	0.0 – 1.0	40	-	90
	1.0 – 2.0	60	-	150
	2.0 – 3.0	170	-	300
	> 3.0	300	-	400

Notes: [1] Undrained shear strength. [2] Effective Internal Angle of Friction. [3] Allowable End Bearing pressure estimate assuming square footing with $D_f/B < 0.5$. Punching shear effect not assessed. [4] Refer to borehole logs (Attachment B) for accurate depths of the soil profile encountered at each borehole location.

Rock coring and strength testing of site bedrock was not undertaken. Based on visual inspection of rock fragments retrieved from boreholes, we provide a conservative allowable bearing capacity of 600 kPa for moderately weathered claystone. If higher values are required for design, further investigation is recommended.

3.4 Risk Assessment of Proposed Development Works

A qualitative geotechnical hazard risk assessment (Table 9) has been completed for the proposed development generally in accordance with the risk matrices provided in Section 7 of the AGS (2007) guidelines. Rotational slide and soil creep are considered hazards at the site, primarily on the lower hill slopes in the north-west. Recommended treatment measures for these hazards are as follows:

- Rotational slide/slump – Good hill slope engineering practice (see Attachment D: Guidelines for Hillside Construction from AGS, 2007); and
- Soil Creep – Maintain vegetation wherever possible and ensure appropriate foundations and footings design.

At this stage, since the development proposal is for sub-division of the land only and no construction designs have been presented, potential hazards relating to construction and building design, such as excavation failure and embankment failure are not assessed.

Table 9: Summary of qualitative slope instability risk assessment

Hazard	Likelihood	Consequence to Property	Risk to Property	Consequence to Life	Risk to Life
Rotational slide/ Slump	Rare	Minor	Very Low	Very high chance of survival	Very Low
Soil Creep	Unlikely	Insignificant	Very Low	Death or injury barely credible	Very Low

The proposed sub-division is therefore considered to constitute a very low risk to life and property resulting from geotechnical hazards and is considered acceptable provided recommendations of this report are implemented. In future, structural design of all structures will need to be suitable to withstand the effects of plastic clays subject to shrink/swell movements (Section 3.1 and 3.6) and waterlogged soils (Section 3.5).

3.5 Waterlogged Soils

Areas of water logged soils may pose a geotechnical constraint for the proposed sub-division (Section 2.6.2). Areas of the site subject to waterlogged soils include the low lying alluvial plains in the east, particularly adjacent to local drainage depressions and creeks.

We note that the amount of water logging in the soils will be dependent on recent rainfall and climate conditions, in particular the water level in Moonee Creek. Where development is proposed in these areas, design and construction should take into account the waterlogged soils and subsequent low strengths of the clay subsoils. Sub-soil drains may need to be installed. The need for these should be determined prior to CC.

3.6 Expansive Soils

Five clay samples from three borehole locations were submitted for laboratory testing of Atterberg Limits to determine the reactivity of the soils in relation to moisture change. A summary of results is provided in Table 10 and Attachment E with the laboratory report provided in Attachment F.

Table 10: Atterberg Limit Results.

	Location	Sample Depth (m)	Liquid Limit (%)	Plasticity Index (%)	USCS Class[1]	Compressibility / Shrink-swell potential [2]
BH 2	Low-lying alluvial plains (2.81 mAHD)	1.0	31	16	CL	Low
BH 4	Low-lying alluvial plains (3.64 mAHD)	0.5	25	13	CL	Low
		1.5	51	32	CH	Medium
BH9	Lower hill slopes (18.5 mAHD)	0.5	65	38	CH	High
		1.0	50	24	CH	Medium

Note: [1] See laboratory analysis results provided in Attachment E. [2] Reference to Hazelton and Murphy (1992).

Analysis of Atterberg Limits testing results (Attachment E) indicates that the clay soils generally have a low – high expansive rating and are classified as either 'Inorganic clays of low to medium plasticity (CL)' or 'Inorganic clays of high plasticity (CH)' in accordance with the *Unified Soil Classification Scheme* (USCS). Engineering suitability for the clay soils are outlined in Table 11. The distribution of CL and CH class soils is shown in the borehole excavation logs (Attachment B).

Table 11: Engineering suitability of site clays (based on Table 2.2.4 of Hazelton and Murphy, 1992).

	Source of Borrow			Suitability For				
	Embankments							
USCS Class.	Water Retaining	Non Water Retaining	Fill	Road Subgrade	Building Foundations	Slope Stability	Trenching/ Tunnelling	Untreated Roads
CL	SUITABLE	GOOD	AVERAGE	AVERAGE	AVERAGE	GOOD	GOOD	POOR
CH	SUITABLE	AVERAGE	UNSUITABLE	UNSUITABLE	POOR	AVERAGE	GOOD	UNSUITABLE

3.7 Preliminary Pavement Design

3.7.1 Penetration and CBR Testing

CBR testing was undertaken on samples collected from four locations at depths ranging from 0.2 – 0.9 m below ground level along the proposed (preliminary) internal roads. These were used to compare with CBR estimated made from DCP testing in accordance with Austroads (1998). Table 12 and Table 13 summarise CBR testing results and indicate a reasonable correlation between laboratory CBR data and data retrieved from DCP testing.

Table 12: Estimated *in-situ* CBR (from DCP's)

	DCP No.												
Depth (m)	**Low-lying alluvial plain (< 5 mAHD)**							**Lower hill slopes (> 5 mAHD)**					
	1	**2**	**3**	**4**	**7**	**11**	**12**	**5**	**6**	**8**	**9**	**10**	**14**
0.15	8	2	1	8	4	5	2	8	7	7	5	10	4
0.30	11	4	2	10	4	4	11	15	29	7	**5**	5	**5**
0.45	30	2	4	2	8	4	**5**	10	11	8	**5**	8	**10**
0.60	55	2	7	5	7	4	4	13	7	8	10	5	13
0.75	10	5	13	11	8	**4**	5	13	8	5	16	29	20
0.90	15	13	27	18	8	**7**	10	11	7	8	29	63	32
1.05	8	23	44	36	8	15	15	15	10	13	46		
1.20	15	38	59	51	7	25	27	15	11	18	51		
1.35	30	42	61	72	8	38	40	16	15	11			
1.50	45	46	72	95	8	58	55	15	23	11			
1.65	63	57	72		8	76	74	27	40	16			
1.80	84	82			8			61	51	25			
1.95					8				61	75			
2.10					11				74				
2.25					23								
2.40					32								
2.55					51								
2.70					72								

Note: Complete DCP log sheets provided in Attachment C.

Table 13: CBR laboratory testing results.

Location		Sample Depth (m)	CBR (2.5 mm penet.)	CBR (5.0 mm penet.)	DCP CBR Estimate
BH 9	Lower hill slopes (18.5 mAHD)	0.2 – 0.5	3.5	3.5	5
BH11	Low-lying alluvial plains (2.9 mAHD)	0.6 – 0.9	7	8	7
BH 12	Low-lying alluvial plains (4.5 mAHD)	0.25 – 0.6	2.5	2.5	5
BH 14	Lower hill slopes (14.5 mAHD)	0.2 – 0.5	9	13	7

Results indicate that CBR is highly variable and careful pavement design and geotechnical supervision will be required on-site to ensure adequate sub-grade is achieved during the road construction process. Data indicates that further testing will be required to fully characterise sub-grade materials prior to final pavement design.

3.7.2 Treatment of Soft Spots

Soft areas of soil that are incapable of providing adequate design CBR values should be stiffened as required or replaced. This may include installation of tensor geogrid and/or more frequent and prolonged compaction of soil layers until the design CBR is achieved. A geotechnical engineer should be consulted for 'soft spot' management during the road construction process. We recommend installation of adequate sub-soil drainage systems to ensure that sub grades do not soften during periods of extended rainfall.

4 Geotechnical Risk Management Recommendations

4.1 Excavations

Following the proposed sub-division of the site, future works will require soil excavation at various locations (e.g. for services, road boxing and shallow foundations).

It is recommended that where possible:

- Temporary batters of 1V:1H should be used when excavating soil materials (<1m). Permanent batters to be 1V:2H.
- Where design batter slopes are not achievable, suitably designed and constructed shoring walls and supports should be implemented during construction works.

Organic topsoils, silty or sandy soils should be stockpiled separately from clay subsoils. Topsoils can be re-used on the site for landscaping purposes, while clayey subsoils can be reused for areas of compacted fill requirement subject to appropriate treatment and control. Any soil taken off-site is to be assessed in accordance with NSW DECC 2009 waste classification guidelines.

4.2 Fill Material

We recommend that fill in excess of 0.5m be suitably engineered to ensure good stability, compaction and water exclusion and/or drainage. The placement of fill is to be performed in accordance with Australian Standard 3798 (2007). This compliance will be outlined in CC documentation.

If fill from off-site is utilised, it should be suitable in accordance with AS 3798 (2007), be well graded, have a maximum particle size of 75mm and be certified as free of unsuitable material. Site sub-soils are not likely to be suitable for use as engineered fill without treatment and/or re-engineering.

All earthworks are to be undertaken in accordance with AS 3798 (2007). Proof rolling of sub-grades should be conducted before placement of any fill, and this should be closely monitored by the site supervisor to identify sub-surface moisture issues and soft / unstable layers. Fill should be free of organics, deleterious substances such as wood, metal, boulders and plastic. Fill should be placed in 150 – 200mm layers. Preliminary site compaction criteria and frequencies of compaction testing for different types of placed fill are outlined below:

1. Building pads: minimum dry density (MDD) of 98% standard (for clay soils), or minimum density index (I_D) of 75% for cohesionless soils (silts and sands), with moisture variation not to exceed +/- 2% of optimum moisture content (OMC).

2. Site pavements: MDD of 98% modified, I_D of 75%, with moisture not to exceed 2% of OMC.

3. Other controlled non-load bearing fill: MDD of 95% standard, I_D of 70%, with moisture not to exceed 2% of OMC.

4.3 Sub-grade Preparation

We recommend that any stripping of topsoil or unsuitable sub-grades (CBR < 4) be undertaken at the onset of excavation and suitably stockpiled for on-site non-engineering uses (landscaped mounds or topsoil re-use) or off-site disposal to a suitable location.

For all areas where fill is to be placed to raise site levels and where on-grade slabs or pavement are to be constructed, preparation of sub-grade should consist of:

1. Stripping of topsoil and unsuitable material and trimming to desired levels providing level foundation keys.

2. Compact sub-grade to achieve a minimum density of 98 % Standard Maximum Dry Density (SMDD) for cohesive soil ; and

3. Proof roll the sub-grade with a minimum 12 tonne deadweight smooth drum roller.

Proof rolling should be closely monitored by the site supervisor and confirmed by geotechnical engineer to detect soft or unstable areas which should be removed and replaced with engineered fill.

4.4 Footings and Foundations

Foundations of all proposed buildings are to be designed by a suitably qualified and experienced structural engineer. Provision of preliminary safe bearing pressures and other geotechnical parameters for structural design will require further investigation and/or site specific analysis at CC stage for buildings associated with future development applications. Preliminary soil and rock strengths for the site are provided in Table 8.

We recommend that all footing excavations should be inspected by a geotechnical engineer during construction to confirm the required

founding stratum has been reached. In the case where footings are to be founded / supported by engineered fill, that these areas be certified through an appropriate level of compaction testing.

Generally we note:

1. All footings should be excavated and poured with minimal delay.

2. All footings should be free from all loose or softened materials prior to pouring.

3. If water ponds in the base of the footings, they should be pumped dry and then re-excavated to remove all loose and softened materials. If a delay in pouring is anticipated, a blinding layer of at least 50 mm concrete is to be placed to protect the base of the footing excavation.

4.5 Retaining Structures

No specific comment can be made regarding retaining structures on the site as the detailed development proposal has not been completed at the time of writing this report however we understand that a retaining wall of unknown size will be required west of the collector road. It is recommended that retaining structures greater than 1.0 m are to be individually assessed and designed by an appropriate engineer. The following general comments are made with regards to minor retaining structures:

- All smaller retaining structures (<1.0 m) are to be backfilled with free-draining aggregate and suitable drainage measures included.
- A geotextile fabric is to be placed between *in-situ* and fill soils and aggregate to prevent the access of fine materials into the aggregate.
- A minimum 100 mm diameter agricultural drainage pipe(s) installed within the aggregate is considered to be sufficient to collect sub-surface seepage that may occur behind minor retaining structures.
- Drainage water should be disposed of to site stormwater discharge structures where possible.

4.6 Groundwater

Where excavation intercepts ephemeral groundwater seepage following rainfall events, gravity drainage to downslope areas or a sump and pump is considered to be appropriate for dewatering during

construction. All site discharges should be passed through a filter material prior to release.

Further consideration may need to be given to drainage below any subgrade slabs for building construction. Final drainage design is to be required at construction phase for buildings associated with future development applications, following detailed structural design.

In relation to bulk excavation works, we note the following:

1. Where deeper excavations are proposed in low lying areas (say > 1-2 m below natural ground level), there is a risk that permanent groundwater levels will be intercepted and possibly lowered by the earthworks should these include some form of permanent sub-soil drainage.

2. In instances where a permanent groundwater table is likely to be affected by the proposed works, Martens and Associated should be contacted and further recommendations shall be developed.

4.7 Stormwater and Groundwater Seepage Management

During site works, all surface flows should be diverted away from excavations and exposed soil areas to temporary flow paths.

All seepage water is to be removed from excavations by sump and pump or gravity methods where possible and allowed to infiltrate into the soil within site boundaries down slope of the development area. All site discharges should pass through a filter or filter material prior to release.

Given groundwater and stormwater is unlikely to be contaminated, any excess water may be discharged into Moonee Creek if infiltration is not practical, provided it passes through a filter media.

4.8 Trafficability and Construction Access

During wet weather, trafficability of heavy machinery on exposed soil/sub-grade materials may be reduced or prevented. Provision for site grading, temporary open drains or toe/crest drains is suggested to collect any overland flow, prevent water ponding and hence minimise potential for any further soil/sub-grade softening or erosion, and to help improve trafficability. The use of dumped aggregate for temporary construction roads may be necessary to allow works during and immediately following wet weather.

