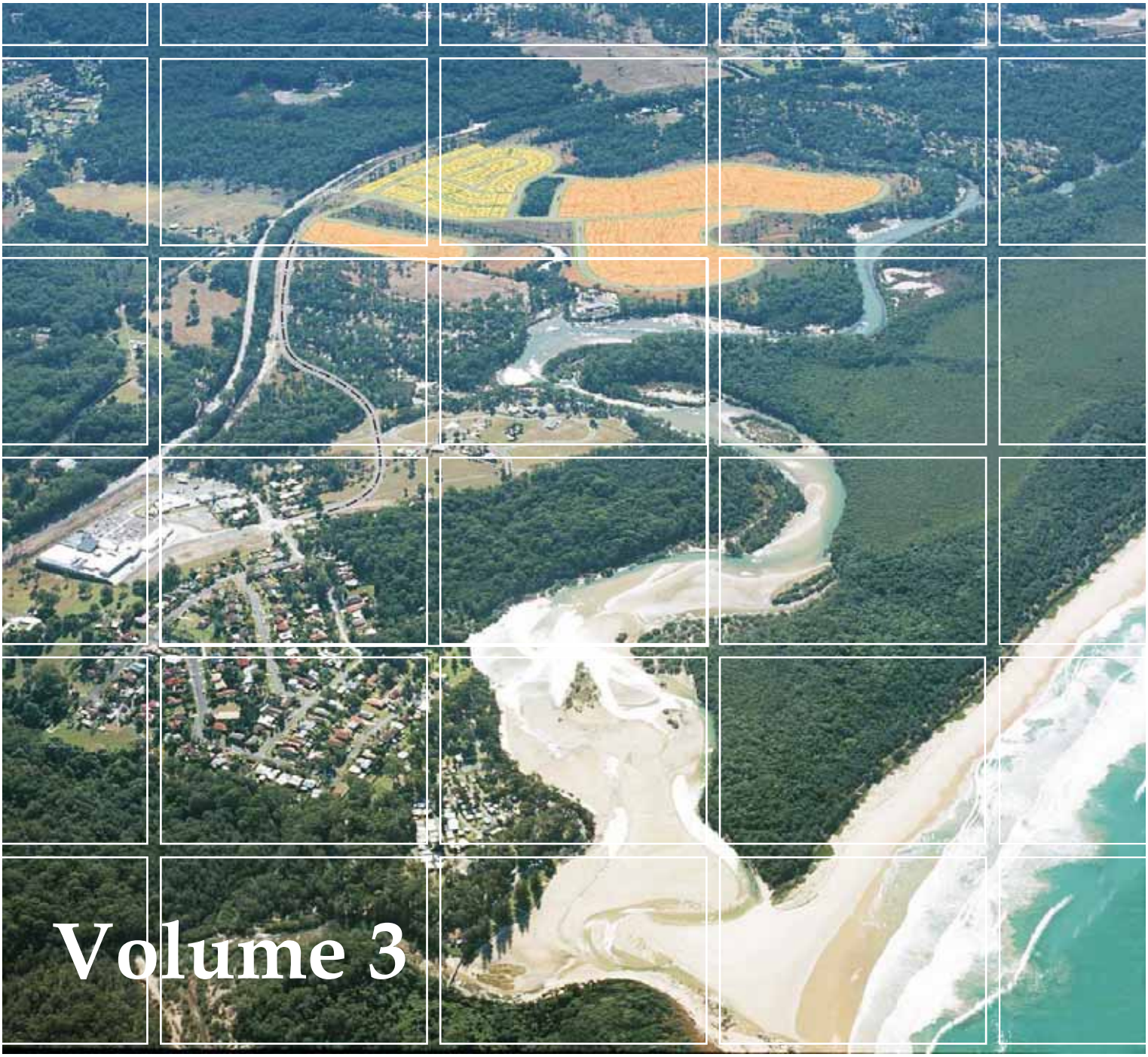

Volume 3

The Glades Estate
Lots 1 & 2 DP 725785
Pacific Highway, Moonee

Environmental Assessment

for Rothwell Boys Pty Ltd

November 2007

0037659

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ERM

The Glades Estate
Lots 1 & 2 DP 725785
Pacific Highway, Moonee

Environmental Assessment

for
Rothwell Boys Pty Ltd

November 2007

Project No. 0037659

Project Manager:	*Carolyn Maginnity*
Signed:	
Date:	*16 November 2007*
Partner:	*Steve O'Connor*
	
Date:	*16 November 2007*

Environmental Resources Management Australia Pty Ltd Quality System

Volume 3

Volume 3

Geotechnical Assessment

RESOURCE DESIGN & MANAGEMENT

PROPOSED SUBDIVISION AT NORTH MOONEE BEACH

Pacific Highway, Moonee Beach NSW

GEOTECHNICAL ASSESSMENT

CH1173/1-AM

16 December 2005

Coffey

CH1173/1-AM
16 December 2005

Resource Design & Management
Suite 34, Jetty Village, 361 Harbour Drive
COFFS HARBOUR NSW 2450

Attention: Mr Ken Maguire

Dear Sir,

RE: PROPOSED SUBDIVISION AT NORTH MOONEE BEACH

Coffey Geosciences Pty Ltd (Coffey) is pleased to present our report on the geotechnical assessment at the above site.

We draw your attention to the attached sheet entitled "Important Information About Your Coffey Report" which should be read in conjunction with this report.

We trust that this report meets with your requirements. If you require further information please contact the undersigned in our Coffs Harbour office.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

DAVID BARKER
Senior Geotechnical Engineer

Distribution:	Original held by:	Coffey Geosciences Pty Ltd
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Coffey Geosciences Pty Ltd ACN 056 335 516

Unit 1, 18 Hurley Drive
Coffs Harbour
NSW 2450 Australia
PO Box 704 Coffs Harbour
NSW 2450 Australia
Telephone +61 2 6651 3213
Facsimile +61 2 6651 5194
Email coffs@coffey.com.au

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1. INTRODUCTION

Coffey Geosciences Pty Ltd has conducted an assessment of geotechnical and grondwater levels for a proposed subdivision development to be located on Lot 1 and Lot 2 DP725785 on the Pacific Highway at North Moonee Beach.

Information relating to the site has been presented previously in relation to some of these issues. This report collates that information, and presents recommendations and information on the following:

- Information from previous reports and letters provided, including surface and subsurface conditions, excavation conditions, and comments on suitability of the site for residential development;
- Comments on general land capability with respect to site filling and drainage and the likely associated effects on groundwater quality;
- Comments on acid sulfate soils and a management plan;
- Groundwater level information to date.

1.1 Information on Previous Work

Coffey has previously carried out a geotechnical investigation, preliminary acid sulfate soils assessment, and collected water level data at the site, from which the following reports and letters were issued;

- CH1173/1-AC dated 8 March 2004 – this letter presented the results of a geotechnical assessment and preliminary recommendations for the proposed residential subdivision development. The letter provided general comments on road construction, footings and founding conditions, excavation conditions and acid sulfate soils.
- CH1173/1-AD dated 24 March 2004 – this facsimile provided comments on the suitability of the site for residential development with respect to geotechnical engineering aspects. A recommendation was also made that a more detailed geotechnical investigation should be carried out prior to final design and construction of the proposed subdivision.
- CH1173/1-AF dated 7 April 2004 – this letter provided similar information as CH1173/1-AC and CH1173/1-AD which are discussed above.
- CH1173/1-AH dated 31 May 2004 – this facsimile advised the client that well loggers which had been installed at the above site to record water level data had been vandalised and irreversibly damaged.
- CH1173/1-AI dated 3 December 2004 – this report provided similar information as CH1173/1-AC and CH1173/1- AD which are discussed above.

These reports and letters should be read in conjunction with this report.

2. SITE DESCRIPTION & PROPOSED DEVELOPMENT

The site is located on the eastern side of the Pacific Highway across from the intersection of the Pacific Highway and Bucca Road, and is in an area of low density rural development.

The site is located in an area of gently to moderately undulating topography and flatter low lying alluvial plains associated with Moonee Creek. Site slopes are generally even grades of about 5^{O} to 10^{O}, with lower lying areas observed to be relatively flat.

3. SCOPE OF WORK

3.1 Fieldwork

Field work for the geotechnical assessment was carried out on 2 March 2004 and 5 April 2004 and consisted of:

- Nine test pits to depths of about 2m;
- Six boreholes to depths between 4.3m and 5m, and;
- Installation of groundwater wells in each borehole.

The nine test pits (TP1 to TP9) were excavated using a 4WD backhoe to depths of about 2m or prior refusal. Samples obtained during test pitting were taken to Coffey's Coffs Harbour laboratory for the preliminary acid sulfate soils assessment.

The six boreholes (BH1 to BH6) were drilled using an MD200 4WD mounted drilling rig equipped with continuous spiral flight augers.

The groundwater wells were installed into the boreholes (BH1 to BH6) to the depths drilled. The lower 2m section of the well was screened with slotted 80mm PVC. Solid (unslotted) 80mm PVC was used to case the well to the ground surface. Coarse sand was placed within the well annulus to a level between 1m and 2m below the ground surface, followed by an annular seal of granular bentonite pellets to about 0.1m below ground surface and then backfilled with drilling cuttings.

The test pits and boreholes were excavated or drilled in the full time presence of a Geotechnical Engineer or Engineering Geologist from Coffey who located the pits and boreholes, took samples, and produced engineering logs of the pits and boreholes. The engineering logs of the pits and boreholes are attached, together with explanation sheets defining the terms and symbols used in their preparation. The test pit and borehole locations are shown on Figure 1.

4. SUB-SURFACE CONDITIONS

4.1 Stratigraphy

The 1:250,000 Geological Map of Dorrigo/Coffs Harbour indicates the site to be on the boundary of the Coramba Beds comprising mudstone, siltstone and greywacke with minor intervals of volcanic rocks and Quaternary Alluvium.

The subsurface conditions observed in the test pits and boreholes are summarised below:

- Topsoil: sands and clays, fine to coarse grained sand, low to medium plasticity fines, dark brown to depths of between 0.1m and 0.3m;
- Alluvial Soil: Sandy Clay and Sand, medium plasticity clay, fine to medium grained sand, brown and grey/orange to depths between 0.5 and 1.3m in test pits TP6, TP8 & TP9, and beyond the depth of investigation of 5m in boreholes BH1, BH2 and BH6;
- Residual Soil: Clay and Sandy Clay, high plasticity, red/orange-brown and grey/red, sand is fine to medium grained to depths beyond 1.8m and 2m in the test pits, and beyond the depth of investigation of 5m in boreholes BH3 to BH5;

- Extremely to Highly Weathered Claystone: Clayey Gravel, fine to coarse grained, grey/orange, medium plasticity fines, to beyond the depth of investigation of 1m and 1.7m in TP4 and TP7.

The subsurface conditions can be separated into two geological zones as follows:

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

The Zone 1 subsurface conditions, in which TP1 to TP5 and TP7 were excavated can be summarised as comprising sand and clay topsoil and colluvial soils, overlying very stiff to hard, high plasticity residual clay, grading to Extremely Weathered Claystone in TP4, TP5 and TP7. Near backhoe refusal was encountered in TP4 and TP7 at depths of 1.7m and 1m respectively.

The Zone 2 subsurface conditions, in which TP6, TP8, TP9 and BH1 to BH6 were excavated and drilled can be summarised as comprising sand and clay topsoil, overlying stiff to very stiff sandy clay alluvial soils in TP6 and TP9, and moist to wet and wet loose sands and stiff to very stiff clays in TP8 and BH1 to BH6, overlying stiff to very stiff residual clay in all test pits and BH3 to BH5 to beyond the limit of investigation.

Further details of the materials intersected by the test pits and boreholes are given on the engineering logs presented in Appendix A, with explanation sheets defining the terms and symbols used in their preparation. The Zone 1 and Zone 2 areas are shown on Figure 1.

4.2 Groundwater

Water inflow was observed in TP6, TP8 and TP9 at about 0.5m, 0.7m and 0.4m depth respectively. Water levels in the boreholes during drilling was observed in BH1, BH2, BH4, BH5 and BH6 at about 3.8m, 1.8m, 2m, 2.4m and 4.95 respectively. It should be noted that groundwater conditions can change depending on rainfall, temperature and other factors

5. DISCUSSION OF GEOTECHNICAL FACTORS FOR DEVELOPMENT

5.1 General

Based on the results of the geotechnical investigations carried out to date, the site is considered to be generally suitable for a residential subdivision development in terms of geotechnical issues. A more detailed geotechnical assessment to address site specific issues is recommended prior to final subdivision design and construction. Details of the recommended scope of this further work can be provided once additional information relating to the proposed development is available.

5.2 Land Capability

Based on the results of the geotechnical investigations carried out to date, the site is considered to be generally suitable for a residential subdivision development. The following section provides comments on the two geological zones.

The soils in the Zone 1 area generally comprise topsoil overlying residual clays. These areas are considered to be generally suitable for a residential subdivision development. Appropriate site preparation should be carried out, including stripping of all unsuitable or deleterious materials such as topsoil and colluvial soils.

The lower lying Zone 2 area is also considered to be suitable for the proposed development, but additional

considerations to construction and operation of the development will be required. These are detailed below:

- Appropriate site preparation is carried out, including striping of all unsuitable or deleterious materials such as topsoil and colluvial soil;
- The area is filled to design levels using suitable fill materials to or above the flood level criteria;
- Industry accepted practices with respect to sedimentation and erosion control should be adopted during and after construction. Fill materials used should not be of a dispersive nature;
- Ideally, fill materials should not be acid sulfate soils, or if they are considered to be acid sulfate soils, they must be appropriately treated prior to re-use as fill;
- Fill materials should comply with relevant NSW EPA and NEPM environmental guidelines with respect to contamination and an assessment may be required if fill materials are imported
- Adequate drainage during and after construction is used, such that during periods of high rainfall no ponding of water occurs. Periods of relatively high groundwater have been experienced in the lower areas, and consideration of the effects of this in relation to the engineering design and construction must be made
- The soils on the site area are generally clayey, therefore infiltration to the groundwater table is likely to be low.

5.3 Road Construction

Based on the anticipated subsurface conditions, subgrade soils exposed during road construction are anticipated to consist of clay residual soils in Zone 1 areas over much of the site, with some clay and sand alluvial and colluvial soils in Zone 2 areas. It is presumed that some site filling will be required in lower areas of the site to achieve design subgrade levels.

Design CBR values recommended for preliminary pavement design are expected to be as follows:

- 3% to 5% for clay residual soils;
- 3% for clay alluvial soils, with possibly the need for thicker pavement and/or geofabric in areas of poor or wet subgrade soils;

Subgrade moisture conditions can change depending on rainfall, temperature and other factors. In general, it is recommended that subsoil drainage is required along the high side of all roads aligned across site slopes and on both sides of roads aligned down slopes. Additional drainage requirements may be required in low lying Zone 2 areas or areas identified during a more detailed geotechnical assessment.

Additional assessment of subgrade CBR will be required for pavement thickness design once the subdivision layout is finalised.

5.4 Footings and Founding Conditions

Based on our preliminary site assessment, we anticipate that most of the proposed residential allotments will be located in areas of residual soils and weathered rock. High level footings designed in accordance with AS2870-1996 are likely to be suitable for residential dwellings. Assessment of the site classification for the lots will be required once the subdivision layout is finalised.

High level footings are likely to be suitable for developments located in the Zone 2 areas of the site, though this area is likely to be variable in nature. Some fill may also be placed over the Zone 2 areas. Suitable

footings will be dependant on the strength properties of clay soils and the density profile for sand soils where encountered. Use of piles to support footings or ground modification (i.e. additional compaction) may be required in some areas. Filling in Zone 2 areas will affect the recommended founding conditions for buildings. Further assessment will be required once the subdivision layout is finalised.

5.5 Excavation Conditions

Where excavation is required, it is anticipated that soil strength materials could be excavated by conventional dozer blade or backhoe bucket. Refusal may be encountered on weathered rock in Zone 1 areas, though this will depend on the location and depth of the excavation.

