SGD1 Pty Ltd
C/- Tattersall Lander Pty Ltd

Geotechnical Assessment:
Riverside Estate, Tea Gardens, NSW.

martens consulting engineers

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P1404136JR03V01
October 2015

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Head Office
Suite 201, 20 George Street
Hornsby, NSW 2077, Australia
ACN 070 240 890 ABN 85 070 240 890
Phone: +61-2-9476-9999
Fax: +61-2-9476-8767
Email: mail@martens.com.au
Web: www.martens.com.au

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Author(s)	Reviewer(s)	Project Manager/Director	Signature
Ralph Erni	Gray Taylor Daniel Martens	Gray Taylor	

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

Contents

1 Introduction

1.1 Overview

This report presents the results of a Geotechnical Assessment, including salinity assessment and pavement thickness design, carried out by Martens & Associates Pty Ltd (MA) on behalf of the Client for the proposed Riverside Estate development at Tea Gardens, NSW (the 'site'). The report has been prepared to support a Development Application (DA) for the proposed site development. The site location is shown in Figure 2, Attachment B.

Previous rounds of ground investigation works have been undertaken at the site, dating back to February, 1996. The works were undertaken in relation to various development proposals for the site.

This report seeks to collate previous investigation works relevant to the geotechnical assessment and to assess the geotechnical risk at the site in light of the current proposed development proposal. It includes advice on management measures to enable construction activities to limit / negate the geotechnical risks associated with the site development. This study does not intend to provide details of previous works, apart from utilising historic data as summarised within the relevant study elements of this report.

1.2 Development Proposal Description

We understand that development approval is sought for the following key elements:

- Subdivision of the site into 767 small to medium residential lots, carried out in 16 stages.
- Construction of internal road and buried services networks.
- Creation of areas dedicated to open space, public recreation and stormwater management corridors.
- Creation of a future commercial area.

Refer to the staging plan prepared by Tattersall Lander Pty Ltd (Figure 1, Attachment A) for further details.

Future lot development is likely to consist of construction of residential dwellings, some swimming pools and associated infrastructure, and installation of buried services.

1.3 Assessment Objectives

The study objectives include assessing:

- Geotechnical conditions for management of geotechnical risks that may affect the site and the proposed development.
- Risk of soil and groundwater salinity so that consideration can be given to local prevailing salinity conditions and the impacts of, and on, the proposed development.
- Subgrade conditions to recommend preliminary pavement material thicknesses suitable for expected lightly-trafficked pavements and provide advice on subgrade preparatory and earthworks requirements.

1.4 Assessment Scope of Works

The assessment scope of works is summarised as follows:

- Review results of previous ground investigations, associated with the proposed site development and relevant to the geotechnical assessment, that were completed by MA and other consultants (report copies provided by the Client).
- Review relevant publicly available documentation.
- A site walkover by a senior geotechnical engineer to assess existing site conditions.

1.5 Relevant Guidelines/Standards

The assessment has been carried out in accordance with the principles of the following guidelines/standards:

- Australian Standard 1726 (1993), *Geotechnical site investigations*.
- Australian Standard 2870 (2011), *Residential slabs and footings*.
- Department of Land and Water Conservation (2002), *Site Investigations for Urban Salinity*.
- Guide to Pavement Technology, Part 2: Pavement Structural Design, Austroads, 2012.

2 Site Investigations

2.1 Previous Site Investigations

The following site investigations, previously carried out at or in the immediate vicinity of the site and considered relevant to this geotechnical assessment, were reviewed:

- Coffey Geotechnics (Coffey, formerly Coffey Partners International), February 1996, *Myall Quays development Groundwater and Surface Water Study*.
- Coffey (formerly Coffey Geosciences), December 2004, Crighton Properties Groundwater Assessment Myall Quays Development, Tea Gardens.
- Coffey (formerly Coffey Geosciences, October 2007, Groundwater Assessment Crighton Properties Riverside Development, Tea Gardens.
- Coffey, August 2008, Riverside Estate Project Application Masterplan Area, Tea Gardens Geotechnical and Acid Sulfate Soils Assessment.
- Martens & Associates (MA), July 2009, Request for additional groundwater information, Riverside Site, Tea Gardens, NSW.
- MA, January 2013, Concept Integrated Water Cycle Management Strategy (revised), Riverside, Tea Gardens, NSW.

2.2 Previous Site Investigation Scope of Works

Previous investigations included drilling of 34 boreholes, excavation of 40 test pits and installation of 24 groundwater monitoring bores (GMBs)/ piezometers. In addition, a standpipe was installed to monitor lake water quality and levels. Test and GMB locations are shown in Figure 3, Attachment B. It is to be noted that, between 2004 and 2007, vandalism and/or loss of four (4) GMBs (GMBs 1, 2, 3 and 7) reduced the number of operative site GMBs (including standpipes) to 17. Two of these were replaced in 2009 with new GMBs (GMB1A and GMB2A). Previous assessment scope of works are summarised below.

2.2.1 DJ Douglas & Partners (now Douglas Partners), 1994 (Coffey, 2004)

- Drilling of 12 boreholes (BH1 to BH12) and iInstallation of groundwater monitoring bores (GMB1 to GMB12), typically 5m deep

and screened over the bottom 2m, to allow groundwater sampling and level monitoring.

(Further bore details and associated assessment results are not known. Some of these bores were utilised by Coffey for subsequent assessments - refer below).

2.2.2 Coffey, 1996

- Drilling of one (1) borehole (BH13) using augering techniques up to 10.5m below ground level (bgl) to allow characterisation of underlying soils.
- Installation of 1 groundwater monitoring bore (GMB13) to allow groundwater sampling and level monitoring.
- Excavation of 1 trial pit between BH10 and BH13 for pump testing.

2.2.3 Coffey, 2004

- Drilling of 4 boreholes (BH21 to BH24) using augering techniques up to 3m bgl to allow characterisation of underlying soils and soil sampling.
- Installation of 4 groundwater monitoring bores (GMB21 to GMB24) to allow groundwater sampling and level monitoring.
- Collection of water samples from bores at the site, inclusive of some bores previously installed by Douglas Partners (refer to Section 2.2.1). Thirteen (13) samples were submitted for chemical laboratory analysis.

2.2.4 Coffey, 2007

- Collection of water samples from bores at the site, inclusive of some bores previously installed by Douglas Partners (refer to Section 2.2.1). Seven (7) samples were submitted for chemical laboratory analysis.

2.2.5 Coffey, 2008

- Excavation of 40 test pits (TP1 to TP34 and TP39 to TP44) via backhoe up to 2.5m bgl to allow characterisation of underlying soils and soil sampling.
- Drilling of six (6) boreholes (BH35 to BH38 and BH45 to BH46) by means of a 4WD drilling rig and using augering techniques up to 10.45m bgl to allow characterisation of underlying soils and soil sampling.

- Collection of water samples from groundwater monitoring bores, of which eight (8) samples were submitted for chemical laboratory analysis.

2.2.6 MA, 2009

- Drilling of three (3) boreholes (BH1A, BH2A and BH25) using augering techniques to between approximatley 5.5m and 7m bgl to allow characterisation of underlying soils.

- Installation of 3 groundwataer monitoring bores (GMB1A, GMB2A and GMB25) up to approximately 2.28m bgl and installation of 1 monitoring bore in the existing lake (GMB26) to allow groundwater sampling and level monitoring.

- Collection of water samples from existing bores at the site, of which 6 samples were submitted for chemical laboratory analysis.

2.2.7 MA, 2013

- Drilling of eight (8) boreholes (BH201 to BH208) using augering techniques to between approximatley 0.7m and 7m bgl to allow characterisation of underlying soils.

- Installation of 3 groundwataer monitoring bores (GMB201 to GMB203) up to approximatley 7m bgl to allow groundwater sampling and level monitoring.

- Collection of water samples from existing bores at the site, of which 19 samples were submitted for chemical laboratory analysis.

2.3 Supplementary Site Investigation

One of MA's Senior Geotechnical Engineers visited the site on July 20, 2015, to carry out a site walkover to assess existing site conditions.

3 Site Conditions

3.1 Study Area Description

The site forms part of an approximately northeast – southwest aligned Pleistocene and Holocene coastal barrier mass.

It lies immediately to the north of the existing township of Tea Gardens and is accessed via Myall Street, the main road linking Tea Gardens / Hawks Nest with the Pacific Highway. The site location is shown in Figure 2, Attachment B.

Table 1, overleaf, presents a summary of general site details. Existing site features are shown in Figure 3, Attachment B. Existing site contours are shown on Figure 4, Attachment B.

At the time of MA's site visit, following a rainfall period, surface soils were observed to be saturated and surface water was ponding across the majority of the site. A number of small incised man-made channels drain collected surface water and possibly intermittent shallow groundwater to the lower-lying heath and wetland areas to the east of the site.

Table 1: Summary of general site details.

Item	Description/Detail
Lot/DP	o Lots 10 in DP 270100. o Lot 40 in DP270100 o Lot 9 in DP 270561.
LGA	Great Lakes.
Site area	Approximately 100 ha.
Topography	Generally low-lying land with grades typically <5%. A series of small sand ridges trend roughly north-south, rising northwards (near the northern site boundary towards Shearwater Estate) with grades typically up to 25%.
Expected geology (DoM, 1996)	Pleistocene beach ridges on the Tomago Coastal Plain, comprising Marine gravel, sand, silt, clay and "Waterloo Rock", overlain in places by Aeolian quartz sands. The northern more elevated site extremes may be underlain by Wootton Beds comprising typically sandstone, siltstone, claystone, shale, limestone or lavas, including possible Glen William Beds.
Expected soil landscape (Murphy, 1995)	Aeolian Tea Gardens soil landscape (tn): narrow beach ridges and swales over Pleistocene quartz sand. Local relief is generally <1m, with elevation ranging between 5m and 8m, or <2m near inner barrier depressions. Slope gradients are generally <5%. Ridges are generally well drained. Swales are generally waterlogged with fresh groundwater table often <1m bgl. Soils are deep (>3m), including acid non-cohesive soils, and humus podzols and peaty humus podzols in crests and swales respectively.
Typical site slopes, aspect	Flat, with a slight fall to the south east (<2%).
Elevation	Between approximately 0.6m above Australian Height Datum (AHD) along the Myall River foreshore to 20m AHD at the northern end of the site, adjacent to Shearwater Estate. Majority of the site varies in elevation from 1.6m AHD to 5m AHD.
Existing site development	Majority of the site was previously cleared of native vegetation for use as a pine plantation, which has since ceased operation. Currently the land remains undeveloped.
Existing vegetation	Variety of coastal vegetation communities, including grasses, reeds and scattered pine and native trees.
Neighbouring conditions	N: Toonang Drive (west) and undeveloped but cleared land (east) followed by forest and rural residential developments (Shearwater Residential Estate). E: Approximately 2km frontage to wetlands along the western Myall River shoreline. S: Existing commercial (west) and residential (east) developments. W: Myall Street (approximately 1km frontage).

3.2 Subsurface Conditions

3.2.1 Subsurface Materials

Subsurface investigations indicate that the site is generally covered by a thin layer of topsoil consisting of clayey/sandy silt, silty sand or sandy clay/clay to depths of up to approximately 0.6m bgl (Figure 5,

Attachment B). Underlying deposits generally comprised medium to very dense sand/ silty sand, overlain in places by generally stiff to very stiff clay of high plasticity and sandy clay/clayey sand layers.

Elevated areas in the north-eastern corner of the site are likely underlain by residual silty / sandy clay / clay, the result of weathering of underlying siltstone, sandstone and claystone (Figure 5, Attachment B). Basement sandstone rock under the site is located at approximately 10m to 20m AHD (Coffey, 2007).

A summary of inferred subsoil profiles at investigation locations is presented in Table 10, Attachment C. Reference should be made to borehole and test pit logs (Attachment D) for further details of the conditions encountered at each borehole/ test pit location and associated notes in Attachment H. Borehole/ test pit locations are shown on Figure 3, Attachment B.

3.2.2 Groundwater

Historical groundwater level measurements at established GMBs are collated in Table 2. Refer to Table 11, Attachment C, for data that was used to compile Table 2. The data includes a long history of instantaneous dipped levels and also some periods of continuous monitoring with data loggers. Approximate GMB locations are presented in Figure 3, Attachment B.

Table 2: Groundwater level summary.

GMB	Ground Level (m AHD)	Groundwater Level (m AHD)			Min Depth to Groundwater (m)
		Minimum	Median	Maximum	
GMB1	1.02	0.24	0.63	0.93	0.09
GMB2	2.37	0.69	1.02	2.02	0.36
GMB3	0.85	0.06	0.74	0.79	0.06
GMB4	2.05	0.82 [4]	1.07 [4]	1.30 [4]	0.74 [4]
GMB5	2.61	1.14	1.66	2.56	0.05
GMB6	0.86	0.28 [3]	0.67 [3]	0.77 [3]	0.09 [3]
GMB7	2.96	1.55 [2]	2.42 [2]	2.82 [2]	0.15 [2]
GMB8	2.60	0.73	1.78	2.46	0.14
GMB9	2.86	1.16 [2]	1.71 [2]	2.11 [2]	0.75 [2]
GMB10	1.49	0.39	0.89	1.23	0.26
GMB11	3.40	1.35	2.01	3.01	0.39
GMB12	3.26	1.37	2.12	3.05	0.21
GMB13[7]	-	-	-	-	-
GMB21	1.03	0.78	0.80	0.81	0.21
GMB22	1.10	0.83	0.85	0.88	0.22
GMB23	1.11	0.76 [2]	0.93 [2]	0.93 [2]	0.18 [2]
GMB24	0.83	0.63	0.65	0.68	0.15
GMB1A[5]	1.71	0.72 [1]	0.82 [1]	1.06 [1]	0.65 [1]
GMB2A[5]	2.48	1.13 [1]	1.20 [1]	1.32 [1]	1.16 [1]
GMB25	1.80	0.78 [1]	0.86 [1]	1.00 [1]	0.80 [1]
GMB26 (lake) [6]	0.49	0.63 [1]	0.70 [1]	0.90 [1]	NA [1]
GMB201	2.74	1.9	1.99	2.08	0.66
GMB202	3.69	0.9	0.95	1.0	2.69
GMB203	5.14	3.82	3.97	4.11	1.03

Notes:

1. Derived based on continuous data logging data (04/06/2009 to 06/07/2009).
2. Derived based on dipped data and continuous data logging data (04/06/2009 to 06/07/2009).
3. Derived based on dipped data and continuous data logging data (late July to mid-November, 1994).
4. Derived based on dipped data and continuous data logging data (late July to late September, 1994).
5. Replacements for GMB1 and GMB2.
6. Lake bed level at standpipe location.
7. No details available.

The following comments are made based on review of site groundwater level data:

1. Groundwater is confined to within a shallow to medium depth marine deposit at or above sea level. The aquifer generally comprises fine to medium grained silty sands and sand with cemented (Coffee Rock) and peaty layers (with surface clay deposits in some areas).

2. The groundwater system is bounded by the Myall River to the east and Port Stephens associated bays and creeks to the south/west. The aquifer adjoins a bedrock controlled hill in the north and north west of the site. It is responsive to tidal fluctuations.

3. Water table depths are frequently shallow and typically less than 1m-2m below existing ground level. Groundwater depth variations are minimal spatially across the majority of the site, in response to minimum site grades. Water levels within the aquifer are dependent on incident rainfall and sea level rather than other catchment processes, such as run-on.

4. The groundwater gradient is down towards the lake to the south east of the site; saline/brackish lake water was not migrating from the lake to the local groundwater system.

Groundwater modelling results (MA, 2013) indicate that the proposed development would result in no discernible impact on groundwater levels within the site or adjacent critical ecosystems (i.e. SEPP 14 wetlands). Development impact on groundwater would be limited to the higher western portions of the site and the north-eastern area with the zone of impact being relatively confined and not extending to downslope critical ecosystems.

For further information on groundwater conditions, refer to MA's report Concept Integrate Water Cycle Management Strategy (Revised) Riverside, Tea Gardens, NSW referenced P1404136JR04V01.

4 Geotechnical Assessment

4.1 Overview

Proposed development works are likely to encounter topsoils to depths of up to 0.6m, overlying generally medium to dense sand/ silty sand. The sands are overlain in places by soft to very stiff clay and contain some sandy clay/clayey sand layers. Layers of very dense iron indurated sand or very stiff to hard clay pans of variable thicknesses are present within the subsoil profile. These were identified at variable locations across the site and at varying depths. A thin layer of loose Aeolian sand covers isolated areas of the site.

The clay soils were inferred to be of medium to high plasticity, with a likely moderate to high reactivity (volume change or shrink/swell potential) to soil moisture content variations.

4.2 Key Geotechnical Constraints

The proposed development is expected to be impacted by the following key geotechnical constraints:

- Poor and variable subgrade/ foundation conditions due to deep and variable soil conditions across the site.
- Compressible clay soils within the upper soil profile, in conjunction with up to about 2.5m of fill to be placed at some areas of the site.
- Possible compressible peat layers within the soil profile (based on experience from previous assessments carried out by MA in the vicinity of the site), in conjunction with up to about 2.5m of fill to be placed at some areas of the site.
- Layers of very dense iron indurated sand or hard clay pans, which may be difficult to excavate using small excavation equipment.
- Potential Acid Sulfate Soils (ASS) within the soil profile (refer MA report reference P1404136JR01V01).
- Shallow groundwater table, typically less than 2m below existing ground level.
- Potential saline soil and groundwater at the site.
- Poor subgrade conditions for proposed pavements and future building foundations.

4.3 Geotechnical Recommendations

Geotechnical recommendations for design and construction of the proposed development are provided in Table 3. Geotechnical design parameters for encountered sub-surface materials presented in Table 3 are based on soil strengths, estimated from borehole logs (Attachment D), and are subject to the recommendations presented in this report. The design parameters are preliminary and should be confirmed by additional investigations and testing prior to issuing of a Construction Certificate or preparation of detailed design.

Table 3: Geotechnical recommendations.

Item	Recommendation
Footings	o New buildings, swimming pools and other lightly loaded structures may be supported by shallow footings, e.g. pad or strip footings or slab-on-ground. o Footings are to extend through topsoil and be founded on at least medium dense sand or stiff clay or on engineered fill, subject to recommended earthworks presented in Section 7. An allowable end bearing pressure of 100kPa may be adopted for preliminary footing design, assuming a minimum embedment depth of 0.75 and subject to the following recommendations and CSIRO Sheet BTF 18, Attachment F. o All footing excavations should be inspected followed by concrete placement with minimal delay following excavation completion. If a delay in concrete placement is anticipated, a blinding layer of at least 50mm concrete should be placed to protect foundation conditions. o A geotechnical engineer is to confirm conditions encountered at foundation level satisfy design assumptions and that the base of all excavations is free from loose or softened material and water prior to footing construction. o Water ponding in the base of footing excavations should be removed by pumping; any loosened and softened material at the footing excavation base should then be removed. o All footings should found on material with similar end bearing capacity to limit differential movement across building footprints. Similarly, individual pad footings should not span the interface between different foundation materials. All footings should be founded in either medium dense or denser sand or at least stiff clay to achieve a uniform allowable bearing pressure.
Site Classification	o Considering the variability of site conditions, in particular presence of clay in some site areas, a preliminary site classification of 'M' should be adopted for design of lightly loaded shallow footings in accordance with AS 2870 (2011). This assumes footings found on natural material below root-affected soils or on engineered fill. A preliminary site classification of 'S' may be adopted for areas underlain by at least 2m medium dense sand. o Further assessment of site subsurface conditions, including laboratory testing, should be carried out at Construction Certificate stage to confirm or reduce the preliminary classification and for final design of foundations at future dwelling locations. o Proposed cutting and site filling, including fill material type and placement conditions, may alter the above site classification. o Consideration should be given to impact of existing and former mature trees on design characteristic free surface movements. o All new shallow footings should be design in accordance with AS 2870 (2011), the recommendations presented in this report and site maintenance guidelines presented in CSIRO Sheet BTF 18, Attachment F.
Piled Foundations	o Where foundations are to extend below the zone of influence of existing or proposed buried infrastructure, piled foundations may be adopted. o The use of CFA piles may be considered. Presence of very dense indurated sand layers / hard clay pans and shallow groundwater levels will likely limit the efficacy of screw, bored in-situ or driven piles. o An allowable end bearing pressure of 300kPa may be adopted for preliminary pile design, assuming a minimum embedment depth of at least 5m and subject to intimate contact between pile and surrounding soil. o For uplift resistance, we recommend adopting 50% of the allowable end bearing pressure.

Item	Recommendation
Soil Retention/ Batters	o Excavations and fill embankments exceeding 0.75m in height should be supported by suitably designed and installed retaining or shoring structures. o Alternatively, soil overburden may be excavated or fill material placed without structural support but with a maximum temporary (less than 1 month) batter slope of 1V (vertical) : 2H (horizontal) and permanent batter slope of 1V : 3H.
Retaining Structures	o Retaining structures, if required, are to be engineer designed and backfilled with suitable gravel and free-draining material. o Retaining wall design should consider impacts of sloping ground and additional surcharge loading from existing structures, construction equipment, backfill compaction and static water pressures unless subsoil drainage is provided behind retaining walls. o Suitable drainage measures, such as a geofabric enclosed Agg-pipe, should be included to collect and redirect seepage water from behind retaining walls.
Overland Flows	o All surface runoff water should be diverted away from excavation areas during construction works and from any retaining structures, footings or crest / base of embankments to prevent water accumulation, foundation / embankment strength reduction and pore water pressure increases.
Soil erosion	o Soil overburden should be removed and spoil managed with erosion control measures in a manner that prevents transportation of sediments off-site and reduces risk of sedimentation of natural drainage channels and existing stormwater drainage systems in the vicinity of the site. o Erosion control measures to be considered in conjunction with recommendation by Landcom (2004) to limit surface run-off and associated risk of surface scour, soil erosion and sedimentation, include: a) Maintaining vegetation where possible. b) Limiting the area of site disturbance. c) Landscaping disturbed areas following completion of construction. d) Use of gabion mattress, or other suitable energy reduction solutions, where required. e) Directing surface water away from excavations/ working platforms. f) Covering exposed excavation/ fill batters.

4.4 Salinity

4.4.1 Salinity Processes

Salts occur naturally in soil or groundwater. Salinity generally refers to the mineral salt concentrations in soil or groundwater resulting from hydrological processes. Accumulation of soil or groundwater salinity, known as salinisation, is often attributable to the alteration of natural water cycles due to land-use or water-use changes.

Typical causes of increased salt concentrations within the soil profile/ groundwater, or mobilisation of the salts to the ground surface, include capillary rise of soil moisture in conjunction with increased surface evaporation, increased application of surface water, rising

groundwater tables or changes to groundwater recharge conditions. This salinisation can have detrimental effects on fauna, flora and on man-made materials, including concrete, brick and metal, if in contact with saline soil or groundwater.

4.4.2 Broad Scale Salinity Processes

A list of key broad scale salinity processes likely to impact the site (based on pg. 16 of Western Sydney Salinity Code of Practice, 2004) is presented in Table 4.

4.4.3 Signs of Potential Saline Soils

No obvious signs of saline conditions were observed at the site in dry areas:

- Vegetation growth appeared healthy and uninhibited.
- Water marks or salt crystals were not observed on ground surfaces.

4.4.4 Possible Site Conditions Impacting Site Salinity Potential

Site conditions that may impact salinity potential at the site include:

- Poorly draining soils.
- New and existing surface water features.
- Shallow groundwater levels, typically <2m bgl.
- Close proximity to wetlands, Myall River and Port Stephens associated bays.

4.4.5 Assessed Salinity Risk Potential

In Table 4, overleaf, the broad scale salinity processes have been assessed in terms of likelihood of occurring at the site, considering the proposed development, site observations and previous investigation findings.

4.4.6 Laboratory Test Results

No laboratory testing has been carried out to date on soils underlying the site. 40 samples from 24 GMB's were submitted to ALS Environmental and Envirolab Services, both National Association of Testing Authorities (NATA) accredited laboratories, for chemical testing. Analytes included electrical conductivity (EC_w), pH, Chloride (Cl) and Sulfate (SO_4). Laboratory test results are collated in Table 5. Refer to

Table 11, Attachment C, for data that was used to compile Table 5. Laboratory test certificates are provided in Attachment E.

Table 4: Potential for broad scale salinity processes at the site.

Key Salinity Process	Description	Potential at Subject Site
Localised concentration of salinity	o Localised concentration of salts due to relatively high evaporation rates. o Usually associated with waterlogged soil and poor drainage. o Increased water use associated with urban development can exacerbate the problem.	High – area impacted by poor surface water drainage and water logged soil. Drainage inhibited due to low slopes and underlying very dense sand/ very stiff clay. No evidence of salt concentrations was observed.
Shale Soil Landscapes	o Where there are poorly drained duplex (texture contrast) soils and shallow ground water flows laterally across the upper B-horizon, salt usually accumulates in the clayey sub-soil. o The situation is worsened when sub-soils are exposed by deep cutting, when buildings are installed into the B-horizon, and when sub-surface water flows are impeded.	Low – Site is underlain predominantly by Quaternary and Pleistocene deposits. Sub-surface water flows are expected not to be impeded.
Deep Groundwater Salinity	o Brackish or saline groundwater rises to a level where capillary action in the soil results in the water and dissolved salts reaching the surface. o Groundwater rises typically caused by increased water infiltration (above average rainfall, vegetation loss, irrigation, increased water use in urban areas).	Moderate – groundwater typically 1m to 2m bgl. Proposed development is expected to: o Not intercept or raise groundwater levels. o Include installation of appropriate drainage measures. o Include appropriate management of surface water infiltration.
Deeply Weathered Soil Landscape	o High salt loads related to un-mapped deeply weathered soil landscapes, comprising fluvial gravel, sand and clay.	Low – Unlikely presence of deeply weathered soil landscapes.

Table 4 indicates a possible high potential for broad scale salinity within the site sub-soils.

Table 5: Results of pH, EC_w, Cl and SO_4 testing on water samples.