4.9 Soil Erosion Control

Suitable sediment and erosion control measures should be installed around all areas of disturbed soil and vegetation to ensure that soil erosion and losses do not occur as a result of any site excavation works. Filter fences and hay bales are appropriate when controlling small areas of runoff (<0.2 ha). Diversion of stormwater from around the construction areas also needs to be addressed in the construction management plan. A detailed sediment and erosion control plan, however, should be produced prior to any site earthworks.

4.10 Adequacy

From a geotechnical perspective, we consider the site suitable for the proposed development, subject to the recommendations and preliminary treatment measures as outlined in this report.

4.11 Summary of Recommended Works

We recommend the following further works at Construction Certificate stage of the development:

1. Evaluation of engineered soil batter options within the context of proposed site design / layout requirements.

2. Preparation of a sediment and erosion control plan.

5 Acid Sulfate Soils Assessment

5.1 Desktop Review

5.1.1 Acid Sulfate Soils Risk Map Classification

According to the (former) NSW Department of Natural Resources (DNR) acid sulfate soil risk maps, the subject site is categorised as being at risk of having acid sulfate soils (Figure 3). Class 2, Class 3 and Class 5 land exists at the site. According to the ASSMAC (1998) guidelines:

- Works below natural ground level and works by which the watertable is likely to be lowered are likely to present an environmental risk if undertaken in Class 2 land.
- Works beyond 1 metre below natural ground level and works by which the watertable is likely to be lowered beyond 1 metre below natural ground level are likely to present an environmental risk if undertaken in Class 3 land.
- Works which are likely to lower the watertable below 1 mAHD on adjacent Class 2 or 4 lands are likely to present an environmental risk if undertaken in Class 5 land.

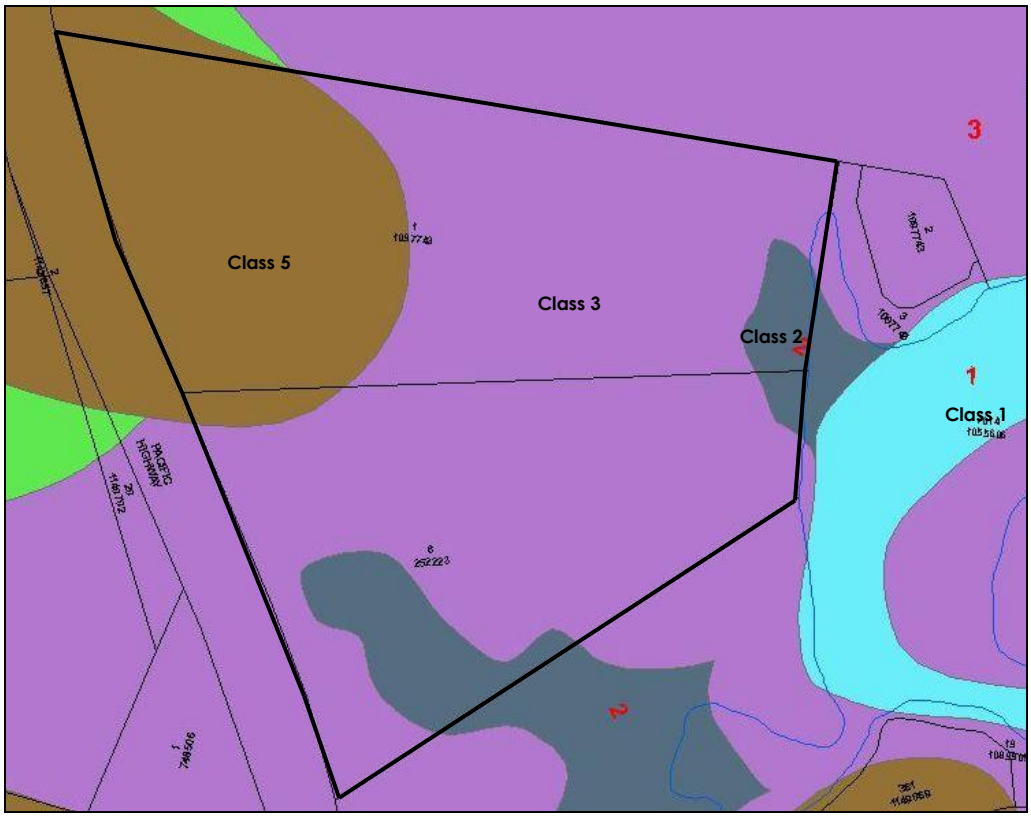

Figure 3: NSW DNR Acid Sulfate Soils Risk Map extract.

5.1.2 Geomorphic Setting

The likelihood of acid sulfate soils occurrence at a site is a function of various geomorphic parameters, in particular those listed in Table 14 (ASSMAC, 1998). Each is an indicator that acid sulfate soils are likely to be present on-site.

Table 14: Geomorphic features indicative of acid sulfate soils

Geomorphic Feature	Present on site?
Holocene sediments	Yes (low lying areas)
Soil horizons less than 5 m AHD	Yes
Marine / estuarine sediments or tidal lakes	Yes
Coastal wetland; backwater swamps; waterlogged or scaled areas; interdune swales or coastal sand dunes.	Yes
Dominant vegetation is mangroves, reeds, rushes and other swamp or marine tolerant species.	Partly[1]
Geologies containing sulphide bearing material / coal deposits or former marine shales/sediments	Likely
Deep older (Pleistocene) estuarine sediments	Likely

Notes: [1] Around creeks only.

All of the geomorphic features listed are present or likely to be present on-site. Therefore, the geomorphic setting of the site indicates that actual or potential ASS could be present and further site testing is recommended.

5.2 Soil Sampling and Laboratory Analysis

5.2.1 Sampling Regime

A soil sample was collected from every soil layer or every half meter generally to maximum depth of 1.5 – 7.0 m below ground level at thirteen boreholes distributed across the site, as shown in Table 15. Borehole locations are shown on the site plan (Attachment A).

Table 15: Collected soil samples

Depth (m bgl)	Borehole												
	1	2	3	4	5	6	7	8	9	10	11	13	14
0.2	X					X					X		0.3mbgl
0.5	X	X	X	X	X	X	X	X	X	X	X		
											0.7mbgl		
1.0	X	X	X	X	X	X	X	X	X	X	X	X	
	1.3mbgl												
1.5	X	X	X	X	X	X	X	X		X	X		
2.0	X	X	X	X	X	X	X		X			X	
2.5	X	X	X	X			X	X			X		
3.0	X	X		X									
3.5	X		X			X	X						
4.0	X	X		X		X							
5.0	5.5mbgl	X	X	X	X	X							
6.0				X		X							
7.0	X												

Total site area is approximately 13 ha. ASSMAC (1998) guidelines recommend that two boreholes per hectare is an appropriate number of sampling locations for sites larger than 4 ha, therefore recommending up to 26 boreholes at the subject site. However, the 13 completed boreholes found a consistent soil profile occurring at the site and the completed soil sampling regime has been designed to assess each soil layer, assuming a catenary sequence. Therefore, the completed sampling density is considered adequate for preliminary assessment of the site.

5.2.2 pH Screening Test

pH testing using the 'field' peroxide test (oxidation in 30% hydrogen peroxide) was completed by Envirolab Laboratories for twenty soil samples taken from six low-lying boreholes and one higher hill slope borehole to assess actual or potential acid sulfate soils and as a screening measure for further laboratory testing (sPOCAS). Soil samples included sandy deposits as well as clayey subsoils (Table 16).

As stated by the ASSMAC (1998) guidelines, actual acid sulfate soils may be indicated by field pH <4 in soils, and potential acid sulfate soils may be indicated one or more of the following:

- Change in colour of the soil from grey tones to brown tones;
- Effervescence;
- The release of sulphur odours from gases such as sulphur dioxide or hydrogen sulphide;
- A lowering of the soil field pH by at least one unit; or
- A final field pH <3.0.

None of the tested samples showed signs of being actual acid sulfate soils (field pH <4), however all but one of the twenty samples (2663/2/4.0) showed slightly – moderately positive signs of being potential acid sulfate soils based on a lowering of pH after oxidation (Table 16). Samples from BH7 proved to have the most positive results. The complete laboratory report is provided as Attachment G. Fifteen of the samples were submitted for further laboratory testing (sPOCAS).

Table 16: Field pH test and field peroxide test (oxidation in 30% hydrogen peroxide) results – Moonee Beach NSW.

BH	BH Elevation (mAHD)	Sample Depth (m)	Soil Texture	pH_F	pH_{FOX}	pH Change	Reaction Rate
BH1	3.5	0.5[1]	SAND	5.2	3.1	-2.1	Slight
		1.0[1]	CLAYEY SAND	5.5	4.1	-1.4	Mod.
		1.5[1]	CLAY	5.3	3.8	-1.5	Slight
		2.5[1]	CLAY	4.5	3.3	-1.2	Slight
BH2	2.8	0.5[1]	SAND	5.4	4.1	-1.3	Slight
		1.0[1]	CLAY	5.4	3.8	-1.6	Slight
		2.0[1]	CLAY	5.6	4.4	-1.2	Slight
		4.0[1]	CLAY	5.7	5.4	-0.3	Slight
BH3	3.4	0.5	CLAY	5.1	3.9	-1.2	Slight
		1.0	CLAY	4.9	3.5	-1.4	Slight
BH4	3.6	0.5[1]	CLAY	5	3.8	-1.2	Slight
		1.0[1]	CLAY	5	3.7	-1.3	Slight
		1.5[1]	CLAY	5	3.5	-1.5	Slight
BH5	11.5	0.5[1]	CLAY	5.7	4.1	-1.6	Mod.
		1.0	CLAY	5.1	3.9	-1.2	Mod.
BH7	1.1	0.5[1]	CLAYEY SAND	4.7	3.5	-1.2	Mod.
		1.0[1]	CLAYEY SAND	5.1	2.6	-2.5	Mod.
		2.5	CLAY	5.5	2.1	-3.4	Mod.
BH11	2.9	0.5	CLAYEY SAND	5.4	4	-1.4	Mod.
		1.0[1]	SANDY CLAY	4.8	3.7	-1.1	Mod.

Note: [1]These samples were submitted for further laboratory testing (sPOCAS).

5.2.3 *sPOCAS Testing*

Fifteen soil samples were submitted to Envirolab Laboratories for acid sulfate soils testing using the Suspended Peroxide Oxidation Combined Acidity and Sulfate (SPOCAS) method to determine the presence of actual or potential ASS material. Selected soil samples aim to include a broad range of the soil layers at the site and also take into account pH screening test results (Section 5.2.2). This testing allows for a preliminary assessment of the extent of ASS at the site.

5.2.4 *Results*

Laboratory testing results are summarised in Table 17 and the complete laboratory report is provided as Attachment G.

Table 17: ASS (SPOCAS) testing results. Samples exceeding the ASSMAC action criteria are highlighted.

Sample ID[1]	Soil Type	pH_{KCL}[2]	pH_{OX}[3]	TPA[4]	TSA[5]	S_{POS}[6]
2663/1/0.5	SAND	4.5	3.4	10	<5.0	<0.005
2663/1/1.0	CLAYEY SAND	4.7	4.0	168	90	0.043
2663/1/1.5	CLAY	4.2	4.1	87	<5.0	0.014
2663/1/2.0	CLAY	3.8	3.8	103	<5.0	0.008
2663/2/0.5	SAND	4.6	4.2	30	<5.0	0.010
2663/2/1.0	CLAY	4.4	3.8	40	12	0.042
2663/2/2.0	CLAY	4.4	4.7	<5.0	<5.0	<0.005
2663/2/4.0	CLAY	5.0	4.7	<5.0	<5.0	<0.005
2663/4/0.5	CLAY	4.2	4.2	27	<5.0	0.011
2663/4/1.0	CLAY	3.5	4.0	110	<5.0	0.007
2663/4/1.5	CLAY	3.6	4.3	72	<5.0	<0.005
2663/5/0.5	CLAY	3.6	4.1	150	<5.0	0.010
2663/7/0.5	CLAYEY SAND	4.4	4.0	<5.0	<5.0	0.012
2663/7/1.0	CLAYEY SAND	4.1	2.5	92	55	0.17
2663/11/1.0	SANDY CLAY	4.2	4.1	27	<5.0	0.012
Guideline Limit	**Coarse Texture (Sands)**			**18**	**18**	**0.03**
(Action Criteria)[7]	**Fine Texture (Clays)**			**62**	**62**	**0.1**

Notes: [1] Format = Project/Borehole/Depth. [2] pH (actual acidity). [3] pH after oxidation with peroxide (potential acidity). [4] Titratable Peroxide Acidity (Moles H^+/tonne). [5] Titratable Sulfidic Acidity (Moles H^+/tonne). [6] Oxidisable sulphur (%). [7] ASSMAC (1998) p.27, for 1-1,000 tonnes disturbed soil.

The ASSMAC (1998) guidelines specify that the proposed site works present a risk of acid generation and, therefore, a management plan is required, if the soil exhibits one of the following criteria:

- Oxidisable sulphur (S_{POS}) is >0.03% or TPA or TSA is >18 mol H^+/tonne if coarse texture soils (sands); or
- Oxidisable sulphur (S_{POS}) is >0.1% or TPA or TSA is >62 mol H^+/tonne if fine texture soils (silty clays and clays).

The laboratory results indicate that eight samples from five boreholes exceed the action criteria triggering the need for a management plan based on TPA, including samples from boreholes situated on the low-lying alluvial plains as well as on the lower hill slopes in the north-west. Two samples (one each from BH1 and BH7) exceed the criteria based on S_{POS}.

The difference between TPA results and S_{POS} results indicates that the majority of soils at the site are unlikely to have pyritic sulfur, but may contain organic sulfur. On this basis, it is recommended that the majority of soils are not actual acid sulfate soils (ASS) or potential acid sulfate soils (PASS), but are *in-situ* acidic soils.

Regardless of the potential causes for a divergence between TPA and S_{POS} results, since two samples indicate the presence of potential acids sulfate soils (PASS) in parts of the site and eight samples trigger the ASSMAC (1998) action criteria, an acid sulfate soils management plan is required. Further testing could alter the requirement for a management plan in certain parts of the site, particularly on the hill slopes where soil horizons lie above 5 mAHD.