Excavation below the depths of backhoe refusal may be possible by the use of larger and more powerful excavators or bull dozers. Heavy ripping may be required in deeper excavations. The use of hydraulic rock hammers may be required in areas of stronger or shallower rock.

Excavations may experience water inflow, particularly in the Zone 2 areas.

5.6 Site Preparation

The following general comments and recommendations are provided for site preparation beneath structures and pavements:

- Following excavation to design level, the exposed subgrade materials should be proof rolled to identify any wet, excessively deflecting or other deleterious material. Any such areas should be over-excavated and backfilled with a clean select material. All topsoil should be stripped and stockpiled for re-use as landscaping materials only.
- Approved fill beneath roads should be placed in layers not exceeding 300mm loose thickness and be compacted to a minimum dry density ratio of 95% Standard Compaction. Clay fill should be placed and maintained at 60% to 90% of Standard OMC.
- The top 300mm of natural subgrade or subgrade fill below pavements should be compacted to a minimum dry density ratio of 100% Standard Compaction.
- All pavement materials should be placed and maintained at 60% to 90% of Standard OMC.
- Approved fill beneath structures should be placed in layers not exceeding 300mm loose thickness and be compacted to a minimum dry density ratio of 98% Standard Compaction. Clay fill should be placed and maintained at 60% to 90% of Standard OMC. All filling beneath structures should be carried out under Level 1 construction monitoring and testing as defined in AS3798-1996. To enable the fill to be classed as controlled fill, earthworks must be carried out in accordance with Level 1 as defined in AS3798-1996.
- Earthworks should be carried out in accordance with the recommendations outlined in AS3798-1996, '*Guidelines for Earthworks for Commercial and Residential Developments*'.

The above scope would generally apply in Zone 2, except that it may be prudent to reduce the extent of excavation to the root affected zone. Depending on site conditions at the time of construction, site preparation in Zone 2 might comprise stripping of the root affected zone with a smooth bladed bucket on a tracked excavator working from outside the stripping area. Placement of a geofabric and/or geogrid underlying a 0.5m working platform of granular fill may also be required.

6. ACID SULFATE SOILS

6.1 Formation and Potential Impacts

Acid Sulfate Soils (ASS) are soils which contain significant concentrations of pyrite which, when exposed to oxygen, in the presence of sufficient moisture, oxidises, resulting in the generation of sulfuric acid. Unoxidised pyritic soils are referred to as potential ASS (PASS). When the soils are exposed, the oxidation of pyrite occurs and sulfuric acids are generated, the soils are said to be actual ASS (AASS).

Pyritic soils typically form in waterlogged, saline sediments rich in iron and sulfate. Typical environments for the formation of these soils include tidal flats, salt marshes and mangrove swamps below about RL 5m AHD. They can also form as bottom sediments in coastal rives and creeks.

Pyritic soils of concern on low lying NSW and coastal lands have mostly formed in the Holocene period, (i.e. 10,000 years ago to present day) predominantly in the 7,000 years since the last rise in sea level. It is generally considered that pyritic soils which formed prior to the Holocene period would already have oxidised and leached during periods of low sea level which occurred during ice ages, exposing pyritic coastal sediments to oxygen.

Disturbance or poorly managed development and use of acid sulfate soils can generate significant amounts of sulfuric acid, which can lower soil and water pH to extreme levels (generally <4) and produce acid and salts, resulting in high salinity.

The low pH, high salinity soils can reduce or altogether preclude vegetation growth and can produce aggressive soil conditions which may be detrimental to concrete and steel components of structures, foundations, pipelines and other engineering works.

Generation of the acid conditions often releases aluminium, iron and other naturally occurring elements from the otherwise stable soil matrices. High concentrations of such elements, coupled with low pH and alterations to salinity can be detrimental to aquatic life. In severe cases, affected waters flowing off-site can have detrimental effect on aquatic ecosystems.

6.2 Risk Maps and Results of Testing

The 1:250,000 scale Moonee Beach acid sulfate soils risk map indicates that the majority of areas to be developed are not within areas with known acid sulfate soils, which agrees with our assessment that much of the site is underlain by residual soils and weathered rock (Zone 1) which are formed in a different manner to that described above and on this basis have acid generating potential if at all.

Areas within gullies and lower lying areas (Zone 2) of about 2m to 4m elevation to AHD were indicated to have a low probability of the presence of acid sulfate soils within 1m to 3m below the ground surface.

Only limited sampling and testing was carried out during previous assessments on the site, therefore limited information is available on the extent of the acid sulfate affected soils, or the amount of lime required to neutralise any acid sulfate soils. The previous testing involved twelve screening tests and four POCAS tests, on samples taken to a maximum depth of 1.6m. The tests results are summarised below in Tables 1 and 2. The laboratory test sheets are presented in Appendix B.

TABLE 1: SUMMARY OF ACID SULFATE SCREENING TESTS

Sample Number	Depth	Actual pH (Soil in Water)	Potential pH (H_2O_2 Oxidation)
TP6	0.1-0.3	5.4	5.0
TP6	0.4-0.6	4.6	4.8
TP6	0.7-0.9	4.9	5.2
TP6	1.2-1.4	4.8	6.1
TP8	0.1-0.3	4.8	6.2
TP8	0.4-0.6	3.8	6.0
TP8	0.7-0.9	3.8	6.3
TP8	1.2-1.4	4.3	5.8
TP9	1.5-1.6	4.8	5.8
TP9	0.1-0.3	5.4	3.7
TP9	0.4-0.6	5.8	6.3
TP9	0.8-0.9	6.1	6.9

The following points are noted from Table 1:

- Soil in water produced pH>4 for the samples tested, except for samples TP8 0.4-0.6 and 0.7-0.9 which had a pH of 3.8. Soil pH<4 in this test is an indication of actual acid sulfate soil.
- H_2O_2 oxidation produced pH>5 in all of the samples tested. Soil pH<3 in this test is an indication of potential acid sulfate soil.

TABLE 2: SUMMARY OF POCAS TESTS

Sample Number and Depth	S_{POS} (%)	Action Criteria Value	TPA (mole/tonne)	Action Criteria Value	Liming Ratio* kg/m^3
TP8 0.4-0.6	0.018	0.03	11	18	4.5
TP8 0.7-0.9	**0.038**	0.03	12	18	6.3
TP8 1.2-1.4	0.013	0.03	9	18	5.3
TP9 0.1-0.3	0.011	0.03	12	18	2.4

Note: * - liming ratios include a factor of safety of 1.5.

Action criteria have been adopted from those presented in ASSMAC (1998) Acid Sulfate Soil Guidelines for excavations greater than 1000 tonnes of soil. S_{POS} in one of the four samples analysed exceeded the action criteria values in Table 4.4 of the ASSMAC Guidelines.

Based on the results of testing carried out so far, the liming rate for treatment of acid sulfate soils is expected to be about 6kg of lime per cubic metre of acid sulfate soil disturbed. This liming rate will need to be further assessed when further testing has been carried out. A preliminary acid sulfate soil management plan is presented in Appendix C.

6.3 Further Assessment

It will be necessary to carry out further sampling and testing of the soils in the Zone 2 area to assess the extent of the affected soils and the liming ratios. The areas affected by acid sulfate soils are likely to be relatively small and the scale and amount of treatment required is anticipated to be relatively minor. We would anticipate that treatment may comprise mixing disturbed soils with a reasonably small amount of lime if required. After testing of the soils an acid sulfate soil management plan including liming ratios, will need to be developed prior to construction.

The area requiring testing covers approximately 5.5ha. The Acid Sulfate Soil Management Advisory Committee (ASSMAC) guidelines suggest for sites above 4ha, that two boreholes be drilled per hectare. Therefore, for this site twelve boreholes are required to comply with the ASSMAC guidelines. The boreholes should extend to 1m below the depth of excavation, and samples taken every 0.5m. The samples should be kept chilled during fieldwork and transport to a laboratory NATA registered for POCAS or CRS testing.

At this stage it is unknown how deep excavations are likely to be, and it is therefore considered impractical to develop a scope of work beyond the general recommendations provided above.

7. WATER LEVEL INFORMATION

Six groundwater wells (BH1 to BH6) were installed in the Zone 2 area on 5 April 2004. Loggers were installed in these boreholes to record water level every three hours over a twelve month period. These loggers were found to be vandalised or removed from the site on the 27 May 2004. Water levels were measured on the 6 April 2004 and 27 May 2004.

The client decided not to replace the loggers, and instead water levels have been measured by direct measurement on a regular basis from May 2005 to date to assess trends in groundwater levels at the site. This monitoring will continue until twelve months of data has been collected.

The data collected to date has been plotted for each groundwater well, and these plots are presented in Appendix D.

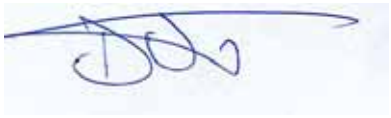
From the plots it can be seen that the water level in BH1 to BH3 and BH6 generally have higher water levels than BH4 and BH5. The highest and lowest measured water levels for each borehole are summarised below in Table 3.

TABLE 3: SUMMARY OF WATER LEVEL DATA

Borehole	Highest Measured Water Level		Lowest Measured Water Level	
	Date	Water Level (mAHD)	Date	Water Level (mAHD)
BH1	1-12-05	3.46	13-07-05	2.65
BH2	1-12-05	2.88	13-07-05	2.05
BH3	16-06-05	3.1	13-07-05 & 1-12-05	2.5
BH4	1-12-05	2.79	13-07-05	1.65
BH5	21-20-05 & 1-12-05	2.7	13-07-05	1.8
BH6	28-06-05 & 21-10-05	3.55	13-07-05	2.85

For and on behalf of

COFFEY GEOSCIENCES PTY LTD



DAVID BARKER
Senior Geotechnical Engineer

Coffey

Information

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. 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. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is 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. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal 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. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary 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 cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is 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 Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey 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.

Coffey Geosciences Pty Ltd ABN 057 056 335 516

Coffey

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they have incorporated the report findings.

Data should not be separated from the report*

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 our reports 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 logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. 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 Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey 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. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design toward construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is 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 Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

** For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, National Headquarters, Canberra, 1987.*

N

LEGEND

- Approximate location of Test Pits
- Approximate location of Boreholes
- Approximate boundary of Zone 1 & Zone 2

Vertical Datum A.H.D.
Established From: PM 75647 (RL 16.80m)

PROJECT- Bore Hole Survey **CLIENT-** Winten Property Group

BORE HOLE LOCATIONS

SOURCE- R.D.M.

DWG. No. 05025/2 **SCALE-** Approx. 1:5000 at A3

0 100 200m

DATE- 19th August 2005

361 Harbour Drive (PO Box 2430)
COFFS HARBOUR NSW 2450
Ph (02) 6651 2688 Fax (02) 6651 3699
Email : rdm@resdesman.com.au

R D M
CONSULTANTS IN ENGINEERING
TOWN PLANNING,SURVEYING &
ENVIRONMENTAL MANAGEMENT

RESOURCE DESIGN & MANAGEMENT

revision	description	drawn	approved	date
	Site Plan - Original	ELC	DB	25/10/2005
	Site Plan – Rev 1	SK	AH	11/10/2007

drawn	SK
approved	AH
date	11 Oct 2007
scale	1:5500
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client: **Resource Design & Management**

project: **Proposed Subdivision, Pacific Highway, North Moonee Beach**

title: **Site Plan**

project no: **CH1173/1-AM** figure no: **FIGURE 1**

Coffey

APPENDIX A

ENGINEERING LOGS

Soil Description

Explanation Sheet

Coffey

DEFINITION:

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 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.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (USC) as shown in the table on the following page.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200mm
Cobbles		63mm to 200mm
Gravel	coarse	20mm to 63mm
	medium	6mm to 20mm
	fine	2.36mm to 6mm
Sand	coarse	600μm to 2.36mm
	medium	200μm to 600μm
	fine	75μm to 200μm

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 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

TERM	UNDRAINED STRENGTH su (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	-	Crumbles or powders when scraped by thumb nail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very Loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:	
		Coarse grained	Fine grained
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	<5%	<15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	5% - 12%	15% - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample	Weakly cemented	Easily broken up by hand in air or water
Lenses	Discontinuous layers of lenticular shape	Moderately cemented	Effort is required to break up the soil by hand in air or water
Pockets	Irregular inclusions of differential material		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material	Structure and fabric of parent rock visible
Residual soil	Structure and fabric of parent rock not visible

TRANSPORTED SOILS

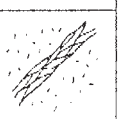
Aeolian soil	Deposited by wind
Alluvial soil	Deposited by stream and rivers
Colluvial soil	Deposited on slopes (transported downslope by gravity)
Fill	Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.
Lacustrine soil	Deposited by lakes
Marine soil	Deposited in ocean basins, bays, beaches and estuaries

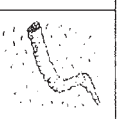
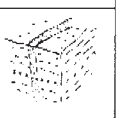
SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60mm and basing fractions on estimated mass)						USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of material less than 63mm is larger than 0.075mm	(A 0.075mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0mm	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 2.0mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all 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
			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2mm				
			DRY STRENGTH	DILATANCY	TOUGHNESS		
FINE GRAINED SOILS More than 50% of material less than 63mm is smaller than 0.075mm		SILTS AND CLAYS Liquid limit less than 50	None to Low	Quick to slow	None	ML	SILT
			Medium to high	None	Medium	CL	CLAY
			Low to medium	Slow to very slow	Low	OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to none	Low to medium	MH	SILT
			High	None	High	CH	CLAY
			Medium to high	None	Low to medium	OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			Pt	PEAT

* Low plasticity - Liquid Limit W_L less than 35%. Medium plasticity - W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2m in length	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter.	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planer to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

Rock Description

Explanation Sheet

Coffey

AS1726-1993 – The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Substance Effectively homogeneous material, may be isotropic or anisotropic.

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

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.
In engineering terms rock substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or in water. Other material is described using soil descriptive terms.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME – Simple rock names are used rather than precise geological classification.

PARTICLE SIZE – Grain size terms for sandstone are:

Coarse grained	0.6mm to 2mm
Medium grained	0.2mm to 0.6mm
Fine grained	0.6mm (just visible) to 0.2mm

FABRIC – Terms for layering or penetrative fabric (eg. bedding, cleavage) are:

Massive	No layering or penetrative fabric
Poorly developed	Layering or fabric just visible. Little effect on properties.
Well developed	Layering or fabric distinct. Rock breaks more easily parallel to layering or fabic.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	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	**XW**	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded, in water. Fabric of original rock still visible.
Distinctly Weathered	**DW**	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly Weathered	**SW**	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	**FR**	Rock shows no sign of decomposition or staining.

Note: *Where physical and chemical changes were caused by hot gases and liquids associated with igneous rocks the terms slightly altered (SA), distinctly altered (DA) and extremely altered (XA) may be used.*

ROCK SUBSTANCE STRENGTH TERMS

Term	Abbreviation	Point Load Index, I_S50 (MPa)	Field Guide to Strength
Very Low	**VL**	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low	**L**	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	**M**	0.3 to 1	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	**H**	1 to 3	A piece of core 150mm long by 50mm diameter can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	**VH**	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High	**EH**	More than 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Notes:

1. *In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.*
2. *The term extremely low is not used as a rock substance strength term. The term is used in AS1726-1993 but the field guide to strength makes it clear that it is a soil in engineering terms.*
3. *The unconfined compressive strength to isotropic rocks and anisotropic rocks which do not fail parallel to the planar anisotropy is typically 10 to 25 times the point load index. The ratio may vary for different rock types and lower strength rocks often have lower ratios than higher strength rocks.*

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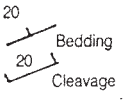
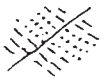
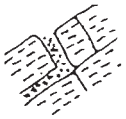
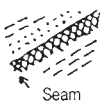
COMMON DEFECTS IN ROCK MASSES

Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.			 (Note 2)
Joint	A surface or crack across which the rock has little or no tensile strength but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.			 (Note 2)
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.			
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.			
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.			
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint. Infilled seams less than 1mm thick may be described as veneer or coating on joint surface.			
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formed by weathering of the rock substance in places.			