Well ID	pH [1]	EC_w [2] (dS/m)	Chloride [2] (mg/L)	Sulfate [2] SO_4 (mg/L)	Exposure Classification[3]	
					Concrete	Steel
GMB1 [4]	6.4	NT [5]	220	33	NT [5]	NT [5]
GMB2 [4]	5.3	NT [5]	82	16	NT [5]	NT [5]
GMB3 [4]	5.9	18.00	7600	1200	Moderate	Severe
GMB4	5.2	0.32	75	10	Moderate	Mild
GMB5	5.1	0.26	49	10	Moderate	Mild
GMB6	5.7	8.40	2900	360	Mild	Severe
GMB7 [4]	5.5	0.20	38	7	Moderate	Mild
GMB8	5.2	0.32	71	24	Moderate	Mild
GMB9	4.0	0.18	37	13	Very severe	Moderate
GMB10	5.6	0.30	150	3	Non-aggressive	Mild
GMB11	5.6	4.70	1400	180	Non-aggressive	Severe
GMB12	5.0	0.27	65	25	Moderate	Mild
GMB13	NT [5]	NT [5]	NT [5]	NT [5]	NT [5]	NT [5]
GMB21	5.6	15.50	5300	702	Mild	Severe
GMB22	5.9	1.61	430	39	Non-aggressive	Severe
GMB23	5.6	0.28	65	6	Non-aggressive	Mild
GMB24	5.5	2.73	800	344	Moderate	Severe
GMB1A	6.2	0.28	30	39	Non-aggressive	Mild
GMB2A	5.1	0.20	50	5	Moderate	Mild
GMB25	5.6	0.26	36	5	Non-aggressive	Mild
Lake26	6.3	16.0	5800	850	Mild	Severe
Lake	5.8	0.18	37	12	Non-aggressive	Non-aggressive
GMB201	5.3	2.00	6400	26	Moderate	Severe
GMB202	5.4	0.11	18	5	Moderate	Non-aggressive
GMB203	5.3	0.19	43	5	Moderate	Non-aggressive

Notes:

1. Actual pH; lowest recorded value.
2. Highest recorded values.
3. Exposure classification for buried reinforced concrete or metal based on Appendix Two, Tables 6.1 and 6.2, of DLWC (2002).
4. GMB lost, destroyed or vandalised sometime between 2004 and 2007.
5. Not tested.

4.4.7 Conclusions

The following comments are made based on the review of the site groundwater quality data:

- Electrical conductivity of groundwater (EC_w) samples collected from GMBs ranges from 0.11dS/m (non-saline) to 18dS/m (highly saline).

- The median EC_w concentration is indicative of fresh water (MA, 2011).

- Although, in accordance with AS2159 (2009), exposure classification for concrete ranges from 'non-aggressive' to 'very severe' and for steel from 'non-aggressive' to 'severe', we consider the majority of the site to be affected by an exposure classification ranging between 'mild' and 'moderate'.

- Apart from groundwater collected from GMB11 and GMB201, located in the north western part of the site, severe and very severe exposure classifications are limited to groundwater collected from close proximity to the wetlands and the Myall River to the east of the site.

- EC_w measurements typically cannot be used to infer soil salinity at the site due to variations in groundwater quality in time, soil permeability and porosity across the site and GMB positioning within the site. However, general groundwater chemistry appears to be consistent throughout previous monitoring periods.

4.4.8 Recommendations

The salinity assessment indicates that EC_w concentrations of site groundwater are indicative of fresh groundwater but that the groundwater is typically mildly to moderately aggressive to buried concrete and steel. However, it is likely that higher EC_w concentrations and more severe exposure classifications affect some site areas. Furthermore, assessment of broad scale salinity processes indicates a possible high potential for salinity within the site sub-soils.

We recommend that saline soil management strategies are prepared at Construction Certificate stage for inclusion in design and adoption in construction of the proposed development, subject to the results of further testing (refer Section 8).

Saline soil management strategies for earthworks and landscaping should include, but not be limited to:

- Maintaining natural water balance.

- Limiting irrigation.

- Limiting soil disturbance, such as cut and fill, so saline or sodic subsoils are not exposed or groundwater is not intercepted.

- Planting of suitable salt-tolerant plant species.

- Retention of existing deep-rooted vegetation.
- Offset landscaping and gardens from building and retaining walls.
- Treating soils with gypsum before landscaping to suit selective species.
- Where consistent with future land use and landscaping plan, planting of deep-rooted, preferably native, trees to increase water absorption.
- Sealing, e.g. by lining, of stormwater detention ponds and water features to reduce infiltration.
- Preparing sediment and erosion control plans that take into account saline soils.
- Replacing excavated soils in their original order.
- Any long term irrigation or watering on-site is to be at a level that does not cause groundwater to become perched.

Management strategies for new buildings and services should include, but not be limited to:

- Limiting soil disturbance, such as compaction of soils, cutting and filling.
- Designing and building structures to limit interference with natural water flow on site.
- Using appropriate construction materials and techniques to salt proof buildings and infrastructure.
- Correctly installing and maintaining damp proof courses in buildings.
- Utilising damp proof courses and water proofing of slabs.
- Using exposure grade bricks/masonry below damp course or in retaining walls.
- Providing concrete strength and cover to steel reinforcing in accordance with AS 3600 (2009) and the exposure classifications outlined in Table 5.

- Limiting excess surface water infiltration into the soil by designing, installing and maintaining appropriate stormwater drainage (gutters, downpipes, pits and pipes).

4.5 Preliminary Pavement Design

4.5.1 Overview

Preliminary pavement designs were previously undertaken by Coffey (Coffey, 2008) for proposed access and collector roads associated with the site development. The designs adopted a traffic loading of Equivalent Standard Axles (ESA) in accordance with Great Lakes Council guidelines (Table 6). These values fall within Austroads guidelines for design traffic ESA values assuming a 20 year design life (Austroads, 2012).

Table 6: Adopted ESAs for proposed collector / access roads.

Road Type	N (ESA)
Collector	$1x10^6$
Local access road	$5x10^5$

CBR values adopted by Coffey for the pavement thickness designs (Table 7) were based on Coffey's experience from the adjoining Myall Quays Estate development.

Additional CBR testing is recommended to provide a better indication of subgrade conditions across proposed pavement areas and/or provide statistical means to support higher CBR values. The additional testing should be undertaken prior to final design and Construction Certification stage.

Table 7: Adopted CBR values for proposed collector / access roads.

Material Type	CBR Value (%)
Clay	2
Sand	10

4.5.2 Pavement Thickness

The designs were prepared by Coffey in accordance with ARRB Special Report No.41, APRG Report 21 and Austroads – Pavement Design 2004. These designs should be reviewed in conjunction with findings associated with additional CBR laboratory testing to comply with Austroads 2012.

Table 8 presents preliminary recommended pavement material thicknesses for the proposed collector and local access roads adopting ESA and CBR values presented in Tables 6 and 7 respectively. Further integration with final pavement details will be required during the construction phase of the development to complete this pavement design.

Table 8: Preliminary pavement material thickness design summary.

Road Type / ESA [1]	CBR (%)	Layer	Thickness (mm)
Collector / 1 x 10^6	2	Wearing course (1 layer of AC10)	40 [1]
		Base (DGB)	150 [2]
		Sub-base (DGS)	150 [2]
		Select fill (CBR>15%) [3]	500
		Total pavement thickness	840
	10	Wearing course (1 layer of AC10)	40 [1]
		Base (DGB)	150
		Sub-base (DGS)	150
		Total pavement thickness	340
Local access roads / 5 x 10^5	2	Wearing course (1 layer of AC10)	40 [1]
		Base (DGB)	150 [2]
		Sub-base (DGS)	150 [2]
		Select fill (CBR>15%) [3]	500
		Total pavement thickness	840
	10	Wearing course (1 layer of AC10)	40 [1]
		Base (DGB)	150
		Sub-base (DGS)	150
		Total pavement thickness	340

Notes:

[1] RTA QA Specification R116.

[2] RTA QA Specification 3051.

[3] Well graded granular material with maximum particle size = 100mm and minimum CBR = 15%.

4.5.3 Subgrade Preparation

The subgrade is to be trimmed and compacted with density testing of the upper 300 mm layer at a rate of 1 test per 50m of road length. The natural subgrade material and the final 300mm of fill material placed to reach design subgrade level should be compacted to a minimum density index (DI) for sands of 80% or minimum density ratio(DR) for

cohesive soils of 100% Standard Maximum Dry Density (SMDD), within 2% of optimum moisture content (OMC). Prior to placement of pavement material, the subgrade should be proof rolled and approved by a geotechnical engineer.

Soft or wet spots can be treated by one of the following methods subject to final design by MA:

1. Removal to a depth of at least 500mm and replacement with approved select fill material under the direction of a geotechnical engineer.

2. *In-situ* stabilisation with cement/lime or similar binding agent to a depth of at least 300 mm below finished level. Use of this method and extent will depend on the condition of material to be stabilised.

3. The use of a geofabric as bridging layer beneath the select fill.

General earthworks should be carried out in accordance with recommendations presented in Section 7.1.

4.5.4 Placement and Testing of Pavement Material

Pavement materials shall be placed in layers (loose) not thicker than 250mm or less than 75 mm. Pavement materials shall be compacted to the following condition:

- Select fill – Minimum DI of 80% for non-cohesive soils or DR of 100% SMDD for cohesive soils, at ±2% OMC.

- Sub-base - Minimum 95% Modified Maximum Dry Density (MMDD) at ±2% OMC.

- Base - Minimum 98% MMDD at ±2% OMC.

Compaction testing shall be undertaken at a rate of 1 per 250m^2 per layer or 3 per pavement layer placed, whichever is the greater. Each pavement layer shall be proof rolled under geotechnical engineering supervision. Subsequent layers of pavement shall not be placed prior to approval of underlying layer.

4.5.5 Subsoil Drainage

Adequate surface and sub-soil drainage is to be provided. Sub-surface drains are to be installed typically on the upslope side of roads and generally extend 500 mm below pavement level. Where clay soils

are located at subgrade level, it is recommended that subsoil drains are installed on both sides of the roads.

Lot drainage design will need to consider the impact of road fill on drainage of adjacent lots, particularly where surface materials comprise clay soils. The use of column drains, extending through the clay soils into underlying more permeable sands, may be considered.

4.6 Acid Sulfate Soils

Earthworks should be carried out in general accordance with the ASSMAC (1998) guidelines, considering potential environmental impacts from site development relating to ASS in and around the site.

Recommendations on possible mitigation measures for ASS management during proposed earthworks that are likely to disturb ASS, e.g. cut and fill activities and trenching works, are presented in an Acid Sulfate Soils Management Plan (ASSMP) provided in MA report reference P1404136JR02V01.

4.7 Further Construction Considerations

4.7.1 Material Excavations

Most soils should generally be readily excavated using conventional earthmoving equipment. Larger equipment may be requird to excavate very dense iron indurated sand or hard clay pans. Over-disturbace of soils below design excavation levels should be avoided. This may be achieved with the use of a 'mud bucket' fitted to an excavator.

4.7.2 Earthworks for Site Preparation

All earthworks should be carried out in accordance with AS3798 (2007) *Guidelines on Earthworks for Commercial and Residential Development.*

We recommend the following general earthworks are carried out for site preparation:

a) Strip topsoil and / or root affected soils, encountered to depths typically between 0.15m and 0.45m and up to 0.6m bgl, and stockpile for either re-use on site or off-site disposal.

b) Where required, excavate natural soils to design levels, segregating and stockpiling materials for either re-use as site filling or removal from site.

c) A suitably qualified geotechnical engineer should inspect the condition of the exposed material at design level to assess the ability of the prepared surface to act as pavement subgrade, foundation for future fill placement or foundation for new buildings and other structures. It is expected that the moisture content within site soils will typically be high and exceed the OMC typical for the material types. The likely need for drying back of clayey subsoils or over-excavation and replacement of wet materials prior to site filling should be considered. Furthermore, allowance should be made for the sensitivity of subgrade preparation times to prevailing weather conditions at the time of construction and associated impacts on construction programming. Mixing of clayey material with lime may be considered to assist material placement or achieve earthworks specifications.

d) Unsuitable, soft or wet material or heaving areas identified by proof rolling are to be removed and replaced to a minimum depth of 500mm below subgrade level, or as directed by the Geotechnical Engineer.

e) Fill material comprising site-won granular material or approved imported granular fill material should be placed in horizontal layers of not more than 300 mm loose thickness. However, the layer thickness should be appropriate for the compaction plant adopted.

f) Earthworks compliance testing should be carried out in accordance with Table 8.1of AS3798 (2007), with testing to be provided by a NATA accredited testing authority.

For areas likely to be subjected to a loading of up to 20 kPa, fill material should be moisture conditioned and compacted to a minimum DI of 75% or DR of 98% SMDD, within 2% of Optimum Moisture Content (OMC). For areas loaded to greater than 20 kPa, the material should be moisture conditioned and compacted to a DI of 80% or DR of 100% SMDD, within 2% of OMC. For general fill areas, fill should be compacted to a DI of 70% or DR of 95% SMDD and moisture conditioned to be within 2% of OMC.

In addition to the above, consideration should be given to additional earthwork requirements/ mitigation measures to limit surface settlement as a result of long-term consolidation of subsurface clay soils and peat, e.g. soil improvement or pre-loading of development platform. Further associated site assessments and laboratory testing may be necessary.

4.7.3 Trafficability

Trafficability of site plant and haulage trucks on clayey sub-soils or loose to medium dense sands is expected to be poor, particualry when the material is wet. A cover of crushed concrete/ aggregate will likely be required in high trafficked areas.

4.7.4 Working platforms

Working platforms for construction plant, piling rigs and crane pads, placed on in-situ material or on new fill, should be designed by an experienced and qualified geotechnical engineer.

4.7.5 Material Re-use

Topsoil may be re-used on site for landscaping purposes only.

Excavated natural granular material, such as sand or silty/clayey sand, could be re-used on site for subgrade replacement and as general fill, subject to approval by a geotechnical engineer.

Clayey soils may be re-used on site as general fill. However, strict moisture conditioning and compaction close to the previously outlined specifications will be essential to limit soil movements due to the reactivity of the soil to changes in soil moisture content.

Over-excavated clayey soils that are over wet are considered unsuitable for re-use as fill material at the site and should be disposed of off-site.

4.7.6 Material Import

Imported granular fill material should comply with AS3798 (2007) and should not contain particles with dimension exceeding 2/3rds of the loose layer thickness or unsuitable material, such as:

- Organic soils, root affected soil, decaying vegetation or other deleterious substances;
- Materials contaminated through past site history;
- Silts or materials subject to volume change; and
- Material that contains wood, metal, plastic, boulders, soluble or perishable material.

4.7.7 Material Disposal

All material to be removed from site for off-site disposal, following treatment in accordance with the ASSMP, must be classified in accordance with NSW DEC (2009) Waste Classification Guidelines Part 1- Classifying Waste, confirming its suitability for re-use or for disposal at an appropriate licensed landfill facility. MA can assist in providing such classification, if required.

5 Adequacy and Additional Assessment Requirements

5.1 Site Suitable for Proposed Development

From a geotechnical perspective, we consider the site is suitable for the proposed development, subject to the recommendations outlined in this report. Recommendations of this report should be reviewed by MA in the context of final development details once this information becomes available (i.e. at CC stage) and with reference to the results of further assessments carried out for the site development.

5.2 Additional Assessment Requirements

We recommend the following additional assessments are carried out during development of final design and prior to issuing of a construction certificate to better manage geotechnical risks, where applicable:

- Settlement analyses for areas likely underlain by loose sand or clay and peat layers, susceptible to settlement/ consolidation upon loading as a result of proposed fill placement. The analyses should include further assessment of soil conditions, such as by cone penetrometer testing (CPT) and laboratory testing of clay/ peat soils.

- Assessment of foundation condition beneath future building platforms and infrastructure locations and up to at least 3m below pile foundation levels, as applicable.

- Laboratory testing of soil, as necessary, for more accurate assessment of subsurface conditions and associated design parameters, including shrink/swell and Atterberg Limit testing, and to confirm or alter preliminary site classifications and design assumptions.

- Assessment of site specific foundation material capacity considering adopted footing types.

- Review of construction staging plans by a geotechnical engineer.

- Further salinity assessments in keeping with final development details and earthwork requirements to delineate salinity conditions in soil profiles across the site and development areas and to assess potential ensuing implications on the proposed development and mitigation requirements. The assessments are to include laboratory

testing of site sub-soils to improve characterisation of site salinity conditions, particularly in proposed development areas.

- Assessment of pavement subgrade conditions along final road alignments, including laboratory soil testing, and of associated design parameters, such as CBR values.

- Detailed pavement designs in accordance with Austroads (2012) by further integrating preliminary and supplementary assessment results with final pavement details.

5.3 Proposed Monitoring and Inspection Program

To maintain site stability, limit adverse geotechnical impacts on site and surrounding areas and reduce the risk of sediment transport off-site due to erosion during site works, we recommend the following (Table 9) be monitored during site works.

Table 9: Recommended inspections/monitoring requirements during site works.

Scope of Works	Frequency/Duration	Who to Complete
Inspect excavation retention (shoring, retaining wall) installations and batters and monitor associated performance.	Daily/ As required.	Builder/ MA[1]
Monitor groundwater seepage from excavation faces to assess adequacy of drainage provision.	When encountered.	Builder/MA
Monitor sedimentation downslope of excavated areas.	During and after rainfall events.	Builder
Monitor sediment and erosion control structures to assess adequacy and for removal of built up spoil.	After rainfall events.	Builder
Inspect exposed material to verify suitability as foundation/ lateral support/ subgrade.	Prior to reinforcement set-up and concrete placement for footings, and prior to fill/ pavement material placement.	MA
Inspect subgrade treatment methodologies (to limit long-term settlement/ consolidation) during bulk filling and monitor associated performance, e.g. by means of survey or appropriate soil settlement gauges.	During construction; verification prior to approval for pavement construction or lot development.	Builder/ MA
Verify the suitability of ASS treatment by monitoring pH after oxidisation and laboratory testing of excavated soil and groundwater.	As outlined in MA report reference P1404136JR01V01.	Builder

Notes:

1. Martens & Associates geotechnical engineer

5.4 Contingency Plan

In the event that the proposed development works cause an adverse impact on site conditions or the surrounding environment, works shall cease immediately. The nature of the impact shall be documented and the reason(s) for the adverse impact investigated. This might require site inspection by a qualified geotechnical or structural engineer.

6 Limitations

Alluvial and marine environments are particularly variable due to their depositional history. Rapid changes in material type and condition can occur over short lateral distances. Recommendations outlined in this report must be observed to assist in mitigating against this variability.

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 any consequences where recommendations in this report are not implemented in full and properly tested, inspected and documented.

In the event that there are any significant changes to the development proposal described in this report, then all recommendations should be reviewed by Martens & Associates.

Occasionally sub-surface soil conditions between completed boreholes / test pits may be found to be different from those expected. This can also occur with groundwater conditions, especially after climatic changes. 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 any implications before recommencement.

This report was prepared by collating results of previous assessments and considering the current proposed development proposal. It is assumed that the data supplied by others is correct, unless otherwise stated. No responsibility is accepted for incomplete or inaccurate data. Any assessments made in this document are based on conditions indicated in published documents. No warranty is included, either express or implied, that actual conditions will conform exactly to the assessment contained in this document.

7 References

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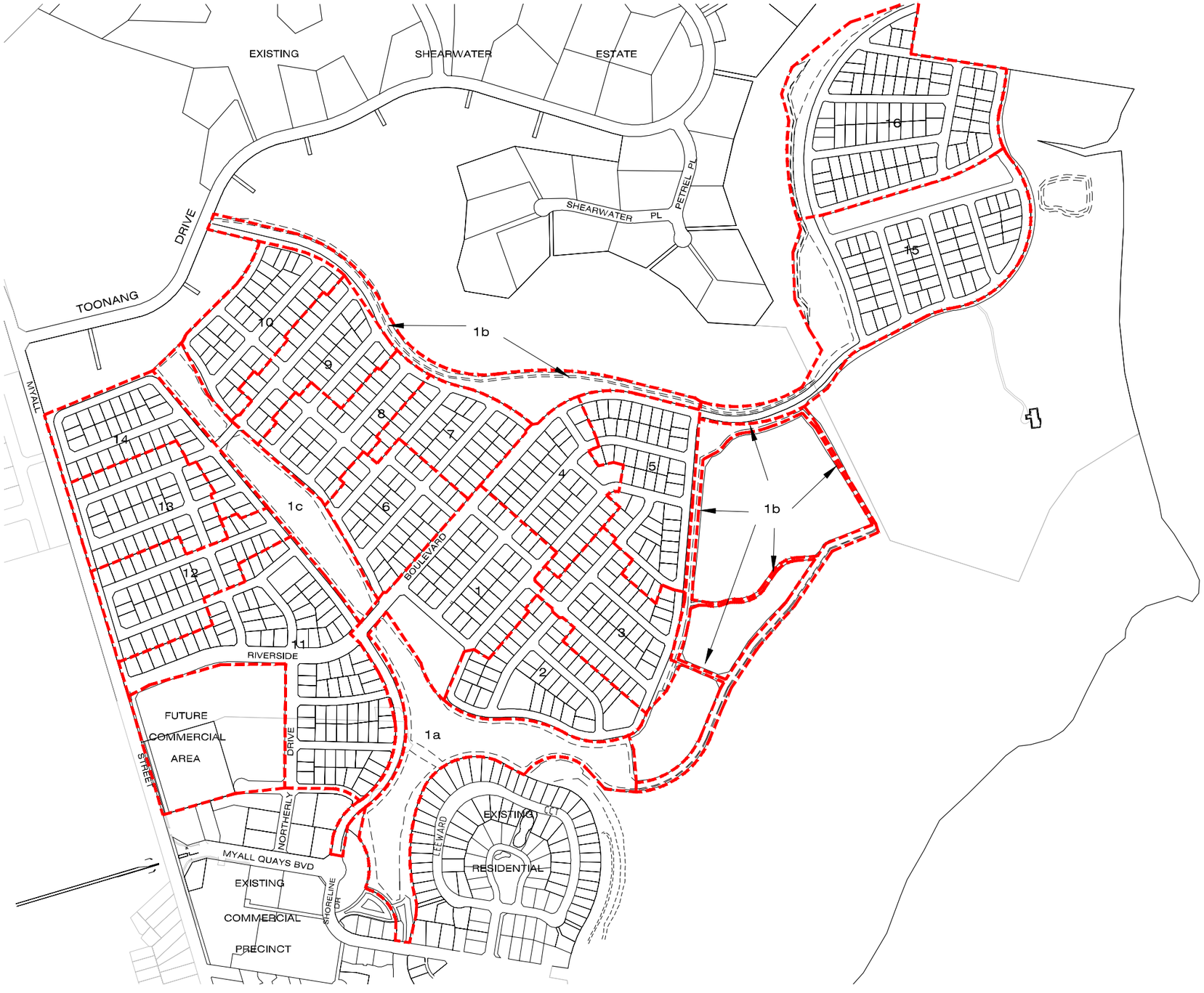
8 Attachment A – Staging Plan



STAGE	LOTS
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2	41
3	47
4	42
5	52
6	39
7	36
8	32
9	38
10	40
11	89
12	44
13	43
14	37
15	58
16	84
TOTAL	767

NOTE
PROPOSED DEVELOPMENT LAYOUT SOURCE: TATTERSALL LANDER P/L (AUGUST 2015)

PAGE BAR SCALE
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UNITS - METRES

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Martens & Associates Pty Ltd ABN 85 070 240 890

Environment | Water | Wastewater | Geotechnical | Civil | Management

Drawn:	KT
Approved:	RE
Date:	07.10.2015
Scale @ A3:	1:7500

STAGING PLAN
RIVERSIDE ESTATE, TEA GARDENS, NSW

Drawing No./ID:
Figure 1

Suite 201, 20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767
Email: mail@martens.com.au Internet: http://www.martens.com.au

Project:	File:	Revision:
P1404136	JD02V01	A

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9 Attachment B – Figures

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KEY

INDICATIVE SITE BOUNDARY

NOTE
PROPOSED DEVELOPMENT LAYOUT SOURCE: TATTERSALL LANDER P/L (AUGUST 2015)
MAP SOURCE: Central Mapping Authority of NSW (1976)
Port Stephens Topographic Map
9332-IV-S First Edition 1:25000 Series

PAGE BAR SCALE
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Martens & Associates Pty Ltd ABN 85 070 240 890	**Environment | Water | Wastewater | Geotechnical | Civil | Management**
Drawn: KT	**SITE LOCATION PLAN:** **RIVERSIDE ESTATE, TEA GARDENS, NSW**
Approved: RE	Drawing No./ID: **Figure 2**
Date: 07.09.2015	
Scale @ A3: 1:30000	

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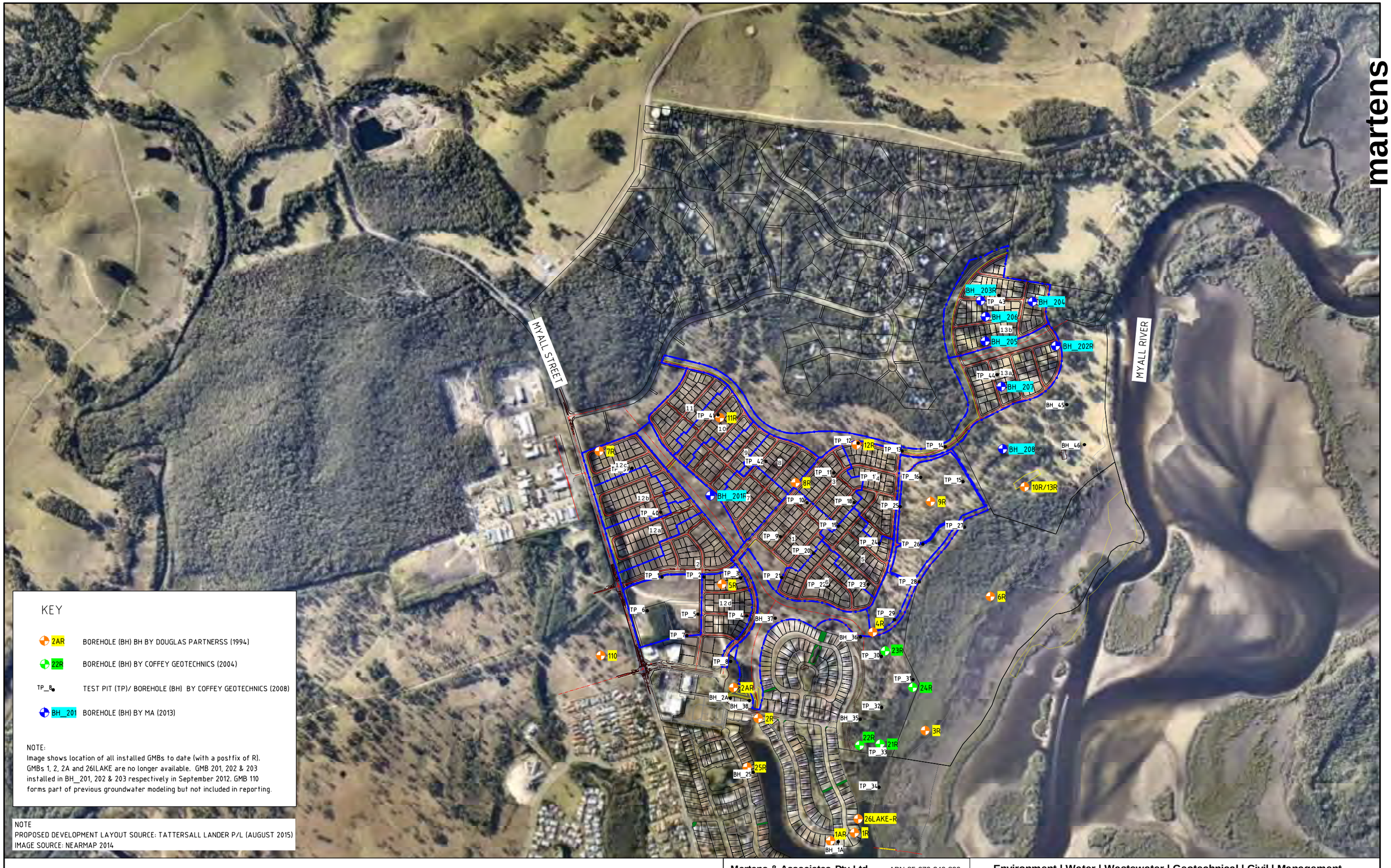
P1404136	JD02V01	A



KEY

2AR	BOREHOLE (BH) BH BY DOUGLAS PARTNERSS (1994)
22R	BOREHOLE (BH) BY COFFEY GEOTECHNICS (2004)
TP_8	TEST PIT (TP)/ BOREHOLE (BH) BY COFFEY GEOTECHNICS (2008)
BH_201	BOREHOLE (BH) BY MA (2013)

NOTE:
Image shows location of all installed GMBs to date (with a postfix of R). GMBs 1, 2, 2A and 26LAKE are no longer available. GMB 201, 202 & 203 installed in BH_201, 202 & 203 respectively in September 2012. GMB 110 forms part of previous groundwater modeling but not included in reporting.