5.3 Conclusion

The preliminary site assessment indicates that there are *in-situ* acidic soils and potential acid sulfate soils (PASS) on-site. Soils also exhibit levels of acidity (TPA) that warrant preparation of a site-specific acid sulfate soils management plan.

A management plan is required to address the risk of acid sulfate soils exposure during site development works. Provided the management plan is implemented, acidic soil conditions should not restrict the proposed development. However, if excavations of more than 3.0 m depth are proposed, then we would recommend further testing of deeper soil horizons.

6 Preliminary Acid Sulfate Soils Management Plan

6.1 Objectives and Scope of Application

Management of site soil disturbance during construction activities shall ensure that environmental degradation due to excavation of acid sulfate soils does not occur.

Final depth of cut/fill earthworks, foundations, biofiltration and OSD basins and service trenches are not confirmed, however the current assessment and management plan has addressed soil layers as deep as 4.0 m below existing ground level, which is sufficient for excavation to 3.0 m depth.

If excavation works intercept natural ground during development of the site, soils should be viewed as PASS. This material shall be treated with lime on site via the following treatment plan:

6.2 Treatment Plan

6.2.1 Soil Management

Treatment of all disturbed soil with fine agricultural lime at the rates noted in Section 6.2.1.2 is proposed. Any excavated soil is to be treated with lime immediately (i.e. within 2 hours) and then stockpiled for backfilling or used on-site as fill. Additional, specific treatment procedures are as follows:

- Excavations should be backfilled as soon as possible to reduce the risk of soil oxidation and acid generation.
- Where lime cannot be applied to excavated material immediately after excavation, the material is to be stockpiled on an impermeable liner, surrounded by an earth bund and covered to prevent leachate generation.
- The impermeable liner is to extend over the bund to ensure that any leachate generated by exposure to rainfall is contained.
- Should leachate be collected, it is also to be neutralised with lime, tested to ensure suitability for site disposal, and then discharged to the land surface.
- Any excavated material, treated or untreated with lime, is not to be disposed of into Moonee Creek.

- Where excavated soils require off-site disposal, all excavated material should be treated and disposed of in accordance with NSW DECC (2009) *Waste Classification Guidelines Part 4: Acid Sulfate Soils*.

- Appropriate sediment and erosion control measures should be installed prior to excavation works commencing, and remain for the duration of works. Control measures shall be installed and maintained in accordance with the *Soils and Construction Handbook* (Landcom, 2004).

Once spoil has been adequately limed it is suitable for backfilling or re-use as fill material on-site. However, potential uses of treated spoil shall be a function of the characteristic of the soil and the intended use of the area to be filled. In particular, geotechnical considerations will affect how and where the treated material can be used.

It is noted that the specification and design of all in-ground structures founded within AASS and PASS must take into consideration the acidic characteristics of the site's soils to ensure appropriate design life-spans for in-ground infrastructure are achieved.

6.2.1.1 *Saturated Soil*

Very moist or saturated soils (particularly fine-grained soils) are generally not able to be adequately treated because it is difficult to effectively mix lime into saturated soils. Therefore the soil needs to be dried out by stockpiling the soil, uncovered during fine weather conditions, on an impermeable liner with a surrounding bund. Once suitably dry, material is to be treated as per general dry material (Section 6.2.1).

If material cannot be dried out, it is to be taken off-site for treatment and/or disposal in accordance with the recommendations of Section 6.2.1.

The management of leachate from wet soil stockpiles is particularly important. Leachate should be managed as described in Section 6.2.1.

6.2.1.2 *Preliminary Dewatering Management Plan*

Due to shallow groundwater levels at the site, temporary dewatering activities are likely to be required as part of trenching and other associated works for the proposed development. Such works would require a specific water assessment program and approval by the NSW Office of Water under the Water Act (1912) or Water Management Act (2000) as applicable and be implemented under the direct supervision of a suitably qualified environmental engineer/scientist of Martens & Associates Pty Ltd.

The liming rate for treating acid water needs to be carefully calculated to achieve optimum pH levels between 6.5 and 8.5. We recommend the following treatment measures:

i. Water from excavations to be pumped into suitably sized tank for dosing with lime.

ii. Monitoring of pH should be carried out regularly during neutralisation procedures.

iii. pH to be measured with an appropriately calibrated pH meter.

iv. Desired pH is to be between 6.5 and 8.5 with a pH of 7 being normally targeted.

v. Hydrated lime should be used to treat water; however it needs to be added incrementally with thorough mixing to prevent exceeding the desired pH. Lime treatment will not be required if monitoring demonstrates a suitable pH.

vi. Quantities of lime to be added will be in accordance with Table 7.1 of ASSMAC (1998) and established once pH testing of groundwater has been undertaken. Actual rates of liming are to be established based on pH and may vary with duration of pumping.

The water assessment program will need to include, but not be limited to:

i. Detailed investigation of surface water and groundwater on the site.

ii. Impacts of the proposed development on surface water and groundwater.

iii. A proposed water quality sampling and monitoring program.

A detailed water assessment program should be developed once the final site layout has been finalised and works have been approved by relevant authorities.

6.3 Required Liming Rates

Lime is to be applied to the soil at the following rates as determined from the laboratory report. This includes a 1.5 safety factor:

- 11 kg per tonne of soil situated on the low-lying alluvial plains below 5 mAHD

- 13 kg per tonne of soil situated above 5 mAHD on the lower hill slopes

As a guide, soil bulk density should be assumed to be approximately 1.6 tonnes/m^3.

Further testing could reduce the applicable liming rate or alter the requirement for a management plan altogether in certain parts of the site, particularly on the hill slopes where soil horizons lie above 5 mAHD.

6.4 Record Keeping

- Complete records of all treatment and any further testing shall be maintained by the construction contractor.
- Records should be made available to regulators if requested.
- If off-site disposal is undertaken, a waste classification assessment is required and details of the waste contractor used and records of the quantity of material taken off-site should be kept.

6.5 On-going Management

Once site works have been completed as part of the proposed development, no further management requirements will be necessary as site groundwater levels will return to pre-development levels following dewatering. Increased environmental risk associated with acid sulfate soils is unlikely to results following completion of proposed site works.

6.6 Investigation Limitations

The preliminary management plan should be reviewed by Martens & Associates when the final development proposal plan becomes available.

7 Limitations Statement

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that any of the construction phase 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 foundations where recommendations are not implemented in full and properly tested, inspected and documented.

A site investigation study cannot be considered a complete and exhaustive characterisation of a site. Occasionally sub-surface soil conditions in areas of the site not specifically tested may be found to be different from those expected. This can also occur with groundwater conditions, especially after changes in the weather. Should, during site works, soil or water conditions be found to be significantly different to those detailed in this report, works shall cease immediately and the new conditions should be addressed by Martens & Associates to determine geotechnical implications before recommencement.

8 References

Australian Geomechanics Society, Landslide Zoning Working Group (March 2007), *Guidelines for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning*, Australian Geomechanics Vol 42 No 1.

Australia Standard 1289.6.3.2 (1997), *Determination of the Penetration Resistance of a Soil using the 9kg Dynamic Cone Penetrometer.*

Australian Standard 1726 (1993) *Geotechnical Site Investigations.*

Australian Standard 2870 (2011) *Residential Slabs and Footings.*

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

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

Austroads (1998) *APRG-21 A guide to the design of new pavements for light traffic*.

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Hazelton P.A and Murphy B.W (1992) *What Do All The Numbers Mean?*

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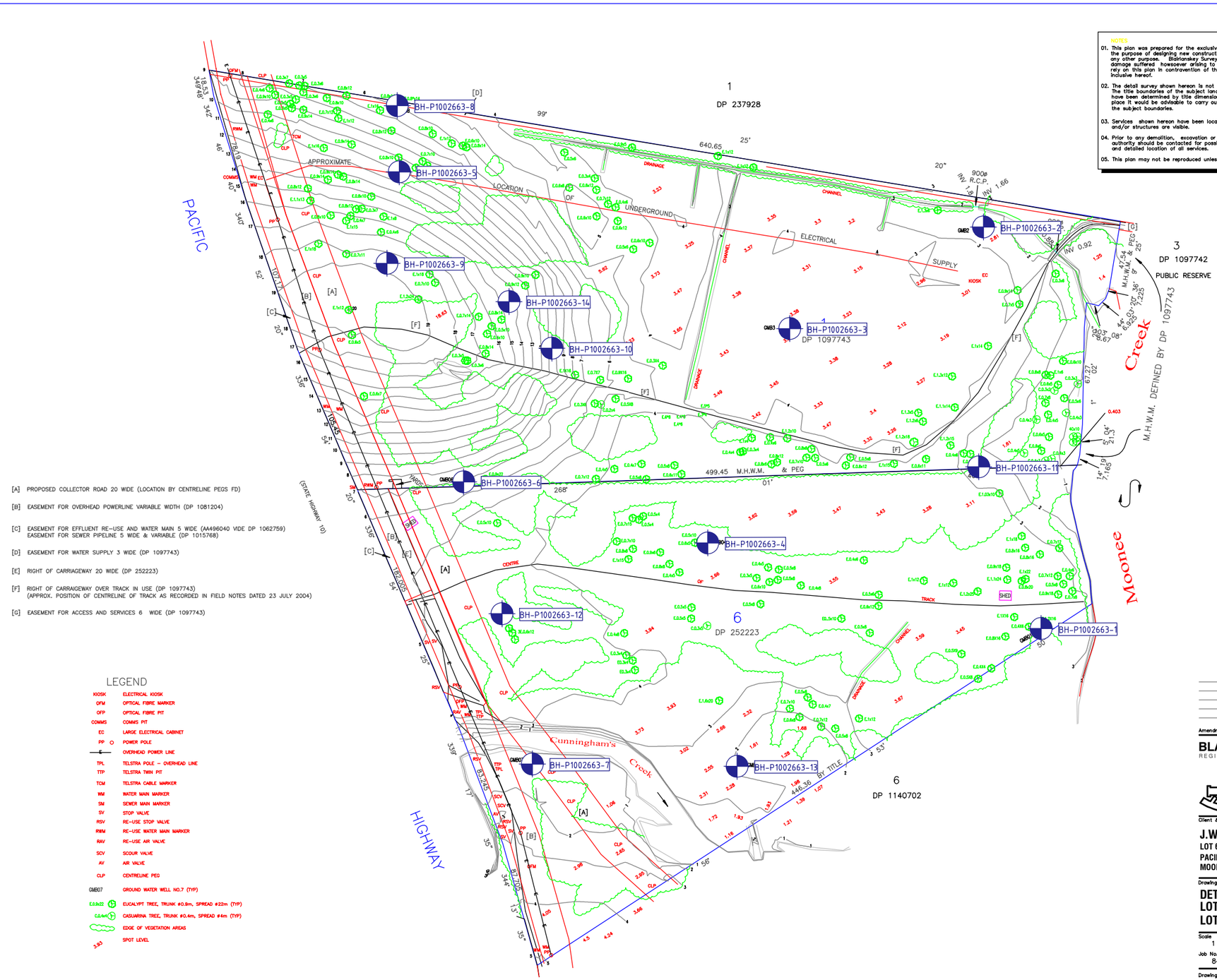
NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC), August 1998, Acid Sulfate Soil Manual.

Soil Conservation Service of NSW, Sydney (1999) *Soil Landscapes of the Coffs Harbour 1:100 000 sheet*

9 Attachment A – Site Plan



[A] PROPOSED COLLECTOR ROAD 20 WIDE (LOCATION BY CENTRELINE PEGS FD)

[B] EASEMENT FOR OVERHEAD POWERLINE VARIABLE WIDTH (DP 1081204)

[C] EASEMENT FOR EFFLUENT RE-USE AND WATER MAIN 5 WIDE (AA496040 VIDE DP 1062759)
EASEMENT FOR SEWER PIPELINE 5 WIDE & VARIABLE (DP 1015768)

[D] EASEMENT FOR WATER SUPPLY 3 WIDE (DP 1097743)

[E] RIGHT OF CARRIAGEWAY 20 WIDE (DP 252223)

[F] RIGHT OF CARRIAGEWAY OVER TRACK IN USE (DP 1097743)
(APPROX. POSITION OF CENTRELINE OF TRACK AS RECORDED IN FIELD NOTES DATED 23 JULY 2004)

[G] EASEMENT FOR ACCESS AND SERVICES 6 WIDE (DP 1097743)

LEGEND

KIOSK	ELECTRICAL KIOSK
OFM	OPTICAL FIBRE MARKER
OFP	OPTICAL FIBRE PIT
COMMS	COMMS PIT
EC	LARGE ELECTRICAL CABINET
PP O	POWER POLE
E	OVERHEAD POWER LINE
TPL	TELSTRA POLE – OVERHEAD LINE
TTP	TELSTRA TWIN PIT
TCM	TELSTRA CABLE MARKER
WM	WATER MAIN MARKER
SM	SEWER MAIN MARKER
SV	STOP VALVE
RSV	RE-USE STOP VALVE
RWM	RE-USE WATER MAIN MARKER
RAV	RE-USE AIR VALVE
SCV	SCOUR VALVE
AV	AIR VALVE
CLP	CENTRELINE PEG
GMB07	GROUND WATER WELL NO.7 (TYP)
E.0.9n22	EUCALYPT TREE, TRUNK ø0.9m, SPREAD ø22m (TYP)
C.0.4n4	CASUARINA TREE, TRUNK ø0.4m, SPREAD ø4m (TYP)
	EDGE OF VEGETATION AREAS
3.53	SPOT LEVEL

NOTES

01. This plan was prepared for the exclusive use of J.W.PLANNING PTY LTD for the purpose of designing new constructions on the land and should not be used for any other purpose. Blairlanskey Surveys accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this plan in contravention of the terms of this clause or clauses 02 to 05 inclusive hereof.

02. The detail survey shown hereon is not a survey defined by the Surveying Act 2002. The title boundaries of the subject land were not marked at the time of survey and have been determined by title dimensions only. Prior to any development taking place it would be advisable to carry out further survey work to define and mark the subject boundaries.

03. Services shown hereon have been located by field survey where surface markers and/or structures are visible.

04. Prior to any demolition, excavation or construction on the site, the relevant authority should be contacted for possible location of further underground services and detailed location of all services.