Notes on defects:

1. *Borehole logs show the true dip of defects and face sketches and sections the apparent dip.*
2. *Partings and joints are not usually shown on the graphic log unless considered significant.*
3. *Sheared zones, sheared surfaces and crushed seams are faults in geological terms.*

DEFECT SHAPE TERMS

Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes in orientation

Note:
The assessment of defect shape is partly influenced by the scale of observation.

ROUGHNESS TERMS

Slickensided	Grooved or striated surface; usually polished
Polished	Shiny smooth surface
Smooth	Smooth to touch; few or no surface irregularities
Rough	Many small surfaxce irregularities (amplitude generally less than 1mm); feels like fine to coarse sand paper
Very rough	Many large surface irregularities (amplitude generally more than 1mm); feels like, or coarser than, very coarse sand paper

COATING TERMS

Clean	No visible coating
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral too thin to measure; may be patchy
Coating	A visible coating up to 1mm thick . Thicker soil material is described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein

BLOCK SHAPE TERMS

Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section

Engineering log - Excavation

Excavation No. **TP1**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Client: ***WINTEN PROPERTY GROUP***

Date started: ***3.2.2004***

Principal:

Date completed: ***3.2.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***DJB***

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

Checked by:

Coffey

equipment type and model: 4WD BACKHOE | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

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

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	None Observed			0.0			**TOPSOIL:** Silty Clayey Sand, fine to coarse grained, dark brown, low plasticity fines	D			TOPSOIL
								CL	**Sandy CLAY:** medium plasticity, pale brown, sand is fine to coarse grained	D/M			RESIDUAL SOIL
						0.5		CH	**CLAY:** high plasticity, orange-pale brown, trace of sand fine to medium grained	M	VSt	×	
						1.0						×	
						1.5					Fb		
						2.0							
									End TP1 at 2m depth due to limit of required investigation. Test pit TP1 terminated at 2m				
						2.5							
						3.0							
						3.5							
						4.0							

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

Excavation No. **TP2**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Engineering log - Excavation

Client: ***WINTEN PROPERTY GROUP***

Date started: ***3.2.2004***

Principal:

Date completed: ***3.2.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***DJB***

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

Checked by:

Coffey

equipment type and model: 4WD BACKHOE | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

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

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			0.0			**TOPSOIL:** Sandy Silty Clay, low plasticity, dark brown, sand is fine to coarse grained	M			TOPSOIL
								CL	**Sandy CLAY:** medium plasticity, brown, sand is fine to coarse grained				COLLUVIAL/RESIDUAL SOIL
						0.5		CH	**CLAY:** high plasticity, red-orange-brown, trace of sand fine to medium grained		VSt	×	RESIDUAL SOIL
						1.0			Colour change grey/red.			×	
						1.5						×	
						2.0			End TP2 at 1.9m depth due to limit of required investigation. Test pit TP2 terminated at 1.9m				
						2.5							
						3.0							
						3.5							
						4.0							

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

Engineering log - Excavation

Excavation No. **TP3**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Client: **WINTEN PROPERTY GROUP**

Date started: **3.2.2004**

Principal:

Date completed: **3.2.2004**

Project: **PROPOSED DEVELOPMENT**

Logged by: **DJB**

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

Checked by:

Coffey

equipment type and model: 4WD BACKHOE | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

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

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			0.5		CL	**TOPSOIL:** Silty Clayey Sand, fine to coarse grained, dark brown, low plasticity fines	M	VSt	×	TOPSOIL
								CH	**Sandy CLAY:** medium plasticity, pale brown, sand is fine to coarse grained				RESIDUAL SOIL
						1.0			**CLAY:** high plasticity, red/orange/brown		H	×	
						1.5			Colour change grey/red.				
						2.0			Gradual Colour change to pale grey-mottled change				
						2.5			End TP3 at 2m depth due to limit of required investigation. Test pit TP3 terminated at 2m				
						3.0							
						3.5							
						4.0							

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
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St	stiff
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Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Excavation No. **TP4**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Engineering log - Excavation

Client: ***WINTEN PROPERTY GROUP***

Date started: ***3.2.2004***

Principal:

Date completed: ***3.2.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***DJB***

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

Checked by:

Coffey

equipment type and model: 4WD BACKHOE | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

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

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			0.0			**TOPSOIL:** Sandy Silty Clay, low plasticity, dark brown, sand is fine to coarse grained	M			TOPSOIL
								CL	**Sandy CLAY:** medium plasticity, pale brown, sand is fine to medium grained		VSt		RESIDUAL SOIL
						0.5		CH	**CLAY:** high plasticity, orange-brown	M>Wp		×	
									Change to grey/red.			×	
						1.0			Colour change to grey mottled orange				
						1.5			**CLAYSTONE:** pale grey mottled orange, highly weathered				HIGHLY WEATHERED CLAYSTONE
									End TP4 at 1.7m depth due to near backhoe refusal. Test pit TP4 terminated at 1.7m				
						2.0							
						2.5							
						3.0							
						3.5							
						4.0							

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

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- 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

Engineering log - Excavation

Excavation No. **TP5**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Client: ***WINTEN PROPERTY GROUP***

Date started: ***3.2.2004***

Principal:

Date completed: ***3.2.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***DJB***

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

Checked by:

Coffey

equipment type and model: 4WD BACKHOE | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

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

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			0.5		CL	**Silty Sandy CLAY:** medium plasticity, pale brown, sand is fine to coarse grained	D			RESIDUAL SOIL, root affected to 50mm
								CH	**CLAY:** high plasticity, red-orange-brown	M	VSt	×	
						1.0			Colour change to grey/red			×	
						1.5			Colour change grey mottled orange				
						2.0			Grading to extremely weathered claystone.				
						2.5			End TP5 at 2.1m depth due to limit of required investigation. Test pit TP5 terminated at 2.1m				
						3.0							
						3.5							
						4.0							

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

Engineering log - Excavation

Excavation No. **TP6**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Client: ***WINTEN PROPERTY GROUP***

Date started: ***3.2.2004***

Principal:

Date completed: ***3.2.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***DJB***

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

Checked by:

Coffey

equipment type and model: 4WD BACKHOE | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

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

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		D					**TOPSOIL:** Clayey Sand, low plasticity, dark brown, some silt	M			TOPSOIL
				D		0.5		CL	**Sandy CLAY:** medium plasticity, brown, sand is fine to medium grained	M>Wp	St/VSt		ALLUVIAL SOIL
				D				CH	**Sandy CLAY:** high plasticity, grey/red, sand is fine to medium grained		VSt	×	RESIDUAL SOIL
				D		1.0			Colour change to grye mottled red and orange				
						1.5							
						2.0			End TP6 at 2m depth due to limit of required investigation. Test pit TP6 terminated at 2m				
						2.5							
						3.0							
						3.5							
						4.0							

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

Engineering log - Excavation

Excavation No. **TP7**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Client: **WINTEN PROPERTY GROUP**

Date started: **3.2.2004**

Principal:

Date completed: **3.2.2004**

Project: **PROPOSED DEVELOPMENT**

Logged by: **DJB**

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

Checked by:

Coffey

equipment type and model: 4WD BACKHOE | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

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

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	None Observed			0.5		CH	**Gravelly Sandy CLAY:** medium plasticity, pale brown, sand is fine to coarse grained, gravel is fine to medium grained **CLAY:** high plasticity, red	D M	VSt/H	×	COLLUVIAL SOIL RESIDUAL SOIL
						1.0		GC	**Clayey GRAVEL:** fine to coarse grained, grey/orange, medium plasticity fines Grading to highly weathered claystone				EXTREMEMLY WEATHERED CLAYSTONE
						1.5			End TP7 at 1m depth due to near backhoe refusal. Test pit TP7 terminated at 1m				
						2.0							
						2.5							
						3.0							
						3.5							
						4.0							

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

Excavation No. **TP8**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Engineering log - Excavation

Client: ***WINTEN PROPERTY GROUP***

Date started: ***3.2.2004***

Principal:

Date completed: ***3.2.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***DJB***

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

Checked by:

Coffey

equipment type and model: 4WD BACKHOE | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

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

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:** sand, fine to medium grained, grey, some low plasticity fines	M			TOPSOIL
				D				SP	**SAND:** fine to medium grained, grey mottled orange, some low plasticity fines Changing to a sand/clayey sand.	W	L		ALLUVIAL SOIL
				D		0.5							
			▶	D		1.0			Some test pit collapse.				
				D		1.5		CH	**Sandy CLAY:** high plasticity, grey, sand is fine to medium grained	M	VSt		RESIDUAL SOIL?
				D				CH	**CLAY:** high plasticity, grey/red, a trace of sand fine grained				
						2.0			End TP9 at 1.9m depth due to limit of required investigation. Test pit TP8 terminated at 1.9m				
						2.5							
						3.0							
						3.5							
						4.0							

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

Engineering log - Excavation

Excavation No. **TP9**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Client: **WINTEN PROPERTY GROUP**

Date started: **3.2.2004**

Principal:

Date completed: **3.2.2004**

Project: **PROPOSED DEVELOPMENT**

Logged by: **DJB**

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

Checked by:

Coffey

equipment type and model: 4WD BACKHOE | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

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

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		D					**TOPSOIL:** Sandy Silty Clay, low plasticity, dark brown, sand is fine to medium grained	M			TOPSOIL
			▶	D		0.5		CH	**Sandy CLAY:** low plasticity, brown, sand is fine to medium grained	M>Wp	VSt		ALLUVIAL SOIL
				D		1.0		CH	**Sandy CLAY:** high plasticity, grey/orange-brown, sand is fine to medium grained				RESIDUAL SOIL
						1.5							
						2.0			End TP9 at 1.8m depth due to limit of required investigation. Test pit TP9 terminated at 1.8m				
						2.5							
						3.0							
						3.5							
						4.0							

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

Engineering Log - Piezometer

Borehole No. **BH1**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Client: ***WINTEN PROPERTY GROUP***

Date started: ***5.4.2004***

Principal:

Date completed: ***5.4.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***AGG/ELC***

Borehole Location: ***REFER TO FIGURE 1***

Checked by:

Coffey

drill model & mounting:MD200 | Easting: | slope: -90° | R.L. Surface:

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

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		C					0		CH	**SANDY CLAY:** brown, high plasticity,	M		
									CH	**CLAY:** grey, high plasticity, some sand.		St-VSt	
							1		CH	**CLAY:** grey to pale brown, high plasticity, some sand.	D		
							2						
							3		CH	**CLAY:** grey to brown , high plasticity, some sand.	M		
							4						Water level at time of drilling about 3.8m
							5			Borehole terminated at 5m			
							6						
							7						
							8						

PIEZOMETER CH1173-1.GPJ COFFEY.GDT 12.16.05

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

Form GEO 5.10 Issue 3 Rev.0

Borehole No. **BH2**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Engineering Log - Piezometer

Client: ***WINTEN PROPERTY GROUP***

Date started: ***5.4.2004***

Principal:

Date completed: ***5.4.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***AGG/ELC***

Borehole Location: ***REFER TO FIGURE 1***

Checked by:

Coffey

drill model & mounting:MD200 | Easting: | slope: -90° | R.L. Surface:

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

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		C	▼				1		CH	**SANDY CLAY:** grey/orange/red, high plasticity.	D-M / W	St-VSt	
							2		CH	**CLAY:** grey/red, medium to high plasticity, some sand.		VSt	Water level at time of drilling about 1.8m
							3		CH	**CLAY:** grey, high plasticity.		H	Drill rate increase
							4						Drill rate decrease
							5						
							6			Borehole terminated at 5m			
							7						
							8						

PIEZOMETER CH1173-1.GPJ COFFEY.GDT 12.16.05

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

Borehole No. **BH3**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Engineering Log - Piezometer

Client: ***WINTEN PROPERTY GROUP***

Date started: ***5.4.2004***

Principal:

Date completed: ***5.4.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***AGG/ELC***

Borehole Location: ***REFER TO FIGURE 1***

Checked by:

Coffey

drill model & mounting:MD200 | Easting: | slope: -90° | R.L. Surface:

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

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		C	▶				1		SP	**SAND:** fine to medium grained, black, organic content about 50%.	M		TOPSOIL
									SP	**SAND:** fine to medium grained, grey.			ALLUVIAL
									SP	**SAND:** dark brown, indurated sand.			
									SP	**SAND:** fine to medium grained, brown.	W		
							2		CH	**CLAY:** high plasticity, grey/brown.	M	St	RESIDUAL?
							3						
							4			Borehole terminated at 4.3m			
							5						
							6						
							7						
							8						

PIEZOMETER CH1173-1.GPJ COFFEY.GDT 12.16.05

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

Engineering Log - Piezometer

Borehole No. **BH4**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Client: ***WINTEN PROPERTY GROUP***

Date started: ***5.4.2004***

Principal:

Date completed: ***5.4.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***AGG/ELC***

Borehole Location: ***REFER TO FIGURE 1***

Checked by:

Coffey

drill model & mounting:MD200 | Easting: | slope: -90° | R.L. Surface:

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

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		C					0		CH	**CLAYEY SAND:** fine to medium grained, dark brown.	M		TOPSOIL
									SP	**SAND:** fine to medium grained, brown/orange			ALLUVIAL
									SP	**SAND:** fine to medium grained, brown.	M-W		
							1		SP	**SAND:** fine to medium grained, pale brown, some clay.	W		
									CH	**CLAY:** high plasticity, grey, some fine to medium grained sand.	M	St	RESIDUAL?
							2						Water level at time of drilling about 2m.
							3						
							4			Borehole terminated at 4.4m			
							5						
							6						
							7						
							8						

PIEZOMETER CH1173-1.GPJ COFFEY.GDT 12.16.05

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

Borehole No. **BH5**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Engineering Log - Piezometer

Client: ***WINTEN PROPERTY GROUP***

Date started: ***5.4.2004***

Principal:

Date completed: ***5.4.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***AGG/ELC***

Borehole Location: ***REFER TO FIGURE 1***

Checked by:

Coffey

drill model & mounting:MD200 | Easting: | slope: -90° | R.L. Surface:

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

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		C					0		CL	**SANDY CLAY:** low plasticity, black/dark brown.	W	S-F	TOPSOIL
									CL	**SANDY CLAY:** medium plasticity, yellow/orange/red/grey.	M		ALLUVIAL
							1		CH	**CLAY:** grey, high plasticity.	D	H	Increase torque RESIDUAL?
							2						
							3			Colour change to red/purple.			
							4		CH	**SANDY CLAY:** high plastcity, grey.	M	VSt-H	
							5			Borehole terminated at 5m			
							6						
							7						
							8						

PIEZOMETER CH1173-1.GPJ COFFEY.GDT 12.16.05

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

Form GEO 5.10 Issue 3 Rev.0

Borehole No. **BH6**

Sheet 1 of 1

Office Job No.: **CH1173/1**

Engineering Log - Piezometer

Client: ***WINTEN PROPERTY GROUP***

Date started: ***5.4.2004***

Principal:

Date completed: ***5.4.2004***

Project: ***PROPOSED DEVELOPMENT***

Logged by: ***AGG/ELC***

Borehole Location: ***REFER TO FIGURE 1***

Checked by:

Coffey

drill model & mounting:MD200 | Easting: | slope: -90° | R.L. Surface:

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

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		C					0		CH	**SANDY CLAY:** high plasticity, grey.	M		TOPSOIL
									CH	**SANDY CLAY:** high plasticity, brown.			ALLUVIAL
							1		CH	**CLAY:** high plasticity, grey.		VSt-H	
							2			Colour change to brown/grey.			
							3			Colour change to grey/brown/yellow			
							4			Some fine gravel.			
							5			Borehole terminated at 5m			
							6						
							7						
							8						