NOTE
PROPOSED DEVELOPMENT LAYOUT SOURCE: TATTERSALL LANDER P/L (AUGUST 2015)
IMAGE SOURCE: NEARMAP 2014

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Environment | Water | Wastewater | Geotechnical | Civil | Management

Drawn:	KT
Approved:	RE
Date:	07.09.2015
Scale @ A3:	1:12000

BOREHOLE, TEST PIT AND GROUNDWATER MONITORING BORE LOCATION PLAN: RIVERSIDE ESTATE, TEA GARDENS, NSW

Drawing No./ID:
Figure 3

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P1404136	JD02V01	A

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Email: mail@martens.com.au Internet: http://www.martens.com.au

Drawn:	KT
Approved:	RE
Date:	07.09.2015
Scale @ A3:	1:7500

EXISTING SITE CONTOURS:
RIVERSIDE ESTATE, TEA GARDENS, NSW

Drawing No./ID:
Figure 4

Project:	File:	Revision:
P1404136	JD02V01	A

NOTE
BASED ON PREVIOUS SOIL LANDSCAPE MAPPING DONE BY MA (P0902346JR08V02)
PROPOSED DEVELOPMENT LAYOUT SOURCE: TATTERSALL LANDER P/L (AUGUST 2015)
IMAGE SOURCE: NEARMAP 2014

PAGE BAR SCALE
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UNITS - METRES

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Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	KT	**SOIL LANDSCAPES: RIVERSIDE ESTATE, TEA GARDENS, NSW**	Drawing No./ID: **Figure 5**
Approved:	RE		
Date:	07.09.2015		
Scale @ A3:	1:12000	Suite 201, 20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767 Email: mail@martens.com.au Internet: http://www.martens.com.au	Project: P1404136 | File: JD02V01 | Revision: A

10 Attachment C – Tables

Table 10: Soil profile summary.

Test ID	Soil Profile[1,2]			
	Topsoil Silty/clayey sand / Sandy/silty clay	Marine deposits Clay / sandy/silty clay / silty/clayey sand	Marine deposits Sand / silty sand	Residual soil Clay
Bore 13	0-0.5	NE	0.5-10.2	10.2-10.5
BH 21	0-0.1	NE	0.1-3.0	NE
BH 22	NE	NE	0-3.0	NE
BH 23	0-0.2	NE	0.2-3.1	NE
BH 24	0-0.3	NE	0.3-3.0	NE
TP1	0-0.3	0.3-0.6	0.6-1.9	NE
TP2	0-0.4	0.4-1.5	1.5-1.9	NE
TP3	0-0.5	0.5-0.8	0.8-1.8	NE
TP4	0-0.4	0.4-2.0	2.0-2.1	NE
TP5	0-0.4	0.4-0.75	0.75-1.9	NE
TP6	0-0.6	NE	0.6-2.1	NE
TP7	NE	0-1.0	NE	NE
TP8	0-0.6	0-0.6	NE	NE
TP9	0-0.6	0.6-1.1	1.1-2.0	NE
TP10	0-0.45	0.45-0.8	0.8-1.9	NE
TP11	0-0.2	0.2-1.0	1.0-1.9	NE
TP12	0-0.4	0.4-1.0	1.0-2.0	NE
TP13	0-0.6	NE	0.6-2.0	NE
TP14	0-0.4	NE	NE	0.4-1.8
TP15	0-0.5	NE	0.5-1.7	NE
TP16	0-0.25	NE	0.25-1.8	NE
TP17	0-0.5	0.5-1.1	1.1-2.0	NE
TP18	0-0.4	0.4-0.8	0.8-1.9	NE
TP19	0-0.35	0.35-1.2	1.2-1.8	NE
TP20	0-0.2	0.2-1.7	NE	NE
TP21	0-0.45	0.45-0.6	0.6-2.0	NE

Test ID	Soil Profile[1,2]			
	Topsoil Silty/clayey sand / Sandy/silty clay	Marine deposits Clay / sandy/silty clay / silty/clayey sand	Marine deposits Sand / silty sand	Residual soil Clay
TP22	0-0.5	0.5-0.8	0.8-1.9	NE
TP23	0-0.3	0.3-0.8	0.8-2.0	NE
TP24	0-0.4	0.4-0.7	0.7-2.0	NE
TP25	0-0.5	0.5-1.1	1.1-2.0	NE
TP26	0-0.3	NE	0.3-1.5	NE
TP27	0-0.6	0.6-0.8	0.8-1.8	NE
TP28	0-0.6	0.6-1.2	1.2-1.8	NE
TP29	0-0.5	0.5-1.4	1.4-1.7	NE
TP30	0-0.3	NE	0.3-1.7	NE
TP31	0-0.1	0.1-1.1	1.1-1.8	NE
TP32	0-0.3	0.3-1.7	NE	NE
TP33	0-0.25	0.25-1.9	1.9-2.0	NE
TP34	0-0.25	0.25-1.9	1.9-2.0	NE
BH35	NE	NE	0-4.0	NE
BH36	0-0.5	NE	0.5-7.0	NE
BH37	0-0.25	NE	0.25-7.0	NE
BH38	0-0.1	0.1-2.2	2.2-7.0	NE
TP39	0-0.15	0.15-1.4	1.4-1.7	NE
TP40	0-0.2	0.2-1.1	1.1-1.7	NE
TP41	0-0.3	0.3-1.5	1.5-2.5	NE
TP42	0-03	0.3-1-1	1.1-1.7	NE
TP43	NE	NE	0-1.85	NE
TP44	NE	NE	0-1.8	NE
BH45	NE	NE	0-10.45	NE
BH46	0-0.5	NE	0.5-7.45	NE
GMB1A	NE	NE	0-5.5	NE
GMB2A	NE	NE	0-7.0	NE

Test ID	Soil Profile[1,2]			
	Topsoil Silty/clayey sand / Sandy/silty clay	Marine deposits Clay / sandy/silty clay / silty/clayey sand	Marine deposits Sand / silty sand	Residual soil Clay
GMB25	NE	NE	0-5.5	NE
BH201	0-0.25	0.25-1.9	1.9-5.5	NE
BH202	0-0.1	NE	0.1-7.0	NE
BH203	0-0.2	0.2-1.2	1.2-7.0	NE
BH204	0-0.3	0.3-1.0	NE	NE
BH205	0-0.2	NE	0.2-1.0	NE
BH206	0-0.25	0.25-1.0	NE	NE
BH207	0-0.2	NE	0.2-0.7	NE
BH208	0-0.2	NE	0.2-1.0	NE

Notes:

1 Refer to borehole and test pit logs for more detailed material descriptions at test locations.

2 Indicative depth range below ground level.

Table 11: Groundwater quality summary.

Source	Sample date		GMB1	GMB2	GMB3	GMB4	GMB5	GMB6	GMB7	GMB8	GMB9	GMB10	GMB11	GMB12	GMB13	GMB21	GMB22	GMB23	GMB24	GMB1A	GMB2A	GMB25	Lake 26	Lake	GMB201	GMB202	GMB203
Coffey (Feb, 1996)	Average result 13/12/94 to 29/8/1995	pH	6.40	5.30	6.20			6.00				5.60	6.00	5.30													
		TDS (mg/L)	490.00	190.00	13900.00			1900.00				420.00	2300.00	220.00													
		Chloride (mg/L)	220.00	82.00	7600.00			1100.00				150.00	1200.00	60.00													
		Sulphate (mg/L)	33.00	16.00	1200.00			170.00				5.00	170.00	25.00													
		Magnesium (mg/L)	36.00	6.00	540.00			76.00				8.40	85.00	5.20													
		Calcium (mgLL)	9.00	1.20	160.00			33.00				7.20	22.00	2.20													
Coffey (Oct, 2007)	29/03/2007	pH				5.32								5.02		5.62	6.05	5.60	5.46								
		TDS (mg/L)				155.00								1210.00		11500.00	1350.00	212.00	2250.00								
		Chloride (mg/L)				50.40								64.60		5300.00	430.00	58.70	800.00								
		Sulphate (mg/L)				10.00								22.00		702.00	39.00	6.00	344.00								
		Magnesium (mg/L)				4.00								6.00		420.00	23.00	7.00	54.00								
		Calcium (mgLL)				2.00								2.00		126.00	11.00	3.00	31.00								
		EC (us/cm)				202.00								268.00		15500.00	1610.00	234.00	2730.00								
		TN (mg/L)				0.93								3.07		12.13	7.24	2.51	9.33								
		TP (mg/L)				0.14								0.76		1.38	0.79	0.32	1.12								
Coffey (Oct, 2007)	30/03/2007	pH									3.99													5.83			
		TDS (mg/L)									200.00													129.00			
		Chloride (mg/L)									34.40													37.40			
		Sulphate (mg/L)									13.00													12.00			
		Magnesium (mg/L)									3.00													3.00			
		Calcium (mgLL)									1.00													8.00			
		EC (us/cm)									178.00													182.00			
		TN (mg/L)									2.53													0.72			
		TP (mg/L)									1.00													0.08			
Martens and Associates (July, 2009)	6/07/2009	pH									4.30							5.70		6.20	5.10	5.60	6.30				
		TDS (mg/L)									96.00							180.00		170.00	120.00	160.00	11000.00				
		Chloride (mg/L)									37.00							65.00		30.00	50.00	25.00	5800.00				
		Sulphate (mg/L)									5.00							5.00		39.00	5.00	5.00	850.00				
		Magnesium (mg/L)									2.90							7.80		8.20	3.40	4.40	360.00				
		Calcium (mgLL)									0.30							3.60		5.60	1.20	3.60	110.00				
		EC (us/cm)									160.00							280.00		280.00	200.00	260.00	14000.00				
		TN (mg/L)									1.00							0.60		7.10	3.80	30.00	0.60				
		TP (mg/L)									1.90							0.05		6.10	2.80	1.20	0.05				
Martens and Associates (Sept, 2012)	4/09/2012	pH			6.7	6.20	6.30	6.40		5.80	4.00		6.10									6.30	7.30				
		TDS (mg/L)			7300	120.00	200.00	3500.00		200.00	160.00		2800.00									130.00	10000.00				
		Chloride (mg/L)			5500	75.00	49.00	1700.00		62.00	27.00		1300.00									36.00	4900.00				
		Sulphate (mg/L)			760	4.00	10.00	210.00		20.00	1.00		170.00									1.00	600.00				
		Magnesium (mg/L)			370	6.10	2.10	130.00		4.80	3.10		77.00									4.20	300.00				
		Calcium (mgLL)			110	2.40	0.90	49.00		2.80	0.50		18.00									4.20	97.00				
		EC (us/cm)			18000	320.00	260.00	6400.00		310.00	170.00		4700.00									240.00	16000.00				
		TN (mg/L)			2.2	1.90	1.90	0.90		1.90	2.80		0.70									5.30	0.90				
		TP (mg/L)			0.05	0.05	0.09	0.05		0.10	1.30		0.50									0.20	0.05				
Martens and Associates (Sept, 2012)	27/09/2012	pH					5.80	5.70	5.50	5.20	4.10	6.00	5.60												5.30	5.40	5.30
		TDS (mg/L)					180.00	4900.00	120.00	160.00	150.00	160.00	2700.00												65.00	1200.00	110.00
		Chloride (mg/L)					44.00	2900.00	38.00	71.00	29.00	53.00	1400.00												640.00	18.00	43.00
		Sulphate (mg/L)					10.00	360.00	7.00	24.00	1.00	3.00	180.00												26.00	5.00	5.00
		Magnesium (mg/L)					1.50	170.00	3.70	5.00	3.10	10.00	87.00												42.00	1.90	4.00
		Calcium (mgLL)					0.60	67.00	3.60	3.10	0.50	6.20	21.00												13.00	1.70	1.10
		EC (us/cm)					230.00	8400.00	200.00	320.00	170.00	300.00	4600.00												2000.00	110.00	190.00
		TN (mg/L)					1.10	1.20	3.00	1.60	1.90	1.60	0.70												9.90	3.30	4.10
		TP (mg/L)					0.05	0.05	0.20	0.30	1.30	0.10	0.07												1.20	0.30	0.60

Value is less than laboratory PQL

11 Attachment D – Borehole and Test Pit Logs

Coffey Partners International Pty. Ltd.
ACN 003 692 019

engineering log - excavation

COFFEY

pit no
PIT 1
sheet 1 of 1

office job no: G398/1

client:	PATTERSON BRITTON	pit commenced:	11/8/95
principal:	CRIGHTON PROPERTIES PTY LTD	pit completed:	11/8/95
project:	MYALL QUAYS RESIDENTIAL DEVELOPMENT	logged by:	GNR
pit location:	10m north of Bore 10; 10m south of Bore 13	checked by:	
equipment type and model:	BACKHOE	R.L. Surface:	NOT MEASURED
excavation dimensions:	10 m long 10 m wide	orientation:	datum: NOT MEASURED

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics; colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		Nil	▽		0		PT	TOPSOIL: black to dark grey, sandy peat, wood fragments, strong organic odour	D	L		
							SP	SAND: fine to medium grained, subangular to well rounded, grey, slightly greasy, slight odour	W			
					1							
					2			Pit PIT 1 Terminated at 2.00 m due to refusal at shallow indurated layer Termination depth approximate. Note: Inflow water very dirty; strong organic odour				
					3							
					4							
					5							
					6							
					7							
					8							

COFEXCA VERSION B2

10 /11 /95 15 :48 :29

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools

SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 — little resistance ranging to very slow progress

WATER
D none observed
✕ not measured
▽ water level
water outflow
water inflow

SAMPLES, TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

CONSISTENCY/DENSITY INDEX
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty. Ltd.
ACN 003 692 019

engineering log - borehole

borehole no: BORE 13
sheet 1 of 2

office job no: G398/1

client:	PATTERSON BRITTON & PARTNERS PTY LTD	hole commenced:	11/8/95
principal:	CRIGHTON PROPOERTIES PTY LTD	hole completed:	11/8/95
project:	MYALL QUAYS RESIDENTIAL DEVELOPMENT	logged by:	GNR
borehole location:	20m north of Bore 10	checked by:	
drill model and mounting:	Bobcat mounted rig; hollow flight augers	slope:	-90 DEG
hole diameter:	150mm	bearing:	
R.L. Surface:	NOT MEASURED	datum:	NOT MEASURED

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
ASB		NIL	11/8/95 ▽		0		PT	TOPSOIL: black to dark grey, sandy peat, wood fragments, strong organic odour	D	L		Backfill 0.0-5.5m
							SP	SAND: fine to medium grained, grey, subangular to well rounded, slightly greasy, slight odour	M	L		
					1							
					2							
							SP	SAND: fine to medium grained, grey, subangular to well rounded, indurated layer				
					3							
							SP	SAND: fine to medium grained, grey, subangular to well rounded, slightly greasy, slight odour				
					4							
					5							Bentonite seal 5.5-6.5m
					6		SP	SAND: fine to medium grained, grey, subangular to well rounded, indurated layer				
							SP	SAND: fine to medium grained, grey, subangular to well rounded, slightly greasy, slight odour				Filter pack 6.5-10.5m
					7							
					8							

COFBORE VERSION B2
10 /11 /95 15 :43 :3

METHOD
- AS auger screwing*
- AD auger drilling*
- RR roller/tricone
- W washbore
- CT cable tool
- HA hand auger
- DT diatube
- *bit shown by suffix
- B blank bit
- V V bit
- T TC bit
- e.g. ADT

SUPPORT
- Nil no support
- M mud
- C casing

PENETRATION
1 2 3 4 — little resistance ranging to very slow progress

WATER
- * not measured
- D none observed
- ▽ water level
- water outflow
- water inflow

SAMPLES, TESTS, ETC
- U undisturbed sample (mm)
- D disturbed sample
- Bs bulk sample
- E environmental sample
- N standard penetration test:
- Nx SPT + sample recovered
- Nc SPT with solid cone
- VS vane shear
- PM pressuremeter
- DP dynamic penetrometer
- WS water sample
- PZ piezometer

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

CONSISTENCY/DENSITY INDEX

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Coffey Partners International Pty. Ltd.
ACN 003 692 019

engineering log - borehole

borehole no: BORE 13
sheet 2 of 2

office job no: G398/1

client:	PATTERSON BRITTON & PARTNERS PTY LTD	hole commenced:	11/8/95
principal:	CRIGHTON PROPOERTIES PTY LTD	hole completed:	11/8/95
project:	MYALL QUAYS RESIDENTIAL DEVELOPMENT	logged by:	GNR
borehole location:	20m north of Bore 10	checked by:	RJB
drill model and mounting:	Bobcat mounted rig; hollow flight augers	slope:	-90 DEG
hole diameter:	150mm	bearing:	
R.L. Surface:	NOT MEASURED	datum:	NOT MEASURED

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
ASB						9		SP	SAND: fine to medium grained, grey, subangular to well rounded, slightly greasy, slight odour	M	L		
						10		SC	CLAYEY SAND: medium to coarse subangular quartz in clay matrix, low plasticity, grey, weathered basement, possibly sandstone		S		
									Borehole BORE 13 Terminated at 10.50 m				
						11							
						12							Piezometer Construction: casing 0-10.5m; screen 7.5-10.5m; stickup 0.15m
						13			Sandstone basement confirmed by examination of recovered rock fragments.				
						14			Note: indurated layers indicated by change in penetration rate; samples returned do not indicate changes in lithology				
						15							
						16							

COFBORE VERSION B2
10/11/95 15:43:13

METHOD
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
*bit shown by suffix
B blank bit
V V bit
T TC bit
e.g. ADT

SUPPORT
Nil no support
M mud
C casing

PENETRATION
1 2 3 4
little resistance
ranging to
very slow progress

WATER
X not measured
D none observed
water level
water outflow
water inflow

SAMPLES, TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
N standard penetration test:
Nx SPT + sample recovered
Nc SPT with solid cone
VS vane shear
PM pressuremeter
DP dynamic penetrometer
WS water sample
PZ piezometer

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

CONSISTENCY/DENSITY INDEX
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TB7-230

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP 1**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.586

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information							material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5				**TOPSOIL:** SAND, fine to medium grained, dark brown with approximately 30% low plasticity fines, with 300mm of rootlets.	M			TOPSOIL
				D	2.0	0.5		CI	**Sandy CLAY:** medium plasticity, dark brown-orange, sand fine to medium grained.				
								SP	**SAND:** fine to medium grained, pale grey-white.		VD		
				D	1.5	1.0							
									Becoming pale grey-brown.	W			
				D	1.0	1.5							
			04-04-07 8:54am		0.5	2.0			Test pit TP 1 terminated at 1.9m				
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP 2**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.433

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N							**TOPSOIL:** Silty Clayey SAND, fine to medium grained, dark brown with approximately 30% of low plasticity fines, with approximately 300mm of rootlets.	M			TOPSOIL
				D	2.0	0.5		CI	**Sandy CLAY:** medium plasticity, dark brown-orange, with some sand lenses.	M/W	St	x	
			04-04-07 9:13am	D	1.5	1.0						x	
					1.0	1.5		SP	**SAND:** fine to medium grained, brown-dark grey.	W			
				D									Rapid inflow of groundwater and pit collapsing below 1.7m depth.
					0.5	2.0			Test pit TP 2 terminated at 1.9m				
					0.0	2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TESTPIT 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

Form GEO 5.2 Issue 3 Rev.2

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Engineering Log - Excavation

Excavation No. TP 3

Sheet 1 of 1

Project No: GEOTSGTE20248AA

Client: TATTERSALL SURVEYORS PTY LTD

Date started: 4.4.2007

Principal:

Date completed: 4.4.2007

Project: RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS

Logged by: CW

Test pit location: REFER TO FIGURE 1

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.571

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5				**TOPSOIL:** Silty Clayey SAND, fine to coarse grained, pale brown-brown, low plasticity fines with some rootlets to 300mm.	M			TOPSOIL
				D	2.0	0.5		SC	**Clayey SAND:** fine to medium grained, orange-brown / pale brown, low plasticity fines.		VD		
						1.0		SP	**SAND:** fine to coarse grained to fine to medium grained, pale grey-white.	M/W			
				D	1.5				Becoming pale brown-white.				
			▼ 04-04-07		1.0	1.5							Rapid inflow of groundwater and pit collapsing below 1.7m depth.
				D					Becoming white.				
					0.5	2.0			Test pit TP 3 terminated at 1.8m				
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP 4**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.260

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.0 / 0.5			**TOPSOIL:** Silty CLAY, medium plasticity, dark grey-black, small percentage of sand <10% with some rootlets.	M			TOPSOIL
				D	1.5 / 1.0		CH	**CLAY:** medium to high plasticity, dark grey.	M>Wp	St	x x x	
				D	1.0 / 1.5							
			▼ 05-04-07 12:12pm		0.5 / 2.0						x x x x x x	
				D			SP	**SAND:** fine to coarse grained, pale grey.	W			Rapid inflow of groundwater at 2.0m depth.
					0.0 / 2.5			Test pit TP 4 terminated at 2.1m				

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP 5**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.765

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	04-04-07 8:35am	D	2.5	0.5			**TOPSOIL:** SAND, fine to medium grained, dark brown, with low plasticity fines, approximately 30% fines with some rootlets to approximately 150mm.	M			TOPSOIL
								CI	**Sandy CLAY:** medium plasticity, orange-brown, sand fine to medium grained.		VSt		
				D	2.0	1.0		SP	**SAND:** fine to medium grained, pale grey-white. Becoming pale grey-brown.		VD		
				D	1.5	1.5							
				D	1.0					W			Rapid groundwater inflow below 1.7m depth.
					0.5	2.0			Test pit TP 5 terminated at 1.9m				
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP 6**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.846

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5 / 0.5			**TOPSOIL:** Silty SAND, fine to medium grained, dark grey mottled white, with some rootlets and roots to 150mm.	D			TOPSOIL
				D			SM	**Silty SAND:** fine to medium grianed, brown / red cemented sand nodules.	M	VD		INDURATED SAND?
				D	2.0 / 1.0							
			▼ 05-04-07 12:33pm		1.5 / 1.5		SP	**SAND:** fine to medium grained, pale brown-white with some cemented sand nodules.				
					1.0 / 2.0			Becoming pale grey-white.	W			
								Lenses of cemented sand nodules dark brown-red present.				Water visible. Pit collapsing due to groundwater.
					0.5 / 2.5			Test pit TP 6 terminated at 2.1m				

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. TP 7

Sheet 1 of 1

Project No: GEOTSGTE20248AA

Client: TATTERSALL SURVEYORS PTY LTD

Date started: 13.4.2007

Principal:

Date completed: 13.4.2007

Project: RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS

Logged by: JJT

Test pit location: REFER TO FIGURE 1

Checked by:

equipment type and model:

Pit Orientation:

Easting: m

R.L. Surface: 2.388

excavation dimensions: m long m wide

Northing: m

datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HA		N			2.0	0.5		CH	**Sandy CLAY:** high plasticity, dark brown, sand fine to medium grained.	M			
			▼	D									
					1.5			SC	**Clayey SAND:** fine to medium grained, grey.		VD		
				D		1.0				W			
									Hole terminated at 1.0m, hole collapsing because of groundwater. Test pit TP 7 terminated at 1m				
					1.0	1.5							
					0.5	2.0							
					0.0	2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- ▼ water level on date shown
- ► water inflow
- ◄ water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP 8**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **13.4.2007**

Principal:

Date completed: **13.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **JJT**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: | Pit Orientation: | Easting: m | R.L. Surface: 3.184

excavation dimensions: m long m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HA		N	Not Measured	D	3.0	0.5		SP	Clayey SAND: fine to medium grained, black.	M	D		
					2.5	1.0			Hole terminated at 0.6m, sand too dry to retrieve. Test pit TP 8 terminated at 0.6m				
					2.0	1.5							
					1.5	2.0							
					1.0	2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP 9**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.735

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5	0.5			TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey, low plasticity fines, with some rootlets and thick roots to 100mm.	M			TOPSOIL
				D				SC	Clayey SAND: fine to medium grained, dark brown-black, low plasticity fines with some black cemented sand nodules up to approximately 0.13m diameter.		D/VD		
				D	2.0	1.0		SP	SAND: medium to coarse grained, pale grey-white.				
			▼ 04-04-07 10:41am		1.5	1.5			Becoming pale grey-brown.	W			Groundwater inflow below 1.8m depth.
				D	1.0	2.0							
					0.5	2.5			Test pit TP 9 terminated at 2m				

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP10**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.585

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	None Observed		2.5 / 0.5			TOPSOIL: Clayey SAND, fine to medium grained, brown, low plasticity fines, with some rootlets and roots (10-30mm thick) to approximately 450mm.	M			TOPSOIL
				D	2.0 / 1.0		SC	Clayey SAND: fine to medium grained, pale brown, with some cemented sand nodules, low plasticity fines.		MD		
							SP	SAND: fine to medium grained, pale grey-white.		D		
				D	1.5 / 1.5					VD		
				D	1.0 / 2.0			One big, 0.7mm dia., cemented sand nodule.	W			No obvious groundwater level or inflow but pit collapsing.
					0.5 / 2.5			Test pit TP10 terminated at 1.9m				

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP11**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: *TATTERSALL SURVEYORS PTY LTD*

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: *RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS*

