Lawson and Treloar Pty Ltd

Brisbane Water Estuary Processes Study

Acid Sulphate Soils Investigation

Report

September 2004

GHD LongMac
Consulting geotechnical engineers and geologists

16 September 2004

Lawson and Treloar Pty Ltd
PO Box 852
Pymble NSW 2073

Our ref: 21/12503//AV545.doc
J2255/L9062

Attn: Louise Howells

Dear Louise,

Brisbane Water Estuary Processes Study
Acid Sulphate Soils Investigation

We are pleased to present herein our report on the acid sulphate soils investigation conducted at Brisbane Water as part of an Estuary Processes Study being conducted by Lawson and Treloar Pty Ltd.

Based on the results of the study, estuarine sediments at all of the investigated areas except St Huberts Island appear to be Potentially Acid Sulphate Soils (PASS) and thus have significant potential for generating acidity on exposure. At some of these locations a foreshore or an lake bed sample recorded a non-PASS result, but the adjacent sample (foreshore/lake bed) recorded a PASS result.

We note that at St Huberts Island, only a foreshore sediment sample was obtained, and hence the sediments beneath permanent water cover may be PASS.

Confirmatory PASS sampling should be conducted to delineate and quantify the acid producing potential of any proposed works area that would expose or drain these sediments. Moreover, an acid sulphate soil management plan will be necessary to address any proposed dredging or development at the confirmed PASS locations. At St Huberts Island, where the non-PASS conditions have been recorded, we also recommend further PASS sampling, due to the limited 'single test' only in this areas, in order to confirm/validate the non-PASS result.

We trust that this report is sufficient for your present requirements. Please contact the undersigned should you have any queries or require further assistance.

Yours faithfully
GHD-LongMac

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Controlled Document No. 2

ACID SULPHATE SOILS INVESTIGATION

for

BRISBANE WATER ESTUARY PROCESSES STUDY

for

LAWSON AND TRELOAR PTY LTD

REF: 21/12503/

DATE: 16 September 2004 Rev No. 0

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A Laboratory Test Results

1. Introduction

This report presents the results of a broadscale sampling exercise to assess the presence or otherwise of PASS conditions at selected points within the Brisbane Waters Estuary, as part of the Brisbane Water Estuary Management Study.

The investigation was commissioned by Lawson and Treloar (LT) in their letter of 25 June 2004 and subsequent email of 29 July 2004.

The work was conducted generally in accordance with our proposal dated 11 August 2003 (ref: AU216).

This report should be read in conjunction with the attached Standard Sheets.

2. Site Setting

2.1 Local

The site comprises the Brisbane Water estuary area, which extends some 10km north-south from Woy Woy to Gosford and about 6km in an east-west direction, as shown on Figure 1.

The sampling sites were nominated by LT, based on the study requirements.

2.2 Geology

The 1:100,000 scale Geological Series Sheet for Sydney (9130, Edition 1, 1983) indicates that the site is underlain by Hawkesbury Sandstone and the Narrabeen Group Terrigal Formation, comprising interbedded laminite shale and sandstone. Quaternary Alluvium is shown over most of the Woy Woy - Umina Peninsula and around the south eastern foreshores of the investigation area.

2.3 PASS Conditions

The site is shown on the Acid Sulphate Soil Risk maps of Broken Bay and Gosford (9130N1 and 9131S2, Dec 1997). These plans show:

- The entire water covered estuary area as having a "high probability" for containing sediments that will develop ASS conditions on exposure.
- The foreshore as having a mix of "high probability" of PASS and disturbed terrain at the foreshore locations.

3. Investigations Undertaken

3.1 Site Sampling

Sediments at eight foreshore locations (PF1 – PF8) and nine lake bed locations (PS1 – PS8A) were sampled on 10 and 14 August 2004, using a 1m length stainless steel suction piston sampler.

Excepting PS8, all points were sampled to 1m sediment depth. At PS8, refusal to the suction piston sampling was met in very stiff (residual?) clay at 0.15m depth. The estuary bed at this location, and for some distance to the north west, appeared to have been excavated in order to provide near-shore wharf facilities for the residences along the steep sided shoreline. The water depth relatively close to the shoreline was greater than 2m depth (the sampling depth limit) in this area. Sampling was conducted at a secondary location (PS8A) some 300m further north-west, where the topography appeared more representative of alluvial sediment conditions at a water depth of less than 2m.

Most of the sampling was conducted at or near low tide conditions.

A Brooker V12 aluminium runabout was used to access the sampling points.

The positions of the sampling points were recorded using autonomous GPS survey, which is generally accurate to within 10m of the grid position.

The recorded locations of the sampling points are given in Table 1 below:

Table 1 – Sample Location Co-Ordinates (MGA)

Test No.	Easting	Northing	Test No.	Easting	Northing
PF1	342 465	6292 329	PS1	342 469	6292 346
PF2	343 522	6297 008	PS2	343 556	6296 999
PF3	348 064	6298 914	PS3	344 785	6298 227
PF4	347 562	6295 526	PS4	347 987	6298 857
PF5	346 422	6292 894	PS5	347 572	6295 542
PF6	347 870	6289 720	PS6	347 700	6289 530
PF7	347 788	6289 450	PS7	346 358	6290 885
PF8	346 370	6289 080	PS8	345 890	6291 435
			PS8A	345 644	6291 610

The work was supervised by a senior geotechnical engineer, who located the borehole positions, obtained the samples and logged the conditions encountered.

The samples recovered were placed on ice in the field.

The locations of the sediment sampling are shown on Figure 1.

3.2 Laboratory Testing

3.2.1 Indicator Testing

17 sample columns were tested as follows:

- 8 foreshore samples (PF1 – PF8).
- 9 lake bed samples (PS1 – PS8A).

Apart from PS8, two samples were taken from each column (upper/lower) for indicator testing. At PS8 only 0.15m of sample was tested, as this was the depth of refusal at this location.

The samples were tested for field pH (1:5 soil:water mix) and oxidised pH (using 30% concentration hydrogen peroxide) in order to assess whether:

i) The soils were Actual Acid Sulphate Soils (AASS, pH<4).

ii) The soils are indicated to be Potentially Acid Sulphate Soils (oxidised pH<3, and/or significant pH drop with strong effervescent reaction).