PIEZOMETER CH1173-1.GPJ COFFEY.GDT 12.16.05

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

Form GEO 5.10 Issue 3 Rev.0

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APPENDIX B

LABORATORY TEST RESULTS

CH 1173/1

Winton Property Group
Proposed Development
Moonee Beach

Potential Acid Sulfate Soils

TEST PIT No.	DEPTH (m)	pH result	
		Actual	Potential
6	0.1-0.3	5.4	5.0
6	0.4-0.6	4.6	4.8
6	0.7-0.9	4.9	5.2
6	1.2-1.4	4.8	6.1
8	0.1-0.3	4.8	6.2
8	0.4-0.6	3.8	6.0
8	0.7-0.9	3.8	6.3
8	1.2-1.4	4.3	5.8
8	1.5-1.6	4.8	5.8
9	0.1-0.3	5.4	3.7
9	0.4-0.6	5.8	6.3
9	0.8-0.9	6.1	6.9

(Sampled 3/3/03)

DETERMINATION OF ACID SULFATE SOIL PROPERTIES

CERTIFICATE OF ANALYSIS

Analysis By: **Bio-Track Pty Ltd** ABN 91 056 237 275

781 Mt. Glorious Road Highvale, Brisbane, Australia, 4520 Ph. 07 3289 7179 Fx. 07 3289 7155

DATE OF REPORT 24 APRIL 2004 Page 1 of 1 Report Pages.
CLIENT NAME MR JOHN MORRISON c/o COFFEY GEOSCIENCES PTY LTD
CLIENT ADDRESS PO BOX 704 COFFS HARBOUR NSW 2450
PROJECT NAME CH 1173/1 YOUR PROJECT/JOB REFERENCE CH 1173/1
SAMPLING DATE no record NUMBER OF SAMPLES 4 SAMPLE TYPE:SOIL SAMPLE FOR ACID SULFATE STUDY
PACKAGING SAMPLES LABELLED - INTACT - BAGGED - CHILLED IN INSULATED PACKAGING ** SAMPLES DISPOSED ON 1/7/2004
DATE RECEIVED 26 MARCH 2004 LAB REF. LR2634.623

METHODOLOGY: As per SPOCAS (DNR QASSIT June 2003) for <850 um fraction, S,Ca & Mg by ICP; CLAY (H) for >40% clay, (M) for 5-40% clay or (L) for <5% clay (approximate estimation only)
LIME1 rates calculated to neutralise TPA (or TAA if >TPA)+ aS RAS, LIME2 rates calculated from TAA+aS POS+ aS RAS - carbonate buffer (aCa A + aMg A)/fineness factor (1.51.5).
NB. Lime rates assume 97% lime neutralisation and Bulk Density = 1.6 g/cc but DO NOT include any safety factors. Suggested factor=1.5-1.8 [Reported as oven dry (85°C) mass]
Equivalent Sulphur (%S eq)= sTAA (%S) + S POS (%S) where sTAA (%S)=TAA/624. a-S RAS (Residual Acid Soluble Sulphur) as S in oxidised 4 M HCl extract- S POS
CBN POS = moles carbonate alkalinity released by oxidation assuming (Ca POS - Ca KCl) + (Mg POS - Mg KCl) is due to carbonate solution. This buffers TPA.

I.D.	DEPTH	CLAY	pH	pH	SHIFT	TAA	TPA	TSA	S KCl	S P	S POS	POS ACID	LIME1	LIME2	%S eq	Ca KCl	Ca P	Mg KCl	Mg P	CBN POS	a-S RAS
	m		KCL	ox	pH	m/t	m/t	m/t	%	%	%	m/t	kg/m3	kg/m3		mg/kg	mg/kg	mg/kg	mg/kg	m/t	m/t
TP 8	0.4-0.6	nd	4.67	5.26	0.6	25	11	0	0.006	0.025	0.018	11	2.1	3.0	0.06	40	40	50	50	0	0
TP 8	0.7-0.9	nd	4.74	4.93	0.2	26	12	0	0.006	0.044	0.038	24	2.2	4.2	0.08	15	20	15	15	0	1
TP 8	1.2-1.4	nd	4.37	5.54	1.2	35	9	0	0.006	0.019	0.013	8	2.9	3.5	0.07	25	20	115	120	1	0
TP 9	0.1-0.3	nd	5.21	5.95	0.7	13	12	0	0.002	0.013	0.011	7	1.0	1.6	0.03	520	430	485	440	0	0

Signatory P. Robertson For and behalf of Bio-Track Pty Ltd

APPENDIX C

ACID SULFATE SOIL MANAGEMENT PLAN

Coffey

PRELIMINARY ACID SULFATE SOILS MANAGEMENT PLAN

Further Assessment

It will be necessary to carry out further sampling and testing of the soils in the Zone 2 area to assess the extent of the affected soils and the liming ratios. The areas affected by acid sulfate soils are likely to be relatively small and the scale and amount of treatment required is anticipated to be relatively minor. We would anticipate that treatment may comprise mixing disturbed soils with a reasonably small amount of lime if required. After testing of the soils an acid sulfate soil management plan including liming ratios, will need to be developed prior to construction.

The area requiring testing covers approximately 5.5ha. The Acid Sulfate Soil Management Advisory Committee (ASSMAC) guidelines suggest for sites above 4ha, that two boreholes be drilled per hectare. Therefore, for this site twelve boreholes are required to comply with the ASSMAC guidelines. The boreholes should extend to 1m below the depth of excavation, and samples taken every 0.5m. The samples should be kept chilled during fieldwork and transport to a laboratory NATA registered for POCAS or CRS testing.

At this stage it is unknown how deep excavations are likely to be, and it is therefore considered impractical to develop a scope of work beyond the general recommendations provided above.

General Management

ASS stockpile / treatment areas must be completely surrounded by bunds designed to be of sufficient capacity to accommodate a critical storm event. Bunds may be constructed of imported or on-site material and should be of sufficiently low permeability to ensure that uncontrolled loss of water to the surrounding area does not occur. This could generally be achieved by use of clay soils. The bund should be compacted by rolling with a padfoot roller to bind the material into a cohesive earth fill rather than a loose or granular material. A minimum of 95% Standard Compaction should be achieved in all earth bunds constructed for environmental protection. Bunded areas should be graded to allow water within the bunded area to flow to a sump area, where the water may be assessed and treated as necessary.

Excavated Potential Acid Sulfate Soils (PASS) should be spread within the bunded area in layers of workable depth (typically not more than 0.3m loose thickness) and be thoroughly mixed with lime through use of a rotary hoe, pulvi-mixer or some similar mechanical process nominated by the contractor to achieve a thorough mix. The liming should be confined to areas of manageable size. Liming areas should remain bunded to allow collection of all leachate and stormwater runoff until test results indicate acceptable levels of neutralisation have been achieved.

Liming Ratios

Further investigations are required to assess liming ratios and expected extent of affected soils.

Good quality fine agricultural lime should be used. In calculating liming ratios a factor of safety of 1.5 should be allowed above the theoretical requirement to take into account the rate of lime reactivity and the possibility of inhomogeneous mixing.

The time required for applied lime to neutralise ASS is widely variable and depends on the specific properties of the neutralised soil, although the lime will begin to neutralise the acid soils from the time of application. Monitoring of the neutralisation rates of the ASS to be removed should be undertaken to provide an indication of the rate of neutralisation and to confirm that the process is working effectively.

Management of Leachate and Excavation Water

Groundwater samples should be obtained to assess background groundwater quality prior to excavation of

PASS at the site. Results of this testing should be forwarded to the ASS Consultant for the project, as a review of recommended groundwater monitoring during construction may be required.

All water runoff from bunded areas is to be collected, monitored and then neutralised prior to release. Water pumped out during dewatering should be monitored on a regular basis during the dewatering period. It is suggested that water pH be checked several times throughout the day. If pH levels are found to become consistently lower over several tests, and the pH value approaches the minimum allowable pH of 6.5, all water should be contained and treated prior to release. Once an acceptable water quality is achieved, the treated water may be released.

The method of neutralisation is either to add lime as a slurry to the collected leachate / excavation water (depending on the salinity of the water to be treated) or to use a mechanical lime spreader to spread lime over an area close to the inlet point of the collection area. The addition of lime will be undertaken in conjunction with field testing to avoid achieving excessively high pH levels. The quality of the water to be finally discharged must meet appropriate guidelines for release.

Monitoring Program

Materials Treated in Bunded Areas

Field testing of the pH of lime treated materials will be required to assess whether pH values are being held at greater than 4. The pH testing should be supplemented with a minimum of two standard ASS laboratory tests from the excavated soil. Testing will be required to produce Total Potential Acidity (TPA) results of zero or indicating a small amount of excess lime.

Delivery dockets for the agricultural lime should be kept with other site records to demonstrate that adequate neutralising agent was used on site.

Excavation Monitoring

Natural soils exposed in the walls and floor of all excavations during dewatering should be checked a number of times for the generation of acid conditions, using an approved field pH screening test. Lime should be added to the exposed surface of the soils if values of pH<4 occur. Any water collected in the excavation should also be checked for indications of acid production. Water pumped out during dewatering should be monitored at regular intervals for indications of acid production. Contingency measures should be put in place in accordance with this plan if water pH values of less than pH 6.5 occur.

The period of dewatering should be minimised by excavating soils above the water table initially and dewatering only for the excavation of the deeper soils. Soils exposed within the excavation, including those above the water table, shall be maintained in a wet condition by frequent irrigation to restrict oxygen entry into the soil within the excavation.

Contingency Measures

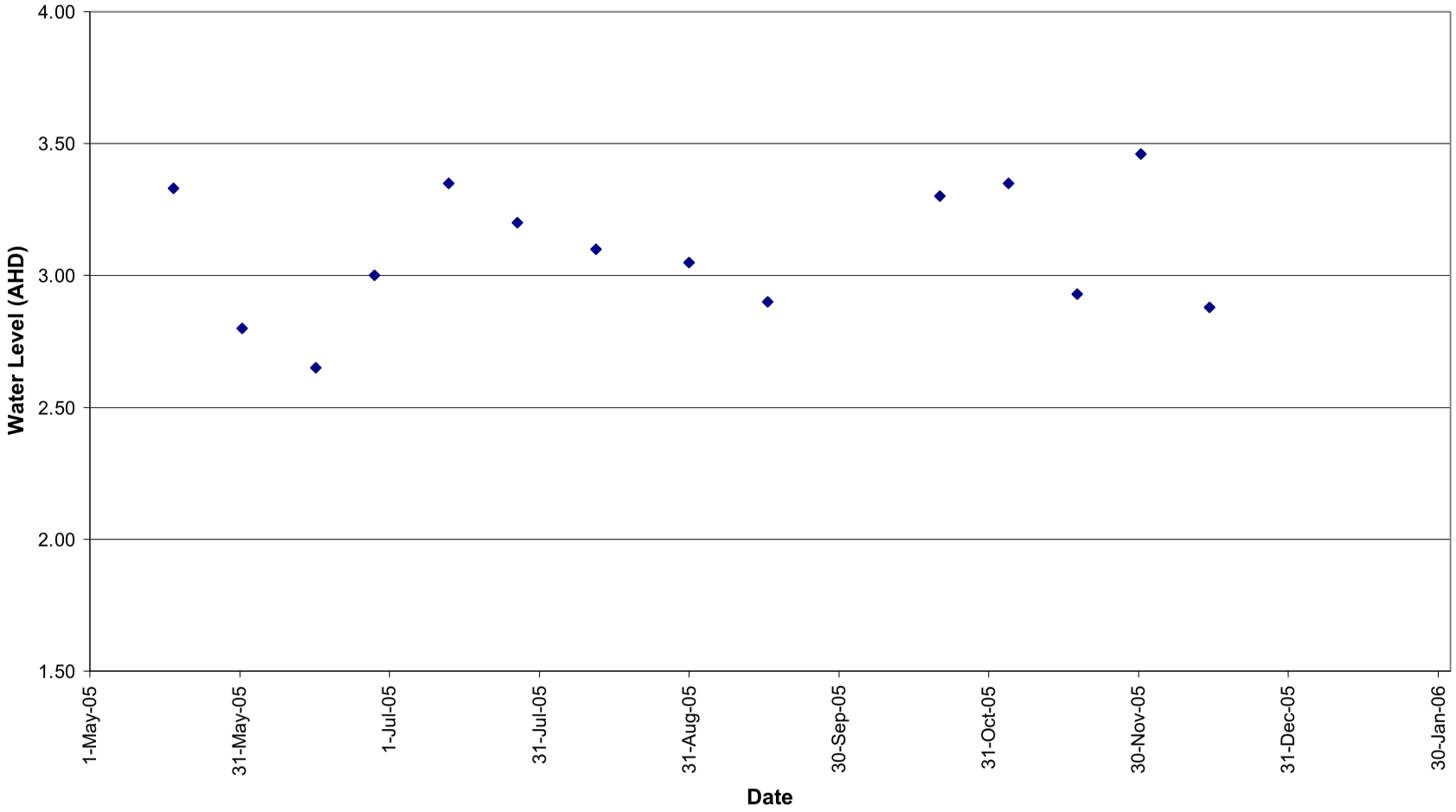
Soil acidity in disturbed materials should be monitored. Should the field pH tests and the laboratory tests show that the soil acidity has not achieved the minimum required standard, then the material must be reworked and additional lime treatment carried out until it is verified that the soil meets the required standard.

If monitoring of the collected water at the point of discharge indicates the pH is below acceptable discharge limits then discharge must immediately cease and further treatment be carried out. Hydrated lime may only be applied in the presence of the ASS Consultant who shall ensure that it is added in small increments so as not to cause unduly high water pH levels, (i.e. above 8.5). The hydrated lime shall be stored in a covered and bunded area to prevent accidental release to waters.

In the event that pH measurement of exposed soils in excavations does not meet required levels, lime shall be spread over the affected area and the pH levels further monitored. Sufficient lime is to be stored in a dry location on-site to permit the immediate implementation of the above contingency measures.