Logged by: **CW**

Test pit location: *REFER TO FIGURE 1*

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.732

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5	0.5			**TOPSOIL:** Silty SAND, fine to medium grained, grey-brown, low plasticity fines? with some rootlets.	M			TOPSOIL
								SC	**Clayey SAND:** fine to medium grained, pale grey-brown, low plasticity fines.		VD		
				D		0.5		SC	**Clayey SAND:** fine to medium grained, orange-brown, dark brown-black, low plasticity fines, with cemented sand nodules up to approximately 0.13mm dia.				
					2.0								
				D		1.0		SP	**SAND:** fine to coarse grained, pale grey-brown.	W			
					1.5								
						1.5			Colour change.				
				D	1.0								
			04-04-07 11:15am			2.0			Test pit TP11 terminated at 1.9m				
					0.5								
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP12**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: *TATTERSALL SURVEYORS PTY LTD*

Date started: *4.4.2007*

Principal:

Date completed: *4.4.2007*

Project: *RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS*

Logged by: *CW*

Test pit location: *REFER TO FIGURE 1*

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 3.126

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			3.0				**TOPSOIL:** Silty Clayey SAND, fine to medium grained, dark grey, low plasticity fines, with some rootlets to approximately 350mm.	M			TOPSOIL
						0.5		SC	**Clayey SAND / Sandy CLAY:** fine to medium grained, dark grey-brown, medium plasticity fines.		St	x x	
				D	2.5			CL	**Sandy CLAY:** low to medium plasticity, orange-brown, sand fine to medium grained.				
						1.0		SP	**SAND:** fine to coarse grained, pale grey-white.		VD		
				D	2.0								
						1.5			Becoming pale grey-brown.				
				D	1.5								
			04-04-07 11:30am		1.0				Test pit TP12 terminated at 2m				
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP13**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.825

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information							material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5	0.5			**TOPSOIL:** Silty SAND, fine to medium grained, dark grey-black with some rootlets and roots (10-30mm thick).	D/M			TOPSOIL
				D				SM	**Silty SAND:** dark brown-dark red, fine to medium grained, with cemented sand nodules to 0.16mm dia.	M	VD		Bucket scraping on hard layer.
			04-04-07 11:51am	D	2.0	1.0			Becoming brown-pale brown cemented nodules of sand still present.				
				D	1.5	1.5			Becoming dark brown-brown weakly cemented nodules present.	W			
					1.0	2.0			Test pit TP13 terminated at 2m				
					0.5	2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP14**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.760

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information						material substance					
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5 / 0.5			TOPSOIL: Silty CLAY, medium plasticity fines, brown with some rootlets approximately 400mm.				TOPSOIL
				D	2.0 / 1.0		CH	CLAY: high plasticity, brown-dark brown.		VSt		
				D	1.5 / 1.5			Becoming dark grey-black with some mottled orange.				
				D	1.0 / 2.0			Test pit TP14 terminated at 1.8m				
					0.5 / 2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation No. **TP15**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.355

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.0	0.5			TOPSOIL: Silty (Clayey) SAND, fine to medium grained, dark grey-black, with some roots 10mm and rootlets to approximately 400mm.	M			TOPSOIL
				D				SP	**SAND:** fine to coarse grained, pale grey-brown, small percent of fines <20%.	M/W	D/VD		
					1.5	1.0			Becoming pale grey mottled black and white.				
				D									
					1.0	1.5							Pit collapsing no groundwater observed.
				D									
					0.5	2.0			Pit collapsing. Test pit TP15 terminated at 1.7m				
					0.0	2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP16**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.683

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
BH		N			2.5				**TOPSOIL:** Silty SAND, fine to medium grained, dark grey-black mottled white, with some rootlets.	D			TOPSOIL
						0.5		SP	**SAND:** fine to medium grained, pale grey-brown.	M	D		
				D	2.0								
						1.0					VD		
				D	1.5					M/W			
			04-04-07 12:54pm			1.5							
				D	1.0			SP	**SAND:** fine to medium grained, dark grey-black, cemented sand nodules, coffee rock.	W			INDURATED SAND
									Pit collapsing.				
						2.0			Test pit TP16 terminated at 1.8m				
					0.5								
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation No. **TP17**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.635

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information							material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
BH		N			2.5	0.5			**TOPSOIL:** Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, low plasticity fines, with some rootlets.	D			TOPSOIL
				D	2.0			SC	**Silty Clayey SAND:** fine to medium grained, dark brown / red, low to medium plasticity fines, with cemented nodules of SAND.	M	VD		
						1.0		SC	**Clayey SAND:** fine to medium grained, brown-pale brown, low plasticity fines, with weakly cemented nodules of sand.				
				D	1.5			SP	**SAND:** fine to coarse grained, pale grey-pale brown.				
			05-04-07 10:53am			1.5							
					1.0				Becoming grey-brown.	W			Rapid inflow of groundwater below 1.7m depth.
				D		2.0							
					0.5				Pit collapsing. Test pit TP17 terminated at 2m				
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation No. **TP18**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.302

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
BH		N			2.0	0.5			**TOPSOIL:** Sandy CLAY, low to medium plasticity, dark brown-black, sand fine to medium grained, with some rootlets to 100mm.	M			TOPSOIL
				D				CI	**CLAY:** medium plasticity, dark grey mottled orange, with minor sand component approximately 10%.		VSt	x	
					1.5			SC	**Clayey SAND:** fine to medium grained, grey, low plasticity fines.		D		
						1.0		SP	**SAND:** fine to coarse grained, pale grey-white. Becoming grey / brown.		VD		
				D	1.0								
			05-04-07 10:35am			1.5							
				D	0.5				Sand becoming indurated and dark brown / red.	W			
					0.0	2.0			Pit collapsing due to inflow of groundwater, collapsing from sides. Test pit TP18 terminated at 1.9m				
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation No. **TP19**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.261

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.0	0.5			TOPSOIL: Clayey SAND, fine to medium grained, dark brown-black, low plasticity fines with some rootlets.	D			TOPSOIL
				D				CH	Sandy CLAY: medium to high plasticity, dark brown-black, sand fine to coarse grained.				
					1.5	1.0							
				D					Becoming dark grey-grey.				
			▼ 04-04-07 2:31pm		1.0	1.5		SP	SAND: fine to coarse grained, pale grey-white.	W	VD		
				D	0.5				Becoming pale brown / grey.				
						2.0			Pit collapsing due to groundwater. Test pit TP19 terminated at 1.8m				
					0.0	2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

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Engineering Log - Excavation

Excavation No. **TP20**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: *TATTERSALL SURVEYORS PTY LTD*

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: *RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS*

Logged by: **CW**

Test pit location: *REFER TO FIGURE 1*

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.255

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
BH		N			2.0	0.5			**TOPSOIL:** Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, with some rootlets.	D			TOPSOIL
								CL	**Sandy CLAY:** low plasticity, dark brown-red, sand fine to medium grained, trace of rootlets and cemented sand nodules.	M			
								CL	**Sandy CLAY:** low to medium plasticity, pale grey-pale brown mottled orange, sand fine to medium grained.				
				D	1.5	1.0				M/W			
			04-04-07 2:15pm	D	1.0	1.5			Becoming pale brown / grey.				
				D									
					0.5	2.0			Pit collapsing due to groundwater. Test pit TP20 terminated at 1.7m				
					0.0	2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation No. **TP21**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.675

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information							material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
BH		N			2.5	0			**TOPSOIL:** Silty Clayey SAND, fine to medium grained, dark grey, low plasticity fines with some rootlets and some thick roots to 300mm.	M			TOPSOIL
				D		0.5		SC	**Clayey SAND:** fine to medium grained, orange-pale brown, low plasticity fines with some cemented red sand nodules.		VD		
					2.0			SP	**SAND:** fine to medium grained, pale grey-white.				
				D	1.5	1.0							
			04-04-07			1.5			Becoming pale brown-pale grey.				
					1.0					W			Rapid groundwater inflow below 1.7m depth.
				D		2.0			Test pit TP21 terminated at 2m				
					0.5								
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation No. **TP22**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.332

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.0	0.5			**TOPSOIL:** Sandy CLAY, low to medium plasticity, dark brown-black, sand fine to medium grained, with some rootlets.	D			TOPSOIL
				D				CI	**CLAY:** medium plasticity, dark brown-black, with some sand component approximately 30%.	M			
					1.5	1.0		SM	**Silty SAND:** fine to medium grained, brown-pale brown, with some cemented sand nodules.		D		
				D							VD		
					1.0	1.5		SP	**SAND:** fine to medium grained, pale grey-white. Becoming pale grey / brown.	M/W			
			04-04-07 2.50m	D	0.5								
					0.0	2.0			Pit collapsing due to groundwtaer inflow. Test pit TP22 terminated at 1.9m				
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation No. **TP23**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.090

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	None Observed		2.0 / 0.0			**TOPSOIL:** Silty Clayey SAND, fine to medium grained, dark grey-black, low plasticity fines, with some rootlets to 300mm.	D			TOPSOIL
					0.5		SC	**Clayey SAND:** fine to medium grained, dark grey-black, low to medium plasticity fines.				
					1.5		CL	**Sandy CLAY:** low to medium plasticity, pale brown / orange, sand fine to medium grained.	M			
				D			SC	**Clayey SAND:** fine to medium grained, pale grey / pale brown, low plasticity fines.		VD		
					1.0		SP	**SAND:** fine to coarse grained, pale grey-white.				
				D	1.0 / 0.5							
					1.5			Becoming grey / brown.	W			No visible water, but pit collapsing below 1.7m depth.
				D	2.0							
					0.0 / 2.5			Test pit TP23 terminated at 2m				

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TESTPIT 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

Form GEO 5.2 Issue 3 Rev.2

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Engineering Log - Excavation

Excavation No. **TP24**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.177

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.0				TOPSOIL: Sandy CLAY, low to medium plasticity, sand fine to medium grained, with some rootlets to 100mm.	M		x x x	TOPSOIL
				D		0.5		CL	**Sandy CLAY:** low to medium plasticity, orange, sand fine to coarse grained.				
					1.5			SP	**SAND:** fine to medium grained, pale grey-white mottled orange.		D		
				D		1.0					VD		
			05-04-07 11:44am		1.0								
						1.5							
					0.5								
				D		2.0			Lenses of colour change to pale grey / brown, with some clay lenses.	W			
					0.0				Pit collapsing from groundwater table. Test pit TP24 terminated at 2m				
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TESTPIT 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

Form GEO 5.2 Issue 3 Rev.2

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Engineering Log - Excavation

Excavation No. **TP25**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.611

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5 / 0.5			**TOPSOIL:** Silty SAND, fine to medium grained, dark grey mottled white with some rootlets and roots (10mm) to 150mm.	D			TOPSOIL
				D	2.0 / 1.0			**Silty SAND:** fine to medium grained, dark grey-black, cemented nodules of SAND.	M	D / VD		INDURATED SAND
			05-04-07 11:08am	D	1.5 / 1.5			100mm band of pale grey-pale brown and then becoming grey-brown weakly cemented sand nodules.	W			
				D	1.0 / 2.0			Becoming dark brown / red weakly sand nodules.				Rapid inflow of groundwater below 1.9m depth.
					0.5 / 2.5			Test pit TP25 terminated at 2m				

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP26**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 1.709

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
BH		N			1.5	0.5			**TOPSOIL:** Silty Sandy CLAY, medium plasticity, dark grey-black, sand fine to medium grained, with some rootlets to 100mm.	M			TOPSOIL
				D	1.0	1.0		SP	**SAND:** fine to coarse grained, pale grey-white.		D		
				D	0.5				Becoming pale brown / grey.				
				D	0.0	1.5			Pit collapsing due to groundwater. Test pit TP26 terminated at 1.5m				
					-0.5	2.0							
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP27**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 1.536

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information							material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N				0.5			**TOPSOIL:** Silty (Clayey) SAND, fine to medium grained, dark grey-black, with some rootlets to 200mm.	D			TOPSOIL
				D	1.0			SM	**Silty SAND:** fine to medium grained, dark brown, with some cemented sand nodules.	M	VD		
						1.0		SP	**SAND:** fine to coarse grained, brown / grey, with small percent of fines approximately 20-30% possibly clay lenses or nodules.				
			04-04-07 3:46pm	D	0.5								
						1.5			Becoming pale grey-white.	M/W			
				D	0.0				Becoming pale grey / brown.				
					-0.5	2.0			Pit collapsing due to groundwater inflow. Test pit TP27 terminated at 1.8m				
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP28**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **4.4.2007**

Principal:

Date completed: **4.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.012

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N				0.5			**TOPSOIL:** Silty SAND, fine to medium grained, dark grey-black, with some rootlets.	D			TOPSOIL
				D	1.5			SM	**Silty SAND:** fine to medium grained, dark brown-black / red, cemented sand nodules.	M	D		
				D	1.0	1.0							
			04-04-07 3:31pm					SP	**SAND:** fine to coarse grained, pale brown / grey.	W			
				D	0.5	1.5			Becoming brown / grey mottled orange.				
					0.0	2.0			Test pit TP28 terminated at 1.8m				
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation No. **TP29**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.170

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.0				**TOPSOIL:** Silty SAND, fine to medium grained, dark brown-black, with some rootlets.	D			TOPSOIL
				D		0.5			**Silty SAND:** fine to medium grianed, pale grey / pale brown.		D		
					1.5			SC	**Clayey SAND:** fine to medium grained, pale brown, low plasticity fines.	M			
				D	1.0	1.0							
						1.5		SP	**SAND:** fine to medium grained, pale grey-white.	W			
				D	0.5								
			05-04-07 3:12pm						Pit collapsing. Test pit TP29 terminated at 1.7m				
					0.0	2.0							
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

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Engineering Log - Excavation

Excavation No. **TP30**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: *TATTERSALL SURVEYORS PTY LTD*

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: *RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS*

Logged by: **CW**

Test pit location: *REFER TO FIGURE 1*

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 1.159

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
BH		N			1.0				TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, low plasticity fines, some rootlets 300mm and roots to 300mm.	D			TOPSOIL
			05-04-07 ▼			0.5		SP	SAND: fine to coarse grained, pale grey-white.	W	MD		Some inflow of groundwater to pit at 0.3m, 8:05am, pit slowly collapsing from sides, organic odour.
				D	0.5						D		
						1.0			Becoming pale brown-grey.				
				D	0.0								
						1.5			Becoming dark brown-red, with some cemented sand nodules.				
				D	-0.5								
					-1.0	2.0			Pit collapsing. Test pit TP30 terminated at 1.7m				
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP31**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 0.732

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type; plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N		D	0.5	0.5		SC	**TOPSOIL:** Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, low to medium plasticity fines, with layer of mulch and rootlets to 100mm.	D			TOPSOIL (swampy area) organic odour.
									Clayey SAND: fine to medium grained, pale grey / pale brown, low plasticity fines.	M	MD		
				D	0.0	1.0			Becoming grey / brown.	W	D		Very slow inflow of groundwater.
			05-04-07 8:29am	D	-0.5	1.5		SP	**SAND:** fine to medium grained, dark brown-red, indurated cemented sand nodules.				Rapid inflow of groundwater.
				D	-1.0				**Silty Gravelly SAND:** fine to coarse grained, dark grey-black, gravel fine to medium grained, rounded-subrounded.				
					-1.5	2.0			Pit collapsing due to inflow of groundwater. Test pit TP31 terminated at 1.8m				
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP32**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 0.994

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N							TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, low plasticity fines, with some rootlets and roots (10mm).	D			TOPSOIL (swampy area)
								SC	**Clayey SAND:** fine to coarse grained, pale grey-pale brown, low plasticity fines maybe low percentage of fines approximately 30-40%.	M	D		Some inflow of water.
			05-04-07 8:47am ▼	D	0.5	0.5							
				D	0.0	1.0			Becoming grey-brown, some presence of cemented sand nodules.	W			Moderate inflow of groundwater 8:47am.
					-0.5	1.5							
				D					Becoming grey mottled brown / orange and presence of subrounded to rounded gravel (fine to medium grained) less than 10mm size.				
					-1.0	2.0			Pit continually collapsed due to water table. Test pit TP32 terminated at 1.7m				
					-1.5	2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP33**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 0.923

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
BH		N			0.5	0.5			**TOPSOIL:** Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, low plasticity fines, with some rootlets to 250mm.	D/M			TOPSOIL (swampy area)
								SC	**Clayey SAND:** fine to coarse grained, pale grey-pale brown.	M	D		
			05-04-07 8:56am ▶	D	0.0	1.0			Becoming grey / brown.	W			Very slow inflow of groundwater 8:56am, organic odour.
				D	-0.5	1.5							
				D	-1.0	2.0		SP	**SAND:** fine to medium grained, dark brown-black, some cemented nodules of sand.				
					-1.5	2.5			Pit collapsing due to water table. Test pit TP33 terminated at 2m				

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TESTPIT 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

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coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP34**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **5.4.2007**

Principal:

Date completed: **5.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **CW**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 0.893

excavation dimensions: 1.5m long 0.4m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			0.5 / 0.5			**TOPSOIL:** Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, low to medium plasticity fines.	M			TOPSOIL
							SC	**Clayey SAND:** fine to coarse grained, pale grey-white, low plasticity fines. Becoming pale grey-pale brown.		D		
			05-04-07 9:13am ▼	D	0.0 / 1.0		SP	**SAND:** with some clayey lenses, fine to medium grained, low plasticity fines.	M/W			Very slow inflow of water, 9:13am.
				D	-0.5 / 1.5		SC	**Clayey SAND:** fine to coarse grained, grey / brown, low to medium plasticity fines. Pit slowly collapsing due to water table.	W	MD L MD		
					-1.0 / 2.0		SM	**Silty SAND:** fine to medium grained, dark brown / red.				
					-1.5 / 2.5			Pit collapsing due to groundwater. Test pit TP34 terminated at 2m				

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
▼ water level on date shown
► water inflow
◄ water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No. **BH35**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **11.4.2007**

Principal:

Date completed: **11.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **JJT**

Borehole Location: **REFER TO FIGURE 1**

Checked by:

drill model and mounting: MD20 | Easting: | slope: -90° | R.L. Surface: 1.006

hole diameter: 100 mm | Northing | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HF		C	▼	SPT 2,2,3 N*=5	0	1		SP	**SAND:** fine to medium grained, grey.	M	MD		
										W			
				SPT 2,3,11 N*=14	-1	2					D		
					-2	3							
				SPT 6,4,12 N*=16	-3	4							
									Borehole BH35 terminated at 4m				
					-4	5							
					-5	6							
					-6	7							
						8							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit
*bit shown by suffix e.g.	ADT

support

M mud N nil

C casing

penetration 1 2 3 4 — no resistance ranging to refusal

water

▼ 10/1/98 water level on date shown

water inflow

water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No.	**BH36**
Sheet	1 of 1
Project No:	**GEOTSGTE20248AA**
Client:	**TATTERSALL SURVEYORS PTY LTD**
Date started:	**11.4.2007**
Principal:	
Date completed:	**11.4.2007**
Project:	**RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**
Logged by:	**JJT**
Borehole Location:	**REFER TO FIGURE 1**
Checked by:	

drill model and mounting: MD20 | Easting: | slope: -90° | R.L. Surface: 2.361

hole diameter: 100 mm | Northing | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HF		C	▼		2			SC	**Clayey SAND:** fine to medium grained, black, clay low plasticity.	M			
				SPT 4,4,5 N*=9		1		SP	**SAND:** fine grained, white.	W	D		
					1			SP	**SAND:** fine to medium grained, black (coffee rock).				
						2		SP	**SAND:** fine grained, white.				
				SPT 2,9,11 N*=20	0				Becoming grey.				
						3					VD		
				SPT 6,13,24 N*=37	-1								
						4		SP	**SAND:** fine to medium grained, black (coffee rock).				
					-2				Becoming softer.				
				SPT 6,9,23 N*=32	-3	5							
						6							
				SPT 8,16,14 N*=30	-4	7							
					-5				Borehole BH36 terminated at 7m				
						8							

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method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit
*bit shown by suffix e.g.	ADT

support

M mud N nil
C casing

penetration 1 2 3 4 — no resistance ranging to refusal

water

▼ 10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description
based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No.	BH37
Sheet	1 of 1
Project No:	GEOTSGTE20248AA
Client:	TATTERSALL SURVEYORS PTY LTD
Date started:	11.4.2007
Principal:	
Date completed:	11.4.2007
Project:	RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS
Logged by:	JJT
Borehole Location:	REFER TO FIGURE 1
Checked by:	

drill model and mounting:	MD20	Easting:	slope:	-90°	R.L. Surface:	Not Measured	
hole diameter:	100 mm	Northing	bearing:		datum:	AHD	

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa (100 200 300 400)	structure and additional observations
HF		C						SC	**Clayey SAND:** fine to medium grained, black, clay low plasticity.	M			
								SP	**SAND:** fine to medium grained, white.		D		
			▼	SPT 4,6,10 N*=16		1				W			
									Becoming dark brown, with some organic material.				
				SPT 1,7,8 N*=15		2							
						3							
				SPT 6,18,R N*=R		4		SP	**SAND:** fine to medium grained, black (coffee rock).		VD		INDURATED SAND
						5			Becoming brown.				
				SPT 5,7,R N*=R		6							
				SPT 6,7,R N*=R		7							
									Borehole BH37 terminated at 7m				
						8							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit
*bit shown by suffix e.g.	ADT

support

M mud N nil
C casing

penetration

1 2 3 4 — no resistance ranging to refusal

water

▼ 10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Borehole

Borehole No. **BH38**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **11.4.2007**

Principal:

Date completed: **11.4.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **JJT**

Borehole Location: **REFER TO FIGURE 1**

Checked by:

drill model and mounting: MD20 | Easting: | slope: -90° | R.L. Surface: 2.303

hole diameter: 100 mm | Northing | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HF		C							TOPSOIL: Clayey SAND, fine grained, dark grey, clay low plasticity.	M			TOPSOIL
					2			CL	**Sandy CLAY**: medium to high plasticity, grey, sand fine grained.	>Wp			
				SPT 2,2,3 N*=5		1							
					1			CL	**Sandy CLAY**: low to medium plasticity, dark brown, sand fine grained.				
			▼			2				W			
				SPT 4,5,5 N*=10	0			SW	**SAND**: fine to medium grained, grey.		D		
						3							
					-1				Becoming black.				
				SPT 12,18,23 N*=41		4							
					-2								
						5							
				SPT 4,8,11 N*=19	-3								
						6					MD		
					-4								
				SPT 4,8,8 N*=16		7							
					-5				Borehole BH38 terminated at 7m				
						8							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit
*bit shown by suffix e.g.	ADT

support

M mud N nil

C casing

penetration 1 2 3 4 — no resistance ranging to refusal

water

▼ 10/1/98 water level on date shown

► water inflow

◄ water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP39**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **1.6.2007**

Principal:

Date completed: **1.6.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **RJP**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.77

excavation dimensions: 2m long 0.45m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N							**TOPSOIL:** Sandy Silty CLAY, medium plasticity, dark grey, sand fine to medium grained.	M			TOPSOIL Root affected.
					2.5	0.5		CH	**CLAY:** high plasticity, grey-brown and orange mottled, some sand.	>Wp	St		
				D								x	
					2.0	1.0		CH	**CLAY:** high plasticity, grey-grey-brown, some orange mottled with a trace of sand fine to medium grained.			x	
				D									
					1.5	1.5		SP	**SAND:** fine to medium grained, white / light grey-brown.	W			Pit collapsing below 1.4m, organic odour.
				D									
					1.0	2.0			Moderate groundwater inflow below 1.4m. Test pit TP39 terminated at 1.7m				
					0.5	2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation No. **TP40**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **1.6.2007**

Principal:

Date completed: **1.6.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **RJP**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.59

excavation dimensions: 2m long 0.45m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5 / 0.5			**TOPSOIL:** Silty Sandy CLAY, medium plasticity, dark grey, sand fine to medium grained.	>Wp			TOPSOIL Root affected.
				D	2.0 / 1.0		CI	**Sandy CLAY:** medium plasticity, grey-brown and orange mottled, sand fine to medium grained. Becoming grey-brown and sand content increasing to Sandy CLAY / Clayey SAND.		St	x	
				D	1.5 / 1.5		SP	**SAND:** fine to medium grained, grey-brown with some clay.	W		x	
			►	D	1.0 / 2.0		SP	**SAND:** fine to medium grained, light grey-brown.				Rapid groundwater inflow below 1.4m. Organic odour.
					0.5 / 2.5			Pit collapsing below 1.1m. Test pit TP40 terminated at 1.7m				

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

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Engineering Log - Excavation

Excavation No. **TP41**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **1.6.2007**

Principal:

Date completed: **1.6.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **RJP**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 3.63

excavation dimensions: 2m long 0.45m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			3.5 / 0.0			**TOPSOIL:** Sandy CLAY, medium plasticity, grey-brown, sand fine to medium grained.	M			TOPSOIL Root affected.
				D	3.0 / 0.5		Cl	**Sandy CLAY:** medium plasticity, light grey-brown and orange mottled, sand fine to medium grained.	>Wp	St	X	
								Becoming light grey-light grey-brown and orange mottled.				
				D	2.5 / 1.0			Sand content increasing light grey-brown and orange mottled.			X	
				D	2.0 / 1.5		SP	**SAND:** fine to medium grained, light grey-brown some orange mottled, cemented.	M			
			▶	D	1.5 / 2.0		SP	**SAND:** fine to medium grained, white-light grey-brown.	W			Slow groundwater inflow below 2.2m. Organic odour.
					2.5			Test pit TP41 terminated at 2.5m				

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP42**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **1.6.2007**

Principal:

Date completed: **1.6.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **RJP**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 2.82

excavation dimensions: 2m long 0.45m wide | Northing: m | datum: AHD

excavation information							material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			2.5	0.5			**TOPSOIL:** Silty Sandy CLAY, low to medium plasticity, sand fine to medium grained, dark grey-brown.	M			TOPSOIL Root affected.
				D				CI	**Sandy CLAY:** medium plasticity, grey-brown and orange mottled, sand fine to medium grained.	>Wp	St	×	
					2.0	1.0		CI	**Sandy CLAY:** medium plasticity, grey-grey-brown some orange mottled, sand fine to medium grained, sand content increasing.			×	
			►	D				SP	**SAND:** fine to medium grained, white.	W			Very slow water inflow below 1.1m.
					1.5	1.5			Becoming grey-grey-brown, with a trace to some clay.				
				D									
					1.0	2.0			Test pit TP42 terminated at 1.7m				
					0.5	2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TESTPIT 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

Form GEO 5.2 Issue 3 Rev.2

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP43**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: **TATTERSALL SURVEYORS PTY LTD**

Date started: **1.6.2007**

Principal:

Date completed: **1.6.2007**

Project: **RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS**

Logged by: **RJP**

Test pit location: **REFER TO FIGURE 1**

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 4.75

excavation dimensions: 2m long 0.45m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			4.5	0.5		SP	**SAND:** fine to medium grained, grey-brown.	M			AEOLIAN Root affected to 0.15m.
				D					Becoming light grey-brown.				
					4.0	1.0		SP	**SAND:** fine to medium grained, grey-brown and orange mottled, trace to some clay.				
				D									
					3.5	1.5		SP	**SAND:** fine to medium grained, light grey-brown, some weakly cemented nodules, grey-brown.				
			►	D	3.0					W			Very slow water inflow below 1.7m.
						2.0			Test pit TP43 terminated at 1.85m				
					2.5	2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP44**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: ***TATTERSALL SURVEYORS PTY LTD***