The indicator test results and sample descriptions are shown on Table 2.

3.2.2 POCAS Testing

On completion of the indicator testing, samples identified as AASS or PASS together with a number of other samples for site coverage purposes were selected for more definitive Peroxide Oxidisation Combined Acidity and Sulphur (POCAS) testing. The purpose of this testing was to assess whether or not the soils would produce sufficient sulphuric acid on exposure to be classified as Potential Acid Sulphate Soils (Total Potential Acidity (TPA)>18 mols H^+/tonne) .

The selected samples were forwarded under Chain of Custody (COC) to Sydney Analytical Laboratories (SAL), for the POCAS analysis.

The laboratory test results are summarised on Tables 3A (foreshore) and 3B (lake bed).

Laboratory test certificates for the POCAS testing are provided in Appendix A.

3.2.3 Geotechnical Testing

Geotechnical testing comprising particle size distribution and hydrometer analyses on sediment samples PF6 – PF8 (0 – 0.5m depth), was requested subsequent to the completion of the PASS sampling and testing programme. This results of this testing are given in Appendix A.

4. Results of Investigation

4.1 Indicator Test Results

The sediments comprised high plasticity silt, sand, sands with silt and clay, clayey sand and sandy clay.

The results of this testing, which are in Table 2, indicated the following:

Foreshore Samples

- Three samples PF2 (clayey sand), PF5 (sand) and PF8 (sand), were assessed to be non-PASS.
- Three samples, PF4 (sand/clayey sand), PF6 (sand with silt and trace clay) and PF7 (sand with trace silt/sand with some silt) were assessed to be PASS only in the upper or lower half of the sediment column. In the case of PF4 and PF7, PASS conditions were indicated in the more clayey/silty portion of the sample. PF6, which appeared to be of similar sediment type throughout the sample column length, was assessed to be PASS in the upper half of the sample only.
- The remaining two samples, PF1 and PF3 (both clayey sand with some clay and silt), were assessed to be PASS for the full sample length.

Lake bed Samples

- Samples PS7 (clayey sand with occasional fine shells) and PS8 (residual clay?), were indicated to be non - PASS.
- Samples PS1 and PS6 (both high plasticity silts) were assessed to be PASS only one half of the sediment column, even though the sediments appeared similar over the individual sample column lengths.
- The remaining 5 sample columns (PS2 – PS5, PS8A) were assessed to be PASS for the full sample length.

Eleven samples were selected for POCAS testing based on the lowest oxidised pH and for site coverage purposes.

4.1.1 POCAS Tests

The eleven samples tested were as follows:

- 4 foreshore samples (PF3,PF4,PF6,PF7).
- 7 lake bed samples (PS1,PS2,PS4 – PS7,PS8A).

The POCAS test results, as provided on the SAL laboratory report included in Appendix A, and summarised in Tables 3A and 3B attached, indicate:

- All samples except PF6, PF7 and PS7 exceed the ASSMAC trigger levels for PASS conditions, and would produce significant acidity on exposure (Total Potential Acidity (TPA)>62 mols H^+/tonne and S_{pos} > 0.1%). In particular, the samples from PS1 (TPA 1290

mols H^+/tonne) and PS4 (TPA 720 mols H^+/tonne), recorded very highly elevated acidity on oxidisation.

- Sample PS7, which recorded a non-PASS indicator result, was also shown to be non-PASS in the POCAS test. We note that this sample had sufficient oxidisable sulphur to be classified as PASS, but it also contained sufficient buffer not to develop any acidity above laboratory detection limits.
- Samples PF6 (0 – 0.5m) and PF7 (0.5 – 1.0m), which recorded positive PASS results in the indicator testing, recorded only relatively minor amounts of oxidisable sulphur compared to the other test samples and no detectable acidity on oxidisation. This apparent anomaly may be due to sampling variance between the indicator test and the POCAS test sub-sample and/or the lesser accuracy of the indicator test.

5. Discussion and Conclusions

Apart from PF5 (St Huberts Island), PASS conditions have been recorded at all test areas, though not necessarily in both foreshore and offshore (lake bed) samples. The PASS conditions appear to less prevalent in the 'foreshore' samples than in the 'offshore samples' tested. We note that at St Huberts Island only a foreshore sample was obtained.

Samples containing greater proportions of silt and clay were more likely to be PASS than the more sandy samples.

The testing has confirmed the high probability of PASS conditions occurring in the estuarine sediments. Any planned work in these areas, which may expose or drain these sediments, should include a sampling plan with sufficient coverage for validation of PASS/non-PASS conditions that is in accordance with the ASSMAC guidelines.

An acid sulphate management plan will need to be prepared in accordance with any positive PASS test results for obtained.