APPENDIX D

WATER LEVEL PLOTS



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Drawn	ELC	**RESOURCE DESIGN & MANAGEMENT**	**Drawing no:**
Approved		**PROPOSED SUBDIVISION**	**BH1**
Date	16/12/05	**PACIFIC HIGHWAY, NORTH MOONEE BEACH**	
Scale	NTS	**PLOT FOR BH1**	Job no: **CH1173/1**

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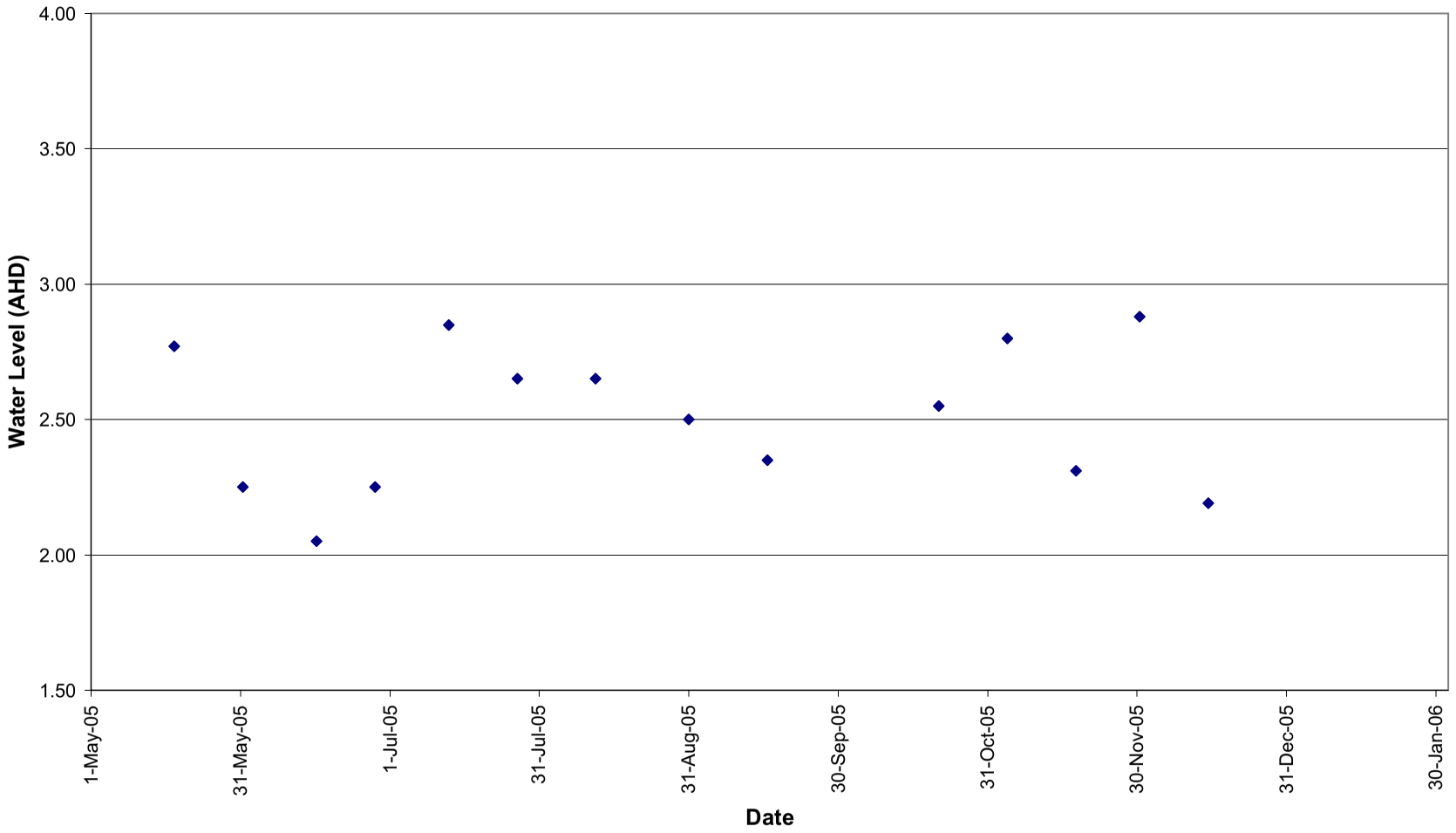

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Approved		**PROPOSED SUBDIVISION**	**BH2**
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Scale	**NTS**	**PLOT FOR BH2**	Job no: **CH1173/1**

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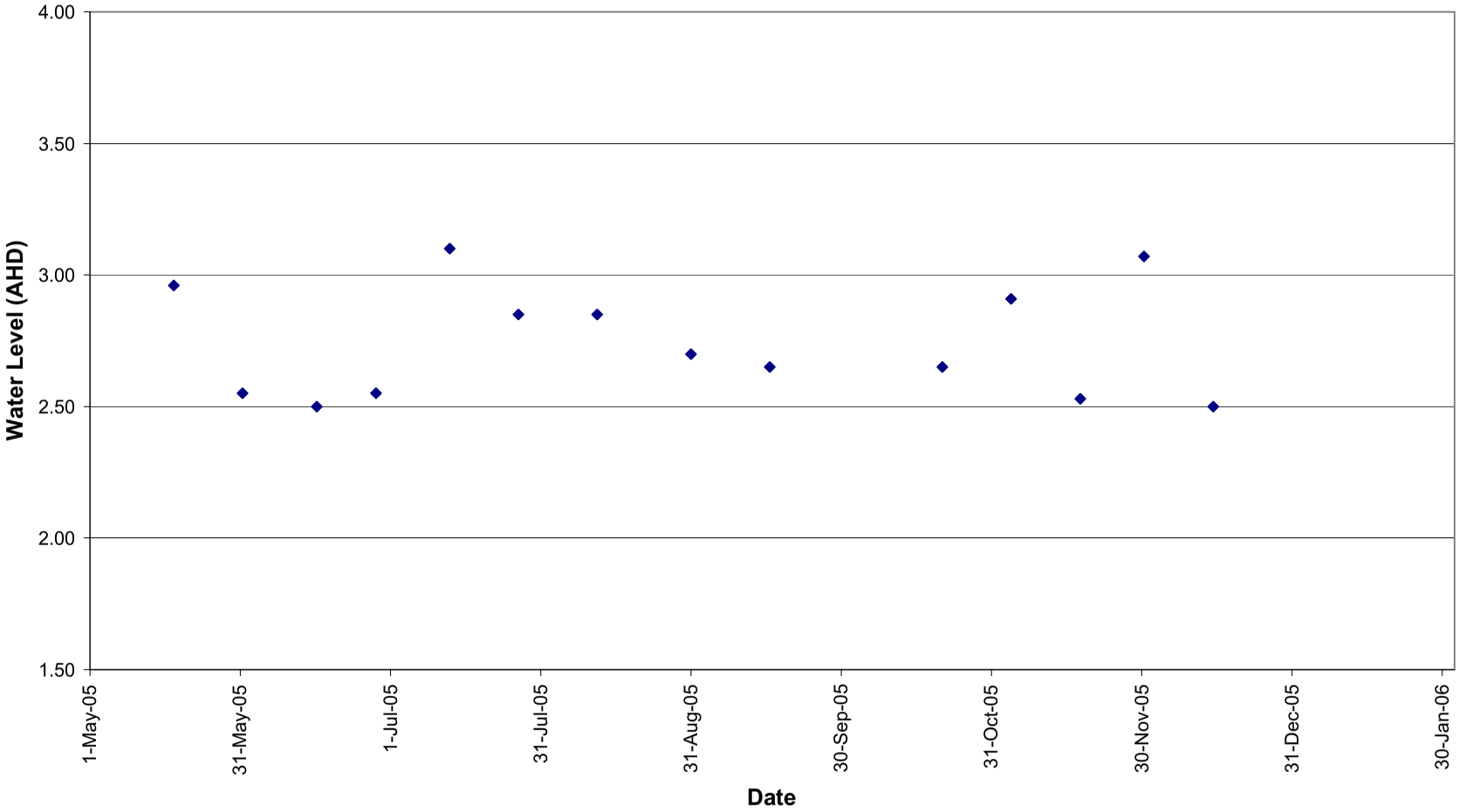

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Approved		**PROPOSED SUBDIVISION**	**BH3**
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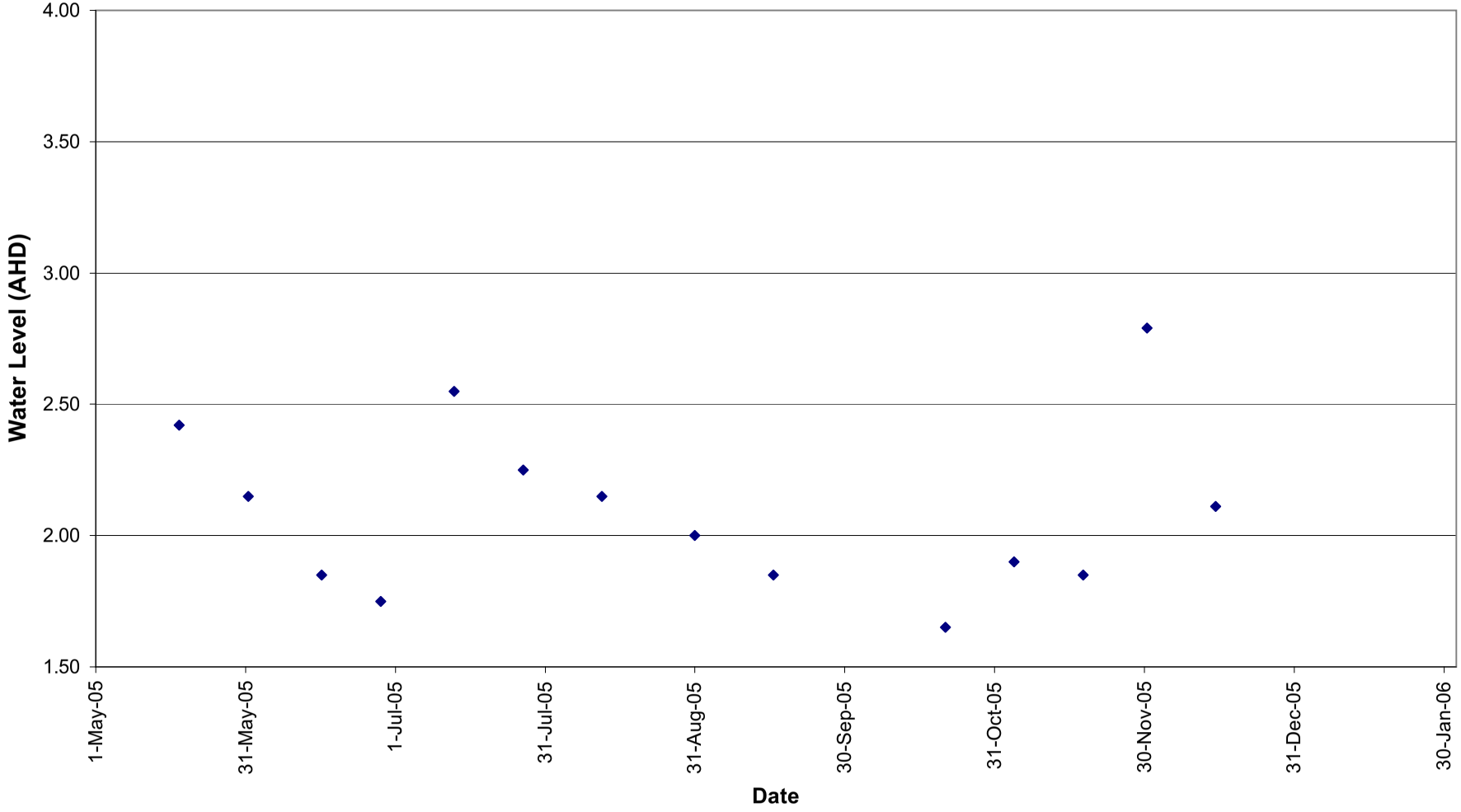

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Drawn	ELC	RESOURCE DESIGN & MANAGEMENT	Drawing no:
Approved		PROPOSED SUBDIVISION	BH4
Date	16/12/05	PACIFIC HIGHWAY, NORTH MOONEE BEACH	
Scale	NTS	PLOT FOR BH4	Job no: CH1173/1

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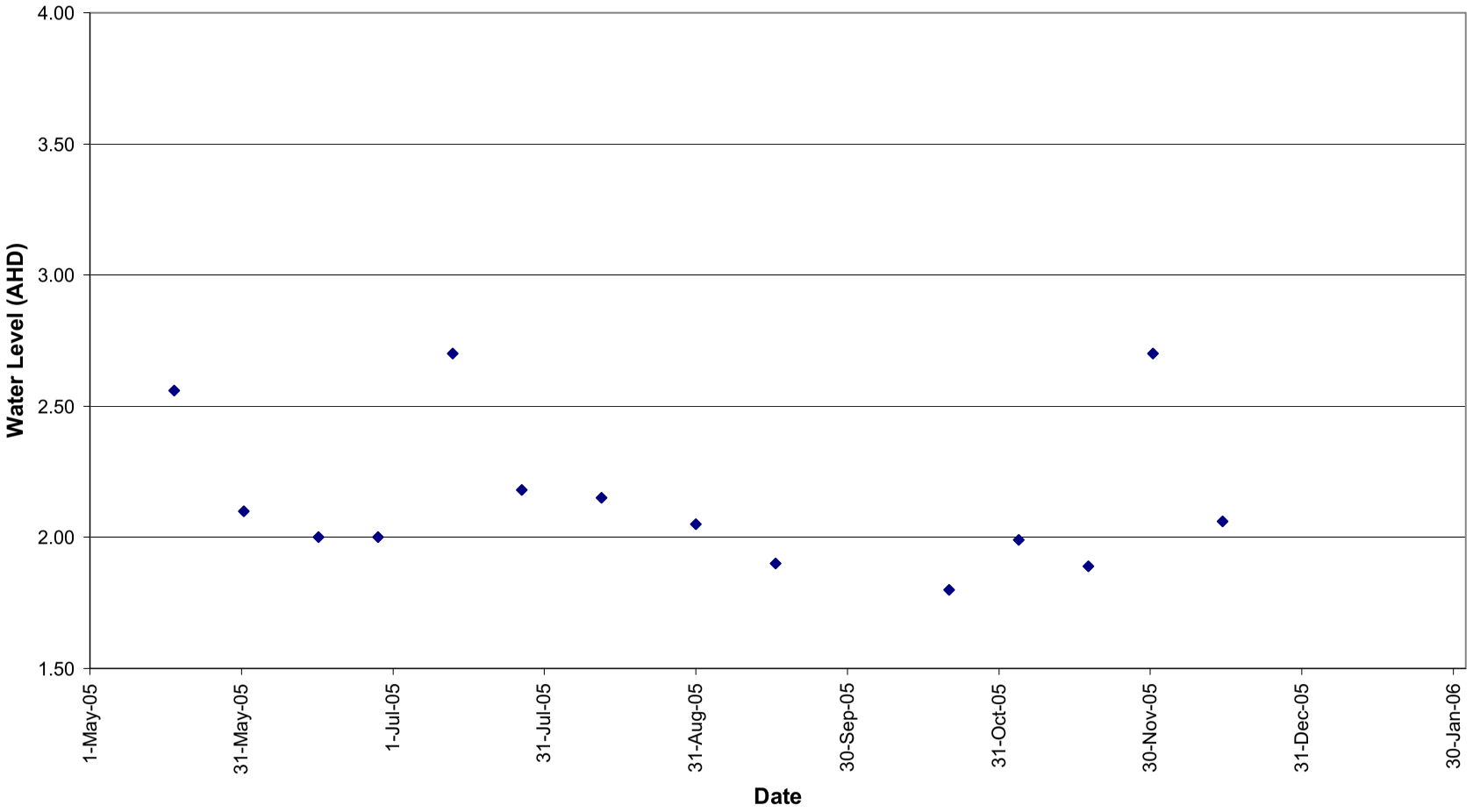

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Drawn	ELC	**RESOURCE DESIGN & MANAGEMENT**	Drawing no:
Approved		**PROPOSED SUBDIVISION**	**BH5**
Date	16/12/05	**PACIFIC HIGHWAY, NORTH MOONEE BEACH**	
Scale	NTS	**PLOT FOR BH5**	Job no: **CH1173/1**