05. This plan may not be reproduced unless this note is included.

N
W E
S

0 30 60 90 120 150
UNITS - METRES

Amendments

BLAIRLANSKEY SURVEYS
REGISTERED SURVEYORS
ABN. 66 711 849 214

P. O. Box 2453 COFFS HARBOUR N.S.W. 2450
190 PACIFIC HIGHWAY COFFS HARBOUR
Tel: (02) 6652 5090
Fax: (02) 6651 1495
Email: bls@blsurvey.com

Client & Project

J.W. PLANNING PTY LTD
LOT 6 DP 252223 & LOT 1 DP 1097743
PACIFIC HIGHWAY
MOONEE BEACH

Drawing Title

DETAIL SURVEY OVER LOT 6 DP 252223 AND LOT 1 DP 1097743

Scale	Date	Approved
1 : 1250	AUGUST 2010	
Job No. 8401	Datum A.H.D.	Field Book No.
Drawing No. 01	Revision No.	

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

MARTENS & ASSOCIATES PTY LTD
Sustainable Solutions
Environmental - Geotechnical - Civil
Hydraulic - Wastewater Engineers

CLIENT/ PROJECT
MOONEE PARKLANDS TRUST
C/- JW PLANNING PTY LTD

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

TITLE
SITE PLAN SHOWING GEOTECHNICAL AND ACID SULFATE SOILS SAMPLING LOCATIONS: LOT 6 DP 252223 AND LOT 1 DP 1097743, PACIFIC HWY, MOONEE BEACH

PROJECT MANAGER: MR GRAY TAYLOR
DRAWING NUMBER: P1002663JD04V01_SHEET 1

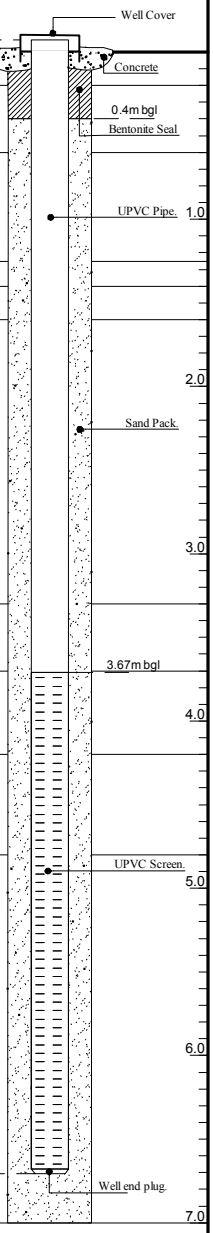
DESIGNED:	DATUM:	SHEET
MT	AHD	1
DRAWN:	HORIZONTAL RATIO:	OF 1 SHEETS
MT	1:3000 @A3 1:1500 @A1	
REVIEWED:	VERTICAL RATIO:	PAPER SIZE:
GT	1:3000 @A3 1:1500 @A1	A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1.0	GEOTECHNICAL AND ACID SULFATE SOILS REPORT	02.09.2010	MT

10 Attachment B – Borehole Excavation Logs

CLIENT	JW Planning Pty Ltd	**COMMENCED**	26.07.10	**COMPLETED**	26.07.10	**REF**	**BH1**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	3.45m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 7.0m depth	**NORTHING**	NA	**ASPECT**	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)	WATER WELL DETAILS
A	Nil	N	M	0.2			SM	SILTY SAND - Brown/grey.		L	A	0.2	2663/1/0.2
A	Nil	N	M	0.6			SP	SAND - Grey/light grey, fine grained, minor clays.		L-MD	A	0.5	2663/1/0.5 +B
A	Nil	N	M	1.0 1.25			SC	CLAYEY SAND - Brown yellow, fine grained, silty, gravels (1-30mm, approx 30%).		MD	A	1.0	2663/1/1.0 +B
A	Nil	N	M	1.4			SC	CLAYEY SAND - Yellow.		D	A	1.3	2663/1/1.3
A	Nil	N	M	1.6			CL	CLAY - Grey with brown/red (minor)mottles.	VSt		A	1.5	2663/1/1.5
A	Nil	N 2.66	M	2.0 3.0 3.3			CL	CLAY - Grey with red mottles, minor sand. - Mottles decreasing with depth.	VSt		A A A	2.0 2.5 3.0	2663/1/2.0 +B 2663/1/2.5 2663/1/3.0
A	Nil	Y	W	3.7			CL	SANDY CLAY - Red/grey with fine grained sand.	VSt		A	3.5	2663/1/3.5 +B
A	Nil	Y	W	4.0 4.2			CL	CLAY - Grey with red/brown, minor sand.			A	4.0	2663/1/4.0 +B
A	Nil	Y	W	4.8			CL	SANDY CLAY - Brown, fine grained sand.	VSt				
A	Nil	Y	W	5.0 6.0 7.0			CL	SAND, CLAYEY SAND, CLAY LAYERS - Grey, red, brown.	VSt		A A	5-5.5 5.5	2663/1/5-5.5 +B 2663/1/5.5
				8.0 9.0				Borehole terminated at 7.0m on clay.			A	7.0	2663/1/7.0



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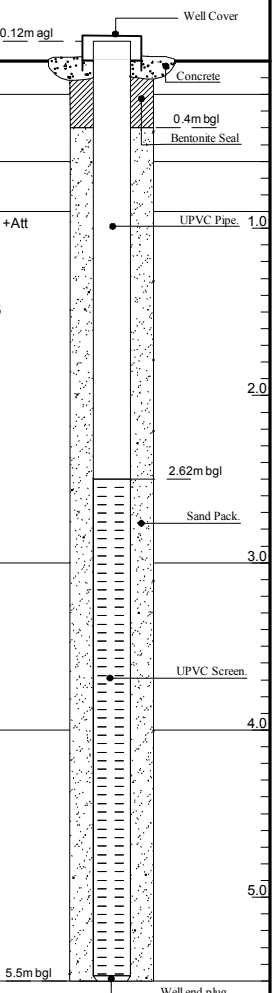
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	JW Planning Pty Ltd	**COMMENCED**	26.07.10	**COMPLETED**	26.07.10	**REF**	**BH2**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	2.81m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 5.5m depth	**NORTHING**	NA	**ASPECT**	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)	WATER WELL DETAILS
A	Nil	N	M	0.2			SM	SILTY SAND - Brown/grey.		L			
A	Nil	N 0.68	M	0.6			SP	SAND - Grey/light grey, minor sands.		L	A	0.5	2663/2/0.5
A	Nil	Y	W	0.9			SC	CLAYEY SAND - Light grey, fine sands.		L			
A	Nil	Y	M	1.0 2.0 3.0			CL	CLAY - Grey, minor sands, minor brown/red mottles.	VSt		A A A A	1.0 1.5 2.0 2.5 3.0	2663/2/1.0+Att 2663/2/1.5 2663/2/2.0 2663/2/2.5 2663/2/3.0
A	Nil	Y	M	4.0			CL	CLAY - Grey/brown/orange with mottles, minor sands.	VSt		A	4.0	2663/2/4.0
A	Nil	Y	M	5.0 5.5			CH	CLAY - Grey with brown/orange/yellow with mottles, minor gravels (<5%), moderately plastic.	VSt		A	5.0	2663/2/5.0
				6.0 7.0 8.0 9.0				Borehole terminated at 5.5m 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	JW Planning Pty Ltd	**COMMENCED**	26.07.10	**COMPLETED**	26.07.10	**REF**	**BH3**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	3.38m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 5.5m depth	**NORTHING**	NA	**ASPECT**	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)	WATER WELL DETAILS
A	Nil	N 0.26	M	0.15			SM	ORGANIC SILTY SAND - Dark grey/brown.		L			0.11m agl; Well Cover; Concrete
A	Nil	Y	W	0.45			SC	CLAYEY SAND - Grey/brown, fine grained, minor gravels.		L			0.4m bgl; Bentonite Seal
A	Nil	Y	M	0.65			CL	CLAY - Orange/brown, minor gravels, sands.	S		A	0.5	2663/3/0.5
A	Nil	Y	M	1.0			CH	CLAY - Grey with minor brown/orange red mottles, moderately plastic.	St		A	1.0	2663/3/1.0; UPVC Pipe. 1.0
				1.8							A	1.5	2663/3/1.5
A	Nil	Y	W	2.0			CL	CLAY - Grey with minor orange/brown mottles, minor gravels, not plastic.	VSt		A	2.0	2663/3/2.0; 2.0
				2.2									
A	Nil	Y	M	3.0			CH	GRAVELLY CLAY - Dark grey/brown, moderately plastic.	VSt		A	2.5	2663/3/2.5; 2.49m bgl; Sand Pack.
				4.0							A	3.5	2663/3/3.5; UPVC Screen.; 3.0; 4.0
A	Nil	Y	M	5.0			CH	CLAY - Grey with brown/orange/yellow with mottles, minor gravels (<5%), moderately plastic. Tending to brown clays with depth.	VSt		A	5.0	2663/3/5.0; 5.0
				5.5									5.49m bgl; Well end plug.
								Borehole terminated at 5.5m on clays.					
				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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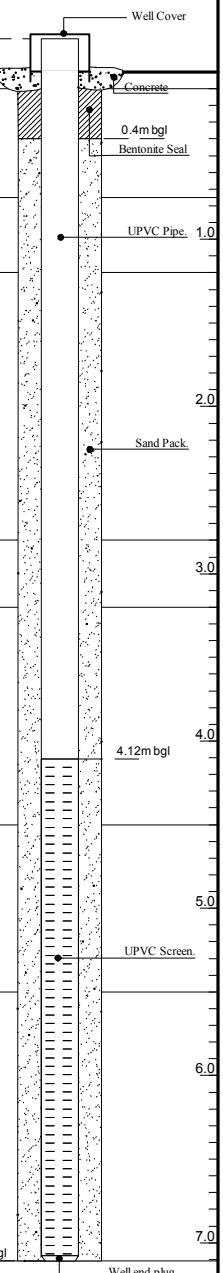
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	JW Planning Pty Ltd	COMMENCED	26.07.10	COMPLETED	26.07.10	**REF**	**BH4**
PROJECT	Geotechnical and Groundwater Assessment	LOGGED	GT	CHECKED	DM	Sheet	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	GEOLOGY	Corumba Beds, Claystone	VEGETATION	Grasses	PROJECT NO.	P1002663
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	3.64m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 7.12m depth	NORTHING	NA	ASPECT	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)	WATER WELL DETAILS
A	Nil	N	M	0.1			OL	ORGANIC SILT - Brown/grey, minor sands.	S				
A	Nil	0.52 Y	M	0.75			CL	CLAY - Grey with minor brown mottles, minor silty sand.	S-F		A	0.5	2663/4/ 0.5 +Att
A	Nil	Y	W	1.0 1.2			CL	CLAY - Grey/light grey with minor red mottles, sands.	St		A	1.0	2663/4/ 1.0 +Att
A	Nil	Y	W	2.0 2.8			CH	CLAY - Grey with red/orange mottles, moderately plastic. - Mottles decreasing with depth.	VSt		A A A	1.5 2.0 2.5	2663/4/ 1.5 +Att 2663/4/ 2.0 2663/4/ 2.5
A	Nil	Y	M	3.0 3.2			CL	CLAY - Brown with grey mottles, minor gravels, sands.	VSt		A	3.0	2663/4/ 3.0 +B
A	Nil	Y	W	4.0 4.5			CH	CLAY - Grey with red/orange/yellow mottles, gravels (5%), moderately plastic.	VSt		A	4.0	2663/4/ 4.0
A	Nil	Y	W	5.0 5.5			CH	CLAY - GRAVELLY CLAY - Grey with brown/yellow mottles.	VSt		A	5.0	2663/4/ 5.0
A	Nil	Y	W	6.0 7.0 7.12			CH	CLAY - Grey minor brown mottles.	VSt		A	6.0	2663/4/ 6.0
				8.0 9.0				Borehole terminated at 7.12m 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	JW Planning Pty Ltd	**COMMENCED**	27.07.10	**COMPLETED**	27.07.10	**REF**	**BH5**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	11.5m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 5.5m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	5-7%

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			CL	SILTY CLAY - Brown/light brown, gravels (1-20mm, approx 20%).	F				
A	Nil	N	M	0.8			CL	CLAY - Red/orange with brown mottles.	F		A	0.5	2663/5/0.5 + Att
A	Nil	N	M	1.0 1.2			CL	CLAY - Grey with red/orange mottles, gravels (1-15mm, approx 10%).	F		A	1.0	2663/5/1.0 + Att 1.0
A	Nil	N	M	1.9			CH	CLAY - Cream/light grey, minor sands.	St		A	1.5	2663/5/1.5
A	Nil	N	D	2.0 3.0			CL	CLAY - Yellow/grey, sands possibly extremely weathered claystone.	St-VSt		A	2.0	2663/5/2.0 2.0
A	Nil	N	D	4.0 5.0 5.5			CL	EXTREMELY TO MODERATELY WEATHERED CLAYSTONE.	VSt		A	5.0	2663/5/5.0 4.0 5.0
				6.0 7.0 8.0 9.0				Borehole terminated at 5.5m on clays.					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

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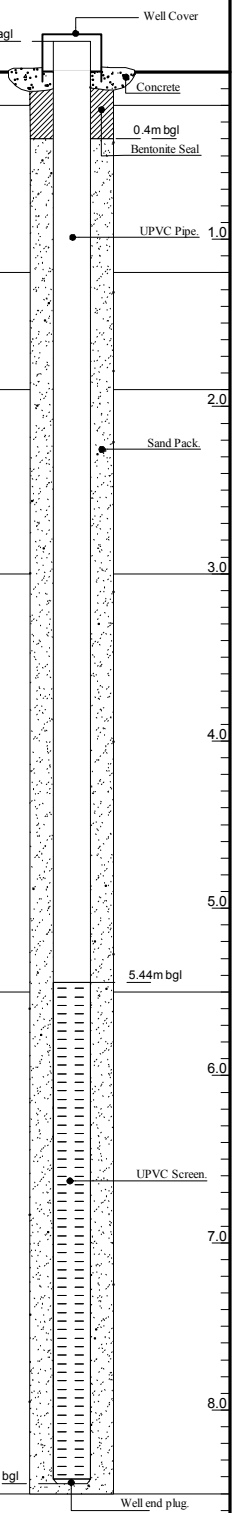
Engineering Log - Borehole

CLIENT	JW Planning Pty Ltd	COMMENCED	27.07.10	COMPLETED	27.07.10	**REF**	**BH6**
PROJECT	Geotechnical and Groundwater Assessment	LOGGED	GT	CHECKED	DM	Sheet	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	GEOLOGY	Corumba Beds, Claystone	VEGETATION	Grasses	PROJECT NO.	P1002663
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	7.0m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 8.5m depth	NORTHING	NA	ASPECT	South	SLOPE	4-6%

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)	WATER WELL DETAILS
A	Nil	N	M	0.2			CL	SILTY CLAY - Brown/light brown, gravels (1-20mm, approx 20%).	F		A	0.2	2663/6/ 0.2
A	Nil	N	M	1.0 1.2			CL	CLAY - Red/orange with brown mottles.	F		A A	0.5 1.0	2663/6/ 0.5 2663/6/ 1.0
A	Nil	N	M	1.9			CL	CLAY - Grey with red/orange mottles, gravels (1-15mm, approx 10%).	F		A	1.5	2663/6/ 1.5
A	Nil	N 2.7 Y	M	2.0 3.0			CL	CLAY - Cream/light grey, with red/orange mottles, minor gravels.	VSt		A	2.0	2663/6/ 2.0
A	Nil	Y	W	4.0 5.0 5.5			CL	CLAY - Cream with yellow/orange mottles. - Bands of orange/grey clays, tending to light grey clays with minor gravels (1-5mm, <5%) at depth.	VSt		A A A	3.5 4.0 5.0	2663/6/ 3.5 2663/6/ 4.0 2663/6/ 5.0
A	Nil	Y	W	6.0 7.0 8.0 8.5			CL	CLAY - Orange/brown, gravels (1-10mm, approx 15%).	VSt		A	6.0	2663/6/ 6.0
				9.0				Borehole terminated at 8.5m on clay.					