References

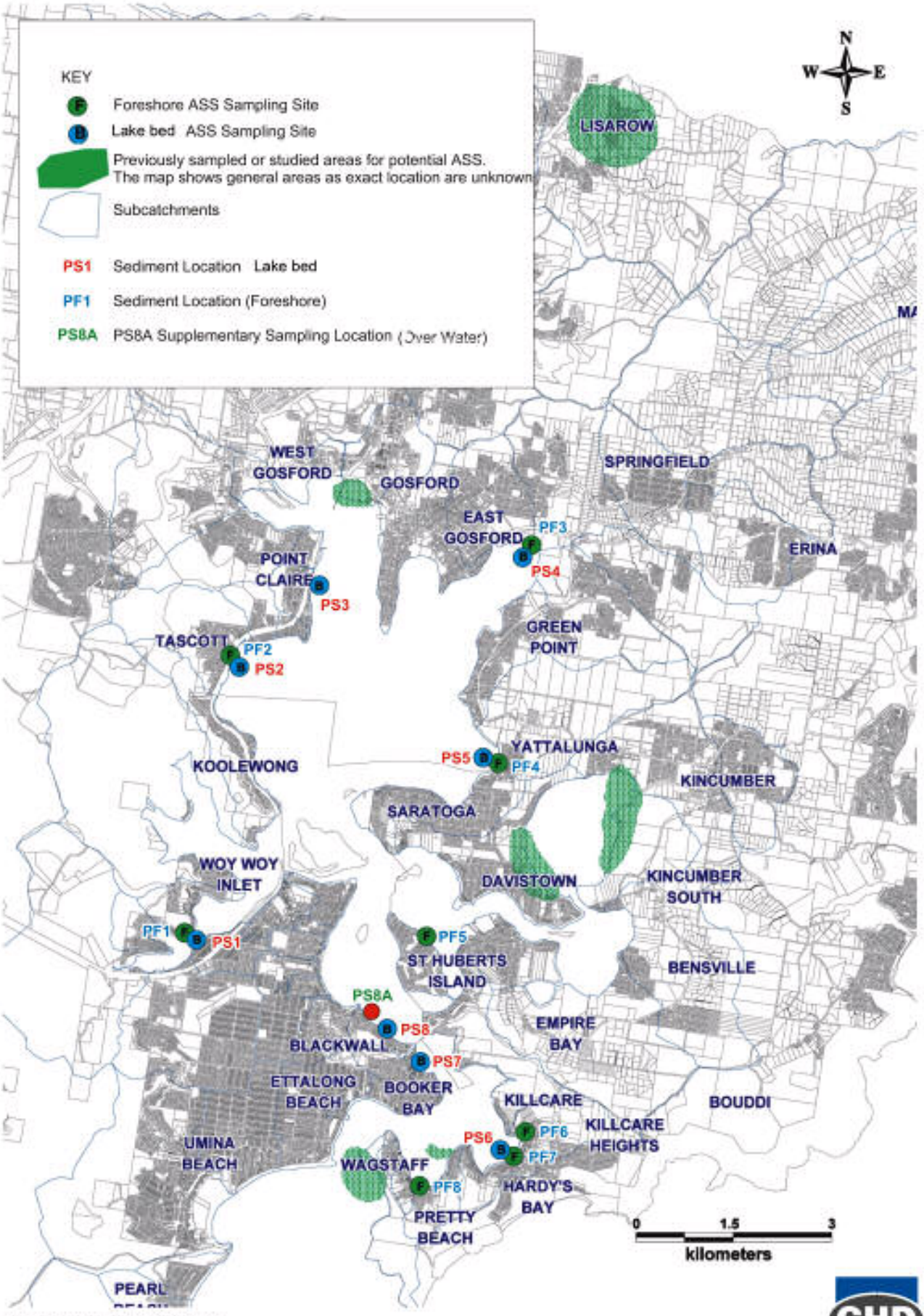
Stone Y, Ahern CR and Blunden B, "Acid Sulphate Soil Management Advisory Committee (ASSMAC) Guidelines" (August 1998), Wollongbar NSW.

Figure

Figure 1 Sediment Sampling Locations

SEDIMENT SAMPLING LOCATIONS

BRISBANE WATER ESTUARY PROCESS STUDY



Source: Base plan supplied by Lawson & Treloar Pty Ltd

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GHD

Figure 1

Standard Sheets

General Notes

Soil Description

GENERAL NOTES

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The report contains the results of a geotechnical investigation conducted for a specific purpose and client. The results should not be used by other parties, or for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information. Reference should be made to the relevant sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc.).

GROUNDWATER

Unless otherwise indicated, the water levels presented on the test hole logs are the levels of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeabilities (i.e. depending on response time of the measuring instrument). Further, variations of this level could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete test hole data. Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions do occur in the natural environment, particularly between discrete test hole locations. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural forces.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to this firm for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels, is required. There may be a requirement to extend foundation depths, to modify a foundation system or to conduct monitoring as a result of this natural variability. Allowance for verification by geotechnical personnel accordingly should be recognised and programmed during construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommended depth of any foundation (piles, caissons, footings etc.) is an engineering estimate. The estimate is influenced, and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions should include at least all of the relevant test hole and test data, together with the appropriate standard description sheets and remarks made in the written report of a factual or descriptive nature.

Ref: DS5.3.1 Issue 1.2 Date: 01/07/03

SOIL DESCRIPTION

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This procedure involves the description of a soil in terms of its visual and tactile properties, and relates to both laboratory samples and field exposures as applicable. A detailed soil profile description, in association with local geology and experience, will facilitate the initial (and often complete) site assessment for engineering purposes.

The method involves an evaluation of each of the items listed below and is in general agreement with both Australian Standard AS 1726 (the Site Investigation Code) and ASTM D2487 and D2488.

MOISTURE

The moisture condition of the soil is most applicable for cohesive soils as a precursor to the assessment of consistency and workability. The moisture condition is described as:-

Dry (dusty, dry to the touch) *Slightly Moist* *Moist* (damp, no visible water) *Very Moist* or *Wet* (visible free water, saturated condition)

In addition, the presence of any seepage or free water is noted on the testhole logs.

COLOUR

Colour is important for correlation of data between testholes and during subsequent excavation operations. The prominent colour is noted, followed by (spotted, mottled, streaked etc.) then secondary colours as applicable. Colour is usually described at as-received moisture condition, though both wet and dry colours may also be appropriate.

CONSISTENCY/RELATIVE DENSITY

This assessment is based on the effort required to penetrate and/or mould the soil, and is an indicator of shear strength.

Granular soils are generally described in terms of density index as listed in AS 1726. These soils are inherently difficult to assess and normally a penetration test procedure (SPT, DCP or CPT) is used in conjunction with published correlations. Alternatively, in-situ density tests can be conducted in association with minimum and maximum densities performed in the laboratory.

Cohesive soils can be assessed by direct measurement (shear vane), or estimated approximately by tactile means and/or the aid of a geological pick as given on the following table. It is emphasised that a "design shear strength" must take cognisance of the in-situ moisture content and the possible variations of moisture with time.

Term	Tactile Properties	Unconfined Compressive Strength q_u (kPa)
Very Soft	Extrudes from fingers when squeezed	<25
Soft	Easily penetrated by thumb about 30-40 mm. Pick head can be pushed in up to shaft. Moulded by light finger pressure.	25-50
Firm	Penetrated by thumb 20-30 mm with moderate effort. Sharp end of pick pushed in 30-40 mm. Moulded by strong finger pressure.	50-100
Stiff	Indented by thumb about 5 mm with moderate effort. Pick pushed in up to 10 mm. Cannot be moulded in fingers.	100-200
Very Stiff	Readily indented by thumb nail. Slight indentation produced by pushing pick into soil.	200-400
Hard	Difficult to indent with thumb nail. Requires power tools for excavation.	>400

STRUCTURE/OTHER FEATURES

The soil structure is generally applicable to cohesive soils and refers to the presence or absence of joints and layering. Typical terms use are intact (no joints), fissured (closed joints), shattered (open joints), slickensided (polished joints indicative of movement), and stratified/laminated. In addition, the presence of other features (ferricrete nodules, timber inclusions) should also be noted as applicable.