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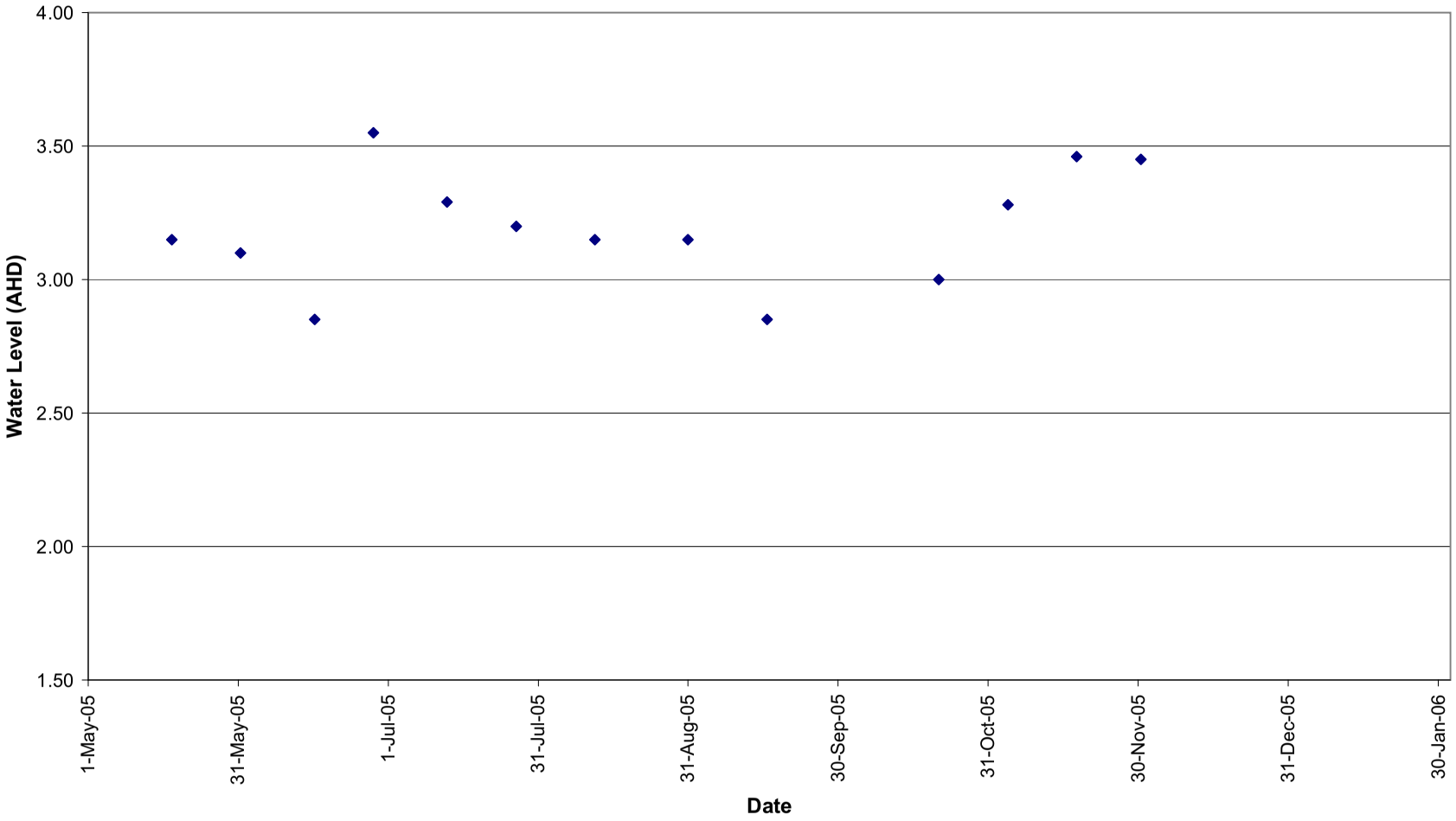

Coffey

Coffey Geosciences Pty Ltd ACN 056 335 516		Geotechnical I **Resources** I Environmental I **Technical** I Project Management	
Drawn	ELC	RESOURCE DESIGN & MANAGEMENT	Drawing no:
Approved		PROPOSED SUBDIVISION	BH6
Date	16/12/05	PACIFIC HIGHWAY, NORTH MOONEE BEACH	
Scale	NTS	PLOT FOR BH6	Job no: CH1173/1

G:\Coffs Harbour\CH1100\CH1173-1\[Water Levels.xls]BH4

Volume 3

Acid Sulfate Soils Assessment

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

ACID SULFATE SOILS ASSESSMENT FOR RESIDENTIAL SUBDIVISION

Lot 1 DP725785 Pacific Highway, Moonee Beach NSW

Resource Design & Management Pty Ltd

GEOTCOFH01173AB-AA
17 July 2007

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
1/18 Hurley Drive Coffs Harbour NSW 2450 Australia

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

17 July 2007

Resource Design & Management Pty Ltd
Suite 34 Jetty Village Shopping Centre
Coffs Harbour NSW 2450

Attention: Ken Maguire

Dear Sir

RE: Acid Sulfate Soils Assessment for Residential Subdivision

Coffey Geotechnics Pty Ltd is pleased to present our report on the acid sulfate soil assessment for the above site.

We draw your attention to the attached sheet entitled “Important Information About Your Coffey Report” which should be read in conjunction with this report.

We trust that this report meets with your requirements. If you require further information please contact the undersigned in our Coffs Harbour office.

For and on behalf of Coffey Geotechnics Pty Ltd

Alicia Zillman

Associate Environmental Engineer

Distribution:	Original held by:	Coffey Geotechnics Pty Ltd
	1 Copy	Coffey (Coffs Harbour library)
	3 Copies	Resource Design & Management Pty Ltd

CONTENTS

1 INTRODUCTION

1.1 General

Coffey Geotechnics Pty Ltd (Coffey) has conducted an acid sulfate soils assessment for a proposed residential subdivision to be located at Lot 1 DP725785 (Lot 1) Pacific Highway, Moonee Beach NSW. The work was commissioned by Ken Maguire of Resource Design Management Pty Ltd (RDM).

The aim of the investigation was to assess the presence or absence of Acid Sulfate Soils (ASS) along an approximately 600m section of road within Stage 1 of the proposed subdivision, and provide an Acid Sulfate Soil Management Plan (ASSMP), if necessary.

The whole of Lot 1 is proposed to become a residential subdivision, which is proposed to be developed in stages. The site is located along a 600m section of road within the Stage 1 area. Previous reports identified two different 'zones' with different subsurface conditions. Zone 1 comprised residual soils and weathered siltstone materials. Zone 2 comprised alluvial and fill soils overlying residual soils. The previous investigation indicated that Zone 2 soils may contain acid sulfate soils. Within the Stage 1 area, Zone 2 soils will be disturbed along the 600m section of road to approximately 0.6m depth.

Coffey have previously carried out work on the site, which was reported in numerous letters, facsimiles and reports. Further information on the previous work is presented in Section 1.2 below.

This report presents the results of the acid sulfate soil assessment.

1.2 Background Information

Coffey has previously carried out a geotechnical investigation, preliminary acid sulfate soils assessment, and collected water level data at the site, from which the following reports and letters were issued;

- CH1173/1-AC dated 8 March 2004 – this letter presented the results of a geotechnical assessment and preliminary recommendations for the proposed residential subdivision development. The letter provided general comments on road construction, footings and founding conditions, excavation conditions and acid sulfate soils.
- CH1173/1-AD dated 24 March 2004 – this facsimile provided comments on the suitability of the site for residential development with respect to geotechnical engineering aspects. A recommendation was also made that a more detailed geotechnical investigation should be carried out prior to final design and construction of the proposed subdivision.
- CH1173/1-AF dated 7 April 2004 – this letter provided similar information as CH1173/1-AC and CH1173/1-AD which are discussed above.
- CH1173/1-AH dated 31 May 2004 – this facsimile advised the client that data loggers which had been installed at the above site to record water level data had been vandalised and irreversibly damaged.
- CH1173/1-AI dated 3 December 2004 – this report provided similar information as CH1173/1-AC and CH1173/1- AD which are discussed above.
- CH1173/1-AM dated 16 December 2005 - This report collated the information presented in the above letter and reports, and presented recommendations and information on:

- Previous reports and letters provided, including surface and subsurface conditions, excavation conditions, and comments on suitability of the site for residential development;
- General land capability with respect to site filling and drainage and the likely associated effects on groundwater quality;
- Acid sulfate soils and a preliminary management plan. From this previous investigation, one test pit (TP9) was located within the site for the current investigation. The results of the testing on samples from this test pit are discussed in Section 7 below;
- Groundwater levels to date.

- CH1173/1-AN dated 26 June 2006 – This letter provided the results of groundwater monitoring on the site over a one year period.

2 FORMATION OF ACID SULFATE SOILS

Acid Sulfate Soils (ASS) are soils which contain significant concentrations of pyrite which, when exposed to oxygen, in the presence of sufficient moisture, oxidises, resulting in the generation of sulfuric acid. Unoxidised pyritic soils are referred to as potential ASS (PASS). When the soils are exposed, the oxidation of pyrite occurs and sulfuric acids are generated, and the soils are said to be actual ASS (AASS).

Pyritic soils typically form in waterlogged, saline sediments rich in iron and sulfate. Typical environments for the formation of these soils include tidal flats, salt marshes and mangrove swamps below about RL 5m AHD. They can also form as bottom sediments in coastal rivers and creeks.

Pyritic soils of concern on low lying NSW and coastal lands have mostly formed in the Holocene period, (i.e. 10,000 years ago to present day) predominantly in the 7,000 years since the last rise in sea level. It is generally considered that pyritic soils which formed prior to the Holocene period would already have oxidised and leached during periods of low sea level which occurred during ice ages, exposing pyritic coastal sediments to oxygen.

Disturbance or poorly managed development and use of acid sulfate soils can generate significant amounts of sulfuric acid, which can lower soil and water pH to extreme levels (generally <4) and produce acid and salts, resulting in high salinity.

The low pH, high salinity soils can reduce or altogether preclude vegetation growth and can produce aggressive soil conditions which may be detrimental to concrete and steel components of structures, foundations, pipelines and other engineering works.

Generation of the acid conditions often releases aluminium, iron and other naturally occurring elements from the otherwise stable soil matrices. High concentrations of such elements, coupled with low pH and alterations to salinity can be detrimental to aquatic life. In severe cases, affected waters flowing off-site can have detrimental effect on aquatic ecosystems.

3 SCOPE OF WORK

The following scope of work was carried out:

- Review of relevant information contained in the previous reports;

- Fieldwork, comprising the excavation of five test pits (TP101 to TP105) and collection of soil samples for subsequent laboratory testing;
- Laboratory testing of eight selected soil samples for Chromium Reducible Sulfur (CRS), Total Actual Acidity (TAA), Total Sulfidic Acidity (TSA) and Total Potential Acidity (TPA) to assess the presence or absence of ASS;
- Data interpretation and reporting of results.

Further information on each stage of work is presented in the sections below.

4 SITE LOCATION AND ATTRIBUTES

4.1 Location and Description

The site is located on a portion of Lot 1 DP725785 (Lot 1). The whole of Lot 1 is proposed to become a residential subdivision, which is proposed to be developed in stages. The study site is located along a 600m section of road within the Stage 1 area. Previous reports identified two different 'zones' with different subsurface conditions on Lot 1. Zone 1 comprised residual soils and weathered siltstone materials and Zone 2 comprised alluvial and fill soils overlying residual soils. The previous investigation identified that Zone 2 soils may contain acid sulfate soils. Within the Stage 1 area, Zone 2 soils will be disturbed along the 600m section of road to approximately 0.6m depth.

For the purposes of this report, the site covers an area approximately 600m long by about 30m wide. The site is located on the western side of Lot 1, and is indicated on Figure 1.

The site is located within a generally level alluvial floodplain area, at the base of a south facing hill with surface slopes of approximately 5^0 to 10^0. At the time of the investigation, the site was vegetated with grasses and scattered trees. Water was ponded in several lower lying areas, and the surface soils were generally wet across the site. No structures were observed on the site at the time of the investigation.

4.2 Proposed Excavations and Site Disturbance

It is understood that the development will involve excavations to about 0.6m depth for services and utilities and road construction. At this stage, it is not known what volumes of soil will be removed, and we have assumed greater than 1000 tonnes of soil will be excavated or disturbed.

The timing of the works is not known, but it is assumed works will be started within the next 12 months, should relevant approvals be granted for the development.

4.3 Acid Sulfate Risk Map & Site Elevation

The 1:25,000 Acid Sulfate Risk Map of Moonee Beach indicates that the site is in an area of low probability of ASS between 1m and 3m below ground surface (Class Ap2) and greater then 3m below ground surface (Class Ap4).

5 FIELDWORK

Fieldwork was carried out on 27 June 2007 and comprised excavation of five test pits (TP101 to TP105) to depths of about 2.0m. The test pits were excavated using a backhoe equipped with a 450mm bucket.

Soil samples were collected from each test pit at 0.5m intervals and placed into plastic zip-lock sample bags. Samples were stored in chilled insulated containers during field work and then transported to a contract laboratory.

Fieldwork was carried out in the full-time presence of a Scientist from Coffey, who nominated the location of the test pits, collected samples and logged the subsurface conditions encountered in the test pits. Figure 1 shows the investigation locations. Engineering Logs are presented in Appendix A, with explanation sheets defining the terms and symbols used in their preparation.

6 SUBSURFACE CONDITIONS

The 1:250,000 geological map for Coffs Harbour / Dorrigo (which covers the Moonee Beach area) indicates the site is on the boundary between the Coramba Beds comprising greywacke, slate and siliceous argillite and Quaternary Alluvium comprising of sands, silts, clays and gravels.

The subsurface conditions interpreted from the test pits is summarised in Table 1 below.

Table 1: Summary of Stratigraphy Observed in Test Pits

Unit	Material Description	Depth to Base of Unit (m)				
		TP101	TP102	TP103	TP104	TP105
1	**Fill:** Gravelly Clay, low plasticity, orange-grey.	-	0.15	-	-	-
2	**Topsoil:** Silty Clay, low plasticity, dark brown.	0.3	0.3	0.2	0.2	0.15
3	**Estuarine / Alluvial Soil:** Silty Clay, low to medium plasticity, grey.	1.3	1.25	1.75	0.9	0.6
4	**Residual Soil:** Silty Gravelly Clay and Gravelly Clay, low to medium plasticity, grey, with some orange-brown mottling, gravel is fine to coarse grained.	>2.0	>2.0	>2.0	1.7	>2.0
5	**Extremely Weathered Siltstone:** Clayey Gravel, fine to coarse grained, white with orange mottle, clay is low plasticity.	-	-	-	>2.0	-

Generally groundwater was observed to be at the surface in most test pit locations.

It should be noted that groundwater inflows and levels may vary depending on a number of factors including rainfall, temperature, infiltration rates and geological conditions.

7 SAMPLING AND LABORATORY TESTING

Samples were collected in each test pit at 0.5m intervals. Samples selected for the acid sulfate soil assessment were sent to a contract NATA accredited laboratory and tested for Total Potential Acidity (TPA), Total Actual Acidity (TAA), Total Sulfidic Acidity (TSA) and Chromium Reducible Sulfur (CRS). Samples were selected on the basis of location and soil type.

The results of the testing are summarised below in Table 2 and presented on the laboratory result sheets presented in Appendix B.

Table 2: Summary of CRS, TAA & TPA Testing

Unit	Location & Depth (m)	Texture	Reduced Inorganic Sulfur (%Scr)	Action Criteria For %Scr	Titratible Potential Acidity (TPA) Mole H^+/Tonne	Action Criteria For TPA Mole H^+/Tonne
Unit 3 - Estuarine/Alluvial Soil	TP101 0.4-0.5	Fine	<0.005	0.03	13	18
Unit 4 – Residual Soil	TP101 1.4-1.5	Coarse	<0.005	0.03	**24**	18
Unit 3 - Estuarine/Alluvial Soil	TP102 0.4-0.5	Fine	<0.005	0.03	11	18
Unit 3 - Estuarine/Alluvial Soil	TP102 0.9-1.0	Fine	0.008	0.03	12	18
Unit 3 - Estuarine/Alluvial Soil	TP103 0.9-1.0	Fine	<0.005	0.03	10	18
Unit 3 - Estuarine/Alluvial Soil	TP103 1.4-1.5	Fine	<0.005	0.03	13	18
Unit 3 - Estuarine/Alluvial Soil	TP104 0.4-0.5	Fine	<0.005	0.03	9	18
Unit 3 - Estuarine/Alluvial Soil	TP105 0.4-0.5	Fine	0.012	0.03	**61**	18

Note: Values in **shaded and bold** exceed adopted action criteria;

Action criteria adopted are based on disturbance of more than 1000 tonnes of acid sulfate soils.

TPA concentrations exceeded the adopted action criteria in samples TP101 1.4-1.5m and TP105 0.4-0.5m.

One test pit (TP9) from the previous investigation reported in CH1173/1-AM, was tested using the field screening test and POCAS. The results of this testing indicated that S_{POS} and TPA were below the action criteria.

Comments on the results are provided in the Section 8.

8 CONCLUSION AND RECOMMENDATIONS

The results of the testing indicate that the soils at the site are unlikely to have pyritic sulfur, but may contain organic sulfur. This is supported by the low Scr results and the relatively high TAA and TPA results in the testing. These results suggest that the soils are unlikely to be ASS.

On this basis it is recommended that the soils are not ASS, but are acidic soils. Therefore, it is recommended that Council is consulted to determine if a management plan for acidic soils is required. Acidic soils are unlikely to cause significant harm to the environment, as the production of acid is slow and is unlikely to leach from the soils in significant quantities in their natural state. Should the soils be disturbed and be washed into waterways then acidification of the water can occur. Acidic soils can have a negative effect on vegetation growth, especially vegetation that is not native to Australia, and concrete footings can also be corroded by acidic soils.