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	JW Planning Pty Ltd	**COMMENCED**	26.07.10	**COMPLETED**	26.07.10	**REF**	**BH7**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	1.1m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 4.2m 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)	WATER WELL DETAILS
A	Nil	N	W	0.2			CL	SILTY CLAY - Dark brown, gravels.	S				0.05m agl Well Cover; Concrete
A	Nil	0.55 Y	M W	0.6 0.75			CL	CLAYEY SAND - Grey/brown/orange, medium grained sand, minor gravels.		L	A	0.5	2663/7/0.5; 0.4m bgl Bentonite Seal
A	Nil	Y	W	1.0 1.2			CL	GRAVELLY CLAYEY SAND - Dark brown/grey, coarse grained sands.		L	A	1.0	2663/7/1.0; UPVC Pipe. 1.0; 1.15m bgl
A	Nil	Y	W	2.0			CL	SANDY CLAY - Grey/dark brown, gravels (1-5mm, approx 15%).	St		A	1.5	2663/7/1.5; 2.0
A	Nil	Y	W	3.0 3.2			CL	CLAY - Grey/green with orange/brown mottles, gravels (5mm, approx 5%) increasing with depth.	St-VSt		B A	2.0 2.5	2663/7/2.0 2663/7/2.5; Sand Pack. 3.0
A	Nil	Y	W	4.0 4.2			CL	CLAY - Cream/light grey, gravels (1-5mm, 5%).	VSt		A	3.5	2663/7/3.5; UPVC Screen. 4.0; 4.15m bgl Well end plug.
				5.0 6.0 7.0 8.0 9.0				Borehole terminated at 4.2m on clays.					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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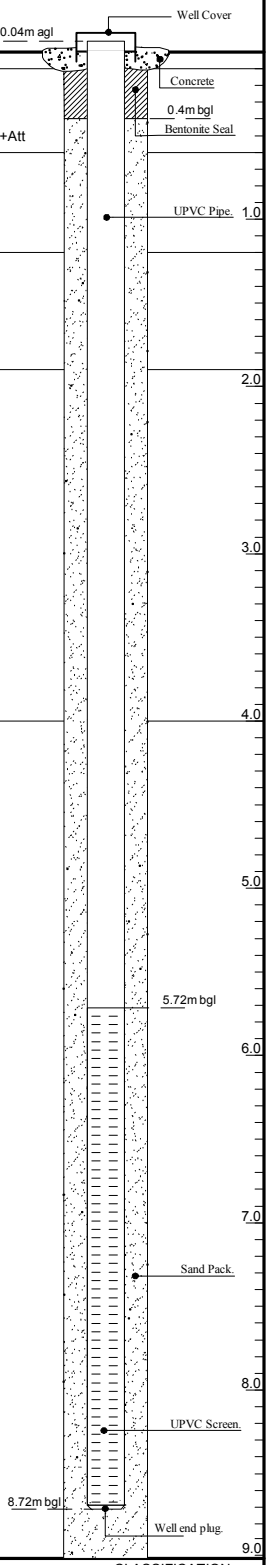
Engineering Log - Borehole

Quality Sheet No. 4

CLIENT	JW Planning Pty Ltd	**COMMENCED**	27.07.10	**COMPLETED**	27.07.10	**REF**	**BH8**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	1 of 2
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	6.0m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 9.2m depth	**NORTHING**	NA	**ASPECT**	North East	**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	0.05			CL	SILTY CLAY - Brown/light brown.	F				
A	Nil	N	M	0.6			CL	CLAY - Red/brown, minor orange mottles, silty.	F		A	0.5	2663/7/0.5 +Att
A	Nil	N	M	1.0 1.2			CH	CLAY - Red/brown, gravels (1-40mm, approx 15%), moderately plastic.	F-St		A	1.0	2663/7/1.0
A	Nil	1.51 ▽ Y	M	1.9			CL	CLAY - Grey with yellow/orange mottles, minor gravels.	St		A	1.5	2663/7/1.5
A	Nil	Y	D	2.0 3.0 4.0			CL	CLAY - Grey/cream with yellow/red mottles, gravels (1-20mm, 20%).	VSt		A	2.5	2663/7/2.5
A	Nil	Y	M	5.0 6.0 7.0 8.0 9.0			CL	CLAY - Brown, grey, cream, orange, sandstone gravels, extremely weathered claystone with moderately weathered claystone bands.	VSt				



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 - Borehole

CLIENT	JW Planning Pty Ltd	**COMMENCED**	27.07.10	**COMPLETED**	27.07.10	**REF**	**BH8**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	2 of 2
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	6.0m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 9.2m depth	**NORTHING**	NA	**ASPECT**	North East	**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	Y	M	9.2		— —	CL	CLAY - Brown, grey, cream, orange, sandstone gravels, extremely weathered claystone with moderately weathered claystone bands. Borehole terminated at 9.2m on moderately to slightly weathered claystone.	VSt				

10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0

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 - Borehole

CLIENT	JW Planning Pty Ltd	**COMMENCED**	27.07.10	**COMPLETED**	27.07.10	**REF**	**BH9**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	18.5m AHD		
EXCAVATION DIMENSIONS	Ø0.1m 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	0.15			CL	SILTY CLAY - Brown/light brown, gravels (1-20mm, approx 20%).	F				
A	Nil	N	M	0.8			CH	CLAY - Red/orange with brown mottles.	F-St		A	0.5	2663/9/0.5 CBR @ 0.2-0.5
A	Nil	N	M	1.0 1.1			CH	CLAY - Grey with red/orange mottles, gravels (1-15mm, approx 10%).	St-VSt		A	1.0	2663/9/1.0 1.0
A	Nil	N	M	1.8			CH	CLAY - Cream/light grey, minor sands.	VSt				
A	Nil	N	D	2.0 2.5			CH	CLAY - Cream/light grey, minor sands.	VSt		A	2.0	2663/9/2.0 2.0
				3.0				Borehole terminated at 2.5m on clays/extremely weathered rock.					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 - Borehole

CLIENT	**JW Planning Pty Ltd**	**COMMENCED**	27.07.10	**COMPLETED**	27.07.10	**REF**	**BH10**
PROJECT	**Geotechnical and Groundwater Assessment**	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	**1 of 1**
SITE	**Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach**	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	11.0m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 2.0m 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	0.15			CL	SILTY ORGANIC CLAY - Dark brown.	F					
A	Nil	N	M	0.65			CL	CLAY - Orange/brown/yellow, moderately plastic.	F		A	0.5	2663/10/ 0.5	
A	Nil	N	M D	0.8 1.0 1.2			CL	CLAY - Grey with yellow/orange/brown mottles, gravels (1-10mm, approx 15%). - Gravels increasing with depth. (Gravelly clay).	St-VSt		A	1.0	2663/10/ 1.0	1.0
A	Nil	N	D	2.0			CL	GRAVELLY CLAY - Grey/yellow.	VSt		A	1.5	2663/10/ 1.5	2.0
								Borehole terminated at 2.0m on gravelly clays (very stiff).						

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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Engineering Log - Borehole

CLIENT	JW Planning Pty Ltd	**COMMENCED**	27.07.10	**COMPLETED**	27.07.10	**REF**	**BH11**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	2.9m AHD		
EXCAVATION DIMENSIONS	Ø0.1m 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	0.25			SM	ORGANIC SILTY SAND - Dark grey/brown.		L	A	0.15	2663/11/ 0.15
A	Nil	N	M	0.5			SC	CLAYEY SAND - Grey/brown, fine grained, minor gravels.		L	A	0.5	2663/11/ 0.5 CBR
A	Nil	N	M	0.9			SC	CLAYEY SAND - Brown/orange, fine grained sands. Clay content increasing with depth.		L	A	0.7	2663/11/ 0.7 CBR @ 0.6-0.9
A	Nil	N	M	1.0 1.3			CH	SANDY CLAY - Orange/brown with red/grey mottles (60% sands).	F-St		A	1.0	2663/11/ 1.0 1.0
A	Nil	N	D	2.0 2.5			CH	CLAY - Red/grey, moderately plastic with orange mottles at depth.	VSt		A A	1.5 2.5	2663/11/ 1.5 2.0 2663/11/ 2.5
				3.0 4.0 5.0 6.0 7.0 8.0 9.0				Borehole terminated at 2.5m 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

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 - Borehole

CLIENT	**JW Planning Pty Ltd**	**COMMENCED**	27.07.10	**COMPLETED**	27.07.10	**REF**	**BH12**
PROJECT	**Geotechnical and Groundwater Assessment**	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	**1 of 1**
SITE	**Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach**	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	4.5m AHD		
EXCAVATION DIMENSIONS	Ø0.1m 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			OL	ORGANIC SILT - Brown/grey, minor sands.	S				
A	Nil	N	M	0.75			CL	CLAY - Grey with minor brown mottles, minor silty sand.	S-F				CBR @ 0.25-0.6
A	Nil	N	M	0.9			CL	CLAY - Grey/brown with orange mottles, sands.	F				
A	Nil	N	D	1.0 2.0 2.5			CH	CLAY - Grey with red/orange mottles, moderately plastic. - Mottles decreasing with depth.	VSt				1.0 2.0
				3.0 4.0 5.0 6.0 7.0 8.0 9.0				Borehole terminated at 2.5m 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
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CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
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N Agricultural

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

martens

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Hornsby, NSW 2077 Australia
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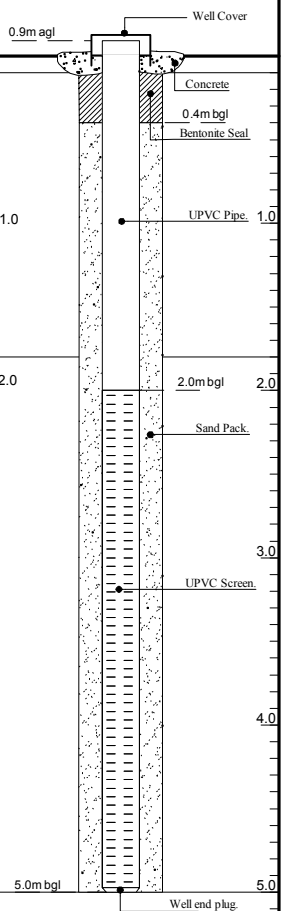
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	JW Planning Pty Ltd	**COMMENCED**	27.07.10	**COMPLETED**	27.07.10	**REF**	**BH13**
PROJECT	Geotechnical and Groundwater Assessment	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	1 of 1
SITE	Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	1.61m AHD		
EXCAVATION DIMENSIONS	Ø0.1m X 2.0m 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	0.1			CL	SILTY CLAY - Brown/grey, minor gravels.	S				
A	Nil	N	D	1.0			CL	CLAY - Grey/light grey, minor brown/orange mottles, minor fine grained sands.	S-F		A	1.0	2663/13/ 1.0
				1.8									
A	Nil	N	D	2.0 3.0 4.0 5.0			CL	CLAY - Grey/light grey, minor gravels increasing with depth, brown/orange mottles, green/grey clays as well.	St-VSt		A	2.0	2663/13/ 2.0
				6.0 7.0 8.0 9.0				Borehole terminated at 5.0m on very stiff 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
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U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
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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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Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	**JW Planning Pty Ltd**	**COMMENCED**	28.07.10	**COMPLETED**	28.07.10	**REF**	**BH14**
PROJECT	**Geotechnical and Groundwater Assessment**	**LOGGED**	GT	**CHECKED**	DM	**Sheet**	**1 of 1**
SITE	**Lot 6 DP 252223 & Lot 1 DP 1097743, Pacific Hwy, Moonee Beach**	**GEOLOGY**	Corumba Beds, Claystone	**VEGETATION**	Grasses	**PROJECT NO.**	P1002663
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	14.5m AHD		
EXCAVATION DIMENSIONS	Ø0.3m X 0.6m 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)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.1			CL	SILTY CLAY - Brown.	S				
A	Nil	N	M	0.6			CL	CLAY - Red/orange with brown mottles.	S-F		A	0.3	2663/14/ 0.3 CBR @ 0.2-0.5
								Borehole terminated at 0.6m on clay.					
				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
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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

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Engineering Log - Borehole

11 Attachment C – DCP Log Sheet

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, mail@martens.com.au, www.martens.com.au