For granular soils, an assessment of grading (well, uniform or poor), particle size (fine, medium etc.) and angularity and shape may also be given.

SOIL TYPE

The soil is described in terms of its estimated grain size composition and the tactile behaviour (plasticity of any fines (less than *0.06 mm)). This system does not differentiate on grading below 0.06 mm, in accordance with the Unified Soil Classification (USC) procedure.

Furthermore, as most natural soils frequently are combinations of various constituents, the primary soil is described and modified by minor components. In brief, the system is as follows:-

Coarse Grained Soils		Fine Grained Soils	
% Fines	Modifier	% Coarse	Modifier
5	omit, or use "trace"	15	omit, or use "trace"
5-12	describe as "with clay/silt" as applicable	15-30	described as "with sand/gravel" as applicable
>12	prefix soil as "silty/clayey" as applicable	>30	prefix soil as "sandy/gravelly" as applicable

(*The 200# sieve (0.075 mm) is commonly used in practice to differentiate between fine and coarse grained soils).
Note: For soils containing both sand and gravel the minor coarse fraction is omitted if less than 15%, or described as "with sand/gravel" as applicable when greater than 15%.

The appropriate USC symbol may also be given after the soil type description in accordance with ASTM D2487 and D2488.

ORIGIN

An attempt is made, where possible, to assess origin (transported, residual, pedogenic, or fill etc.) since this assists in the judgement of probable engineering behaviour. This assessment is generally restricted to field logging activities. An interpretation of landform is a useful guide to the origin of transported soils (e.g. colluvium, talus, slide debris, slope wash, alluvium, lacustrine, estuarine, aeolian and littoral deposits) while local geology and remnant fabric will assist identification of residual soils.

Ref: DS623.1.1 Issue 'F2' Date: 01/07/03

Tables

Table 2 PASS Indicator Tests

Table 3 POCAS Test Results Summary

PASS Indicator Tests - Hydrogen Peroxide **TABLE 2**

Test Hole No.	Sample Depth (m)	Soil Description	Reaction (1 to 5)[Note 1]	Estimated Depth to Water Table (m)	Soil pH (5:1 Mixture)	
					Distilled Water (pH_F)	Hydrogen Peroxide (pH_{FOX})
		FORESHORE SEDIMENT SAMPLES				
PF1	0 – 0.5	Dark grey CLAYEY SAND with some silt and roots	5	0	6.89	**2.35**
PF1	0.5 - 1	Dark grey CLAYEY SAND with some silt and roots	5	0	6.92	**2.48**
PF2	0 – 0.5	Grey brown CLAYEY SAND trace silt and root fibres	4	0	7.81	3.22
PF2	0.5 - 1	Grey brown CLAYEY SAND trace silt and root fibres	1	0	7.96	4.59
PF3	0 – 0.5	Grey brown CLAYEY SAND trace silt and numerous root fibres	5	0	7.51	**2.50**
PF3	0.5 - 1	Grey brown CLAYEY SAND trace silt and numerous root fibres	5	0	7.48	**1.61**
PF4	0 – 0.5	Grey brown fine SAND trace silt and numerous root fibres	2	0	8.25	4.45
PF4	0.5 - 1	Grey brown CLAYEY SAND numerous root fibres	3	0	8.04	**2.29**
PF5	0 – 0.5	Grey brown fine to medium SAND trace silt	1	0	7.96	5.08
PF5	0.5 - 1	Yellow brown fine to coarse SAND	1	0	7.90	4.80
PF6	0 – 0.5	Dark brown fine to medium SAND with silt and trace of clay	3	0	8.18	**2.67**
PF6	0.5 - 1	Dark brown fine to medium SAND with silt and trace of clay	3	0	8.16	4.78
PF7	0 – 0.5	Grey brown fine to medium SAND trace silt	3	0	8.20	5.10
PF7	0.5 - 1	Grey brown fine to medium SAND some silt	3	0	7.84	**2.01**

Note 1, Reaction Levels:

1. No Reaction – No effervescence or heat generation;
2. Mild Reaction – Slight effervescence, cold or just perceptible heat generation;
3. Moderate Reaction – Distinct effervescence (bubbling, foaming), cylinder becomes warm;
4. Strong Reaction – Strong effervescence (strong bubbling), steam, cylinder becomes very warm / hot;
5. Extreme reaction – Violent effervescence (very strong bubbling, overflowing top of cylinder), steaming, high heat generation.

PASS Indicator Tests - Hydrogen Peroxide **TABLE 2 Cont.**

Test Hole No.	Sample Depth (m)	Soil Description	Reaction (1 to 5)[Note 1]	Recorded Water Depth (m)	Soil pH (5:1 Mixture)	
					Distilled Water (pH_F)	Hydrogen Peroxide (pH_{FOX})
PF8	0 -0.5	Grey brown SAND some carbonaceous gravel and shells trace silt	2	0	7.93	5.15
PF8	0.5 - 1	Grey brown SAND some carbonaceous gravel and shells trace silt	3	0	8.11	4.89
		LAKE BED SEDIMENT SAMPLES				
PS1	0 – 0.5	Dark grey high plasticity SILT with trace fine sand	5	2.1	7.16	**2.83**
PS1	0.5 - 1	Dark grey high plasticity SILT with trace fine sand	5	2.1	8.57	3.22
PS2	0 – 0.5	Grey brown fine to medium SAND some silt and clay	5	1.6	7.11	**1.48**
PS2	0.5 - 1	Grey CLAYEY SAND	4	1.6	7.80	**1.36**
PS3	0 – 0.5	Grey CLAYEY SAND	5	1.8	7.55	**1.59**
PS3	0.5 - 1	Grey CLAYEY SAND	5	1.8	7.64	**1.58**
PS4	0 – 0.5	Grey high plasticity SILT with trace fine sand	5	1.0	7.80	**1.90**
PS4	0.5 - 1	Grey high plasticity SILT with trace fine sand	5	1.0	7.98	**2.49**
PS5	0 – 0.5	Grey brown fine SAND trace silt	3	1.1	7.98	**2.17**
PS5	0.5 - 1	Grey brown fine SAND trace silt and clay	3	1.1	8.00	**1.76**
PS6	0 – 0.5	Dark grey brown high plasticity SILT with trace fine sand		1.2	8.17	3.99
PS6	0.5 - 1	Dark grey brown high plasticity SILT with trace fine sand	4	1.2	8.44	**1.87**