Generally, two options for dealing with acidic soils may be considered. These include implementation of a sediment control plan which would prevent acidic soils from entering waterways, or treatment of the acidic soils with lime. The decision as to which option to adopt would depend on the need to implement a sediment control plan for the development, and/or the volumes of materials that may be excavated and treated with lime.

The acidic soils could be treated with lime to increase the pH. A bulk density of 1.6t/m^3 has been assumed for the residual soils. Using the Total Actual Acidity (TAA) results, the liming ratio requirements were assessed to be 7kg/m^3 of soil for acidic soils excavated.

Good quality fine agricultural lime should be used to treat the excavated soils. In calculating the liming ratios, a factor of safety of 1.5 has been allowed (as recommended in the ASSMAC guidelines) above the theoretical requirement to take into account the rate of lime reactivity and the possibility of inhomogeneous mixing.

In addition, it is recommended that the alluvial/colluvial and residual soils be considered as having a severe exposure classification in respect to aggressivity to buried structural elements. The recommendations indicated in AS2159-1995, with respect to concrete piles (Table 6.1 of that document) should be adopted for foundations at the site.

9 LIMITATIONS

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

This report does not address issues relating to potentially hazardous building materials or services which may be present on the site.

For and on behalf of Coffey Geotechnics Pty Ltd

Alicia Zillman

Associate Environmental Engineer

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Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. 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. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal 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. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary 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 cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is 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 Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey 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.

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Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

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 our reports 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 logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
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 Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

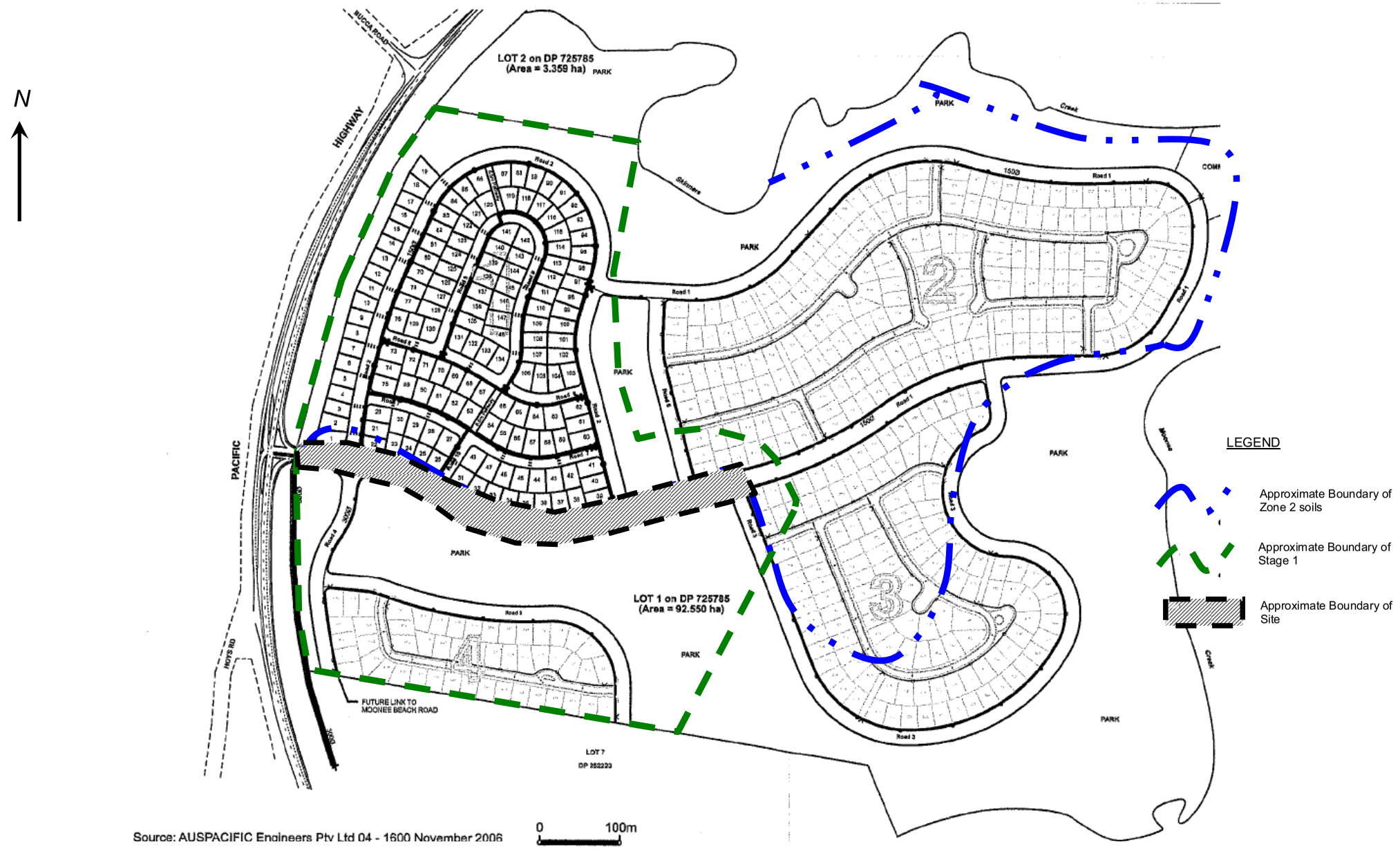
Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is 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 Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures



revision	description	drawn	approved	date

drawn	ELC
approved	AZ
date	16-7-2007
scale	NTS
original size	A3

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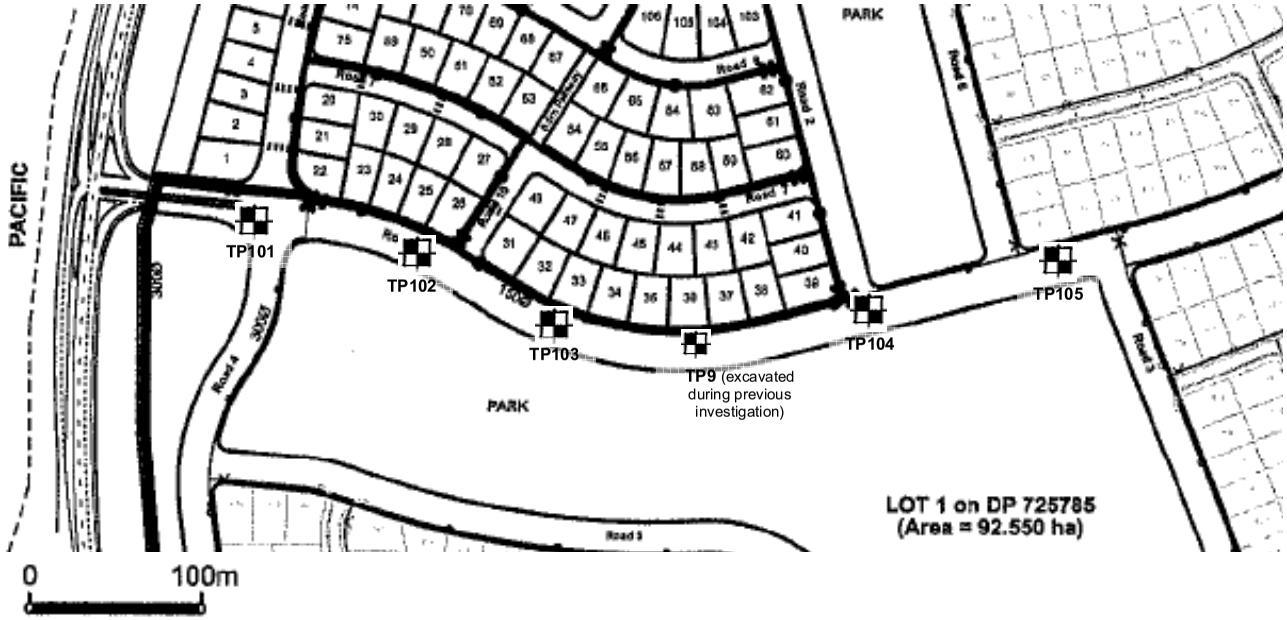
client:	Resource Design & Management Pty Ltd
project:	Proposed Residential Subdivision Lot 1 DP725785 Pacific Highway Moonee Beach NSW 2450
title:	Plan Showing Site Location on Lot 1
project no: GEOTCOFH01173AB	figure no: FIGURE 1

N



LEGEND:

TP101 — Approximate location of test pits

revision	description	drawn	approved	date

0 30 60 120 180
Horizontal Scale (metres)

drawn	ELC
approved	AZ
date	16-7-2007
scale	~1:3000
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client: Resource Design & Management Pty Ltd

project: Proposed Residential Subdivision
Lot 1 DP725785 Pacific Highway
Moonee Beach NSW 2450

title: Site Plan Showing Investigation Locations

project no: GEOTCOFH01173AB figure no: FIGURE 2

Appendix A

Engineering Logs

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Soil Description Explanation Sheet (1 of 2)

DEFINITION:

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 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.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 µm to 2.36 mm
	medium	200 µm to 600 µm
	fine	75 µm to 200 µm

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 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

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	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 detected 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 STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material — Structure and fabric of parent rock visible.

Residual soil — Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil — Deposited by wind.

Alluvial soil — Deposited by streams and rivers.

Colluvial soil — Deposited on slopes (transported downslope by gravity).

Fill — Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.

Lacustrine soil — Deposited by lakes.

Marine soil — Deposited in ocean basins, bays, beaches and estuaries.

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Soil Description Explanation Sheet (2 of 2)

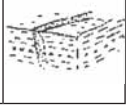
SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)							USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials 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 all 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.					
		SILTS & CLAYS Liquid limit less than 50	**DRY STRENGTH**	**DILATANCY**	**TOUGHNESS**			
			None to Low	Quick to slow	None		ML	SILT
			Medium to High	None	Medium		CL	CLAY
			Low to medium	Slow to very slow	Low		OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium		MH	SILT
			High	None	High		CH	CLAY
			Medium to High	None	Low to medium		OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				Pt	PEAT

• Low plasticity – Liquid Limit W_L less than 35%. • Modium plasticity – W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

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Rock Description Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance	In engineering terms roch substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.
Defect	Discontinuity or break in the continuity of a substance or substances.
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.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME	Simple rock names are used rather than precise geological classification.
PARTICLE SIZE	Grain size terms for sandstone are:
Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mm to 0.6mm
Fine grained	Mainly 0.06mm (just visible) to 0.2mm
FABRIC	Terms for layering of penetrative fabric (eg. bedding, cleavage etc.) are:
Massive	No layering or penetrative fabric.
Indistinct	Layering or fabric just visible. Little effect on properties.
Distinct	Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	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 Material	**XW**	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	**HW**	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	**MW**	The whole of the rock substance is discoloured, usually by iron staining or bleaching , to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	**SW**	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	**FR**	Rock substance unaffected by weathering.

Notes on Weathering:

1. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
2. Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

ROCK SUBSTANCE STRENGTH TERMS

Term	Abbrev-iation	Point Load Index, I_S50 (MPa)	Field Guide
Very Low	**VL**	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
Low	**L**	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	**M**	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	**H**	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	**VH**	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	**EH**	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

Notes on Rock Substance Strength:

1. In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
2. The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
3. The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index (Is50). The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

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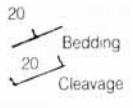
Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.			
Joint	A surface or crack across which the rock has little or no tensile strength. but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.			
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.			
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.			
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.			
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.			
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formad by weathering of the rock substance in place.			

DEFECT SHAPE TERMS	
Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes of orientation

Note: The assessment of defect shape is partly influenced by the scale of the observation.

ROUGHNESS TERMS	
Slickensided	Grooved or striated surface, usually polished
Polished	Shiny smooth surface
Smooth	Smooth to touch. Few or no surface irregularities
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS	
Clean	No visible coating
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.

BLOCK SHAPE TERMS	
Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greate than cross section

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

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Engineering Log - Excavation

Excavation No. **TP101**

Sheet 1 of 1

Project No: **GEOTCOFH01173AB**

Client: ***Resource Design & Management Pty Ltd***

Date started: ***27.6.2007***

Principal:

Date completed: ***27.6.2007***

Project: ***Proposed Subdivision, Pacific Hwy, Moonee Beach***

Logged by: ***VS***

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

Checked by:

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

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

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		CL	**TOPSOIL:** Silty Clay, low plasticity, dark brown, high in organic material	W	VS		TOPSOIL
				D		0.5		CL	**Silty CLAY:** low to medium plasticity, grey	M	S	×	ESTUARINE/ ALLUVIAL SOIL
				D		1.0						×	
				D		1.5		CL	**Gravelly Silty CLAY:** low plasticity, grey, gravel is angular and fine to medium grained.		St/VSt		RESIDUAL SOIL
				D		2.0							
						2.5			End of test pit at 2m due to limit of required investigation Test pit TP101 terminated at 2m				
						3.0							
						3.5							
						4.0							

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. ***TP102***

Sheet 1 of 1

Project No: ***GEOTCOFH01173AB***

Client: ***Resource Design & Management Pty Ltd***

Date started: ***27.6.2007***

Principal:

Date completed: ***27.6.2007***

Project: ***Proposed Subdivision, Pacific Hwy, Moonee Beach***

Logged by: ***VS***

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

Checked by:

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

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

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	▼		0.0		CL	**FILL:** Silty Gravelly Clay, low plasticity, dark brown and orange brown, high in organic material, gravel is fine to coarse grained	W			TOPSOIL
				D	0.5		CL	**Silty CLAY:** medium plasticity, grey	W	S	×	ESTUARINE/ ALLUVIAL SOIL
				D	1.0						×	
				D	1.5		CL	**Gravelly CLAY:** low plasticity, grey with orange/white mottling, gravel is angular and fine to medium grained		St/VSt		RESIDUAL SOIL
				D	2.0							
								End of test pit at 2m due to limit of required investigation Test pit TP102 terminated at 2m				
					2.5							
					3.0							
					3.5							
					4.0							

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. **TP103**

Sheet 1 of 1

Project No: **GEOTCOFH01173AB**

Client: ***Resource Design & Management Pty Ltd***

Date started: ***27.6.2007***

Principal:

Date completed: ***27.6.2007***

Project: ***Proposed Subdivision, Pacific Hwy, Moonee Beach***

Logged by: ***VS***

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

Checked by:

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

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

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		CL	**TOPSOIL:** Silty Clay, low plasticity, dark brown	W			TOPSOIL
								CL	**Silty CLAY:** medium plasticity, grey	M	S	X X	ESTUARINE/ ALLUVIAL SOIL
				D		0.5							
				D		1.0							
				D		1.5							
				D		2.0		CL	**Gravelly CLAY:** low plasticity, grey with orange/white mottling, gravel is angular and fine to medium grained		St/VSt		RESIDUAL SOIL
									End of test pit at 2m due to limit of required investigation Test pit TP103 terminated at 2m				
						2.5							
						3.0							
						3.5							
						4.0							

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. ***TP104***

Sheet 1 of 1

Project No: ***GEOTCOFH01173AB***

Client: ***Resource Design & Management Pty Ltd***

Date started: ***27.6.2007***

Principal:

Date completed: ***27.6.2007***

Project: ***Proposed Subdivision, Pacific Hwy, Moonee Beach***

Logged by: ***VS***

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

Checked by:

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

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

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				0.0		CL	**TOPSOIL:** Silty Clay, low plasticity, dark brown	W			TOPSOIL
								CL	**Silty CLAY:** medium plasticity, grey	M			ESTUARINE/ ALLUVIAL SOIL
				D		0.5							
				D		1.0		CL	**Gravelly CLAY:** low plasticity, grey with orange/white mottling, gravel is angular and fine to medium grained				RESIDUAL SOIL
				D		1.5							
				D		2.0		GC	**Clayey GRAVEL:** fine to coarse grained, angular, white/ orange brown mottling				EXTREMELY WEATHERED SILTSTONE
									End of test pit at 2m due to limit of required investigation Test pit TP104 terminated at 2m				
						2.5							
						3.0							
						3.5							
						4.0							