Site	Moonee Beach Subdivision	**DCP Group Reference**	**1/1**
Client	JW Planning Pty Ltd	**Log Date**	26 and 27 July 2010
Logged by	MT		
Checked by	GT/DM		
Comments			

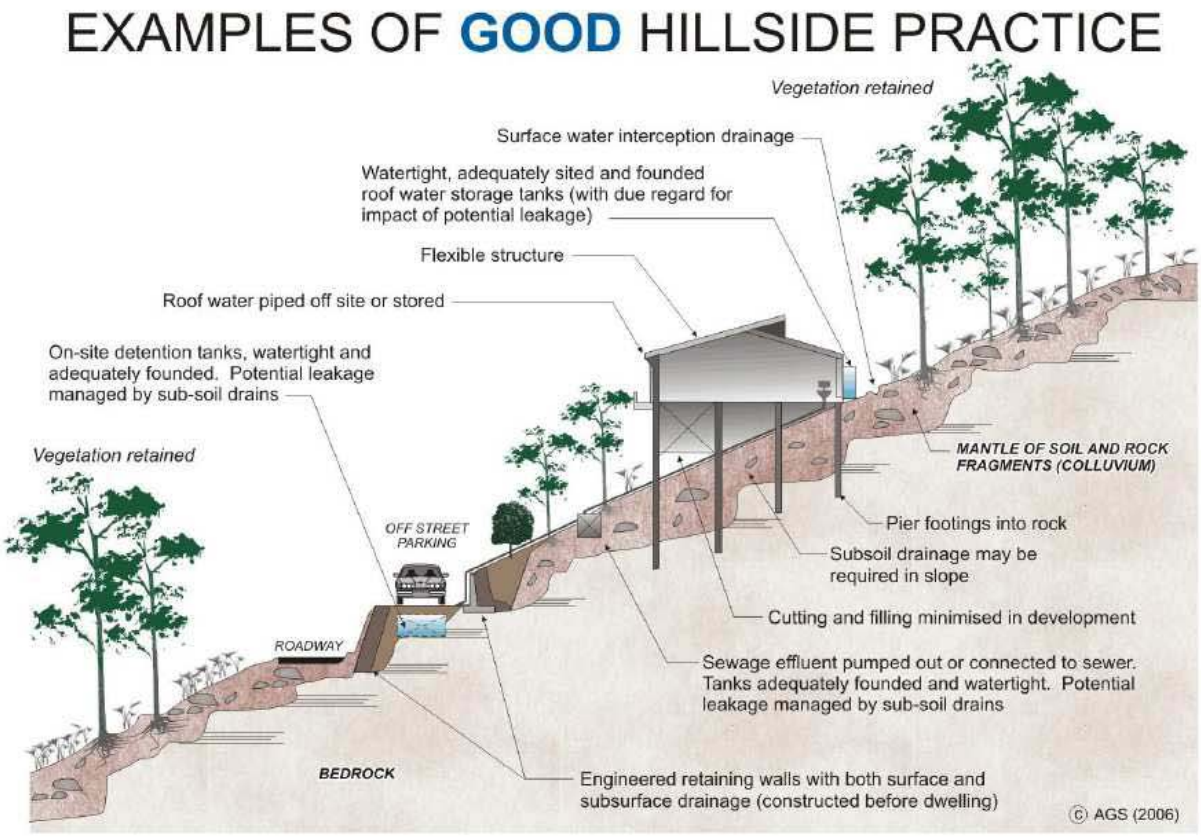
TEST DATA

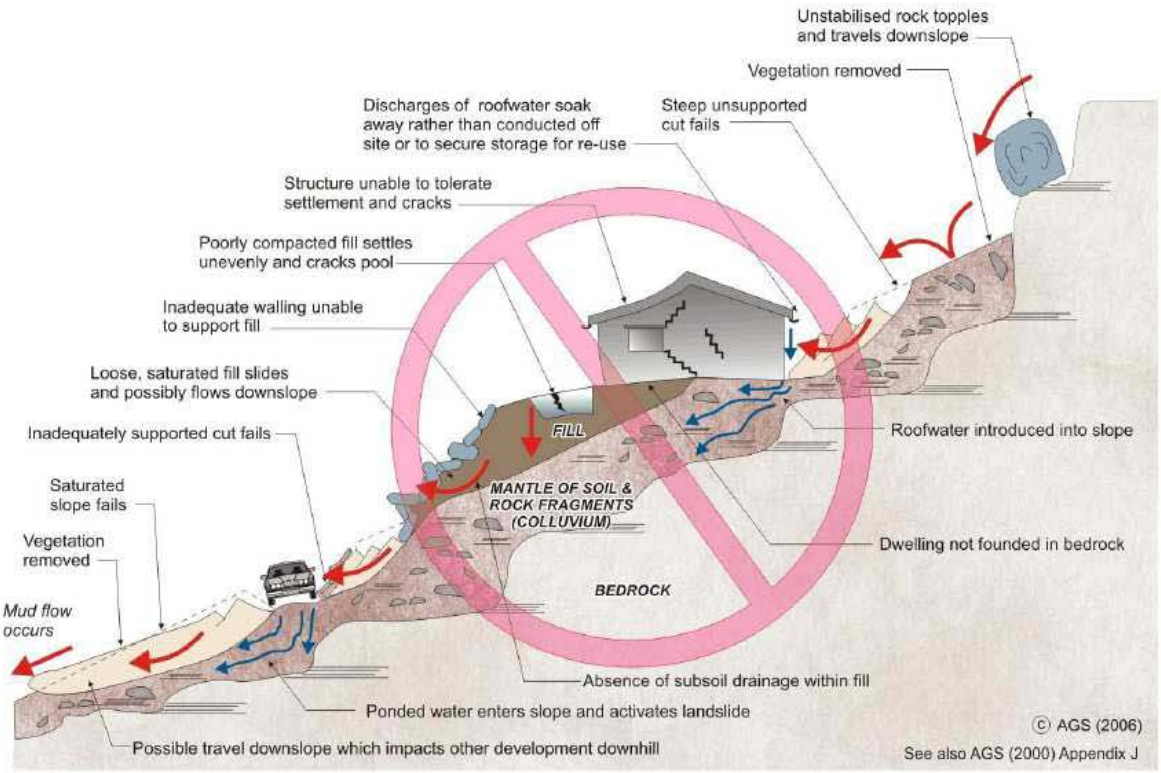
Depth Interval (m)	DCP 1	DCP 2	DCP 3	DCP 4	DCP 5	DCP 6	DCP 7	DCP 8	DCP 9	DCP 10	DCP 11	DCP 12	DCP 14	Geomean
0.15	6	2	1	6	6	5	3	5	4	7	4	2	3	1
0.30	8	3	2	7	10	18	3	5	4	4	3	8	4	2
0.45	19	2	3	2	7	8	6	6	4	6	3	4	7	2
0.60	32	2	5	4	9	5	5	6	7	4	3	3	9	2
0.75	7	4	9	8	9	6	6	4	11	18	3	4	13	3
0.90	10	9	17	12	8	5	6	6	18	36	5	7	20	5
1.05	6	15	26	22	10	7	6	9	27		10	10		6
1.20	10	23	34	30	10	8	5	12	30		16	17		5
1.35	19	25	35	40	11	10	6	8			23	24		6
1.50	27	27	40	51	10	15	6	8			33	32		6
1.65	36	33	40		17	24	6	11			42	41		6
1.80	46	45			35	30	6	16						6
1.95						35	6	42						6
2.10						41	8							8
2.25							15							15
2.40							20							20
2.55							30							30
2.70							40							40

12 Attachment D – Guidelines for Hillside Construction (AGS, 2007)

APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	


EXAMPLES OF GOOD HILLSIDE PRACTICE
Vegetation retained
Surface water interception drainage
Watertight, adequately sited and founded roof water storage tanks (with due regard for impact of potential leakage)
Flexible structure
Roof water piped off site or stored
On-site detention tanks, watertight and adequately founded. Potential leakage managed by sub-soil drains
Vegetation retained
MANTLE OF SOIL AND ROCK FRAGMENTS (COLLUVIUM)
OFF STREET PARKING
Pier footings into rock
Subsoil drainage may be required in slope
Cutting and filling minimised in development
ROADWAY
Sewage effluent pumped out or connected to sewer. Tanks adequately founded and watertight. Potential leakage managed by sub-soil drains
BEDROCK
Engineered retaining walls with both surface and subsurface drainage (constructed before dwelling)
© AGS (2006)


EXAMPLES OF POOR HILLSIDE PRACTICE
Unstabilised rock topples and travels downslope
Vegetation removed
Discharges of roofwater soak away rather than conducted off site or to secure storage for re-use
Steep unsupported cut fails
Structure unable to tolerate settlement and cracks
Poorly compacted fill settles unevenly and cracks pool
Inadequate walling unable to support fill
Loose, saturated fill slides and possibly flows downslope
Inadequately supported cut fails
FILL
Roofwater introduced into slope
Saturated slope fails
MANTLE OF SOIL & ROCK FRAGMENTS (COLLUVIUM)
Vegetation removed
Dwelling not founded in bedrock
BEDROCK
Mud flow occurs
Absence of subsoil drainage within fill
Ponded water enters slope and activates landslide
© AGS (2006)
Possible travel downslope which impacts other development downhill
See also AGS (2000) Appendix J

13 Attachment E – Atterberg Limits and Site Classification Analysis

Atterberg Limits Test Summary

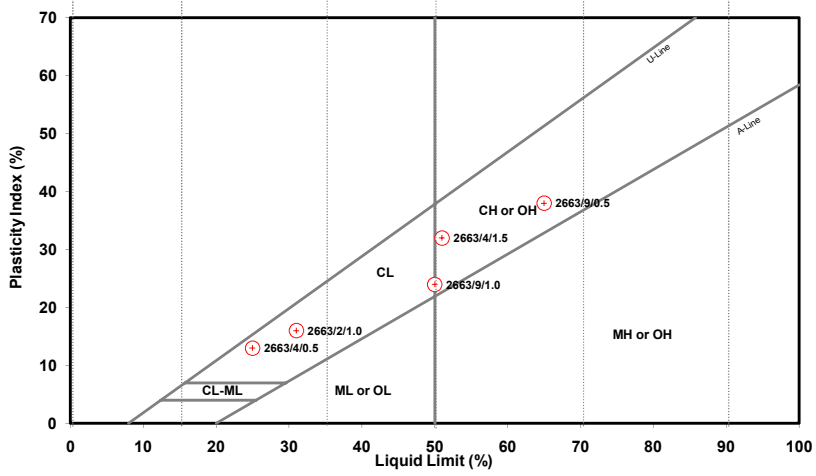
6/37 Leighton Place, Hornsby, NSW 2077, Ph: (02) 9476 9999 Fax: (02) 9476 8767, mail@martens.com.au, www.martens.com.au

PROJECT DETAILS

Project	Geotechnical Assessment: Proposed Subdivision, Moonee Beach NSW			Ref. No.	P1002663JS11V01
Officer	Mark Terei	Reviewed	Gray Taylor / Daniel Martens	Date Created	24.08.2010

TEST NUMBER	USCS Class	Liquid Limit (%)	Plasticity Index (%)	Sample ID	Plastic Limit (%)
1	CL	31.0	16.0	2663/2/1.0	15.0
2	CL	25.0	13.0	2663/4/0.5	12.0
3	CH	51.0	32.0	2663/4/1.5	19.0
4	CH	65.0	38.0	2663/9/0.5	27.0
5	CH	50.0	24.0	2663/9/1.0	26.0
6					
7					
8					
9					
10					

Plasticity	Non-plastic	Low	Intermediate	High	V. High	Extreme
Symbol	NP	L	I	H	V	E



14 Attachment F – Geotechnical Laboratory Test Report

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

CLIENTS | PEOPLE | PERFORMANCE

GHD GEOTECHNICS

Material Test Report

Report No: SYD105110
Issue No: 1

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

Project: 2116124 P1002663

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: 11/08/2010

Sample Details

Sample ID	SYD10-7128
Client Sample ID	
Date Sampled	02/08/2010
Specification	
Location	
Sampled By	Supplied by Client
Boring No.	2
Depth	1.0m
Soil Description	Grey sandy CLAY

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	N/A	
Mould Length (mm)		0	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	31	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	15	
Plasticity Index (%)	AS 1289.3.3.1	16	

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: SYD105111
Issue No: 1

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

Project: 2116124 P1002663

Sample Details

Sample ID	SYD10-7129
Client Sample ID	
Date Sampled	02/08/2010
Specification	
Location	
Sampled By	Supplied by Client
Boring No.	4
Depth	0.5m
Soil Description	Grey CLAY

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	N/A	
Mould Length (mm)		0	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	25	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	12	
Plasticity Index (%)	AS 1289.3.3.1	13	

Comments

N/A

CLIENTS | PEOPLE | PERFORMANCE

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: SYD105112
Issue No: 1

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

Project: 2116124 P1002663

Sample Details

Sample ID	SYD10-7130
Client Sample ID	
Date Sampled	02/08/2010
Specification	
Location	
Sampled By	Supplied by Client
Boring No.	4
Depth	1.5m
Soil Description	Mottled grey orange & brown CLAY

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	N/A	
Mould Length (mm)		0	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	51	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	32	

Comments

N/A

CLIENTS | PEOPLE | PERFORMANCE

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: SYD105107
Issue No: 1

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

Project: 2116124 P1002663

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Laboratory Accreditation No. 679

D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 11/08/2010

Sample Details

Sample ID	SYD10-7122
Client Sample ID	
Date Sampled	02/08/2010
Specification	
Location	
Sampled By	Supplied by Client
Boring No.	9
Depth	0.2 - 0.5m
Soil Description	CLAY : red/brown with sand

Test Results

Description	Method	Result	Limits
CBR At 2.5	AS 1289.6.1.1	3.5	
CBR At 5.0		3.5	
Laboratory Moisture Ratio		100	
Laboratory Density Ratio		100	
Moisture Content Top 30mm (%)		31.5	
Moisture Content of Remaining Depth (%)		30.7	
Swell (%)		0.2	
Dry Density After Soaking (t/m³)		1.494	
Oversize Material			
Oversize Material (%)		0.0	
Surcharge Mass (g)		4500.0	
Compactive Effort		Standard	
Period of Soaking (Days)		4	
Moisture Content (%)	AS 1289.2.1.1	29.0	
Standard Maximum Dry Density (t/m³)	AS 1289.5.1.1	1.50	
Standard Optimum Moisture Content (%)		28.0	
Oversize Sieve (mm)		19.0	
Oversize Material (%)		0	