Note 1, Reaction Levels:

1. No Reaction – No effervescence or heat generation;
2. Mild Reaction – Slight effervescence, cold or just perceptible heat generation;
3. Moderate Reaction – Distinct effervescence (bubbling, foaming), cylinder becomes warm;
4. Strong Reaction – Strong effervescence (strong bubbling), steam, cylinder becomes very warm / hot;
5. Extreme reaction – Violent effervescence (very strong bubbling, overflowing top of cylinder), steaming, high heat generation.

PASS Indicator Tests - Hydrogen Peroxide **TABLE 2 Cont.**

Test Hole No.	Sample Depth (m)	Soil Description	Reaction (1 to 5)[Note 1]	Recorded Water Depth (m)	Soil pH (5:1 Mixture)	
					Distilled Water (pH_F)	Hydrogen Peroxide (pH_{FOX})
PS7	0 – 0.5	Dark grey CLAYEY SAND occasional fine shells	4	1.8	8.05	5.75
PS7	0.5 - 1	Dark grey CLAYEY SAND occasional fine shells	4	1.8	8.02	5.73
PS8	0 – 0.15	Dark brown very stiff SANDY CLAY (residual?)	3	1.7	8.29	5.65
PS8A	0 – 0.5	Dark brown CLAYEY SAND	4	2.0	8.25	**2.72**
PS8A	0.5 - 1	Grey brown fine to medium SAND trace clay and silt	3	2.0	8.34	**1.77**

Note 1, Reaction Levels:

1. No Reaction – No effervescence or heat generation;
2. Mild Reaction – Slight effervescence, cold or just perceptible heat generation;
3. Moderate Reaction – Distinct effervescence (bubbling, foaming), cylinder becomes warm;
4. Strong Reaction – Strong effervescence (strong bubbling), steam, cylinder becomes very warm / hot;
5. Extreme reaction – Violent effervescence (very strong bubbling, overflowing top of cylinder), steaming, high heat generation.

POCAS Test Results vs ASSMAC Guideline Limits – Foreshore Samples

TABLE 3A

Analyte	ASSMAC * Guideline Limits		Sample (Depth in m)								
	For < 1000 tonnes disturbed	For > 1000 tonnes disturbed	PF3 (0.5 – 1.0)	PF4 (0.5 – 1.0)	PF6 (0 – 0.5)	PF7 (0.5 – 1.0)					
TPA (mol H^+/T)	62	18	**120**	**90**	<5	<5					
S_{pos} (%)	0.1	0.03	**0.21**	**0.24**	**0.09**	**0.05**					
TSA (mol H^+/T)	62	18	**120**	**90**	<5	<5					
TAA (mol H^+/T)	-	-	<5	<5	<5	<5					
MATERIAL TYPE			CLAYEY SAND	CLAYEY SAND	SAND SOME SILT TRACE CLAY	SAND SOME SILT					

NOTES:

*Limit (Trigger Level) below which it is not necessary to prepare an acid sulphate soil management plan.

TPA =Total Potential Acidity
S_{pos} = Sulphur in TSA
TSA =Total Sulphidic Acidity
TAA =Total Actual Acidity (= TPA – TSA)

ASSMAC Acid Sulphate Soil Manual NSW Acid Sulphate Soil Management Advisory Committee published by NSW Agriculture August 1998

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Consulting geotechnical engineers and geologists

POCAS Test Results vs ASSMAC Guideline Limits – Overwater Samples

TABLE 3B

Analyte	ASSMAC * Guideline Limits		Sample (Depth in m)								
	For < 1000 tonnes disturbed	For > 1000 tonnes disturbed	PS1 (0 – 0.5)	PS2 (0 – 0.5)	PS4 (0 – 0.5)	PS5 (0.5 – 1.0)	PS6 (0.5 – 1.0)	PS7 (0.5 – 1.0)	PS8A (0.5 – 1.0)		
TPA (mol H^+/T)	62	18	**1290**	**110**	**720**	**75**	**165**	<5	**100**		
S_{pos} (%)	0.1	0.03	**2.25**	**0.14**	**1.35**	**0.14**	**0.62**	**0.13**	**0.28**		
TSA (mol H^+/T)	62	18	**1290**	**110**	**720**	**75**	**165**	<5	**100**		
TAA (mol H^+/T)	-	-	<5	<5	<5	<5	<5	<5	<5		
MATERIAL TYPE			HIGH PLASTICITY SILT	SAND SOME SILT & CLAY	HIGH PLASTICITY SILT	FINE SAND TRACE SILT & CLAY	HIGH PLASTICITY SILT	CLAYEY SAND	FINE SAND TRACE SILT & CLAY		

NOTES:

*Limit (Trigger Level) below which it is not necessary to prepare an acid sulphate soil management plan.

TPA =Total Potential Acidity
S_{pos} = Sulphur in TSA
TSA =Total Sulphidic Acidity
TAA =Total Actual Acidity (= TPA – TSA)

ASSMAC Acid Sulphate Soil Manual NSW Acid Sulphate Soil Management Advisory Committee published by NSW Agriculture August 1998

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Appendix A

Laboratory Test Results

POCAS	Report No.	SAL 14927
Geotechnical	Report No.'s	12551 -12553

SYDNEY ANALYTICAL LABORATORIES

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852

ANALYTICAL REPORT for:

GHD LONGMAC PTY LTD

LOCKED BAG 2727
ST LEONARDS 1590

ATTN: BOB BATCHELDER

JOB NO: SAL14927

CLIENT ORDER: 2112503

DATE RECEIVED: 12/08/04

DATE COMPLETED: 20/08/04

TYPE OF SAMPLES: SOILS

NO OF SAMPLES: 11

NATA Accredited Laboratory
Number: 1884

NATA ENDORSED TEST REPORT
This document shall not be reproduced, except in full.