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. ***TP105***

Sheet 1 of 1

Project No: ***GEOTCOFH01173AB***

Client: ***Resource Design & Management Pty Ltd***

Date started: ***27.6.2007***

Principal:

Date completed: ***27.6.2007***

Project: ***Proposed Subdivision, Pacific Hwy, Moonee Beach***

Logged by: ***VS***

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

Checked by:

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

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

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						CL	**TOPSOIL:** Silty Clay, low plasticity, dark brown				TOPSOIL
								CL	**Silty CLAY:** low plasticity, grey				ESTUARINE / ALLUVIAL SOIL
				D		0.5		CL	<<B>Silty CLAY: **medium plasticity, grey with orange/white mottling**				RESIDUAL SOIL
				D		1.0							
				D		1.5							
				D		2.0			End of test pit at 2m due to limit of required investigation Test pit TP105 terminated at 2m				
						2.5							
						3.0							
						3.5							
						4.0							

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
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VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Appendix B

Laboratory Test Result Sheets

RESULTS OF ACID SULPHATE SOIL ANALYSIS (Page 1 of 1)

8 samples supplied by Coffey on 28th June, 2007 - Lab. Job No. E7531

Analysis requested by Emma Coleman. - **Your Project: GEOT COFH01173AB**

Sample Site	Depth (m)	EAL lab code	Texture (note 7)	Lab. Bulk Density tonne DW/m^3	Reduced Inorganic Sulphur (% chromium reducible S) (%Scr) (note 2)	Reduced Inorganic Sulphur (Scr) mole H^+/tonne	TAA pH_{kcl}	Titratable Actual Acidity (TAA) mole H^+/tonne (to pH 6.5)	TPA pH_{ox}	TPA pH_{TPA}	Titratable Potential Acidity (TPA) mole H^+/tonne (to pH 6.5)	Titratable Sulphidic Acidity (TSA) mole H^+/tonne	NET ACIDITY Chromium Suite mole H^+/tonne (based on %Scrs)
Method No.					*22B*	*a- 22B*	*23A*	*23F*	*23B*		*23G*	*23H*	*note 5*
BH101	0.4-0.5	*E7531/1*	Fine	1.6	<0.005	0	5.82	2	5.70	5.70	13	11	2.0
BH101	1.4-1.5	*E7531/2*	Coarse	1.6	<0.005	0	6.60	0	5.96	5.55	24	24	0.0
BH102	0.4-0.5	*E7531/3*	Fine	1.8	<0.005	0	6.20	2	5.69	5.62	11	9	1.5
BH102	0.9-1.0	*E7531/4*	Fine	1.4	0.008	5	5.64	2	6.02	5.81	12	11	6.5
BH103	0.9-1.0	*E7531/5*	Fine	1.5	<0.005	0	6.19	1	6.27	5.82	10	9	1.0
BH103	1.4-1.5	*E7531/6*	Fine	1.4	<0.005	0	6.12	2	6.25	5.94	13	11	1.5
BH104	0.4-0.5	*E7531/7*	Fine	1.5	<0.005	0	5.91	2	5.40	6.21	9	8	1.5
BH105	0.4-0.5	*E7531/8*	Fine	1.4	0.012	7	4.58	27	4.96	4.62	61	34	34.5 Refer Note 6 & 7

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)

2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & Sulphate) and **'Chromium Reducible Sulphur' technique** (Scr - Method 22B)

3 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines.*** QLD DNRME.

4 - Bulk density was determined immediately on arrival to laboratory (insitu bulk density is preferred)

5 - **ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Scrs or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF**

6 - The neutralising requirement does not include a safety margin for complete neutralisation (a factor of 1.5 is often recommended)

7 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays

8 - Neutralisation Calculation for neutralisation of actual and potential acidity (ie. sum of calculation based on Crs and TAA)

9 - .. Denotes not requested or required

10 - TAA is NATA certified but other SPOCAS is validated but awaiting full NATA certification

(Classification of potential acid sulphate material if: coarse Scr≥0.03%S or 19mole H^+/t**; medium Scr≥0.06%S** or 37mole H+/t**; fine Scr≥0.1%S** or 62mole H+/t**)**

* Projects that disturb >1000 tonnes of ASS soils with ≥0.03% S, a detailed management plan may be required.

checked: .....

NET ACIDITY TPA Only mole H^+/tonne (based on TPA)	LIME CALCULATION CRS Suite kg $CaCO_3/m^3$ (includes 1.5 safety Factor)	LIME CALCULATION TPA Only kg $CaCO_3/m^3$ (includes 1.5 safety Factor)
note 5	*note 5*	*note 5*
13.0	0.2	1.6
23.5	0.0	2.8
10.5	0.2	1.4
12.0	0.7	1.3
9.5	0.1	1.1
12.5	0.2	1.3
9.0	0.2	1.0
61.0	3.6	6.4
Refer Note 6 & 7	**(Note: Use either Liming Rate, NOT sum of both)**	

checked: .....

Volume 3

Stormwater Assessment

Volume 3

Hydraulic Assessment

Cardno LawsonTreloar

Shaping the Future

THE GLADES, MOONEE BEACH

HYDRAULIC ASSESSMENT

April 2007
Job No. LJ8596_02/R2

Auspacific Engineers

Cardno Lawson Treloar Pty Ltd

ABN 55 001 882 873

Ground Floor, 9 Gardner Close

Milton Queensland 4064

PO Box 388 Toowong

Queensland 4066 Australia

Telephone: 07 3310 2455

Facsimile: 07 3369 9722

International: +61 7 3310 2455

cltqld@cardno.com.au

www.cardno.com.au

Document Control

Version	Date	Author		Reviewer		Approved	
		Name	Initials	Name	Initials	Name	Initials
LJ8596_02/R2	04/04/07	K. Quinn		J. McArthur		J. McArthur	

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REFERENCE DRAWING

Auspacific Engineers drawing number 04-1600 P1-B

APPENDICES

1. INTRODUCTION

This report has been prepared by Cardno Lawson Treloar Pty Ltd (CLT), specialist hydrologic and hydraulic consultants, to assess flooding associated with the proposed residential subdivision, known as the "The Glades", at Moonee Beach, Coffs Harbour. The investigation has been carried out for Auspacific Engineers, the civil engineers for the project, acting on behalf of The Rothwell Boys Pty Ltd.

This report presents the details of the hydraulic modelling of the existing and developed site including proposed road crossings and outlines the impacts of the development on flooding in the area. The report addresses Coffs Harbour City Council's requirements for a flood study for a proposed development outlined in the *Floodplain Development and Management Policy and the requirements of the Moonee Development Control Plan*.

This report supersedes our previous report of October 2005 (Cardno Lawson Treloar Report #J8596/R1). Since this earlier report there has been a revised development extent and layout which included a revision of the location of an internal road crossing and hence further modelling has been undertaken. The proposed development extent and layout is shown on Auspacific Engineers drawing number 04-1600 P1 dated November 2006.

2. SITE CHARACTERISTICS

The proposed 523 lot residential development covers an area of approximately 96 ha. The site is located on Lots 1 and 2 DP 725785 within the Coffs Harbour Local Government Area. The site is bounded to the north by Skinners Creek and to the west by the Pacific Highway. Moonee Creek forms the eastern boundary of the site. Figure 1 shows the location of the site. The attached reference drawing from Auspacific Engineers (04-1600 P1) shows the development layout.

The site is currently undeveloped with scattered trees over the majority of the area. Some stands of trees are located along the banks of the creeks and through the centre section of the site.

There are two high points within the site, the first adjacent to the Pacific Highway and the second in the centre of the site. The ground falls in all directions from these high points towards Skinners Creek, Moonee Creek and the drainage path in the southern part of the site. Existing ground levels range between 2 mAHD and 16 mAHD.

Moonee Creek discharges to the ocean approximately 2 km downstream of the southern site boundary.

3. HYDRAULICS

3.1 Previous Studies

Several flood studies have been carried out in the area around the site. The most recent was the *Moonee Creek Flood Study* prepared for Coffs Harbour City Council by Paterson Consultants in June 1998. A MIKE11 model of Moonee Creek and its tributaries was established to determine peak water surface levels throughout the catchment. Inflow hydrographs were derived from RORB models of the major Moonee Creek catchments. The MIKE11 model was calibrated to recorded flood levels in Moonee Creek and several of its tributaries from a storm event in November 1996. It was found that the model was generally predicting within 0.1 m of the recorded flood levels, and was therefore considered to be acceptable.

An earlier study by Gutteridge Haskins & Davies completed in April 1994 examined flooding associated with the proposed "Heritage Park" development which is located on the western side of the Pacific Highway, to the north of the site of the "The Glades". This study utilised several HEC2 models to size culvert structures within the development and to assess the impacts of the proposed development on flood levels.

3.2 Hydraulic Approach

The MIKE11 model of Moonee Creek constructed by Paterson Consultants was supplied by Coffs Harbour City Council. The model was updated from version 3.2 to version 1999b. Figure 1 shows the extent of the full Moonee Creek MIKE11 model.

Model cross sections in the area of the site were checked and additional cross sections added to more accurately model the proposed development. Figure 2 shows the modelled cross sections and MIKE11 branch names in the vicinity of the site. Additional cross sections were created from the detailed survey of the site carried out by RDM, with information also sourced from 2 m contours of the area provided by Coffs Harbour City Council.

The bridge crossing of the Pacific Highway over Skinners Creek was not included in the original MIKE11 model. The bridge was added to the updated model, using the details of the structure included in the Gutteridge Haskins & Davies (1994) HEC2 models. The details of the culverts under the Pacific Highway for the southern drainage path were also updated based on survey information provided by RDM.

The hydraulic roughness of each creek was maintained as originally modelled by Paterson Consultants, since the model had been calibrated to the November 1996 flood event. Adopted Mannings n values in the southern drainage path ("Bucca" MIKE11 branch) and the reaches of Skinners Creek and Moonee Creek adjacent to the site are listed in Table 1.

Table 1 Adopted Mannings n values

MIKE 11 Branch	Mannings n
Bucca	0.06
Moonee	0.1
Skinners	0.08

The catchment hydrology was not reassessed as part of the current study. The Paterson Consultants MIKE11 model adopted ultimate land uses for the catchment as allowed under the Development Control Plan current at the time. Paterson Consultants found that ultimate land uses only increased peak catchment flows by approximately 1% over the

existing land uses at that time. For the current study, a range of durations from 2 hours to 12 hours has been modelled for each flood event.

Downstream boundary conditions in the model were updated from the previous modelling based on the procedure outlined in the previous Department of Infrastructure, Planning and Natural Resources' (DIPNR) *Floodplain Management Guideline No. 5 – Ocean Boundary Conditions* (2004). This guideline recommends that the 1% AEP flood event is modelled by considering an envelope of the 1% AEP flood event flows with a normal tidal cycle and a high tide with a smaller flood event. This method will identify areas where flooding will occur primarily from backwater from elevated ocean levels.

For the current study, three simulations were considered to form the envelope curve for the 1% AEP event, namely:

- 1% AEP flood event flows with normal tides (0.6 mAHD)
- 5% AEP flood event flows with 5% AEP tide (2.3 mAHD)
- 20% AEP flood event flows with 1% AEP tide (2.6 mAHD)

In all cases, the tidal cycle was adjusted for each storm duration modelled so that the peak of the tidal cycle would correspond with the peak flood levels.

It should be noted that although greenhouse effects on ocean water levels are predicted to be in the range of a 0.03 to 0.25m rise by 2040, no specific allowance has been included in the tide levels outlined above. As outlined in *Guideline No 5 – Ocean Boundary Conditions* this is because elevated ocean levels recommended in the Guideline are already conservative and a freeboard of up to 0.5m is generally applied to flood level estimates.

The 5% AEP flood event and 20% AEP flood event were also analysed with normal tidal cycles to assess the impact of the development on smaller flood events.

The development was modelled by assuming all parts of the development would be filled above the 1% AEP flood level. This was achieved by extending the model cross section vertically at the development extent.

The Road 4 crossing (refer Reference Drawing) of the Bucca MIKE11 branch was modelled by including a culvert structure in the model. The culverts were sized to ensure no adverse upstream impacts at the Pacific Highway and with 1% AEP flood immunity assumed for Road 4.

Details of the modelled culvert arrangement are provided below:

- Four 1050 mm diameter RCPs
- Length 20 m (assumed local road with 8 m pavement and 4 m shoulders)
- Upstream and downstream invert level – 3 mAHD
- Minimum road level – 4.65 mAHD (assuming approximately 600 mm cover).

3.3 Hydraulic Results

Peak flood levels, flows and velocities for the enveloped 1% AEP flood event and the 5% and 20% AEP flood events are presented in Appendix A. These show that the development has no significant impact on flood levels within Moonee Creek or Skinners Creek. Flood levels in the Bucca MIKE11 branch are increased by up to 108 mm due to

filling, and by 90 mm directly upstream of the proposed road crossing (Road 4). These impacts are contained within the site boundary and do not cause impacts on upstream or downstream properties.

Figure 3 shows the 1% AEP flood event inundation extent in the vicinity of the site. Only the existing inundation extent has been shown, due to the insignificant impacts of the development on flood levels. Figure 3 also shows water surface level contours in the area of the site.

It was found that the 1% AEP flood flows with normal tides produced the highest flood levels for the majority of the site. Downstream of Bucca 1270 and Moonee 6580 peak flood levels result from the high tailwater scenario (ie 20% AEP flood flows with 1% AEP tailwater).

Figure 4 shows the Flood Risk Precincts in the area of the site. As outlined in Coffs Harbour City Council's *Potentially Flood Prone Land Information Sheet*, the High Flood Risk is the area of land subject to high hydraulic hazard in the 1% AEP flood event and the Medium Flood Risk is land subject to low hydraulic hazard in the 1% AEP flood event. The hydraulic hazard was defined using the provisional hazard categories defined in the NSW Government (2001) *Floodplain Management Manual*. The development is located outside of the High Flood Risk precinct. Some minor filling would be required in the Medium Flood Risk precinct.

The development complies with the requirements for filling within 1% AEP flood level as outlined in Council's *Moonee Development Control Plan* 2004.

The modelling also indicates that if the access road into the Estate is set at a minimum level of RL 4.65mAHD, the access will have a flood immunity in excess of the 1% AEP flood event.

4. CONCLUSIONS

Based on the results of the MIKE11 modelling, the proposed “The Glades” development at Moonee Beach has been assessed to have no adverse impacts on flooding of adjacent properties. The development also has no detrimental impacts on the culvert or bridge structures under the Pacific Highway.

Areas of localised filling are required on the eastern and southern sides of the development. These are in areas classified as Medium Flood Risk and will not lead to any significant impacts on existing flood levels.

To avoid adverse impacts on flood levels at the Pacific Highway, the proposed Road 4 crossing of the southern drainage path should be comprised of four 1050 mm diameter culverts or equivalent.

5. QUALIFICATIONS

This report has been prepared by Cardno Lawson Treloar (CLT) specifically for Auspacific Engineers and specifically to provide advice on pre- and post- development flooding characteristics associated with the development of Lots 1 and 2 DP 725785, Moonee Beach.

Our analysis and overall approach has been specifically catered for the particular requirements of this project, and may not be applicable beyond this scope. For this reason any other third parties are not authorised to utilise this report without further input and advice from Cardno Lawson Treloar.

The report is based on the following information prepared by others:

- Detailed survey of the site provided by RDM;
- 2m aerial photogrammetry contours provided by Coffs Harbour City Council;
- Proposed development layout provided by Auspacific Engineers (Drawing Number: 04-1600 P1 dated November 2006);
- Topographic maps sourced from Department of Lands;
- MIKE11 model data and streamflow estimates by Paterson Consultants, prepared for Coffs Harbour City Council; and
- HEC2 model data by Gutteridge Haskins & Davies.

The accuracy of this report is dependent on the accuracy of this information.

6. REFERENCES

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FIGURES