Comments

N/A

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GHD GEOTECHNICS

Material Test Report

Report No: SYD105106
Issue No: 1

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

Project: 2116124 P1002663

NATA 679

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D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 11/08/2010

Sample Details

Sample ID	SYD10-7126
Client Sample ID	
Date Sampled	02/08/2010
Specification	
Location	
Sampled By	Supplied by Client
Boring No.	9
Depth	0.5m
Soil Description	Brown CLAY

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	N/A	
Mould Length (mm)		0	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	65	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	27	
Plasticity Index (%)	AS 1289.3.3.1	38	

Comments

N/A

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GHD GEOTECHNICS

Material Test Report

Report No: SYD105109
Issue No: 1

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

Project: 2116124 P1002663

NATA 679

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Laboratory Accreditation No. 679

D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 11/08/2010

Sample Details

Sample ID	SYD10-7127
Client Sample ID	
Date Sampled	02/08/2010
Specification	
Location	
Sampled By	Supplied by Client
Boring No.	9
Depth	1.0m
Soil Description	Grey & brown mottled CLAY

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	N/A	
Mould Length (mm)		0	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	50	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	26	
Plasticity Index (%)	AS 1289.3.3.1	24	

Comments

N/A

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Material Test Report

Report No: SYD105108
Issue No: 1

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

Project: 2116124 P1002663

NATA 679

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D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 11/08/2010

Sample Details

Sample ID	SYD10-7123
Client Sample ID	
Date Sampled	02/08/2010
Specification	
Location	
Sampled By	Supplied by Client
Boring No.	11
Depth	0.6 - 0.9m
Soil Description	CLAY : grey, with sand

Test Results

Description	Method	Result	Limits
CBR At 2.5	AS 1289.6.1.1	7	
CBR At 5.0		8	
Laboratory Moisture Ratio		100	
Laboratory Density Ratio		99	
Moisture Content Top 30mm (%)		15.5	
Moisture Content of Remaining Depth (%)		14.7	
Swell (%)		0.2	
Dry Density After Soaking (t/m³)		1.883	
Oversize Material			
Oversize Material (%)		0.0	
Surcharge Mass (g)		4500.0	
Compactive Effort		Standard	
Period of Soaking (Days)		4	
Moisture Content (%)	AS 1289.2.1.1	20.6	
Standard Maximum Dry Density (t/m³)	AS 1289.5.1.1	1.90	
Standard Optimum Moisture Content (%)		13.5	
Oversize Sieve (mm)		19.0	
Oversize Material (%)		0	

Comments

N/A

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Material Test Report

Report No: SYD105105
Issue No: 1

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

Project: 2116124 P1002663

Sample Details

Sample ID	SYD10-7125
Client Sample ID	
Date Sampled	02/08/2010
Specification	
Location	
Sampled By	Supplied by Client
Boring No.	12
Depth	0.25 - 0.6
Soil Description	CLAY : grey

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	22.4	
Standard Maximum Dry Density (t/m³)	AS 1289.5.1.1	1.84	
Standard Optimum Moisture Content (%)		14.0	
Oversize Sieve (mm)		19.0	
Oversize Material (%)		0	
CBR At 2.5	AS 1289.6.1.1	9	
CBR At 5.0		13	
Laboratory Moisture Ratio		100	
Laboratory Density Ratio		100	
Moisture Content Top 30mm (%)		16.3	
Moisture Content of Remaining Depth (%)		15.9	
Swell (%)		0.5	
Dry Density After Soaking (t/m³)		1.838	
Oversize Material			
Oversize Material (%)		0.0	
Surcharge Mass (g)		4500.0	
Compactive Effort		Standard	
Period of Soaking (Days)		4	

Comments

N/A

Sydney Laboratory
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GHD GEOTECHNICS

Material Test Report

Report No: SYD105104
Issue No: 1

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

Project: 2116124 P1002663

NATA 679

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D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 11/08/2010

Sample Details

Sample ID	SYD10-7124
Client Sample ID	
Date Sampled	02/08/2010
Specification	
Location	
Sampled By	Supplied by Client
Boring No.	14
Depth	0.2 - 0.5m
Soil Description	CLAY :red brown, some sand & organic matter

Test Results

Description	Method	Result	Limits
CBR At 2.5	AS 1289.6.1.1	2.5	
CBR At 5.0		2.5	
Laboratory Moisture Ratio		100	
Laboratory Density Ratio		100	
Moisture Content Top 30mm (%)		28.3	
Moisture Content of Remaining Depth (%)		27.3	
Swell (%)		0.9	
Dry Density After Soaking (t/m³)		1.517	
Oversize Material			
Oversize Material (%)		0.0	
Surcharge Mass (g)		4500.0	
Compactive Effort		Standard	
Period of Soaking (Days)		4	
Moisture Content (%)	AS 1289.2.1.1	31.6	
Standard Maximum Dry Density (t/m³)	AS 1289.5.1.1	1.53	
Standard Optimum Moisture Content (%)		26.0	
Oversize Sieve (mm)		19.0	
Oversize Material (%)		0	

Comments

N/A

15 Attachment G – Acid Sulfate Soils Laboratory Testing Report

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 44160

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

Attention: Ben Rose / Gray Taylor

Sample log in details:

Your Reference:	**P1002663JC01V01, Moonee Beach**
No. of samples:	20 Soils
Date samples received:	30/07/2010
Date completed instructions received:	30/07/2010

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:	2/08/10
Date of Preliminary Report:	not issued
Issue Date:	2/08/10

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Tests not covered by NATA are denoted with *.

Results Approved By:

Nick Sarlamis
Inorganics Supervisor

ACCREDITED FOR TECHNICAL COMPETENCE

sPOCAS field test						
Our Reference:	UNITS	44160-1	44160-2	44160-3	44160-4	44160-5
Your Reference	----------	2663/1	2663/1	2663/1	2663/1	2663/2
Depth	----------	0.5	1.0	1.5	2.5	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	5.2	5.5	5.3	4.5	5.4
pHFOX (field peroxide test)*	pH Units	3.1	4.1	3.8	3.3	4.1
Reaction Rate*	-	Slight	Moderate	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	44160-6	44160-7	44160-8	44160-9	44160-10
Your Reference	----------	2663/2	2663/2	2663/2	2663/3	2663/3
Depth	----------	1.0	2.0	4.0	0.5	1.0
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	5.4	5.6	5.7	5.1	4.9
pHFOX (field peroxide test)*	pH Units	3.8	4.4	5.4	3.9	3.5
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	44160-11	44160-12	44160-13	44160-14	44160-15
Your Reference	----------	2663/4	2663/4	2663/4	2663/5	2663/5
Depth	----------	0.5	1.0	1.5	0.5	1.0
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	5.0	5.0	5.0	5.7	5.1
pHFOX (field peroxide test)*	pH Units	3.8	3.7	3.5	4.1	3.9
Reaction Rate*	-	Slight	Slight	Slight	Moderate	Moderate

sPOCAS field test						
Our Reference:	UNITS	44160-16	44160-17	44160-18	44160-19	44160-20
Your Reference	----------	2663/7	2663/7	2663/7	2663/11	2663/11
Depth	----------	0.5	1.0	2.5	0.5	1.0
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	4.7	5.1	5.5	5.4	4.8
pHFOX (field peroxide test)*	pH Units	3.5	2.6	2.1	4.0	3.7
Reaction Rate*	-	Moderate	Moderate	Moderate	Moderate	Moderate

Method ID	Methodology Summary
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.

Report Comments:

Asbestos was analysed by Approved Identifier: Not applicable for this job
Asbestos was authorised by Approved Signatory: Not applicable for this job
INS: Insufficient sample for this test NT: Not tested PQL: Practical Quantitation Limit <: Less than >: Greater than
RPD: Relative Percent Difference NA: Test not required LCS: Laboratory Control Sample NR: Not requested

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 batches of 20. The duplicate sample RPD and matrix spike recoveries for the sample batch were within 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. Surrogates: 60-140% is acceptable for general organics and 10-140% for

sPOCAS Our Reference: Your Reference Depth Type of sample	UNITS ---------- ----------	44160-A-1 2663/1 0.5 Soil	44160-A-2 2663/1 1.0 Soil	44160-A-3 2663/1 1.5 Soil	44160-A-4 2663/1 2.5 Soil	44160-A-5 2663/2 0.5 Soil
Date prepared	-	6/8/2010	6/8/2010	6/8/2010	6/8/2010	6/8/2010
Date analysed	-	6/8/2010	6/8/2010	6/8/2010	6/8/2010	6/8/2010
pH $_{kcl}$	pH units	4.5	4.7	4.2	3.8	4.6
TAA pH 6.5	moles H^+/t	10	77	85	100	40
s-TAA pH 6.5	%w/w S	0.016	0.12	0.14	0.16	0.064
pH $_{Ox}$	pH units	3.4	4.0	4.1	3.8	4.2
TPA pH 6.5	moles H^+/t	10	168	87	103	30
s-TPA pH 6.5	%w/w S	0.016	0.27	0.14	0.16	0.048
TSA pH 6.5	moles H^+/t	<5.0	90	<5.0	<5.0	<5.0
s-TSA pH 6.5	%w/w S	<0.01	0.14	<0.01	<0.01	<0.01
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	<0.005	0.018	0.025	0.020	<0.005
S$_P$	%w/w	<0.005	0.061	0.039	0.028	0.011
S$_{POS}$	%w/w	<0.005	0.043	0.014	0.008	0.010
a-S$_{POS}$	moles H^+/t	<5.0	27	8.8	5.2	6.0
Ca$_{KCl}$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Ca$_P$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Ca$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg$_{KCl}$	%w/w	<0.005	<0.005	0.010	0.011	<0.005
Mg$_P$	%w/w	<0.005	<0.005	0.011	0.012	<0.005
Mg$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
SRAS	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
S$_{HCl}$	%w/w S	<0.005	0.035	0.022	0.019	<0.005
S$_{NAS}$	%w/w S	<0.005	0.017	<0.005	<0.005	<0.005
a-S$_{NAS}$	moles H^+/t	<5	8.0	<5	<5	<5
s-S$_{NAS}$	%w/w S	<0.01	0.013	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	12	104	94	105	46
Liming rate	kg $CaCO_3$/t	0.88	7.8	7.0	7.9	3.5
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

sPOCAS Our Reference: Your Reference Depth Type of sample	UNITS ---------- ----------	44160-A-6 2663/2 1.0 Soil	44160-A-7 2663/2 2.0 Soil	44160-A-8 2663/2 4.0 Soil	44160-A-11 2663/4 0.5 Soil	44160-A-12 2663/4 1.0 Soil
Date prepared	-	6/8/2010	6/8/2010	6/8/2010	6/8/2010	6/8/2010
Date analysed	-	6/8/2010	6/8/2010	6/8/2010	6/8/2010	6/8/2010
pH kcl	pH units	4.4	4.4	5.0	4.2	3.5
TAA pH 6.5	moles H^+/t	27	17	7.5	47	113
s-TAA pH 6.5	%w/w S	0.044	0.028	0.012	0.076	0.18
pH Ox	pH units	3.8	4.7	4.7	4.2	4.0
TPA pH 6.5	moles H^+/t	40	<5.0	<5.0	27	110
s-TPA pH 6.5	%w/w S	0.064	<0.01	<0.01	0.044	0.18
TSA pH 6.5	moles H^+/t	12	<5.0	<5.0	<5.0	<5.0
s-TSA pH 6.5	%w/w S	0.020	<0.01	<0.01	<0.01	<0.01
ANCE	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
a-ANCE	moles H^+/t	<5	<5	<5	<5	<5
s-ANCE	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
SKCl	%w/w S	0.016	0.012	0.005	<0.005	0.027
SP	%w/w	0.059	0.015	0.007	0.014	0.033
SPOS	%w/w	0.042	<0.005	<0.005	0.011	0.007
a-SPOS	moles H^+/t	26	<5.0	<5.0	7.0	<5.0
CaKCl	%w/w	0.005	0.031	0.041	<0.005	<0.005
CaP	%w/w	0.005	0.031	0.041	<0.005	<0.005
CaA	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
MgKCl	%w/w	0.023	0.12	0.10	0.013	0.039
MgP	%w/w	0.023	0.12	0.10	0.013	0.038
MgA	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
SRAS	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
SHCl	%w/w S	0.017	0.011	0.012	0.005	0.026
SNAS	%w/w S	<0.005	<0.005	0.007	<0.005	<0.005
a-SNAS	moles H^+/t	<5	<5	<5	<5	<5
s-SNAS	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	54	19	<10	55	117
Liming rate	kg $CaCO_3$/t	4.1	1.5	<0.75	4.2	8.8
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