.....
Issued on 26/08/04
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL14927
CLIENT ORDER: 2112503

	SAMPLES	TAA mol/T	TPA mol/T	*S(KCl) %	*S(P) %	*S(POS) %
1	PF4/0.5-1.0	<5	90	0.04	0.28	0.24
2	PF6/0-0.5	<5	<5	0.02	0.11	0.09
3	PF7/0.5-1.0	<5	<5	0.01	0.06	0.05
4	PS4/0-0.5	<5	720	0.25	1.60	1.35
5	PS5/0.5-1.0	<5	75	0.03	0.17	0.14
6	PS6/0.5-1.0	<5	165	0.07	0.69	0.62
7	PS7/0.5-1.0	<5	<5	0.03	0.16	0.13
8	PS8A/0.5-1.0	<5	100	0.03	0.31	0.28
9	PF3/0.5-1.0	<5	120	0.02	0.23	0.21
10	PS1/0-0.5	<5	1290	0.10	2.35	2.25
11	PS2/0-0.5	<5	110	0.02	0.16	0.14
	MDL	5	5	0.01	0.01	0.01
	Method Code	C31	C30	C41	C41	C41
	Preparation	P12	P12	P12	P12	P12

ANALYTICAL REPORT

JOB NO: SAL14927
CLIENT ORDER: 2112503

	SAMPLES	TSA mol/T
1	PF4/0.5-1.0	90
2	PF6/0-0.5	<5
3	PF7/0.5-1.0	<5
4	PS4/0-0.5	720
5	PS5/0.5-1.0	75
6	PS6/0.5-1.0	165
7	PS7/0.5-1.0	<5
8	PS8A/0.5-1.0	100
9	PF3/0.5-1.0	120
10	PS1/0-0.5	1290
11	PS2/0-0.5	110
	MDL	5
	Method Code	C42
	Preparation	P12

RESULTS ON DRY BASIS

ANALYTICAL REPORT

JOB NO: SAL14927
CLIENT ORDER: 2112503

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

P12	Sample dried, jaw crushed and sieved at 2mm Visible shell removed prior to crushing
C31	Total Actual Acidity - RTA T1030
C30	Total Potential Acidity - RTA T1031
*C41	Peroxide Oxidation - Combined Acidity & Sulphate (POCAS) ASS Method 21 (Draft 1.63 for ASSMACTC May 1997)
C42	Total Sulphidic Acidity - Calculation (TPA-TAA)

*The laboratory's NATA registration does not cover performance of this service

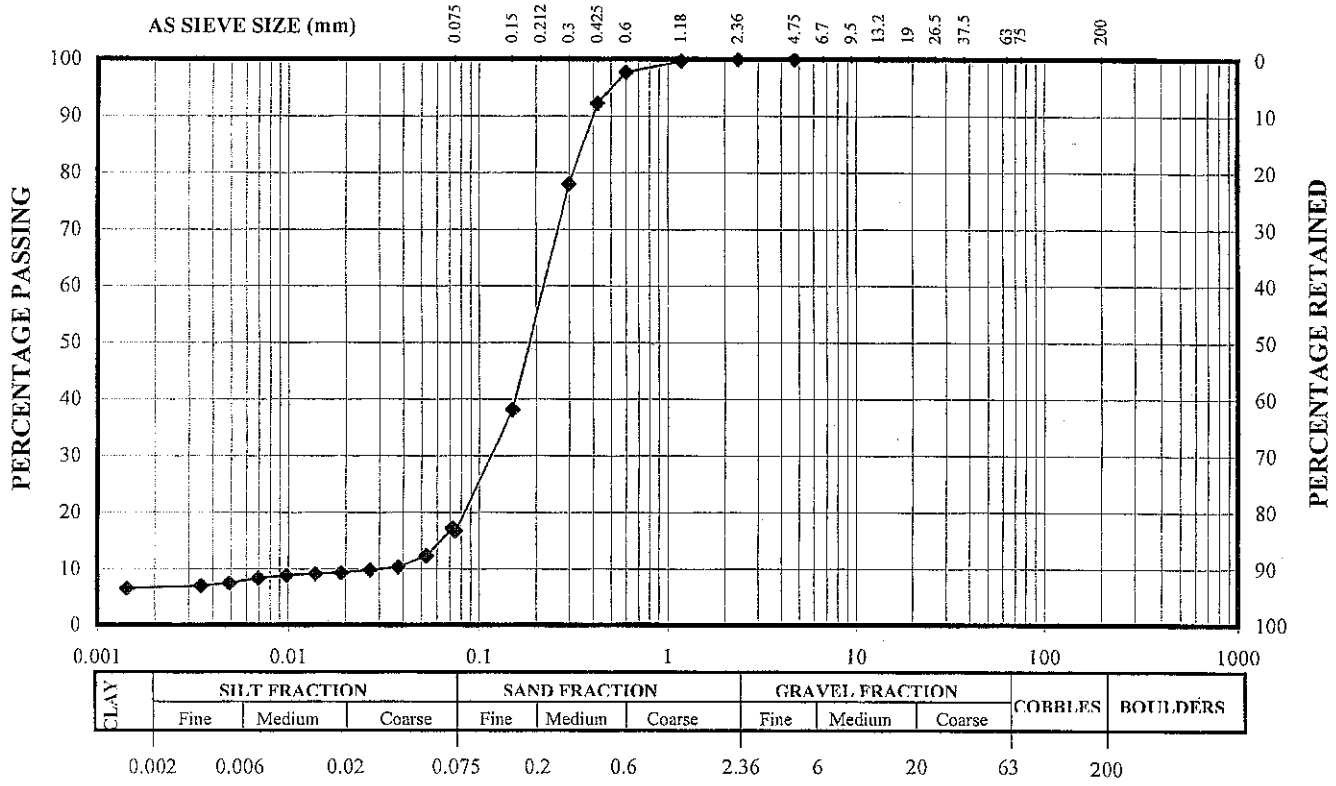
A preliminary report was faxed on 20/08/04