Date started: ***1.6.2007***

Principal:

Date completed: ***1.6.2007***

Project: ***RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS***

Logged by: ***RJP***

Test pit location: ***REFER TO FIGURE 1***

Checked by:

equipment type and model: 4WD Backhoe | Pit Orientation: | Easting: m | R.L. Surface: 4.46

excavation dimensions: 2m long 0.45m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	None Observed	D	4.0 / 0.5		SP	**SAND:** fine to medium grained, dark grey-brown.	M			AEOLIAN Root affected to 0.3m.
								Becoming light grey-brown.				
				D	3.5 / 1.0		SP	**SAND:** fine to medium grained, dark brown, some silt / Silty SAND.				INDURATED SAND
				D	3.0 / 1.5			Becoming cleaner and less cemented, brown.				
					2.5 / 2.0			Test pit TP44 terminated at 1.8m				
					2.0 / 2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No.	BH45
Sheet	1 of 2
Project No:	GEOTSGTE20248AA
Client:	TATTERSALL SURVEYORS PTY LTD
Date started:	5.6.2007
Principal:	
Date completed:	5.6.2007
Project:	RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS
Logged by:	RJP
Borehole Location:	REFER TO FIGURE 1
Checked by:	

drill model and mounting: | Easting: | slope: -90° | R.L. Surface: 3.20

hole diameter: mm | Northing | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HF		C			3			SP	**SAND:** fine to medium grained, grey-brown.	M	D		AEOLIAN SAND
						1							
				SPT 2,5,7 N*=12	2				Becoming light grey-brown.				
					1	2							
			▼	SPT 5,6,8 N*=14						W			
					0	3			Becoming dark grey-brown.				
				SPT 3,15,21 N*=36	-1	4		SP	**SAND:** fine to coarse grained, dark brown, trace of gravel fine grained and silt.		VD		
					-2	5			With a trace fine grained gravel.				20 blows for 100mm penetration.
				SPT 9,21,20 N*=41		6							
					-3								
				SPT 8,18,21 N*=39	-4	7			Becoming fine to medium grained, light brown and brown.				21 blows for 100mm penetration.
						8							

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing

penetration 1 2 3 4 — no resistance ranging to refusal

water
▼ 10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

Form GEO 5.3 Issue 3 Rev.2

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Engineering Log - Borehole

Borehole No.	BH45
Sheet	2 of 2
Project No:	GEOTSGTE20248AA
Client:	TATTERSALL SURVEYORS PTY LTD
Date started:	5.6.2007
Principal:	
Date completed:	5.6.2007
Project:	RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS
Logged by:	RJP
Borehole Location:	REFER TO FIGURE 1
Checked by:	

drill model and mounting: | Easting: | slope: -90° | R.L. Surface: 3.20

hole diameter: mm | Northing | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HF		C			-5	9		SP	SAND: fine to coarse grained, dark brown, trace of gravel fine grained and silt. *(continued)*	W	D		
				SPT 5,13,17 N*=30									
					-6	10							
				SPT 1,6,15 N*=21	-7								
			▼ Collapsed back to 2.3m		-8	11			Borehole BH45 terminated at 10.45m				
					-9	12							
					-10	13							
					-11	14							
					-12	15							
						16							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

M mud N nil

C casing

penetration 1 2 3 4 — no resistance ranging to refusal

water

▼ 10/1/98 water level on date shown

► water inflow

◄ water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No. **BH46**

Sheet 1 of 1

Project No: **GEOTSGTE20248AA**

Client: *TATTERSALL SURVEYORS PTY LTD*

Date started: **6.6.2007**

Principal:

Date completed: **6.6.2007**

Project: *RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS*

Logged by: **RJP**

Borehole Location: *REFER TO FIGURE 1*

Checked by:

drill model and mounting: | Easting: | slope: -90° | R.L. Surface: 1.07

hole diameter: mm | Northing | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HF		C	▼						TOPSOIL: Sandy CLAY / Clayey SAND, low plasticity, dark grey, sand fine to medium grained, some silt.	M			TOPSOIL
								SP	SAND: fine to medium grained, grey-brown.		MD		
				SPT 3,2,2 N*=4	0	1			Becoming light grey-brown.	W			
					-1	2							
				SPT 7,12,14 N*=26	-2	3		SP	SAND: fine to medium grained, dark brown, trace silt.		VD		
				SPT 5,16,23 N*=39	-3	4		SP	SAND: fine to medium grained, some clay, brown and dark brown, trace fine grained gravel.				
					-4	5							
				SPT 2,9,18 N*=27	-5	6		SP	SAND: fine to medium grained, light brown.				
				SPT 3,10,18 N*=28	-6	7			Becoming fine to coarse grained, trace fine grained gravel, light grey-brown.				
						8			Borehole BH46 terminated at 7.45m				

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing

penetration 1 2 3 4
no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

Form GEO 5.3 Issue 3 Rev.2

Coffey Geosciences Pty Ltd ACN 056 335 516

Borehole No. **BH 21**

Sheet 1 of 1

Engineering Log - Piezometer

Office Job No.: ***E12752/03***

Client: ***CARDNO***

Date started: ***30.4.2004***

Principal: ***CRIGHTON PROPERTIES***

Date completed: ***30.4.2004***

Project: ***MYALL QUAYS ESTATE***

Logged by: ***KML***

Borehole Location: ***See Figure 5***

Checked by: TW

drill model & mounting: Gemco Trailer | Easting: | slope: -90° | R.L. Surface: 1.026

hole diameter: | Northing: | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	well details	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	structure and additional observations
ADV		N	▼	D		0.6	0.5			**TOPSOIL:** dark grey-brown, sand, with organics.	M		TOPSOIL
									SP	**SAND:** fine to medium grained, dark grey, strong organic odour.			ALLUVIUM
						0.0	1.0				W		
				D									
						-0.5	1.5						
						-1.0	2.0						
						-1.5	2.5						
						-2.0	3.0			Borehole terminated at 3m			
						-2.5	3.5						
							4.0						

PIEZOMETER E12752-3 BH21-24.GPJ COFFEY.GDT 20.12.04

Form GEO 5.10 Issue 3 Rev.0

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

C casing N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water

▼ 10/1/98 water level on date shown

water inflow

water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressure meter
Bs	bulk sample
R	refusal
E	environmental sample
PID	PID measurement
WS	water sample
PZ	piezometer

classification symbols and soil description based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Coffey Geosciences Pty Ltd ACN 056 335 516

Borehole No. **BH 22**

Sheet 1 of 1

Engineering Log - Piezometer

Office Job No.: ***E12752/03***

Client: ***CARDNO***

Date started: ***30.4.2004***

Principal: ***CRIGHTON PROPERTIES***

Date completed: ***30.4.2004***

Project: ***MYALL QUAYS ESTATE***

Logged by: ***KML***

Borehole Location: ***See Figure 5***

Checked by: TW.

drill model & mounting: Gemco Trailer | Easting: | slope: -90° | R.L. Surface: 1.095

hole diameter: | Northing: | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	well details	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	structure and additional observations
ADV		N	▼	D		1.0	0.5			**SAND:** fine to medium grained, dark grey-brown, organic odour, organics in top 0.2m.	M		ALLUVIUM
						0.5	1.0				W		
				D		0.0	1.0						
						-0.5	1.5						
						-1.0	2.0						
						-1.5	2.5						
						-2.0	3.0			Borehole terminated at 3m			
						-2.5	3.5						
							4.0						

PIEZOMETER E12752-3 BH21-24.GPJ COFFEY.GDT 20.12.04

Form GEO 5.10 Issue 3 Rev.0

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support: C casing; N nil

penetration: 1 2 3 4 — no resistance ranging to refusal

water: ▼ 10/1/98 water level on date shown; ► water inflow; ◄ water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressure meter
Bs	bulk sample
R	refusal
E	environmental sample
PID	PID measurement
WS	water sample
PZ	piezometer

classification symbols and soil description based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Coffey Geosciences Pty Ltd ACN 056 335 516

Borehole No. **BH 23**

Sheet 1 of 1

Engineering Log - Piezometer

Office Job No.: ***E12752/03***

Client: ***CARDNO***

Date started: ***30.4.2004***

Principal: ***CRIGHTON PROPERTIES***

Date completed: ***30.4.2004***

Project: ***MYALL QUAYS ESTATE***

Logged by: ***KML***

Borehole Location: ***See Figure 5***

Checked by: TW.

drill model & mounting: Gemco Trailer | Easting: | slope: -90° | R.L. Surface: 0.895

hole diameter: | Northing: | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	well details	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	structure and additional observations
ADV		N				0.5	0.5			**TOPSOIL:** dark grey-brown, sand fine to medium grained, with organics.	M		TOPSOIL
				D					SP	**SAND:** light brown, fine to medium grained.			ALLUVIUM
						0.0	1.0		SP	**SAND:** dark grey-brown, fine to medium grained.	W		
				D		-0.5	1.5						
						-1.0	2.0						
						-1.5	2.5						
						-2.0	3.0						
						-2.5	3.5			Borehole terminated at 3.1m			
						-3.0	4.0						

PIEZOMETER E12752-3 BH21-24.GPJ COFFEY.GDT 20.12.04

Form GEO 5.10 Issue 3 Rev.0

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

C casing N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water

10/1/98 water level on date shown

water inflow

water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressure meter
Bs	bulk sample
R	refusal
E	environmental sample
PID	PID measurement
WS	water sample
PZ	piezometer

classification symbols and soil description based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Coffey Geosciences Pty Ltd ACN 056 335 516

Borehole No. **BH 24**

Sheet 1 of 1

Engineering Log - Piezometer

Office Job No.: ***E12752/03***

Client: ***CARDNO***

Date started: ***30.4.2004***

Principal: ***CRIGHTON PROPERTIES***

Date completed: ***30.4.2004***

Project: ***MYALL QUAYS ESTATE***

Logged by: ***KML***

Borehole Location: ***See Figure 5***

Checked by: EM.

drill model & mounting: Gemco Trailer | Easting: | slope: -90° | R.L. Surface: 1.198

hole diameter: | Northing: | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	well details	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	structure and additional observations
ADV		N				1.0	0.5			**TOPSOIL:** dark grey-brown, sand fine to medium grained, with organics.	M		TOPSOIL
			▼	D		0.5	1.0		SP	**SAND:** fine to medium grained, dark grey-brown, notable organic odour.	W		ALLUVIUM
						0.0	1.5						
						-0.5	2.0						
						-1.0	2.5						
						-1.5	3.0			Borehole terminated at 3m			
						-2.0	3.5						
						-2.5	4.0						

PIEZOMETER E12752-3 BH21-24.GPJ COFFEY.GDT 20.12.04

Form GEO 5.10 Issue 3 Rev.0

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support: C casing; N nil

penetration: 1 2 3 4 — no resistance ranging to refusal

water: ▼ 10/1/98 water level on date shown; ► water inflow; ◄ water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressure meter
Bs	bulk sample
R	refusal
E	environmental sample
PID	PID measurement
WS	water sample
PZ	piezometer

classification symbols and soil description based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

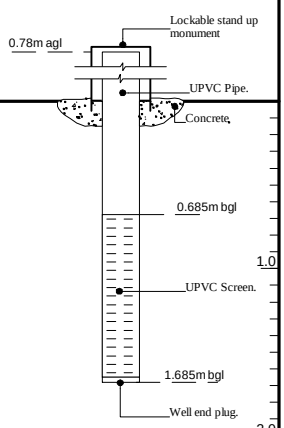
VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

CLIENT	Crighton Properties Pty Ltd	**COMMENCED**	24.10.11	**COMPLETED**	24.10.11	**REF**	**GMB1A**
PROJECT	Groundwater Assessment	**LOGGED**	BR	**CHECKED**	GT/DM	**Sheet**	**1 of 1**
SITE	MRD, Tea Gardens, NSW	**GEOLOGY**	Marine Sands	**VEGETATION**	Grass	**PROJECT NO.**	P0902346
EQUIPMENT	Auger	**EASTING**	219893.60	**RL SURFACE**	2.52mAHD		
EXCAVATION DIMENSIONS	Ø90mm X 5.5m depth	**NORTHING**	1385661.38	**ASPECT**	NA	**SLOPE**	<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)
		N	M									
		1.04 ▽	M	1.0								
		-	W									
				2.0								
V	Nil	Y	W				SM	SILTY SAND - Brown.				
				3.0								
				4.0								
				5.0								
				5.5								
								Borehole terminated at 5.5m in silty sand.				
				6.0								
				7.0								
				8.0								
				9.0								

WATER WELL DETAILS



Note: Bore backfill with natural material.

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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

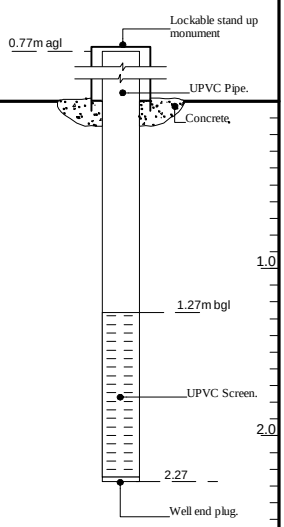
martens
MARTENS & ASSOCIATES PTY LTD
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - Borehole

CLIENT	Crighton Properties Pty Ltd	**COMMENCED**	24.10.11	**COMPLETED**	24.10.11	**REF**	**GMB2A**
PROJECT	Groundwater Assessment	**LOGGED**	BR	**CHECKED**	GT/DM	**Sheet**	1 of 1
SITE	MRD, Tea Gardens, NSW	**GEOLOGY**	Marine Sands	**VEGETATION**	Grass	**PROJECT NO.**	P0902346
EQUIPMENT	Auger	**EASTING**	220359.156	**RL SURFACE**	2.479mAHD		
EXCAVATION DIMENSIONS	Ø90mm X 7.0m depth	**NORTHING**	1385847.319	**ASPECT**	NA	**SLOPE**	NA

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
		N	M	0.0									
		1.33 ▽	M	1.0									
			W	2.0									
V	Nil	Y	W	3.0			SM	SILTY SAND - Dark brown.					
				4.0									
				5.0									
				6.0									
				7.0				Borehole terminated at 7.0m in silty sand.					
				8.0									
				9.0									



Note: Bore backfill with natural material.

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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

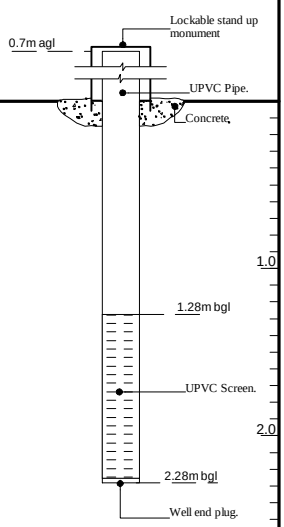
Engineering Log - Borehole

CLIENT	Crighton Properties Pty Ltd	**COMMENCED**	24.10.11	**COMPLETED**	24.10.11	**REF**	**GMB25**
PROJECT	Groundwater Assessment	**LOGGED**	BR	**CHECKED**	GT/DM	**Sheet**	1 of 1
SITE	MRD, Tea Gardens, NSW	**GEOLOGY**	Marine Sands	**VEGETATION**	Grass	**PROJECT NO.**	P0902346
EQUIPMENT	Auger	**EASTING**	220407.133	**RL SURFACE**	1.798mAHD		
EXCAVATION DIMENSIONS	Ø90mm X 5.5m depth	**NORTHING**	1385267.804	**ASPECT**	East?	**SLOPE**	<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)
		N	M									
		1.2 ▽	M	1.0								1.0
			W									
				2.0								2.0
V	Nil	Y	W	3.0			SM	SILTY SAND - Brown.				3.0
				4.0								4.0
				5.0								5.0
				5.5								
								Borehole terminated at 5.5m in silty sand.				
				6.0								6.0
				7.0								7.0
				8.0								8.0
				9.0								9.0

WATER WELL DETAILS



Note: Bore backfill with natural material.

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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

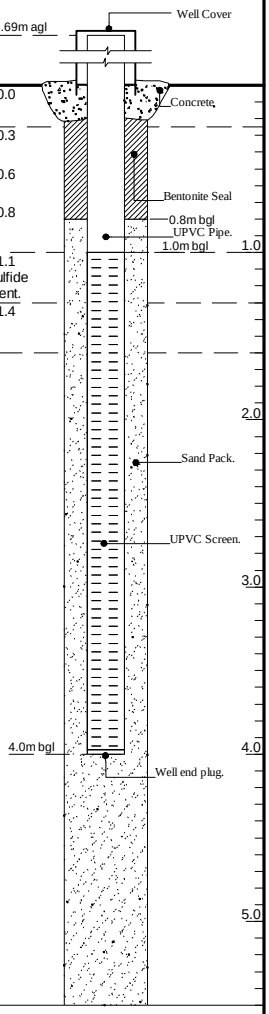
Engineering Log - Borehole

CLIENT	**Crighton Properties Pty Ltd**	**COMMENCED**	25.09.12	**COMPLETED**	25.09.12	**REF**	**BH201**
PROJECT	**Hydrogeological Investigation**	**LOGGED**	NF	**CHECKED**	GT/DM	**Sheet**	**1 of 1**
SITE	**MRD, Tea Gardens, NSW**	**GEOLOGY**	Marine Sands	**VEGETATION**	Sedges and Grasses	**PROJECT NO.**	P0902346
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	100mmØ X 5.5m depth	**NORTHING**	NA	**ASPECT**	-	**SLOPE**	<5%

EXCAVATION DATA / MATERIAL DATA / SAMPLING & TESTING

METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA (Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.)	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	SAMPLING & TESTING
V	Nil	N	M	0.25			OL	ORGANIC SILT - Dark brown to black, with some organic matter present, and minor fine grained sand.	VS-S		D	0.0	2346/201/ 0.0
								SANDY CLAY - Medium plasticity, grey brown to grey, with some fine to medium grained sand and minor organic matter present (rootlets). Sand content decreasing with depth, becoming high plasticity >0.7m.	St		D	0.3	2346/201/ 0.3
V	Nil	N	M				CL		VSt		D	0.6	2346/201/ 0.6
				1.0					St		D	0.8	2346/201/ 0.8
V	Nil	N	M				SP	Sand content increasing >0.9m.			D	1.1	2346/201/ 1.1 Hydrogen sulfide odour present.
				1.3				SAND - Medium grained sand, brown to dark brown.					
V	Nil	N	D				CL	SANDY CLAY - Low to medium plasticity, brown to dark brown, with some medium grained sand.	F-St		D	1.4	2346/201/ 1.4
				1.6									
				2.0									
				3.0									
V	Nil	N	M				SC	ORGANIC CLAYEY SAND - Medium grained sand, black to dark grey, with some organic matter present, grading to organic sand >1.9m.					
				4.0									
				5.0									
				5.5									
								Borehole terminated at 5.5m in organic clayey sand.					
				6.0									
				7.0									
				8.0									
				9.0									

WATER WELL DETAILS



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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)
E Environmental sample

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

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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MARTENS & ASSOCIATES PTY LTD
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Hornsby, NSW 2077 Australia
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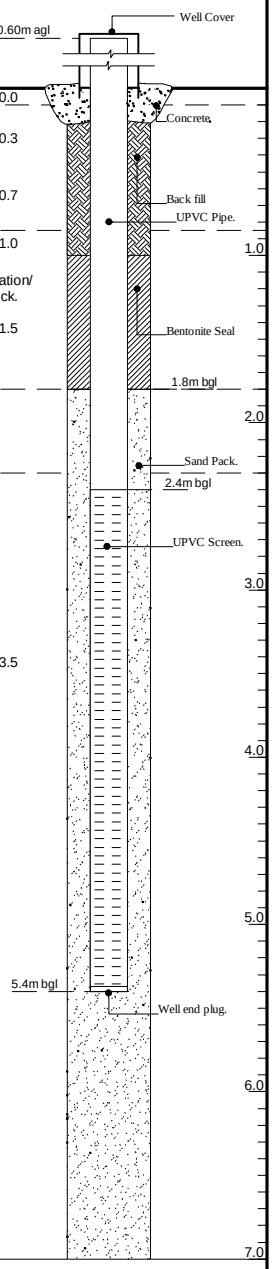
Engineering Log - Borehole

CLIENT	**Crighton Properties Pty Ltd**	**COMMENCED**	25.09.12	**COMPLETED**	25.09.12	**REF**	**BH202**
PROJECT	**Hydrogeological Investigation**	**LOGGED**	NF	**CHECKED**	GT/DM	**Sheet**	**1 of 1**
SITE	**MRD, Tea Gardens, NSW**	**GEOLOGY**	Marine Sands	**VEGETATION**	Grasses and Ferns	**PROJECT NO.**	P0902346
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	100mmØ X 7.0m depth	**NORTHING**	NA	**ASPECT**	-	**SLOPE**	<5%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
V	Nil	N	D	0.1			SP	LOAMY SAND - Medium grained, dark grey, with some organic matter present.			D	0.0	2346/202/0.0
V	Nil	N	D				SP	SAND - Medium grained, pale grey to grey, with some organic matter present.		L	D	0.3	2346/202/0.3
			M	0.85						MD-D	D	0.7	2346/202/0.7
V	Nil	N	M	1.0			SP	SAND - Medium grained, pale grey, poorly graded, very minor shell fragments present.			D	1.0	2346/202/1.0 Hard panatration/ coffee rock.
				1.8							D	1.5	2346/202/1.5
V	Nil	N	M	2.0			SP	SAND - Medium grained, dark brown to dark orange brown, cemented occasional roots and rootles present.					
				2.3									
		Y	W										
V	Nil	Y	W	5.0			SC	SAND - Medium grained, pale brown to grey brown, with some shell fragments present.			D	3.5	2346/202/3.5
				7.0				Borehole terminated at 7.0m in sand.					
				9.0									



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

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6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
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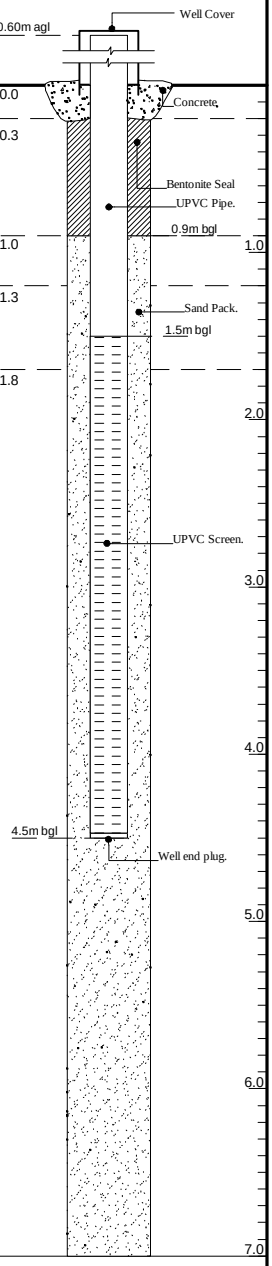
Engineering Log - Borehole

CLIENT	**Crighton Properties Pty Ltd**	**COMMENCED**	25.09.12	**COMPLETED**	25.09.12	**REF**	**BH203**
PROJECT	**Hydrogeological Investigation**	**LOGGED**	NF	**CHECKED**	GT/DM	**Sheet**	**1 of 1**
SITE	**MRD, Tea Gardens, NSW**	**GEOLOGY**	Marine Sands	**VEGETATION**	Grasses and Ferns	**PROJECT NO.**	P0902346
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	100mmØ X 7.0m depth	**NORTHING**	NA	**ASPECT**	-	**SLOPE**	<5%

EXCAVATION DATA / MATERIAL DATA / SAMPLING & TESTING

METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER WELL DETAILS
V	Nil	N	D	0.2			SP	LOAMY SAND - Medium brown to dark grey, organic matter and rootlets present, grasses at surface.		VL-L	D	0.0	2346/203/ 0.0
V	Nil	N	M	0.9			SC	CLAYEY SAND - Medium grained, dark brown, grading to low plasticity sandy clay >0.70m.		L-MD	D	0.3	2346/203/ 0.3
V	Nil	N	M	1.0			CL	SANDY CLAY - Low ot medium plasticity, grey brown to dark yellow brown, with some fine to medium grained sand present.			D	1.0	2346/203/ 1.0
V	Nil	Y	W	1.2			SP	SAND - Medium grained, dark grey, mottled orange brown and yellow brown, with some shell fragments and minor fines.			D	1.3	2346/203/ 1.3
		Y	W	1.7							D	1.8	2346/203/ 1.8
		Y	W	2.0									
				2.25									
V	Nil	Y	W	3.0			SP	SAND - Medium grained, grey to dark grey, with some shell fragments present.					
				4.0									
				5.0									
				6.0									
				7.0									
								Borehole terminated at 7.0m in sand.					
				8.0									
				9.0									



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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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E Environmental sample
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	**Crighton Properties Pty Ltd**	**COMMENCED**	25.09.12	**COMPLETED**	25.09.12	**REF**	**BH204**
PROJECT	**Hydrogeological Investigation**	**LOGGED**	NF	**CHECKED**	GT/DM	**Sheet**	**1 of 1**
SITE	**MRD, Tea Gardens, NSW**	**GEOLOGY**	Marine Sands	**VEGETATION**	Grasses and Ferns	**PROJECT NO.**	P0902346
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	100mmØ X 1.0m depth	**NORTHING**	NA	**ASPECT**	-	**SLOPE**	<5%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.3			SP	ORGANIC LOAMY SAND - Medium grained, dark brown, black, with some organic matter and fines present.			D	0.1	2346/204/ 0.1
V	Nil	N	M	0.5			SP	LOAMY SAND - Medium grained, dark brown, with minor fines present.			D	0.4	2346/204/ 0.4
V	Nil	N Y	M W	0.65			SP	ORGANIC LOAMY SAND - Medium grained, dark brown to black, roots and rootles present.			D	0.6	2346/204/ 0.6
V	Nil	N	M	0.8			SC	CLAYEY SAND - Medium grained, pale brown, with minor shell fragments present.			D	0.9	2346/204/ 0.9
				1.0				Borehole terminated at 1.0m in clayey sand.					
				1.5									
				2.0									
				2.25									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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)
E Environmental sample

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

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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