sPOCAS Our Reference: Your Reference Depth Type of sample	UNITS ---------- ----------	44160-A-13 2663/4 1.5 Soil	44160-A-14 2663/5 0.5 Soil	44160-A-16 2663/7 0.5 Soil	44160-A-17 2663/7 1.0 Soil	44160-A-20 2663/11 1.0 Soil
Date prepared	-	6/8/2010	6/8/2010	6/8/2010	6/8/2010	6/8/2010
Date analysed	-	6/8/2010	6/8/2010	6/8/2010	6/8/2010	6/8/2010
pH kcl	pH units	3.6	3.6	4.4	4.1	4.2
TAA pH 6.5	moles H^+/t	75	163	22	37	45
s-TAA pH 6.5	%w/w S	0.12	0.26	0.036	0.060	0.072
pH Ox	pH units	4.3	4.1	4.0	2.5	4.1
TPA pH 6.5	moles H^+/t	72	150	<5.0	92	27
s-TPA pH 6.5	%w/w S	0.12	0.24	<0.01	0.15	0.044
TSA pH 6.5	moles H^+/t	<5.0	<5.0	<5.0	55	<5.0
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	0.088	<0.01
ANCE	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
a-ANCE	moles H^+/t	<5	<5	<5	<5	<5
s-ANCE	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
SKCl	%w/w S	0.034	0.011	0.010	0.021	0.014
SP	%w/w	0.038	0.021	0.022	0.20	0.026
SPOS	%w/w	<0.005	0.010	0.012	0.17	0.012
a-SPOS	moles H^+/t	<5.0	6.1	7.5	109	7.4
CaKCl	%w/w	0.005	0.015	0.013	0.019	<0.005
CaP	%w/w	0.006	0.015	0.014	0.020	<0.005
CaA	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
MgKCl	%w/w	0.072	0.050	0.027	0.037	0.014
MgP	%w/w	0.073	0.050	0.027	0.036	0.014
MgA	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
SRAS	%w/w	0.008	<0.005	<0.005	0.007	<0.005
SHCl	%w/w S	0.035	0.012	0.011	0.021	0.014
SNAS	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
a-SNAS	moles H^+/t	<5	<5	<5	<5	<5
s-SNAS	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	78	169	30	147	52
Liming rate	kg $CaCO_3$/t	5.9	13	2.3	11	3.9
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	-			6/8/2010	44160-A-1	6/8/2010 || 6/8/2010	LCS	6/8/2010
Date analysed	-			6/8/2010	44160-A-1	6/8/2010 || 6/8/2010	LCS	6/8/2010
pH kcl	pH units		LAB.64	5.6	44160-A-1	4.5 || 4.5 || RPD: 0	LCS	102%
TAA pH 6.5	moles H^+/t	5	LAB.64	<5	44160-A-1	10 || 12 || RPD: 18	LCS	103%
s-TAA pH 6.5	%w/w S	0.01	LAB.64	<0.01	44160-A-1	0.016 || 0.020 || RPD: 22	LCS	100%
pH Ox	pH units		LAB.64	3.8	44160-A-1	3.4 || 3.3 || RPD: 3	LCS	117%
TPA pH 6.5	moles H^+/t	5	LAB.64	<5.0	44160-A-1	10 || 10 || RPD: 0	LCS	79%
s-TPA pH 6.5	%w/w S	0.01	LAB.64	<0.01	44160-A-1	0.016 || 0.016 || RPD: 0	LCS	79%
TSA pH 6.5	moles H^+/t	5	LAB.64	<5.0	44160-A-1	<5.0 || <5.0	LCS	76%
s-TSA pH 6.5	%w/w S	0.01	LAB.64	<0.01	44160-A-1	<0.01 || <0.01	LCS	75%
ANCE	% $CaCO_3$	0.05	LAB.64	<0.05	44160-A-1	<0.05 || <0.05	[NR]	[NR]
a-ANCE	moles H^+/t	5	LAB.64	<5	44160-A-1	<5 || <5	[NR]	[NR]
s-ANCE	%w/w S	0.05	LAB.64	<0.05	44160-A-1	<0.05 || <0.05	[NR]	[NR]
SKCl	%w/w S	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	128%
SP	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	102%
SPOS	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	96%
a-SPOS	moles H^+/t	5	LAB.64	<5.0	44160-A-1	<5.0 || <5.0	LCS	97%
CaKCl	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	92%
CaP	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	86%
CaA	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	[NR]	[NR]
MgKCl	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	92%
MgP	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	102%
MgA	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	[NR]	[NR]
SRAS	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	[NR]	[NR]
SHCl	%w/w S	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	97%
SNAS	%w/w S	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	[NR]	[NR]
a-SNAS	moles H^+/t	5	LAB.64	<5	44160-A-1	<5 || <5	[NR]	[NR]
s-SNAS	%w/w S	0.01	LAB.64	<0.01	44160-A-1	<0.01 || <0.01	[NR]	[NR]
a-Net Acidity	moles H^+/t	10	LAB.64	<10	44160-A-1	12 || 14 || RPD: 15	LCS	96%

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			6/8/2010	44160-A-1	6/8/2010 || 6/8/2010	LCS	6/8/2010
Date analysed	-			6/8/2010	44160-A-1	6/8/2010 || 6/8/2010	LCS	6/8/2010
pH kcl	pH units		LAB.64	5.6	44160-A-1	4.5 || 4.5 || RPD: 0	LCS	102%
TAA pH 6.5	moles H^+/t	5	LAB.64	<5	44160-A-1	10 || 12 || RPD: 18	LCS	103%
s-TAA pH 6.5	%w/w S	0.01	LAB.64	<0.01	44160-A-1	0.016 || 0.020 || RPD: 22	LCS	100%
pH Ox	pH units		LAB.64	3.8	44160-A-1	3.4 || 3.3 || RPD: 3	LCS	117%
TPA pH 6.5	moles H^+/t	5	LAB.64	<5.0	44160-A-1	10 || 10 || RPD: 0	LCS	79%
s-TPA pH 6.5	%w/w S	0.01	LAB.64	<0.01	44160-A-1	0.016 || 0.016 || RPD: 0	LCS	79%
TSA pH 6.5	moles H^+/t	5	LAB.64	<5.0	44160-A-1	<5.0 || <5.0	LCS	76%
s-TSA pH 6.5	%w/w S	0.01	LAB.64	<0.01	44160-A-1	<0.01 || <0.01	LCS	75%
ANCE	% $CaCO_3$	0.05	LAB.64	<0.05	44160-A-1	<0.05 || <0.05	[NR]	[NR]
a-ANCE	moles H^+/t	5	LAB.64	<5	44160-A-1	<5 || <5	[NR]	[NR]
s-ANCE	%w/w S	0.05	LAB.64	<0.05	44160-A-1	<0.05 || <0.05	[NR]	[NR]
SKCl	%w/w S	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	128%
SP	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	102%
SPOS	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	96%
a-SPOS	moles H^+/t	5	LAB.64	<5.0	44160-A-1	<5.0 || <5.0	LCS	97%
CaKCl	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	92%
CaP	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	86%
CaA	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	[NR]	[NR]
MgKCl	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	92%
MgP	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	102%
MgA	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	[NR]	[NR]
SRAS	%w/w	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	[NR]	[NR]
SHCl	%w/w S	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	LCS	97%
SNAS	%w/w S	0.005	LAB.64	<0.005	44160-A-1	<0.005 || <0.005	[NR]	[NR]
a-SNAS	moles H^+/t	5	LAB.64	<5	44160-A-1	<5 || <5	[NR]	[NR]
s-SNAS	%w/w S	0.01	LAB.64	<0.01	44160-A-1	<0.01 || <0.01	[NR]	[NR]
a-Net Acidity	moles H^+/t	10	LAB.64	<10	44160-A-1	12 || 14 || RPD: 15	LCS	96%

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	44160-A-1	0.88 || 1.1 || RPD: 22	LCS	96%
a-Net Acidity without ANCE	moles H^+/t	10	LAB.64	<10	44160-A-1	NA || NA	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$ /t	0.75	LAB.64	<0.75	44160-A-1	NA || NA	[NR]	[NR]

QUALITY CONTROL sPOCAS	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	44160-A-14	6/8/2010 || 6/8/2010
Date analysed	-	44160-A-14	6/8/2010 || 6/8/2010
pH kcl	pH units	44160-A-14	3.6 || 3.6 || RPD: 0
TAA pH 6.5	moles H^+/t	44160-A-14	163 || 150 || RPD: 8
s-TAA pH 6.5	%w/w S	44160-A-14	0.26 || 0.24 || RPD: 8
pH ox	pH units	44160-A-14	4.1 || 4.1 || RPD: 0
TPA pH 6.5	moles H^+/t	44160-A-14	150 || 158 || RPD: 5
s-TPA pH 6.5	%w/w S	44160-A-14	0.24 || 0.25 || RPD: 4
TSA pH 6.5	moles H^+/t	44160-A-14	<5.0 || 7.5
s-TSA pH 6.5	%w/w S	44160-A-14	<0.01 || 0.012
ANCE	% $CaCO_3$	44160-A-14	<0.05 || <0.05
a-ANCE	moles H^+/t	44160-A-14	<5 || <5
s-ANCE	%w/w S	44160-A-14	<0.05 || <0.05
SKCl	%w/w S	44160-A-14	0.011 || 0.010 || RPD: 10
SP	%w/w	44160-A-14	0.021 || 0.020 || RPD: 5
SPOS	%w/w	44160-A-14	0.010 || 0.009 || RPD: 11
a-SPOS	moles H^+/t	44160-A-14	6.1 || 5.8 || RPD: 5
CaKCl	%w/w	44160-A-14	0.015 || 0.014 || RPD: 7
CaP	%w/w	44160-A-14	0.015 || 0.016 || RPD: 6
CaA	%w/w	44160-A-14	<0.005 || <0.005
MgKCl	%w/w	44160-A-14	0.050 || 0.049 || RPD: 2
MgP	%w/w	44160-A-14	0.050 || 0.050 || RPD: 0
MgA	%w/w	44160-A-14	<0.005 || <0.005
SRAS	%w/w	44160-A-14	<0.005 || <0.005
SHCl	%w/w S	44160-A-14	0.012 || 0.010 || RPD: 18
SNAS	%w/w S	44160-A-14	<0.005 || <0.005
a-SNAS	moles H^+/t	44160-A-14	<5 || <5

QUALITY CONTROL sPOCAS	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
S-SNAS	%w/w S	44160-A-14	<0.01 || <0.01
a-Net Acidity	moles H^+/t	44160-A-14	169 || 156 || RPD: 8
Liming rate	kg $CaCO_3$/t	44160-A-14	13 || 12 || RPD: 8
a-Net Acidity without ANCE	moles H^+/t	44160-A-14	NA || NA
Liming rate without ANCE	kg $CaCO_3$/t	44160-A-14	NA || NA

Report Comments:

Asbestos was analysed by Approved Identifier: Not applicable for this job
Asbestos was authorised by Approved Signatory: Not applicable for this job

INS: Insufficient sample for this test
NA: Test not required
<: Less than

PQL: Practical Quantitation Limit
RPD: Relative Percent Difference
>: Greater than

NT: Not tested
NA: Test not required
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.

16 Attachment H – 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)

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.

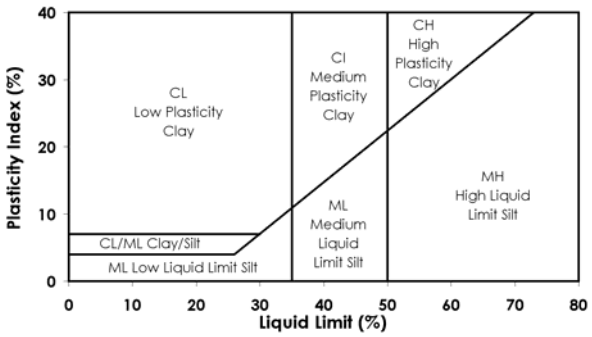
Particle Size

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)

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.

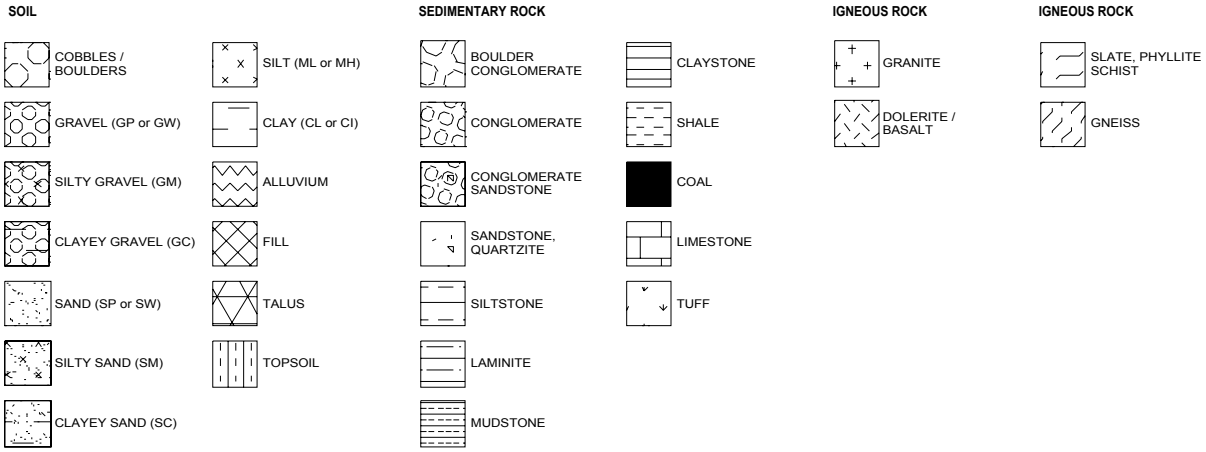
Symbol	Field Texture Grade	Behaviour of moist bolus	Ribbon length	Clay content (%)
S	Sand	Coherence nil to very slight; cannot be moulded; single grains adhere to fingers	0 mm	< 5
LS	Loamy sand	Slight coherence; discolours fingers with dark organic stain	6.35 mm	5
CLS	Clayey sand	Slight coherence; sticky 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)

martens consulting engineers

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)

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.

Rock Core Recovery

TCR = Total Core Recovery

$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100\%$$

SCR = Solid Core Recovery

$$= \frac{\Sigma \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100\%$$

RQD = Rock Quality Designation

$$= \frac{\Sigma \text{Axial lengths of core} > 100\,\text{mm long}}{\text{Length of core run}} \times 100\%$$

Rock Strength Tests

▼ Point load strength Index (Is50) - axial test (MPa)

▶ Point load strength Index (Is50) - diametrall test (MPa)

● Unconfined compressive strength (UCS) (MPa)

Defect Type Abbreviations and Descriptions

Defect Type (with inclination given)

BP	Bedding plane parting
X	Foliation
L	Cleavage
JT	Joint
F	Fracture
SZ	Sheared zone (Fault)
CS	Crushed seam
DS	Decomposed seam
IS	Infilled seam
V	Vein

Coating or Filling

Cn	Clean
Sn	Stain
Ct	Coating
Fe	Iron Oxide

Planarity

Cu	Curved
Ir	Irregular
Pl	Planar
St	Stepped
Un	Undulating

Roughness

Po	Polished
Ro	Rough
Sl	Slickensided
Sm	Smooth
Vr	Very rough

Inclination

The inclination of defects are measured from perpendicular to the core axis.

Rock Data

Explanation of Terms (2 of 2)

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Test Methods

Explanation of Terms (1 of 2)

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