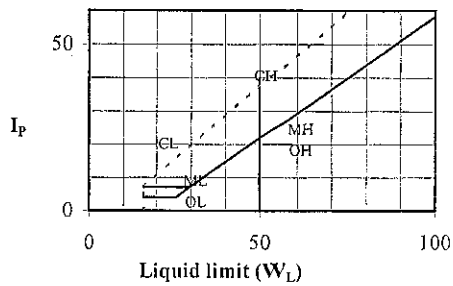
SOIL CLASSIFICATION REPORT

Trial Hole:	PF 6
Depth:	0.0 to 0.5
Sample No:	3596/01

Client: Lawson & Treloar
Project: Material Evaluation
Location: Brisbane Water Pass

Client Sample No.: n/av
Sample History: Supplied by Client





TEST METHODS
Classification AS1726 A2 Particle size AS1289.3.6.2

OTHER TESTS

GRADING
$C_u = D_{60} / D_{10} =$ 7.5
$C_c = D_{30}^2 / (D_{10} \times D_{60}) =$ 2.0

PARTICLE DENSITY 2.65 (assumed)

PRE-TREATMENT HYDROMETER N/A

TEST CONDITION Washed sieve with dispersing agent

GROUP SYMBOL:

SOIL NAME: grey silty SAND (visual only)

REMARKS:

INDEX PROPERTIES (%)
Liquid Limit = N/A Plastic Limit = N/A
Plasticity Index = N/A Linear Shrinkage % = Not determined

Atterberg Limits (History/preparation)

Liquid Limit (type of test)

Linear Shrinkage (mould size)

Tested by:	SI
Date tested:	27.08.2004
Checked by:	S. Ignatin
Date checked:	7/9/04

Authorised Signatory: S. Ignatin 08.09.04

GHD LONGMAC
57 Herbert St, Artarmon NSW, 2064
Tel: 9462 4700 Fax: 9462 4710
GEOTECHNICAL TESTING SERVICES

This laboratory is accredited by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with its scope of accreditation.
NATA Accredited Laboratory Number: 679

JOB No.	2112503
REPORT No.	12551

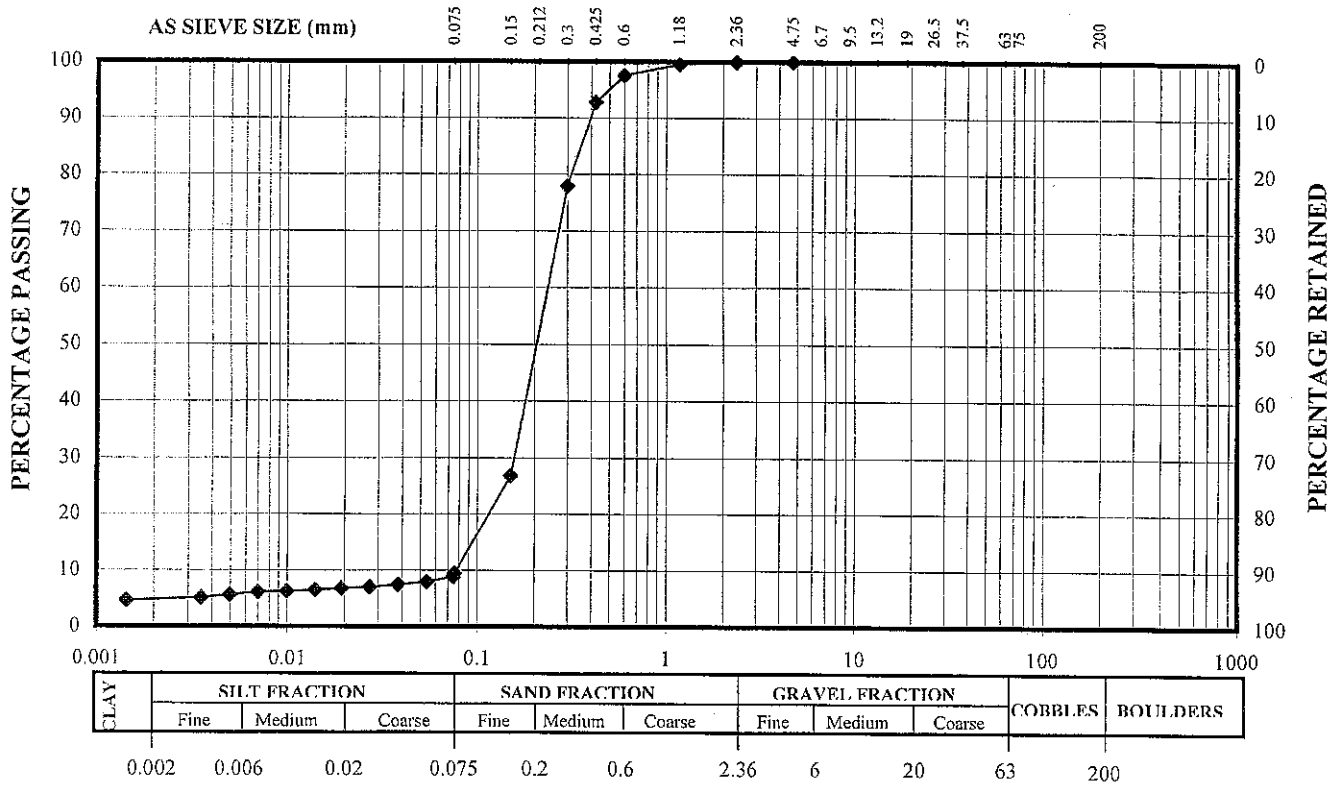
Ref: FAS\VUTIL\LABS\TARTS\SIEVE

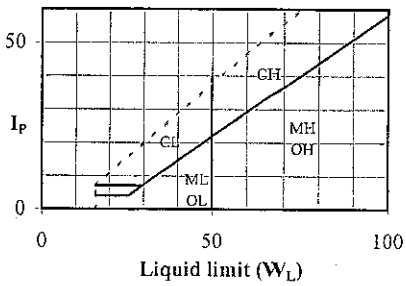
SOIL CLASSIFICATION REPORT

Trial Hole:	PF 7
Depth:	0.0 to 0.5
Sample No:	3596/02

Client: Lawson & Treloar
Project: Material Evaluation
Location: Brisbane Water Pass

Client Sample No.: n/av
Sample History: Supplied by Client





TEST METHODS
Classification AS1726 A2 Particle size AS1289.3.6.2

OTHER TESTS

GRADING
$C_u = D_{60} / D_{10} =$ 3.2
$C_c = D_{30}^2 / (D_{10} \times D_{60}) =$ 1.3