Quality Sheet No. 4

martens

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

Engineering Log - Borehole

CLIENT	**Crighton Properties Pty Ltd**	**COMMENCED**	25.09.12	**COMPLETED**	25.09.12	**REF**	**BH205**
PROJECT	**Hydrogeological Investigation**	**LOGGED**	NF	**CHECKED**	GT/DM	**Sheet**	**1 of 1**
SITE	**MRD, Tea Gardens, NSW**	**GEOLOGY**	Marine Sands	**VEGETATION**	Grasses and Ferns	**PROJECT NO.**	P0902346
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	100mmØ X 1.0m depth	**NORTHING**	NA	**ASPECT**	-	**SLOPE**	<5%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.0			SP	ORGANIC LOAMY SAND - Medium grained, dark grey, with some organic matter present.			D	0.0	2346/205/ 0.0
				0.2									
V	Nil	N	M				SP	SAND - Medium grained, pale grey.			D	0.3	2346/205/ 0.3
				0.5									0.5
				0.6									
		N	M	0.7							D	0.7	2346/205/ 0.7
		Y	W										
V	Nil	Y	W				SP	SAND - Medium grained, dark brown, grading to orange brown with depth, with some minor shell fragments and fines present.					
				1.0									1.0
								Borehole terminated at 1.0m in sand.					
				1.5									1.5
				2.0									2.0
				2.25									2.25

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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)
E Environmental sample

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

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Engineering Log - Borehole

CLIENT	**Crighton Properties Pty Ltd**	**COMMENCED**	25.09.12	**COMPLETED**	25.09.12	**REF**	**BH206**
PROJECT	**Hydrogeological Investigation**	**LOGGED**	NF	**CHECKED**	GT/DM	**Sheet**	**1 of 1**
SITE	**MRD, Tea Gardens, NSW**	**GEOLOGY**	Marine Sands	**VEGETATION**	Grasses	**PROJECT NO.**	P0902346
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	100mmØ X 1.0m depth	**NORTHING**	NA	**ASPECT**	-	**SLOPE**	<5%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.25			SP	ORGANIC LOAMY SAND - Medium grained, dark brown, with some fines and organic present.			D	0.1	2346/206/ 0.1
V	Nil	N	M	0.5			SP	ORGANIC LOAMY SAND - Medium grained, dark brown to black, with some organics.			D	0.3	2346/206/ 0.3 0.5
V	Nil	N Y	M W	0.7 0.8			SP	SAND - Medium grained, dark grey, with minor organics.			D	0.7	2346/206/ 0.7
V	Nil	Y	W	1.0			SP	LOAMY SAND - Medium grained, black, parcially cemented.					Hard panatration/ coffee rock. 1.0
				1.5				Borehole terminated at 1.0m in sand.					1.5
				2.0									2.0
				2.25									2.25

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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)
E Environmental sample

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

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Engineering Log - Borehole

CLIENT	**Crighton Properties Pty Ltd**	**COMMENCED**	25.09.12	**COMPLETED**	25.09.12	**REF**	**BH207**
PROJECT	**Hydrogeological Investigation**	**LOGGED**	NF	**CHECKED**	GT/DM	**Sheet**	**1 of 1**
SITE	**MRD, Tea Gardens, NSW**	**GEOLOGY**	Marine Sands	**VEGETATION**	Grasses	**PROJECT NO.**	P0902346
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	100mmØ X 0.7m depth	**NORTHING**	NA	**ASPECT**	-	**SLOPE**	<5%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	D	0.2			SP	ORGANIC LOAMY SAND - Medium grained, dark grey, with some organic matter present.			D	0.0	2346/207/ 0.0
V	Nil	N	D	0.5			SP	SAND - Medium grained, pale grey.			D	0.3	2346/207/ 0.3
		N	D	0.6									
		Y	W	0.7									
				1.0				Borehole terminated at 1.0m in sand.					
				1.5									
				2.0									
				2.25									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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)
E Environmental sample

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

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Engineering Log - Borehole

CLIENT	**Crighton Properties Pty Ltd**	**COMMENCED**	25.09.12	**COMPLETED**	25.09.12	**REF**	**BH208**
PROJECT	**Hydrogeological Investigation**	**LOGGED**	NF	**CHECKED**	GT/DM	**Sheet**	**1 of 1**
SITE	**MRD, Tea Gardens, NSW**	**GEOLOGY**	Marine Sands	**VEGETATION**	Grasses	**PROJECT NO.**	P0902346
EQUIPMENT	Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	100mmØ X 1.0m depth	**NORTHING**	NA	**ASPECT**	-	**SLOPE**	<5%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	D	0.2			SP	ORGANIC LOAMY SAND - Medium grained, dark grey, with some organic matter present.			D	0.0	2346/208/ 0.0
V	Nil	N	M	0.5			SP	SAND - Medium grained, pale grey.			D	0.4	2346/208/ 0.4
		N	M	0.7									
		Y	W										
				1.0									0.5
								Borehole terminated at 1.0m in sand.					1.0
				1.5									1.5
				2.0									2.0
				2.25									2.25

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
PT Push tube
A Auger
TC Tungsten Carbide Bit
V V-Bit

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)
E Environmental sample

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

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Engineering Log - Borehole

12 Attachment E – Laboratory Test Reports

ALS 5 Rosegum Close, Warabrook, NSW 2304. Phone (02) 4968 9433; Facsimile (02 4968 0349. Email Samples.Newcastle@alsenviro.com

CHAIN OF CUSTODY DOCUMENTATION

Australian Laboratory Services Pty Ltd

CLIENT: Coffey Geosciences	SAMPLER: JJT
ADDRESS / OFFICE: Sandgate	MOBILE: 0421 763 913
PROJECT MANAGER (PM): Andrew Fulton	PHONE
PROJECT ID: Myall Quays	EMAIL REPORT TO: andrew_fulton@coffey.com.au
SITE: P.O. NO.:	EMAIL INVOICE TO: (if different to report)
RESULTS REQUIRED (Date): standard QUOTE NO.:	ANALYSIS REQUIRED including SUITES (note - suite codes must be listed to attract suite prices)

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: (Yes) No N/A
SAMPLE TEMPERATURE 3.9°C
CHILLED: (Yes) No

COMMENTS / SPECIAL HANDLING / STORAGE OR DIPOSAL:

Notes: e.g. Highly contaminated samples e.g. "High PAHs expected". Extra volume for QC or trace LORs etc.

****Please see note below****

ALS ID	SAMPLE ID	MATRIX	DATE	Time	CONTAINER INFORMATION Type / Code	Total bottles	8 Metals	Ca,Mg, Na, K, Chloride, Sulphate	Total Alkalinity, Total Hardness	Nitrite, Nitrate, Ammonia, TKN	Total Phosphorus	pH, Ec, TDS	TOC	BOD
1	22	H20	29/03/2007				x	x	x	x	x	x	x	x
2	21		29/03/2007				x	x	x	x	x	x	x	x
3	24		29/03/2007				x	x	x	x	x	x	x	x
4	23		29/03/2007				x	x	x	x	x	x	x	x
5	4A		29/03/2007				x	x	x	x	x	x	x	x
6	8		29/03/2007				x	x	x	x	x	x	x	x
7	DUP1		29/03/2007				x	x	x	x	x	x	x	x
	10						Sample not received							
	11						Sample not received							
	5						Sample not received							
8	?1		30/03/2007				x	x	x	x	x	x		
	8#						Sample not received							
	D1						Sample not received							
9	D2		30/03/2007				x	x	x	x	x	x		x
10	POND		30/03/2007				x	x	x			x		x
	Split	▼	30/03/2007				x	x	x	x		x		x

Environmental Division
Sydney
Work Order
ES0704246

Telephone : 61-2-8784 8555

Send to SGS Acknowledged FF

RELINQUISHED BY:		RECEIVED BY		METHOD OF SHIPMENT
Name: Jon Tonks	Date: 30/3/07	Name: Ken Reid	Date: 30/3/07	Con' Note No:
Of: Coffeys	Time: 5:52pm	Of: ALS Newcastle	Time: 5:55 pm	
Name: Kate Kelly	Date: 2/4/07	Name: Frank Ferraro	Date: 03/04/07	Transport Co:
Of: ALS Newcastle	Time: 4pm	Of: ALS Sydney	Time: 08:30	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserveed Plastic; AG = Amber Glass Unpreserved; V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bad for Acid Sulphate Soils; B = Unpreserved Bag.

AUSTRALIAN LABORATORY SERVICES P/L

*** **Please Note:-Modifications made, as per Ross Best (Coffey). 2/4/07, 11:15am. Both verbally and as per attached email. ***

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: COFFEY GEOTECHNICS	Laboratory	: Environmental Division Sydney	Page	: 1 of 7
Contact	: MR ANDREW FULTON	Contact	: Victor Kedicioglu	Work Order	: ES0704246
Address	: 13 MANGROVE ROAD SANDGATE NSW AUSTRALIA 2304	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164		
E-mail	: andrew_fulton@coffey.com.au	E-mail	: Victor.Kedicioglu@alsenviro.com		
Telephone	: 49676377	Telephone	: 61-2-8784 8555		
Facsimile	: 49675402	Facsimile	: 61-2-8784 8500		
Project	: MYALL QUAYS	Quote number	: EN/007/07	Date received	: 2 Apr 2007
Order number	: - Not provided -			Date issued	: 12 Apr 2007
C-O-C number	: - Not provided -			No. of samples	- Received : 10
Site	: - Not provided -				Analysed : 10

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Position	Department
Ankit Joshi		Inorganics - NATA 825 (10911 - Sydney)
Phyu Phyu Lwin	Spectroscopist	Inorganics - NATA 825 (10911 - Sydney)

ALS Environmental

Comments

This report for the ALSE reference ES0704246 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical Results for Samples Submitted**
- **Surrogate Recovery Data**

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Specific comments for Work Order **ES0704246**

It has been noted that RP is greater than TP (sample ID D2), however this difference is within the limits of experimental variation.
TDS by method EA-015 may bias high on various sample due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
EK059G: It has been noted that Nitrite is greater than NOx on sample ID (22), however this difference is within the limits of experimental variation.

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 22	21	24	23	4A
Sample Matrix Type / Description:				WATER	WATER	WATER	WATER	WATER
Sample Date / Time:				29 Mar 2007 15:00	29 Mar 2007 15:00	29 Mar 2007 15:00	29 Mar 2007 15:00	29 Mar 2007 15:00
Laboratory Sample ID:				ES0704246-001	ES0704246-002	ES0704246-003	ES0704246-004	ES0704246-005
EA005: pH								
pH Value		0.01	pH Unit	6.05	5.62	5.46	5.60	5.32
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C		1	µS/cm	1610	15500	2730	234	202
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	1350	11500	2250	212	155
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3		1	mg/L	123	2040	300	39	23
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	102	92	26	28	14
Total Alkalinity as CaCO3		1	mg/L	102	92	26	28	14
ED040F: Dissolved Major Anions								
Sulphate as SO4 2-	14808-79-8	1	mg/L	39	702	344	6	10
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1.0	mg/L	430	5300	800	58.7	50.4
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	11	126	31	3	2
Magnesium	7439-95-4	1	mg/L	23	420	54	7	4
Sodium	7440-23-5	1	mg/L	283	2650	551	31	29
Potassium	7440-09-7	1	mg/L	7	65	24	1	<1
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.001	0.002	0.006	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	0.007	0.002	0.005	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	0.001	0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.003	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.016	0.008	0.085
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.010	mg/L	0.655	0.934	0.893	0.179	0.212
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N		0.010	mg/L	0.087	<0.010	0.013	<0.010	<0.010

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Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID : 22	21	24	23	4A
Sample Matrix Type / Description :				WATER	WATER	WATER	WATER	WATER
Sample Date / Time :				29 Mar 2007 15:00	29 Mar 2007 15:00	29 Mar 2007 15:00	29 Mar 2007 15:00	29 Mar 2007 15:00
Laboratory Sample ID :				ES0704246-001	ES0704246-002	ES0704246-003	ES0704246-004	ES0704246-005
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.010	mg/L	<0.010	0.027	0.013	0.013	0.034
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N		0.010	mg/L	0.037	0.027	0.026	0.013	0.034
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N		0.1	mg/L	7.2	12.1	9.3	2.5	0.9
EK067G: Total Phosphorous-As P by Discrete Analyser								
Total Phosphorus as P		0.01	mg/L	0.79	1.38	1.12	0.32	0.14
EK071G: Reactive Phosphorous as P by discrete analyser								
Reactive Phosphorus as P		0.010	mg/L	0.095	0.035	0.062	----	0.017
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon		1	mg/L	189	109	94	56	16
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand		2	mg/L	<2	<2	<2	9	9

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 8	DUP1	?1	D2	POND
Sample Matrix Type / Description				WATER	WATER	WATER	WATER	WATER
Sample Date / Time				29 Mar 2007 15:00	29 Mar 2007 15:00	30 Mar 2007 15:00	30 Mar 2007 15:00	30 Mar 2007 15:00
Laboratory Sample ID				ES0704246-006	ES0704246-007	ES0704246-008	ES0704246-009	ES0704246-010
EA005: pH								
pH Value		0.01	pH Unit	5.02	5.53	3.99	3.86	5.83
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C		1	µS/cm	268	15500	2730	169	182
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	1210	9700	200	195	129
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3		1	mg/L	29	2070	14	13	33
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	6	96	26	<1	23
Total Alkalinity as CaCO3		1	mg/L	6	96	26	<1	23
ED040F: Dissolved Major Anions								
Sulphate as SO4 2-	14808-79-8	1	mg/L	22	701	13	10	12
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1.0	mg/L	64.6	5180	34.4	33.7	37.4
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	2	127	<1	<1	8
Magnesium	7439-95-4	1	mg/L	6	427	3	3	3
Sodium	7440-23-5	1	mg/L	39	2670	15	14	22
Potassium	7440-09-7	1	mg/L	4	66	4	4	2
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	0.002	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	0.001	<0.001	0.001	0.005
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.001
Zinc	7440-66-6	0.005	mg/L	0.009	<0.005	0.017	0.032	0.029
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.010	mg/L	0.303	1.14	0.545	0.541	<0.010
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N		0.010	mg/L	0.027	<0.010	0.028	0.027	<0.010

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 8	DUP1	?1	D2	POND
Sample Matrix Type / Description				WATER	WATER	WATER	WATER	WATER
Sample Date / Time				29 Mar 2007 15:00	29 Mar 2007 15:00	30 Mar 2007 15:00	30 Mar 2007 15:00	30 Mar 2007 15:00
Laboratory Sample ID				ES0704246-006	ES0704246-007	ES0704246-008	ES0704246-009	ES0704246-010
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.010	mg/L	0.039	0.011	<0.010	0.013	0.020
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N		0.010	mg/L	0.066	0.011	0.034	0.040	0.020
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N		0.1	mg/L	3.0	11.2	2.5	3.8	0.7
EK067G: Total Phosphorous-As P by Discrete Analyser								
Total Phosphorus as P		0.01	mg/L	0.76	1.33	1.00	1.10	0.08
EK071G: Reactive Phosphorous as P by discrete analyser								
Reactive Phosphorus as P		0.010	mg/L	0.036	0.016	0.799	1.12	<0.010
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon		1	mg/L	22	110	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand		2	mg/L	<2	<2	----	6	5

ALS Environmental

Surrogate Control Limits

- **No surrogates present on this report.**

ALS Environmental

QUALITY CONTROL REPORT

Client	:	**COFFEY GEOTECHNICS**	**Laboratory**	: Environmental Division Sydney	**Page**	:	**1 of 11**
Contact	:	MR ANDREW FULTON	**Contact**	: Victor Kedicioglu			
Address	:	13 MANGROVE ROAD SANDGATE NSW AUSTRALIA 2304	**Address**	: 277-289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	:	**ES0704246**
					Amendment No.	:	
Project	:	MYALL QUAYS	**Quote number**	: EN/007/07	**Date received**	:	**2 Apr 2007**
Order number	:	- Not provided -			**Date issued**	:	**12 Apr 2007**
C-O-C number	:	- Not provided -					
Site	:	- Not provided -					
E-mail	:	andrew_fulton@coffey.com.au	**E-mail**	: Victor.Kedicioglu@alsenviro.com	**No. of samples**		
Telephone	:	49676377	**Telephone**	: 61-2-8784 8555	**Received**	:	10
Facsimile	:	49675402	**Facsimile**	: 61-2-8784 8500	**Analysed**	:	10

This final report for the ALSE work order reference ES0704246 supersedes any previous reports with this reference.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

Work order specific comments

TDS by method EA-015 may bias high on various sample due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
EK059G: It has been noted that Nitrite is greater than NOx on sample ID (22), however this difference is within the limits of experimental variation.
It has been noted that RP is greater than TP (sample ID D2), however this difference is within the limits of experimental variation.

ALSE - Excellence in Analytical Testing

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IED 17025

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Ankit Joshi	Inorganics - NATA 825 (10911 - Sydney)
Phyu Phyu Lwin	Inorganics - NATA 825 (10911 - Sydney)

ALS Environmental

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** = *Limit of Reporting,* ***RPD*** = *Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: WATER ***Laboratory Duplicates (DUP) Report***

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EA005: pH						
EA005: pH - (QC Lot: 385626)				**pH Unit**	**pH Unit**	**%**
ES0704246-001	22	pH Value	0.01 pH Unit	6.05	6.05	0.0
ES0704246-010	POND	pH Value	0.01 pH Unit	5.83	5.86	0.5
EA010P: Conductivity by PC Titrator						
EA010P: Conductivity by PC Titrator - (QC Lot: 385345)				**µS/cm**	**µS/cm**	**%**
ES0704246-001	22	Electrical Conductivity @ 25°C	1 µS/cm	1610	1580	2.0
ES0704252-001	Anonymous	Electrical Conductivity @ 25°C	1 µS/cm	22400	22300	0.4
EA015: Total Dissolved Solids						
EA015: Total Dissolved Solids - (QC Lot: 385565)				**mg/L**	**mg/L**	**%**
ES0704217-001	Anonymous	Total Dissolved Solids @180°C	1 mg/L	7890	7720	2.2
ES0704229-006	Anonymous	Total Dissolved Solids @180°C	1 mg/L	500	508	1.6
ED037P: Alkalinity by PC Titrator						
ED037P: Alkalinity by PC Titrator - (QC Lot: 385344)				**mg/L**	**mg/L**	**%**
ES0704246-001	22	Hydroxide Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Carbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Bicarbonate Alkalinity as CaCO3	1 mg/L	102	102	0.0
		Total Alkalinity as CaCO3	1 mg/L	102	102	0.0
ES0704252-001	Anonymous	Hydroxide Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Carbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Bicarbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Total Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
ED040F: Dissolved Major Anions						
ED040F: Dissolved Major Anions - (QC Lot: 386020)				**mg/L**	**mg/L**	**%**
ES0704246-001	22	Sulphate as SO4 2-	1 mg/L	39	40	0.0
ED045G: Chloride Discrete analyser						
ED045G: Chloride Discrete analyser - (QC Lot: 386094)				**mg/L**	**mg/L**	**%**

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
ED045G: Chloride Discrete analyser - continued						
ED045G: Chloride Discrete analyser - (QC Lot: 386094) - continued				mg/L	mg/L	%
ES0704246-001	22	Chloride	1.0 mg/L	430	436	1.4
ES0704246-008	?1	Chloride	1.0 mg/L	34.4	33.9	1.5
ED093F: Dissolved Major Cations						
ED093F: Dissolved Major Cations - (QC Lot: 386021)				mg/L	mg/L	%
ES0704246-001	22	Calcium	1 mg/L	11	11	0.0
		Magnesium	1 mg/L	23	24	0.0
		Sodium	1 mg/L	283	285	0.6
		Potassium	1 mg/L	7	7	0.0
ES0704314-001	Anonymous	Calcium	1 mg/L	3	3	0.0
		Magnesium	1 mg/L	62	63	2.3
		Sodium	1 mg/L	779	746	4.3
		Potassium	1 mg/L	<1	<1	0.0
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 385229)				mg/L	mg/L	%
ES0704242-001	Anonymous	Arsenic	0.001 mg/L	<0.001	<0.001	0.0
		Cadmium	0.0001 mg/L	<0.0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Copper	0.001 mg/L	0.001	<0.001	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Nickel	0.001 mg/L	<0.001	<0.001	0.0
		Zinc	0.005 mg/L	0.014	0.014	0.0
ES0704246-002	21	Arsenic	0.001 mg/L	0.002	<0.001	0.0
		Cadmium	0.0001 mg/L	<0.0001	<0.0001	0.0
		Chromium	0.001 mg/L	0.002	0.002	0.0
		Copper	0.001 mg/L	0.001	0.001	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Nickel	0.001 mg/L	<0.001	<0.001	0.0
		Zinc	0.005 mg/L	<0.005	<0.005	0.0
EG035F: Dissolved Mercury by FIMS						

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG035F: Dissolved Mercury by FIMS - continued						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 385598)				mg/L	mg/L	%
ES0704246-001	22	Mercury	0.0001 mg/L	<0.0001	<0.0001	0.0
ES0704289-004	Anonymous	Mercury	0.0001 mg/L	<0.0001	<0.0001	0.0
EK055G: Ammonia as N by Discrete Analyser						
EK055G: Ammonia as N by Discrete Analyser - (QC Lot: 386879)				mg/L	mg/L	%
ES0704246-001	22	Ammonia as N	0.010 mg/L	0.655	0.670	2.3
ES0704246-010	POND	Ammonia as N	0.010 mg/L	<0.010	<0.010	0.0
EK057G: Nitrite as N by Discrete Analyser						
EK057G: Nitrite as N by Discrete Analyser - (QC Lot: 385367)				mg/L	mg/L	%
ES0704246-002	21	Nitrite as N	0.010 mg/L	<0.010	<0.010	0.0
ES0704246-010	POND	Nitrite as N	0.010 mg/L	<0.010	<0.010	0.0
EK059G: NOX as N by Discrete Analyser						
EK059G: NOX as N by Discrete Analyser - (QC Lot: 386091)				mg/L	mg/L	%
ES0704246-001	22	Nitrite + Nitrate as N	0.010 mg/L	0.037	0.036	2.7
ES0704246-010	POND	Nitrite + Nitrate as N	0.010 mg/L	0.020	0.019	5.1
EK061: Total Kjeldahl Nitrogen (TKN)						
EK061: Total Kjeldahl Nitrogen (TKN) - (QC Lot: 387458)				mg/L	mg/L	%
ES0704246-001	22	Total Kjeldahl Nitrogen as N	0.1 mg/L	7.2	6.4	11.7
ES0704246-010	POND	Total Kjeldahl Nitrogen as N	0.1 mg/L	0.7	0.7	0.0
EK067G: Total Phosphorous-As P by Discrete Analyser						
EK067G: Total Phosphorous-As P by Discrete Analyser - (QC Lot: 387459)				mg/L	mg/L	%
ES0704246-001	22	Total Phosphorus as P	0.01 mg/L	0.79	0.76	3.9
ES0704246-010	POND	Total Phosphorus as P	0.01 mg/L	0.08	0.03	85.7
EK071G: Reactive Phosphorous as P by discrete analyser						
EK071G: Reactive Phosphorous as P by discrete analyser - (QC Lot: 385204)				mg/L	mg/L	%
ES0704246-001	22	Reactive Phosphorus as P	0.010 mg/L	0.095	0.111	15.5
EP005: Total Organic Carbon (TOC)						
EP005: Total Organic Carbon (TOC) - (QC Lot: 385545)				mg/L	mg/L	%
ES0704203-004	Anonymous	Total Organic Carbon	1 mg/L	20	20	0.0
ES0704252-001	Anonymous	Total Organic Carbon	1 mg/L	4	3	0.0

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EP030: Biochemical Oxygen Demand (BOD)						
EP030: Biochemical Oxygen Demand (BOD) - (QC Lot: 385733)				**mg/L**	**mg/L**	**%**
EB0703652-001	Anonymous	Biochemical Oxygen Demand	2 mg/L	6	6	0.0
EB0703660-015	Anonymous	Biochemical Oxygen Demand	2 mg/L	23	19	19.0
EP030: Biochemical Oxygen Demand (BOD) - (QC Lot: 385734)				**mg/L**	**mg/L**	**%**
EB0703640-001	Anonymous	Biochemical Oxygen Demand	2 mg/L	3850	3640	5.5
ES0704278-001	Anonymous	Biochemical Oxygen Demand	2 mg/L	1740	1840	5.8

ALS Environmental

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Flagged outliers on control limits for inorganics tests may be within the NEPM specified data quality objective of recoveries in the range of 70 to 130%. Where this occurs, no corrective action is taken. Abbreviations: LOR = Limit of reporting.