PARTICLE DENSITY 2.65 (assumed)

PRE-TREATMENT HYDROMETER N/A

TEST CONDITION Washed sieve with dispersing agent

GROUP SYMBOL:

SOIL NAME: grey silty SAND (visual only)

REMARKS:

INDEX PROPERTIES (%)
Liquid Limit = N/A Plastic Limit = N/A
Plasticity Index = N/A Linear Shrinkage % = Not determined

Atterberg Limits (History/preparation)

Liquid Limit (type of test)

Linear Shrinkage (mould size)

Tested by:	SI
Date tested:	25.08.2004
Checked by:	
Date checked:	7/9/04

Authorised Signatory:
J. Ignatin
02.09.04

GHD LONGMAC
57 Herbert St, Artarmon NSW, 2064
Tel: 9462 4700 Fax: 9462 4710
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JOB No.	2112503
REPORT No.	12552

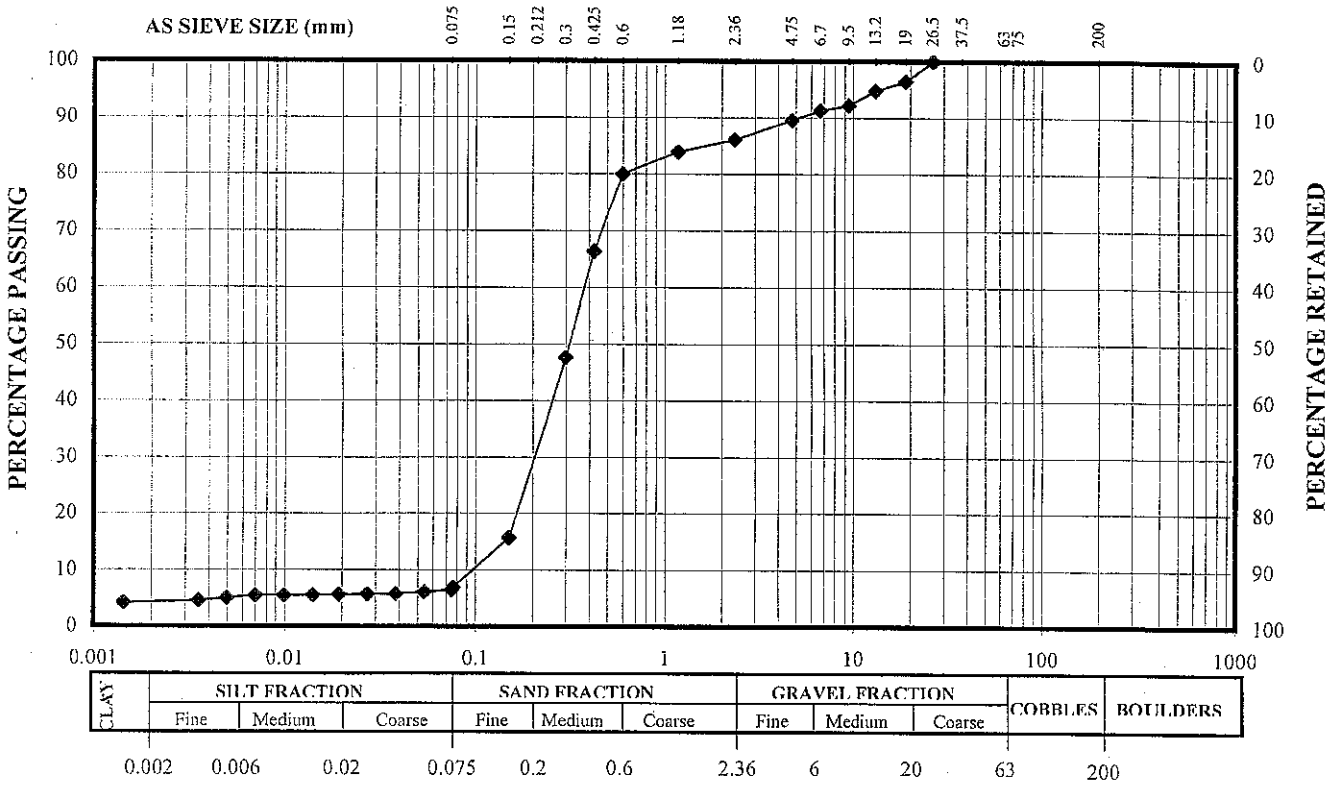
Ref: FANWOTTILALABSSTARTSIEVE

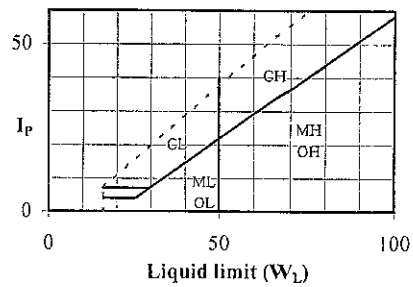
SOIL CLASSIFICATION REPORT

Trial Hole:	PF 8
Depth:	0.0 to 0.5
Sample No:	3596/03

Client: Lawson & Treloar
Project: MaterialEvaluation
Location: Brisbane Water Pass

Client Sample No.: n/av
Sample History: Supplied by Client





TEST METHODS
Classification AS1726 A2 Particle size AS1289.3.6.2

OTHER TESTS

GRADING
$C_u = D_{60} / D_{10} =$ 3.7
$C_c = D_{30}^2 / (D_{10} \times D_{60}) =$ 1.2

PARTICLE DENSITY 2.65 (assumed)

PRE-TREATMENT HYDROMETER N/A

TEST CONDITION Washed sieve with dispersing agent

GROUP SYMBOL:

SOIL NAME: grey silty SAND with gravel (visual only)

REMARKS:

INDEX PROPERTIES (%)
Liquid Limit = N/A Plastic Limit = N/A
Plasticity Index = N/A Linear Shrinkage % = Not determined

Atterberg Limits (History/preparation)

Liquid Limit (type of test)

Linear Shrinkage (mould size)

Tested by:	SI
Date tested:	25.08.2004
Checked by:	[signature]
Date checked:	7/9/04

Authorised Signatory: [signature] 08.09.04

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JOB No.	2112503
REPORT No.	12553

Ref: PAWUPHLALABSSTARTNSIEVE