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	*LOR*	*Method blank result*	*Actual Results*		*Recovery Limits*	
			Spike concentration	*Spike Recovery*	*Dynamic Recovery Limits*	
				LCS	*Low*	*High*
EA010P: Conductivity by PC Titrator						
EA010P: Conductivity by PC Titrator - (QC Lot: 385345)		µS/cm	µS/cm	%	%	%
Electrical Conductivity @ 25°C	1 µS/cm	----	2000	101	86.3	112
	1 µS/cm	<1	----	----	----	----
EA015: Total Dissolved Solids						
EA015: Total Dissolved Solids - (QC Lot: 385565)		mg/L	mg/L	%	%	%
Total Dissolved Solids @180°C	1 mg/L	----	293	107	77.9	122
	1 mg/L	<1	----	----	----	----
ED037P: Alkalinity by PC Titrator						
ED037P: Alkalinity by PC Titrator - (QC Lot: 385344)		mg/L	mg/L	%	%	%
Total Alkalinity as CaCO3	1 mg/L	----	200	91.6	80.2	108
ED040F: Dissolved Major Anions						
ED040F: Dissolved Major Anions - (QC Lot: 386020)		mg/L	mg/L	%	%	%
Sulphate as SO4 2-	1 mg/L	<1	1	----	----	----
	1 mg/L	----	150	93.4	82.9	114
ED045G: Chloride Discrete analyser						
ED045G: Chloride Discrete analyser - (QC Lot: 386094)		mg/L	mg/L	%	%	%
Chloride	1 mg/L	----	50	104	83.7	124
	1 mg/L	----	250	96.0	83.7	124
	1.0 mg/L	<1.0	----	----	----	----
ED093F: Dissolved Major Cations						
ED093F: Dissolved Major Cations - (QC Lot: 386021)		mg/L	mg/L	%	%	%
Calcium	1 mg/L	<1	----	----	----	----
	1 mg/L	----	50	92.9	82.9	121

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	*LOR*	*Method blank result*	*Actual Results*		*Recovery Limits*	
			Spike concentration	*Spike Recovery*	*Dynamic Recovery Limits*	
				LCS	*Low*	*High*
ED093F: Dissolved Major Cations - continued						
ED093F: Dissolved Major Cations - (QC Lot: 386021) - continued		mg/L	mg/L	%	%	%
Magnesium	1 mg/L	----	50	96.1	82.7	114
	1 mg/L	<1	----	----	----	----
Potassium	1 mg/L	----	50	94.5	84.3	118
	1 mg/L	<1	----	----	----	----
Sodium	1 mg/L	<1	----	----	----	----
	1 mg/L	----	50	92.1	77.4	113
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 385229)		mg/L	mg/L	%	%	%
Arsenic	0.001 mg/L	<0.001	----	----	----	----
	0.001 mg/L	----	0.1	94.6	70	130
Cadmium	0.0001 mg/L	----	0.1	92.3	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
Chromium	0.001 mg/L	----	0.1	96.4	70	130
	0.001 mg/L	<0.001	----	----	----	----
Copper	0.001 mg/L	----	0.1	91.7	70	130
	0.001 mg/L	<0.001	----	----	----	----
Lead	0.001 mg/L	<0.001	----	----	----	----
	0.001 mg/L	----	0.1	94.3	70	130
Nickel	0.001 mg/L	----	0.1	91.9	70	130
	0.001 mg/L	<0.001	----	----	----	----
Zinc	0.005 mg/L	----	0.1	101	70	130
	0.005 mg/L	<0.005	----	----	----	----
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 385598)		mg/L	mg/L	%	%	%
Mercury	0.0001 mg/L	<0.0001	----	----	----	----
	0.0001 mg/L	----	0.010	115	80.5	117
EK055G: Ammonia as N by Discrete Analyser						
EK055G: Ammonia as N by Discrete Analyser - (QC Lot: 386879)		mg/L	mg/L	%	%	%

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EK055G: Ammonia as N by Discrete Analyser - continued						
EK055G: Ammonia as N by Discrete Analyser - (QC Lot: 386879) - continued		mg/L	mg/L	%	%	%
Ammonia as N	0.01 mg/L	----	1.00	105	75.6	128
	0.010 mg/L	<0.010	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser						
EK057G: Nitrite as N by Discrete Analyser - (QC Lot: 385367)		mg/L	mg/L	%	%	%
Nitrite as N	0.010 mg/L	<0.010	----	----	----	----
	0.01 mg/L	----	0.96	102	66.6	131
EK059G: NOX as N by Discrete Analyser						
EK059G: NOX as N by Discrete Analyser - (QC Lot: 386091)		mg/L	mg/L	%	%	%
Nitrite + Nitrate as N	0.010 mg/L	<0.010	----	----	----	----
	0.01 mg/L	----	0.96	94.3	76.9	122
EK061: Total Kjeldahl Nitrogen (TKN)						
EK061: Total Kjeldahl Nitrogen (TKN) - (QC Lot: 387458)		mg/L	mg/L	%	%	%
Total Kjeldahl Nitrogen as N	0.1 mg/L	----	10	98.2	62.4	140
	0.1 mg/L	<0.1	----	----	----	----
EK067G: Total Phosphorous-As P by Discrete Analyser						
EK067G: Total Phosphorous-As P by Discrete Analyser - (QC Lot: 387459)		mg/L	mg/L	%	%	%
Total Phosphorus as P	0.01 mg/L	<0.01	----	----	----	----
	0.01 mg/L	----	4.42	90.3	64.3	120
EK071G: Reactive Phosphorous as P by discrete analyser						
EK071G: Reactive Phosphorous as P by discrete analyser - (QC Lot: 385204)		mg/L	mg/L	%	%	%
Reactive Phosphorus as P	0.010 mg/L	<0.010	----	----	----	----
	0.01 mg/L	----	0.50	102	83.8	122
EP005: Total Organic Carbon (TOC)						
EP005: Total Organic Carbon (TOC) - (QC Lot: 385545)		mg/L	mg/L	%	%	%
Total Organic Carbon	1 mg/L	----	10	92.2	86.9	125
	1 mg/L	<1	----	----	----	----
EP030: Biochemical Oxygen Demand (BOD)						

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	*LOR*	*Method blank result*	*Actual Results*		*Recovery Limits*	
			Spike concentration	*Spike Recovery*	*Dynamic Recovery Limits*	
				LCS	*Low*	*High*
EP030: Biochemical Oxygen Demand (BOD) - continued						
EP030: Biochemical Oxygen Demand (BOD) - (QC Lot: 385733)		mg/L	mg/L	%	%	%
Biochemical Oxygen Demand	2 mg/L	<2	----	----	----	----
	2 mg/L	----	200	99.5	66.8	112
EP030: Biochemical Oxygen Demand (BOD) - (QC Lot: 385734)		mg/L	mg/L	%	%	%
Biochemical Oxygen Demand	2 mg/L	<2	----	----	----	----
	2 mg/L	----	200	96.0	66.8	112

ALS Environmental

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** *= Limit of Reporting,* ***RPD*** *= Relative Percent Difference.*

* Indicates failed QC

Matrix Type: WATER

Matrix Spike (MS) Report

					Actual Results		*Recovery Limits*	
					Sample Result	*Spike Recovery*	*Static Limits*	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
ED045G: Chloride Discrete analyser								
ED045G: Chloride Discrete analyser - (QC Lot: 386094)				mg/L	mg/L	%	%	%
Chloride	ES0704246-001	22	1 mg/L	250	430	125	70	130
EG020F: Dissolved Metals by ICP-MS								
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 385229)				mg/L	mg/L	%	%	%
Arsenic	ES0704242-001	Anonymous	0.001 mg/L	0.2	<0.001	98.1	70	130
Cadmium			0.0001 mg/L	0.05	<0.0001	98.4	70	130
Chromium			0.001 mg/L	0.2	<0.001	94.9	70	130
Copper			0.001 mg/L	0.2	0.001	95.4	70	130
Lead			0.001 mg/L	0.2	<0.001	100	70	130
Nickel			0.001 mg/L	0.2	<0.001	96.8	70	130
Zinc			0.005 mg/L	0.2	0.014	104	70	130
EG035F: Dissolved Mercury by FIMS								
EG035F: Dissolved Mercury by FIMS - (QC Lot: 385598)				mg/L	mg/L	%	%	%
Mercury	ES0704246-001	22	0.0001 mg/L	0.0100	<0.0001	116	70	130
EK055G: Ammonia as N by Discrete Analyser								
EK055G: Ammonia as N by Discrete Analyser - (QC Lot: 386879)				mg/L	mg/L	%	%	%
Ammonia as N	ES0704246-001	22	0.01 mg/L	1.00	0.655	93.3	70	130
EK057G: Nitrite as N by Discrete Analyser								
EK057G: Nitrite as N by Discrete Analyser - (QC Lot: 385367)				mg/L	mg/L	%	%	%
Nitrite as N	ES0704246-002	21	0.01 mg/L	0.60	<0.010	102	70	130
EK059G: NOX as N by Discrete Analyser								
EK059G: NOX as N by Discrete Analyser - (QC Lot: 386091)				mg/L	mg/L	%	%	%
Nitrite + Nitrate as N	ES0704246-001	22	0.01 mg/L	0.60	0.037	92.3	70	130
EK061: Total Kjeldahl Nitrogen (TKN)								

ALS Environmental

Matrix Type: WATER

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EK061: Total Kjeldahl Nitrogen (TKN) - continued								
EK061: Total Kjeldahl Nitrogen (TKN) - (QC Lot: 387458)				mg/L	mg/L	%	%	%
Total Kjeldahl Nitrogen as N	ES0704246-001	22	0.1 mg/L	25	7.2	100	70	130
EK067G: Total Phosphorous-As P by Discrete Analyser								
EK067G: Total Phosphorous-As P by Discrete Analyser - (QC Lot: 387459)				mg/L	mg/L	%	%	%
Total Phosphorus as P	ES0704246-001	22	0.01 mg/L	5	0.79	75.3	70	130
EK071G: Reactive Phosphorous as P by discrete analyser								
EK071G: Reactive Phosphorous as P by discrete analyser - (QC Lot: 385204)				mg/L	mg/L	%	%	%
Reactive Phosphorus as P	ES0704246-001	22	0.01 mg/L	0.50	0.095	101	70	130
EP005: Total Organic Carbon (TOC)								
EP005: Total Organic Carbon (TOC) - (QC Lot: 385545)				mg/L	mg/L	%	%	%
Total Organic Carbon	ES0704203-004	Anonymous	1 mg/L	100	20	94.9	70	130

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 30674

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

Attention: Ben Rose

Sample log in details:

Your Reference:	**P0902346**
No. of samples:	6 Waters
Date samples received:	08/07/09
Date completed instructions received:	08/07/09

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:	15/07/09
Date of Preliminary Report:	Not issued
Issue Date:	15/07/09

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Tests not covered by NATA are denoted with *.

Results Approved By:

Jacinta Hurst
Operations Manager

ACCREDITED FOR TECHNICAL COMPETENCE

Ion Balance Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- ----------	30674-1 2346/1A/GW 6/07/2009 Water	30674-2 2346/2A/GW 6/07/2009 Water	30674-3 2346/9/GW 6/07/2009 Water	30674-4 2346/23/GW 6/07/2009 Water	30674-5 2346/25/GW 6/07/2009 Water
Date prepared	-	9/07/2009	9/07/2009	9/07/2009	9/07/2009	9/07/2009
Date analysed	-	9/07/2009	9/07/2009	9/07/2009	9/07/2009	9/07/2009
Calcium - Dissolved	mg/L	5.6	1.2	0.30	3.6	3.6
Potassium - Dissolved	mg/L	19	8.9	4.5	2.1	2.0
Sodium - Dissolved	mg/L	27	22	16	35	34
Magnesium - Dissolved	mg/L	8.2	3.4	2.9	7.8	4.4
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	140	18	<0.1	25	45
Carbonate Alkalinity as $CaCO_3$	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Total Alkalinity as $CaCO_3$	mg/L	140	18	<0.1	25	45
Sulphate, SO4	mg/L	39	<5	<5	<5	5
Chloride (titration) - water	mg/L	30	50	37	65	25
Ionic Balance	%	-26	-7.4	1.1	1.5	9.6

Ion Balance Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- ----------	30674-6 2346/26/GW 6/07/2009 Water
Date prepared	-	9/07/2009
Date analysed	-	9/07/2009
Calcium - Dissolved	mg/L	110
Potassium - Dissolved	mg/L	130
Sodium - Dissolved	mg/L	3,820
Magnesium - Dissolved	mg/L	360
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<0.1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	50
Carbonate Alkalinity as $CaCO_3$	mg/L	<0.1
Total Alkalinity as $CaCO_3$	mg/L	50
Sulphate, SO4	mg/L	850
Chloride (titration) - water	mg/L	5,800
Ionic Balance	%	5.8

HM in water - dissolved Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- ----------	30674-1 2346/1A/GW 6/07/2009 Water	30674-2 2346/2A/GW 6/07/2009 Water	30674-3 2346/9/GW 6/07/2009 Water	30674-4 2346/23/GW 6/07/2009 Water	30674-5 2346/25/GW 6/07/2009 Water
Date prepared	-	13/07/2009	13/07/2009	13/07/2009	13/07/2009	13/07/2009
Date analysed	-	13/07/2009	13/07/2009	13/07/2009	13/07/2009	13/07/2009
Arsenic-Dissolved	µg/L	2.0	3.0	<1.0	<1.0	8.0
Cadmium-Dissolved	µg/L	<0.10	<0.10	0.10	<0.10	<0.10
Chromium-Dissolved	µg/L	2.0	1.0	<1.0	<1.0	3.0
Copper-Dissolved	µg/L	3.0	2.0	1.0	<1.0	<1.0
Lead-Dissolved	µg/L	<1.0	<1.0	2.0	<1.0	<1.0
Mercury-Dissolved	µg/L	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel-Dissolved	µg/L	2.0	3.0	3.0	2.0	2.0
Zinc-Dissolved	µg/L	<1.0	9.0	31	3.0	2.0

HM in water - dissolved Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- ----------	30674-6 2346/26/GW 6/07/2009 Water
Date prepared	-	13/07/2009
Date analysed	-	13/07/2009
Arsenic-Dissolved	µg/L	2.0
Cadmium-Dissolved	µg/L	<0.10
Chromium-Dissolved	µg/L	<1.0
Copper-Dissolved	µg/L	<1.0
Lead-Dissolved	µg/L	<1.0
Mercury-Dissolved	µg/L	<0.50
Nickel-Dissolved	µg/L	<1.0
Zinc-Dissolved	µg/L	<1.0

Miscellaneous Inorganics Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- ----------	30674-1 2346/1A/GW 6/07/2009 Water	30674-2 2346/2A/GW 6/07/2009 Water	30674-3 2346/9/GW 6/07/2009 Water	30674-4 2346/23/GW 6/07/2009 Water	30674-5 2346/25/GW 6/07/2009 Water
Date prepared	-	9/07/2009	9/07/2009	9/07/2009	9/07/2009	9/07/2009
Date analysed	-	9/07/2009	9/07/2009	9/07/2009	9/07/2009	9/07/2009
pH	pH Units	6.2	5.1	4.3	5.7	5.6
Electrical Conductivity	µS/cm	280	200	160	280	260
Total Dissolved Solids (grav)	mg/L	170	120	96	180	160
Ammonia as N in water	mg/L	<1.0	<1.0	<0.5	<0.1	0.6
NOx as N in water	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0
TKN in water	mg/L	7.1	3.8	1	<0.5	30
Total Nitrogen in water	mg/L	7.1	3.8	1	<0.6	30
Phosphorus - Total	mg/L	6.1	2.8	1.9	<0.050	1.2

Miscellaneous Inorganics Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- ----------	30674-6 2346/26/GW 6/07/2009 Water
Date prepared	-	9/07/2009
Date analysed	-	9/07/2009
pH	pH Units	6.3
Electrical Conductivity	µS/cm	14,000
Total Dissolved Solids (grav)	mg/L	11,000
Ammonia as N in water	mg/L	<0.1
NOx as N in water	mg/L	<1.0
TKN in water	mg/L	<0.5
Total Nitrogen in water	mg/L	<0.6
Phosphorus - Total	mg/L	<0.050

Method ID	Methodology Summary
Metals.20 ICP-AES	Determination of various metals by ICP-AES.
LAB.6	Alkalinity - determined titrimetrically in accordance with APHA 20th ED, 2320-B.
LAB.9	Sulphate determined turbidimetrically.
LAB.11	Chloride determined by argentometric titration.
LAB.41	Gravimetric determination of the total solids content of water.
Metals.22 ICP-MS	Determination of various metals by ICP-MS.
Metals.21 CV-AAS	Determination of Mercury by Cold Vapour AAS.
LAB.1	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
LAB.2	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA2510 20th ED and Rayment & Higginson.
LAB.18	Total Dissolved Solids - determined gravimetrically by drying the sample, in accordance with APHA 20th ED, 2540-C.
LAB.57	Ammonia water extractable - determined colourimetrically based on EPA350.1
LAB.55	Nitrate water extractable - determined colourimetrically based on EPA114A.
LAB.62	TKN - determined colourimetrically based on EPA110A.
LAB.66	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.

QUALITY CONTROL Ion Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			9/7/09	30674-5	9/07/2009 || 9/07/2009	LCS-W2	9/7/09
Date analysed	-			9/7/09	30674-5	9/07/2009 || 9/07/2009	LCS-W2	9/7/09
Calcium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	30674-5	3.6 || 4.1 || RPD: 13	LCS-W2	90%
Potassium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	30674-5	2.0 || 2.1 || RPD: 5	LCS-W2	105%
Sodium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	30674-5	34 || 35 || RPD: 3	LCS-W2	110%
Magnesium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	30674-5	4.4 || 5.0 || RPD: 13	LCS-W2	100%
Bicarbonate Alkalinity as $CaCO_3$	mg/L	0.1	LAB.6	<0.1	30674-5	45 || <0.1	LCS-W2	100%
Carbonate Alkalinity as $CaCO_3$	mg/L	0.1	LAB.6	<0.1	30674-5	<0.1 || <0.1	[NR]	[NR]
Total Alkalinity as $CaCO_3$	mg/L	0.1	LAB.6	<0.1	30674-5	45 || <0.1	LCS-W2	100%
Sulphate, SO4	mg/L	5	LAB.9	<5	30674-5	5 || [N/T]	LCS-W2	103%
Chloride (titration) - water	mg/L	20	LAB.11	<20	30674-5	25 || [N/T]	LCS-W2	104%
Ionic Balance	%		LAB.41	[NT]	30674-5	9.6 || [N/T]	[NR]	[NR]

QUALITY CONTROL HM in water - dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			13/07/2009	30674-5	13/07/2009 || 13/07/2009	LCS-W3	13/07/2009
Date analysed	-			13/07/2009	30674-5	13/07/2009 || 13/07/2009	LCS-W3	13/07/2009
Arsenic-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	8.0 || 8.0 || RPD: 0	LCS-W3	102%
Cadmium-Dissolved	µg/L	0.1	Metals.22 ICP-MS	<0.10	30674-5	<0.10 || <0.10	LCS-W3	110%
Chromium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	3.0 || 4.0 || RPD: 29	LCS-W3	104%
Copper-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	<1.0 || <1.0	LCS-W3	99%
Lead-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	<1.0 || <1.0	LCS-W3	106%
Mercury-Dissolved	µg/L	0.5	Metals.21 CV-AAS	<0.50	30674-5	<0.50 || <0.50	LCS-W3	94%
Nickel-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	2.0 || 2.0 || RPD: 0	LCS-W3	94%
Zinc-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	2.0 || 2.0 || RPD: 0	LCS-W3	93%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			9/7/09	30674-5	9/07/2009 || 9/07/2009	LCS-W2	9/7/09
Date analysed	-			9/7/09	30674-5	9/07/2009 || 9/07/2009	LCS-W2	9/7/09
pH	pH Units		LAB.1	[NT]	30674-5	5.6 || [N/T]	LCS-W2	66%
Electrical Conductivity	µS/cm	1	LAB.2	<1.0	30674-5	260 || [N/T]	LCS-W2	100%
Total Dissolved Solids (grav)	mg/L	5	LAB.18	<5	30674-5	160 || [N/T]	LCS-W2	92%
Ammonia as N in water	mg/L	0.1	LAB.57	<0.1	30674-5	0.6 || [N/T]	LCS-W2	90%
NOx as N in water	mg/L	0.1	LAB.55	<0.1	30674-5	<1.0 || [N/T]	LCS-W2	101%
TKN in water	mg/L	0.5	LAB.62	<0.5	30674-5	30 || [N/T]	LCS-W2	92%
Total Nitrogen in water	mg/L	0.6	LAB.66	<0.6	30674-5	30 || [N/T]	[NR]	[NR]
Phosphorus - Total	mg/L	0.05	Metals.20 ICP-AES	<0.050	30674-5	1.2 || 1.4 || RPD: 15	LCS-W2	98%

QUALITY CONTROL Ion Balance	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	30674-1	9/07/2009 || 9/07/2009
Date analysed	-	30674-1	9/07/2009 || 9/07/2009
Calcium - Dissolved	mg/L	30674-1	5.6 || [N/T]
Potassium - Dissolved	mg/L	30674-1	19 || [N/T]
Sodium - Dissolved	mg/L	30674-1	27 || [N/T]
Magnesium - Dissolved	mg/L	30674-1	8.2 || [N/T]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	30674-1	140 || 140 || RPD: 0
Carbonate Alkalinity as $CaCO_3$	mg/L	30674-1	<0.1 || <0.1
Total Alkalinity as $CaCO_3$	mg/L	30674-1	140 || 140 || RPD: 0
Sulphate, SO4	mg/L	30674-1	39 || [N/T]
Chloride (titration) - water	mg/L	30674-1	30 || [N/T]
Ionic Balance	%	30674-1	-26 || [N/T]

QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	30674-1	9/07/2009 || 9/07/2009
Date analysed	-	30674-1	9/07/2009 || 9/07/2009
pH	pH Units	30674-1	6.2 || 6.2 || RPD: 0
Electrical Conductivity	µS/cm	30674-1	280 || 280 || RPD: 0
Total Dissolved Solids (grav)	mg/L	30674-1	170 || 170 || RPD: 0
Ammonia as N in water	mg/L	30674-1	<1.0 || <1.0
NOx as N in water	mg/L	30674-1	<1.0 || <1.0
TKN in water	mg/L	30674-1	7.1 || [N/T]
Total Nitrogen in water	mg/L	30674-1	7.1 || [N/T]
Phosphorus - Total	mg/L	30674-1	6.1 || [N/T]

Report Comments:

Nitrate and Ammonia: detection limits have been raised due to matrix interferences.

Asbestos was analysed by Approved Identifier: 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 SVOC and speciated phenols.

martens
consulting engineers since 1989

SOIL ANALYSIS CHAIN OF CUSTODY FORM

Project												
Name	P0902346											
Martens Contact Officer	Ben Rose					**Contact Email**	brose@martens.com.au					
Sampling and Shipping	**Sample Date**	06.07.2009		**Dispatch Date**	08.07.2009		**Turnaround Time**	standard				
	Our Reference	P0902346				**Shipping Method (X)**	**Hand**		**Post**		**Courier**	X
	On Ice (X)	X	**No Ice (X)**		**Other (X)**							
Laboratory												
Name	EnviroLab											
Sample Delivery Address	12 Ashley Street, Chatswood, NSW, 2067											
Delivery Contact	**Name**	Aileen Hie		**Phone**	(02) 9910 6200	**Fax**		**Email**				
Please Send Report By (X)	**Post**		**Fax**		**Email**	X	**Reporting Email Address**	brose@martens.com.au				

Jacinta,

The following groundwater samples are enclosed in the esky:

1 2346/1A/GW
2 2346/2A/GW
3 2346/9/GW
4 2346/23/GW
5 2346/25/GW
6 2346/26/GW

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: 9910 6200

Job No: 30674
Date received: 8/7/09
Time received: 1
Received by: SS
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Please test all samples for the following:

Head Office
Unit 6 / 37 Leighton Place
Hornsby NSW 2077, Australia
Ph 02 9476 9999 **Fax** 02 9476 8767

> mail@martens.com.au
> www.martens.com.au
MARTENS & ASSOCIATES P/L
ABN 85 070 240 890 ACN 070 240 890

- pH
- EC
- Total Dissolved Solids
- Major cations and anions
- Metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury)
- Ammonia
- Nox
- TKN
- TN
- TP

If you require any further information, please do not hesitate to contact the writer.

For and on behalf of

MARTENS & ASSOCIATES PTY LTD

BEN ROSE
BEnvMgt
Environmental Scientist

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 78418

Client:

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

Attention: Ben Rose

Sample log in details:

Your Reference:	**P0902346JC11V01, Riverside**		
No. of samples:	9 waters		
Date samples received / completed instructions received	05/09/12	/	05/09/12

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: / Issue Date:	12/09/12	/	12/09/12
Date of Preliminary Report:	not issued		

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

Results Approved By:

Rhian Morgan
Reporting Supervisor

Nick Sarlamis
Inorganics Supervisor

Miscellaneous Inorganics						
Our Reference:	UNITS	78418-1	78418-2	78418-3	78418-4	78418-5
Your Reference	----------	2346/GW3	2346/GW4	2346/GW5	2346/GW6	2346/GW8
Date Sampled	----------	04/09/2012	04/09/2012	03/09/2012	04/09/2012	03/09/2012
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	05/09/2012	05/09/2012	05/09/2012	05/09/2012	05/09/2012
Date analysed	-	05/09/2012	05/09/2012	05/09/2012	05/09/2012	05/09/2012
pH	pH Units	6.7	6.2	6.3	6.4	5.8
Total Dissolved Solids (grav)	mg/L	7,300	120	200	3,500	200
Chloride, Cl	mg/L	5,500	75	49	1,700	62
Sulphate, SO4	mg/L	760	4	10	210	20
Electrical Conductivity	µS/cm	18,000	320	260	6,400	310
Total Nitrogen in water	mg/L	2.2	1.9	1.9	0.9	1.9

Miscellaneous Inorganics					
Our Reference:	UNITS	78418-6	78418-7	78418-8	78418-9
Your Reference	----------	2346/GW9	2346/GW11	2346/GW25	2346/GW26
Date Sampled	----------	04/09/2012	03/09/2012	04/09/2012	04/09/2012
Type of sample		Water	Water	Water	Water
Date prepared	-	05/09/2012	05/09/2012	05/09/2012	05/09/2012
Date analysed	-	05/09/2012	05/09/2012	05/09/2012	05/09/2012
pH	pH Units	4.0	6.1	6.3	7.3
Total Dissolved Solids (grav)	mg/L	160	2,800	130	10,000
Chloride, Cl	mg/L	27	1,300	36	4,900
Sulphate, SO4	mg/L	<1	170	1	600
Electrical Conductivity	µS/cm	170	4,700	240	16,000
Total Nitrogen in water	mg/L	2.8	0.7	5.3	0.9

Metals in Waters - Acid extractable						
Our Reference:	UNITS	78418-1	78418-2	78418-3	78418-4	78418-5
Your Reference	----------	2346/GW3	2346/GW4	2346/GW5	2346/GW6	2346/GW8
Date Sampled	----------	04/09/2012	04/09/2012	03/09/2012	04/09/2012	03/09/2012
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Date analysed	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Phosphorus - Total	mg/L	<0.05	<0.05	0.09	<0.05	0.1

Metals in Waters - Acid extractable					
Our Reference:	UNITS	78418-6	78418-7	78418-8	78418-9
Your Reference	----------	2346/GW9	2346/GW11	2346/GW25	2346/GW26
Date Sampled	----------	04/09/2012	03/09/2012	04/09/2012	04/09/2012
Type of sample		Water	Water	Water	Water
Date prepared	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Date analysed	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Phosphorus - Total	mg/L	1.3	0.5	0.2	<0.05

Metals in Water - Dissolved						
Our Reference:	UNITS	78418-1	78418-2	78418-3	78418-4	78418-5
Your Reference	----------	2346/GW3	2346/GW4	2346/GW5	2346/GW6	2346/GW8
Date Sampled	----------	04/09/2012	04/09/2012	03/09/2012	04/09/2012	03/09/2012
Type of sample		Water	Water	Water	Water	Water
Date digested	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Date analysed	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Calcium - Dissolved	mg/L	110	2.4	0.9	49	2.8
Magnesium - Dissolved	mg/L	370	6.1	2.1	130	4.8

Metals in Water - Dissolved					
Our Reference:	UNITS	78418-6	78418-7	78418-8	78418-9
Your Reference	----------	2346/GW9	2346/GW11	2346/GW25	2346/GW26
Date Sampled	----------	04/09/2012	03/09/2012	04/09/2012	04/09/2012
Type of sample		Water	Water	Water	Water
Date digested	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Date analysed	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Calcium - Dissolved	mg/L	0.5	18	4.2	97
Magnesium - Dissolved	mg/L	3.1	77	4.2	300

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-5oC.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Inorg-055/062	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			05/09/2012	78418-1	05/09/2012 || 05/09/2012	LCS-W1	05/09/2012
Date analysed	-			05/09/2012	78418-1	05/09/2012 || 05/09/2012	LCS-W1	05/09/2012
pH	pH Units		Inorg-001	[NT]	78418-1	6.7 || [N/T]	LCS-W1	101%
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	78418-1	7300 || [N/T]	LCS-W1	92%
Chloride, Cl	mg/L	1	Inorg-081	<1	78418-1	5500 || 5500 || RPD: 0	LCS-W1	94%
Sulphate, SO4	mg/L	1	Inorg-081	<1	78418-1	760 || 760 || RPD: 0	LCS-W1	101%
Electrical Conductivity	µS/cm	1	Inorg-002	<1	78418-1	18000 || [N/T]	LCS-W1	110%
Total Nitrogen in water	mg/L	0.1	Inorg-055/062	<0.1	78418-1	2.2 || 2.3 || RPD: 4	LCS-W1	93%
QUALITY CONTROL Metals in Waters - Acid extractable	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			06/09/2012	78418-1	06/09/2012 || 06/09/2012	LCS-W1	06/09/2012
Date analysed	-			06/09/2012	78418-1	06/09/2012 || 06/09/2012	LCS-W1	06/09/2012
Phosphorus - Total	mg/L	0.05	Metals-020 ICP-AES	<0.05	78418-1	<0.05 || <0.05	LCS-W1	95%
QUALITY CONTROL Metals in Water - Dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date digested	-			06/09/2012	78418-6	06/09/2012 || 06/09/2012	LCS-W1	06/09/2012
Date analysed	-			06/09/2012	78418-6	06/09/2012 || 06/09/2012	LCS-W1	06/09/2012
Calcium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	78418-6	0.5 || 0.5 || RPD: 0	LCS-W1	95%
Magnesium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	78418-6	3.1 || 3.1 || RPD: 0	LCS-W1	95%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	78418-2	05/09/2012 || 05/09/2012	78418-2	05/09/2012
Date analysed	-	78418-2	05/09/2012 || 05/09/2012	78418-2	05/09/2012
Total Dissolved Solids (grav)	mg/L	78418-2	120 || 120 || RPD: 0	[NR]	[NR]
Total Nitrogen in water	mg/L	78418-2	1.9 || [N/T]	78418-2	99%
QUALITY CONTROL Metals in Waters - Acid extractable	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	78418-2	06/09/2012
Date analysed	-	[NT]	[NT]	78418-2	06/09/2012
Phosphorus - Total	mg/L	[NT]	[NT]	78418-2	99%

Report Comments:

Sample #6: TDS\Conductivity ratio outside acceptance limits due to presence of organics

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

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

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

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

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

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SOIL ANALYSIS CHAIN OF CUSTODY FORM

Additional Testing												
Name	P0902346 – Riverside											
Martens Contact Officer	Ben Rose					**Contact Email**	brose@martens.com.au					
Sampling and Shipping	**Sample Date**	3/9/12 + 4/9/12	**Dispatch Date**	5/9/12		**Turnaround Time**	standard					
	Our Reference	P0902346JC11V01				**Shipping Method (X)**	**Hand**		**Post**		**Courier**	X
	On Ice (X)	X	**No Ice (X)**		**Other (X)**							
Laboratory												
Name	EnviroLab											
Sample Delivery Address	12 Ashley Street, Chatswood											
Delivery Contact	**Name**	Aileen	**Phone**	9910 6200	**Fax**		**Email**					
Please Send Report By (X)	**Post**		**Fax**		**Email**	X	**Reporting Email Address**	brose@martens.com.au please cc dmartens@martens.com.au and gharlow@martens.com.au and mkovelis@martens.com.au				

	Sample ID	pH	TDS	Chloride	Sulphate	Magnesium	Calcium	EC	TN	TP
1	2346/GW3/04.09.12	x	x	x	x	x	x	x	x	x
2	2346/GW4/04.09.12	x	x	x	x	x	x	x	x	x
3	2346/GW5/03.09.12	x	x	x	x	x	x	x	x	x
4	2346/GW6/04.09.12	x	x	x	x	x	x	x	x	x
5	2346/GW8/03.09.12	x	x	x	x	x	x	x	x	x
6	2346/GW9/04.09.12	x	x	x	x	x	x	x	x	x
7	2346/GW11/03.09.12	x	x	x	x	x	x	x	x	x
8	2346/GW25/04.09.12	x	x	x	x	x	x	x	x	x
9	2346/GW26/04.09.12	x	x	x	x	x	x	x	x	x

— Note for / sample / location there is no red bottle

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 78418

Date Received: 5.9.12.
Time Received: 14.10
Received by: JIA LIU
Temp: Cool / Ambient
Cooling: Ice / Ice pack
Security: Intact / Broken / None

Received By: JIA LIU / ELS.

Head Office
Unit 6 / 37 Leighton Place
Hornsby NSW 2077, Australia
Ph 02 9476 9999 **Fax** 02 9476 8767

> mail@martens.com.au
> www.martens.com.au
MARTENS & ASSOCIATES P/L
ABN 85 070 240 890 ACN 070 240 890

ACEA

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 79518

Client:

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

Attention: Ben Rose

Sample log in details:

Your Reference:	**P0902346JC14V01, Riverside**		
No. of samples:	10 waters		
Date samples received / completed instructions received	27/09/12	/	27/09/12

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: / Issue Date:	5/10/12	/	5/10/12
Date of Preliminary Report:	Not issued		

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

Results Approved By:

Rhian Morgan
Reporting Supervisor

Nick Sarlamis
Inorganics Supervisor

Alex MacLean
Chemist

Miscellaneous Inorganics						
Our Reference:	UNITS	79518-1	79518-2	79518-3	79518-4	79518-5
Your Reference	----------	2346/GW5	2346/GW6	2346/GW7	2346/GW8	2346/GW9
Date Sampled	----------	25/09/2012	25/09/2012	25/09/2012	25/09/2012	25/09/2012
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	27/09/2012	27/09/2012	27/09/2012	27/09/2012	27/09/2012
Date analysed	-	27/09/2012	27/09/2012	27/09/2012	27/09/2012	27/09/2012
pH	pH Units	5.8	5.7	5.5	5.2	4.1
Total Dissolved Solids (grav)	mg/L	180	4,900	120	160	150
Total Suspended Solids @ 103-105^{O}C	mg/L	36	48	230	140	9
Chloride, Cl	mg/L	44	2,900	38	71	29
Sulphate, SO4	mg/L	10	360	7	24	<1
Electrical Conductivity	µS/cm	230	8,400	200	320	170
Total Nitrogen in water	mg/L	1.1	1.2	3.0	1.6	1.9

Miscellaneous Inorganics						
Our Reference:	UNITS	79518-6	79518-7	79518-8	79518-9	79518-10
Your Reference	----------	2346/GW10	2346/GW11	2346/GW202	2346/GW201	2346/GW203
Date Sampled	----------	25/09/2012	25/09/2012	26/09/2012	26/09/2012	26/09/2012
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	27/09/2012	27/09/2012	27/09/2012	27/09/2012	27/09/2012
Date analysed	-	27/09/2012	27/09/2012	27/09/2012	27/09/2012	27/09/2012
pH	pH Units	6.0	5.6	5.4	5.3	5.3
Total Dissolved Solids (grav)	mg/L	160	2,700	65	1,200	110
Total Suspended Solids @ 103-105^{O}C	mg/L	190	120	1,000	9,800	2,100
Chloride, Cl	mg/L	53	1,400	18	640	43
Sulphate, SO4	mg/L	3	180	5	26	5
Electrical Conductivity	µS/cm	300	4,600	110	2,000	190
Total Nitrogen in water	mg/L	1.6	0.7	3.3	9.9	4.1

Metals in Waters - Acid extractable						
Our Reference:	UNITS	79518-1	79518-2	79518-3	79518-4	79518-5
Your Reference	----------	2346/GW5	2346/GW6	2346/GW7	2346/GW8	2346/GW9
Date Sampled	----------	25/09/2012	25/09/2012	25/09/2012	25/09/2012	25/09/2012
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Date analysed	-	02/10/2012	02/10/2012	02/10/2012	02/10/2012	02/10/2012
Phosphorus - Total	mg/L	<0.05	<0.05	0.2	0.3	1.3

Metals in Waters - Acid extractable						
Our Reference:	UNITS	79518-6	79518-7	79518-8	79518-9	79518-10
Your Reference	----------	2346/GW10	2346/GW11	2346/GW202	2346/GW201	2346/GW203
Date Sampled	----------	25/09/2012	25/09/2012	26/09/2012	26/09/2012	26/09/2012
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Date analysed	-	02/10/2012	02/10/2012	02/10/2012	02/10/2012	02/10/2012
Phosphorus - Total	mg/L	0.1	0.07	0.3	1.2	0.6

Metals in Water - Dissolved						
Our Reference:	UNITS	79518-1	79518-2	79518-3	79518-4	79518-5
Your Reference	----------	2346/GW5	2346/GW6	2346/GW7	2346/GW8	2346/GW9
Date Sampled	----------	25/09/2012	25/09/2012	25/09/2012	25/09/2012	25/09/2012
Type of sample		Water	Water	Water	Water	Water
Date digested	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Date analysed	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Calcium - Dissolved	mg/L	0.6	67	3.6	3.1	<0.5
Magnesium - Dissolved	mg/L	1.5	170	3.7	5.0	3.1

Metals in Water - Dissolved						
Our Reference:	UNITS	79518-6	79518-7	79518-8	79518-9	79518-10
Your Reference	----------	2346/GW10	2346/GW11	2346/GW202	2346/GW201	2346/GW203
Date Sampled	----------	25/09/2012	25/09/2012	26/09/2012	26/09/2012	26/09/2012
Type of sample		Water	Water	Water	Water	Water
Date digested	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Date analysed	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Calcium - Dissolved	mg/L	6.2	21	1.7	13	1.1
Magnesium - Dissolved	mg/L	10	87	1.9	42	4.0

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-5oC.
Inorg-019	Suspended Solids - determined gravimetrcially by filtration of the sample, in accordance with APHA 22nd ED, 2540-D.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Inorg-055/062	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			27/09/2012	79518-1	27/09/2012 || 27/09/2012	LCS-W1	27/09/2012
Date analysed	-			27/09/2012	79518-1	27/09/2012 || 27/09/2012	LCS-W1	27/09/2012
pH	pH Units		Inorg-001	[NT]	79518-1	5.8 || 5.7 || RPD: 2	LCS-W1	102%
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	79518-1	180 || [N/T]	LCS-W1	93%
Total Suspended Solids @ 103-105^{O}C	mg/L	5	Inorg-019	<5	79518-1	36 || [N/T]	LCS-W1	91%
Chloride, Cl	mg/L	1	Inorg-081	<1	79518-1	44 || 44 || RPD: 0	LCS-W1	104%
Sulphate, SO4	mg/L	1	Inorg-081	<1	79518-1	10 || 10 || RPD: 0	LCS-W1	107%
Electrical Conductivity	µS/cm	1	Inorg-002	<1	79518-1	230 || 230 || RPD: 0	LCS-W1	108%
Total Nitrogen in water	mg/L	0.1	Inorg-055/062	<0.1	79518-1	1.1 || 1.1 || RPD: 0	LCS-W1	106%

QUALITY CONTROL Metals in Waters - Acid extractable	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			28/09/2012	79518-1	28/09/2012 || 28/09/2012	LCS-W1	28/09/2012
Date analysed	-			28/09/2012	79518-1	02/10/2012 || 02/10/2012	LCS-W1	28/09/2012
Phosphorus - Total	mg/L	0.05	Metals-020 ICP-AES	<0.05	79518-1	<0.05 || <0.05	LCS-W1	100%

QUALITY CONTROL Metals in Water - Dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date digested	-			28/09/2012	79518-3	28/09/2012 || 28/09/2012	LCS-W1	28/09/2012
Date analysed	-			28/09/2012	79518-3	28/09/2012 || 28/09/2012	LCS-W1	28/09/2012
Calcium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	79518-3	3.6 || 3.6 || RPD: 0	LCS-W1	104%
Magnesium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	79518-3	3.7 || 3.7 || RPD: 0	LCS-W1	100%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	79518-2	27/09/2012 || 27/09/2012	79518-2	27/09/2012
Date analysed	-	79518-2	27/09/2012 || 27/09/2012	79518-2	27/09/2012
Total Dissolved Solids (grav)	mg/L	79518-2	4900 || 4900 || RPD: 0	[NR]	[NR]
Total Suspended Solids @ 103-105^{O}C	mg/L	79518-2	48 || 51 || RPD: 6	[NR]	[NR]
Chloride, Cl	mg/L	79518-2	2900 || [N/T]	79518-2	#
Sulphate, SO4	mg/L	79518-2	360 || [N/T]	79518-2	#
Total Nitrogen in water	mg/L	79518-2	1.2 || [N/T]	79518-2	121%

QUALITY CONTROL Metals in Waters - Acid extractable	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	79518-2	28/09/2012
Date analysed	-	[NT]	[NT]	79518-2	28/09/2012
Phosphorus - Total	mg/L	[NT]	[NT]	79518-2	104%
QUALITY CONTROL Metals in Water - Dissolved	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date digested	-	[NT]	[NT]	79518-4	28/09/2012
Date analysed	-	[NT]	[NT]	79518-4	28/09/2012
Calcium - Dissolved	mg/L	[NT]	[NT]	79518-4	95%
Magnesium - Dissolved	mg/L	[NT]	[NT]	79518-4	85%

Report Comments:

Chloride\Sulphate:# Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

Samples 8, 9 and 10: TDS reported are derived by calculation of Conductivity. Due to large amount of colloids in sample TDS results by gravimetric analysis is overexagerrated

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

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

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

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

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

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SOIL ANALYSIS CHAIN OF CUSTODY FORM

Additional Testing												
Name	P0902346 – Riverside											
Martens Contact Officer	Grant Harlow					**Contact Email**	gharlow@martens.com.au					
Sampling and Shipping	**Sample Date**	25/9/12 + 26/9/12	**Dispatch Date**			27/9/12	**Turnaround Time**		standard			
	Our Reference	P0902346JC14V01				**Shipping Method (X)**	**Hand**		**Post**		**Courier**	X
	On Ice (X)	X	**No Ice (X)**		**Other (X)**							
Laboratory												
Name	EnviroLab											
Sample Delivery Address	12 Ashley Street, Chatswood											
Delivery Contact	**Name**	Aileen		**Phone**	9910 6200	**Fax**		**Email**				
Please Send Report By (X)	**Post**		**Fax**		**Email**	X	**Reporting Email Address**	gharlow@martens.com.au please cc dmartens@martens.com.au and brose@martens.com.au and mkovelis@martens.com.au				

	Sample ID	pH	TDS	TSS	Chloride	Sulphate	Magnesium	Calcium	EC	TN	TP
1-	2346/GW5/25.09.12	x	x	x	x	x	x	x	x	x	x
2-	2346/GW6/25.09.12	x	x	x	x	x	x	x	x	x	x
3-	2346/GW7/26.09.12	x	x	x	x	x	x	x	x	x	x
4-	2346/GW8/25.09.12	x	x	x	x	x	x	x	x	x	x
5-	2346/GW9/25.09.12	x	x	x	x	x	x	x	x	x	x
6-	2346/GW10/25.09.12	x	x	x	x	x	x	x	x	x	x
7-	2346/GW11/25.09.12	x	x	x	x	x	x	x	x	x	x
8-	2346/GW202/26.09.12	x	x	x	x	x	x	x	x	x	x
9-	2346/GW201/26.09.12	x	x	x	x	x	x	x	x	x	x
10-	2346/GW203/26.09.12	x	x	x	x	x	x	x	x	x	x

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 79518

Date Received: 27/9/12
Time Received: 14:30
Received by: AW
Temp: (Cool)/Ambient
Cooling: (Ice)/Icepack
Security: (Intact)/Broken/None

Head Office
Unit 6 / 37 Leighton Place
Hornsby NSW 2077, Australia
Ph 02 9476 9999 **Fax** 02 9476 8767

> mail@martens.com.au
> www.martens.com.au
MARTENS & ASSOCIATES P/L
ABN 85 070 240 890 ACN 070 240 890

ACEA

13 Attachment F – CSIRO – BTF 18-2011

Foundation Maintenance and Footing Performance: A Homeowner's Guid

Foundation Maintenance and Footing Performance:
A Homeowner's Guide

PUBLISHING

BTF 18-2011 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870-2011, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume, particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.

In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Notes

1. Where controlled fill has been used, the site may be classified A to E according to the type of fill used.
2. Filled sites. Class P is used for sites which include soft fills, such as clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soil subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.
3. Where deep-seated moisture changes exist on sites at depths of 3 m or greater, further classification is needed for Classes M to E (M-D, H1-D, H2-D and E-D).

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

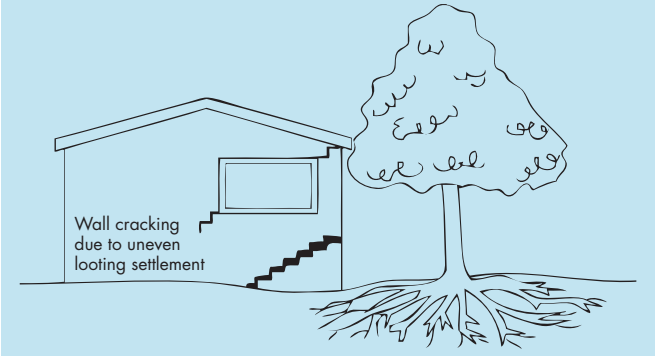
The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Trees can cause shrinkage and damage



Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation causes a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem. Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870-2011.

AS 2870-2011 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

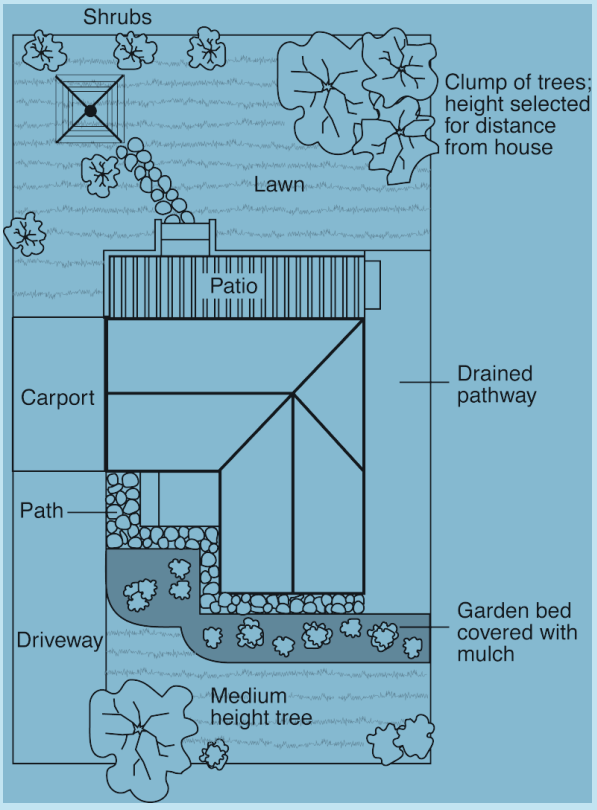
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving should

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly.	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired.	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 mm but also depends on number of cracks	4

Gardens for a reactive site



extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

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14 Attachment G – Pavement Thickness Design Summary (Coffey, 2008)

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

13 Mangrove Road, Sandgate, NSW, 2304
Ph: (02) 4967 6377 Fax (02) 4967 5402

pavement thickness design summary

client : ***TATTERSALL SURVEYORS PTY LTD*** job no : ***GEOTSGTE20248AA***

principal : ***CRIGHTON PROPERTIES PTY LTD*** laboratory : ***NEWCASTLE***

project : ***PROPOSED SUBDIVISION*** report date : ***May 09, 2007***

location : ***RIVERSIDE ESTATE, PROJECT APPLICATION, TEA GARDENS*** test report no.: ***MAY09-03/1***

council : ***GREAT LAKES COUNCIL*** designed by : ***RJP*** checked by :

road name or type :		***LOCAL ACCESS***	***LOCAL ACCESS***	***COLLECTOR***	***COLLECTOR***
chainage interval :	(m)	***Clay Subgrade***	***Sand Subgrade***	***Clay Subgrade***	***Sand Subgrade***
design traffic loading:	(ESA)	***5 x 10^5***	***5 x 10^5***	***1 x 10^6***	***1 x 10^6***
wearing course thickness :	(mm)	***40***	***40***	***40***	***40***
basecourse thickness:	(mm)	***150***	***150***	***150****	***150****
sub-base thickness:	(mm)	***150***	***150***	***150****	***150****
select thickness:	(mm)	***500***	***-***	***500***	***-***
total thickness :	(mm)	***840***	***340***	***840***	***340***
CBR used for design :	(%)	***2***	***10***	***2***	***10***

design traffic loading : Design traffic loading is the number of equivalent standard axles (E.S.A.) in the design lane during the design period. For definitions, refer Appendix 1.1 "Pavement Design" AUSTROADS. Refer covering letter/report.

Material Quality

wearing course : ***RTA QA Specification R116***

basecourse : ***Conforming to ARRB Special Report No 41, * RTA QA Specification 3051***

sub-base: ***Conforming to ARRB Special Report No 41, * RTA QA Specification 3051***

select : ***Well graded granular material, maximum particle size 100mm, minimum CBR 15%.***

Note : Recommended material types may vary from those of job specification or statutory authority. Refer covering letter/report.

Compaction Requirements

wearing course : ***RTA QA Specification R116***

basecourse : ***98% MODIFIED***

sub-base : ***95% MODIFIED***

select : ***80% DI, 100% STD***

subgrade : ***80% DI, 100% STD***

fill below : ***70% DI, 95% STD***

Modified: Minimum required dry density ratio, AS1289 5.4.1-1993, calculated using field dry density determined by AS1289 5.3.1-2004 or equivalent, and the maximum dry density obtained using AS1289 5.2.1-2003 or equivalent.

Standard: As above, but maximum dry density obtained using AS1289 5.1.1-2003 or equivalent.

Density Index: Minimum required Density Index AS1289 5.6.1-1998, calculated using field dry density determined by AS1289 5.3.1-2004 or equivalent, and laboratory values of maximum and minimum density obtained by AS1289 5.5.1-1998 or equivalent.

Note: Recommendations for compaction may vary from those of job specification or statutory authority. Refer covering letter/report.

Drainage: The design assumes the provision of adequate surface and subsurface drainage of the pavement and adjacent areas. Refer covering letter/report.

Form Number L2.10RL Version 6.0

15 Attachment H – Notes Relating to 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.

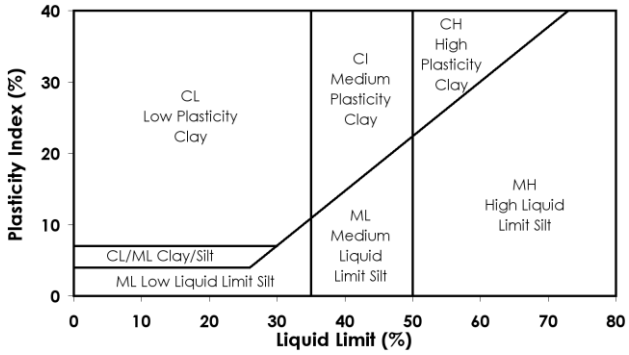
Particle Size

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)	Apprx SPT "N"	Field Guide
Very Soft	<12	2	A finger can be pushed well into the soil with little effort. Sample extrudes between fingers when squeezed in fist.
Soft	12 - 25	2 to 4	A finger can be pushed into the soil to about 25mm depth. Easily moulded in fingers.
Firm	25 - 50	4 – 8	The soil can be indented about 5mm with the thumb, but not penetrated. Can be moulded by strong pressure in the figures.
Stiff	50 - 100	8 – 15	The surface of the soil can be indented with the thumb, but not penetrated. Cannot be moulded by fingers.
Very Stiff	100 - 200	15 – 30	The surface of the soil can be marked, but not indented with thumb pressure. Difficult to cut with a knife. Thumbnail can readily indent.
Hard	> 200	> 30	The surface of the soil can be marked only with the thumbnail. Brittle. Tends to break into fragments.
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)

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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)

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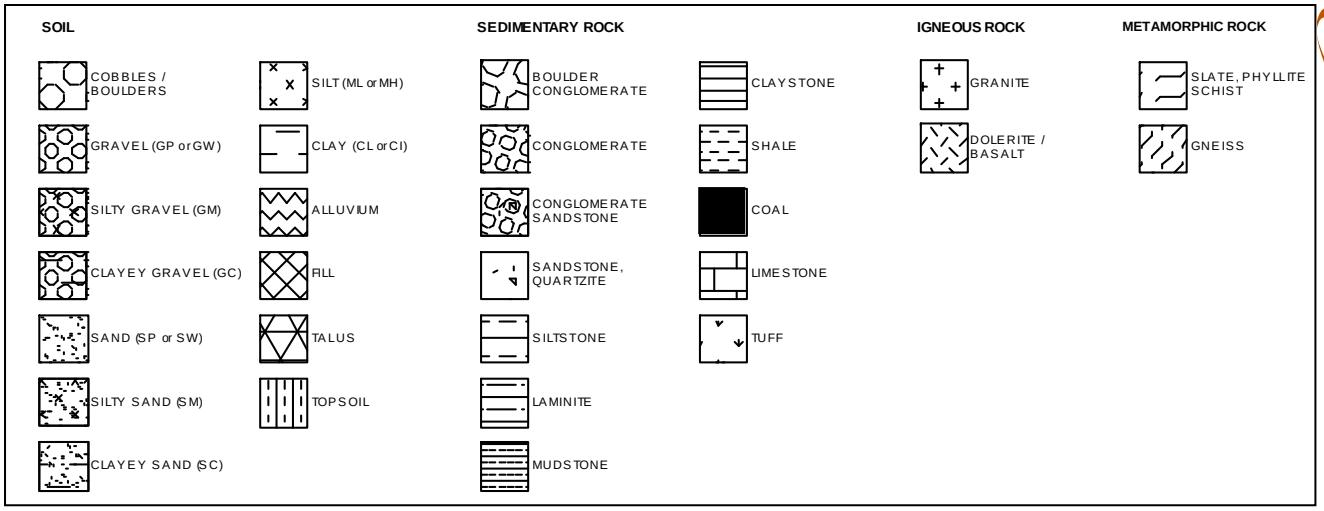
Symbols for Soil and Rock



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)

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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 low	≤0.03	Easily remoulded by hand to a material with soil properties.	EL
Very low	>0.03 ≤0.1	May be crumbled in the hand. Sandstone is 'sugary' and friable.	VL
Low	>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.	L
Medium	>0.3 ≤1.0	A piece of core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife.	M
High	>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.	H
Very high	>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.	VH
Extremely high	>10	A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer.	EH

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

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

RQD = Rock Quality Designation

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

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.

Test Methods

Explanation of Terms (1 of 2)

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Sampling

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

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

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

Drilling Methods

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

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

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

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

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

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

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

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

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

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

Standard Penetration Tests

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

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

The test results are reported in the following form:

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

as 4, 6, 7
N = 13

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

as 15, 30/40 mm.

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

CONE PENETROMETER TESTING AND INTERPRETATION

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

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

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

Test Methods

Explanation of Terms (2 of 2)

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

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

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

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

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

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

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

q_c = (12 to 18) c_u

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

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

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

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

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

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

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

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

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

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