

**BROADSCALE
GEOTECHNICAL INVESTIGATION
REPORT FOR THE
YARRABILBA DEVELOPMENT**

Carried out for:

DELFIN LEND LEASE LTD

Prepared by

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REPORT**

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1 INTRODUCTION

A broadscale geotechnical investigation was carried out for the proposed Yarrabilba project, as requested by Delfin Lend Lease.

The Yarrabilba project is a proposed major, master planned residential project which, if approved, will be built over an extended period and will ultimately house up to 59,000 people. The planning and approvals process is expected to take up to 2 years to achieve. Over this period, studies will be carried out to gather information on a number of key issues. The development of the Yarrabilba project will involve a staged process of increasing detail as the master plan is refined.

Yarrabilba will be constructed on approximately 2000ha of land located midway between Beenleigh and Mt Tamborine. Yarrabilba will offer a wide range of services, community, education and recreation facilities.

An underpinning objective in the planning of this project is the objective of achieving a new international benchmark in **sustainable**, large-scale urban development. This will include total water cycle management concepts.

The objective of this initial geotechnical investigation was to gather an appreciation of the key geotechnical prevailing conditions and begin to develop a **geotechnical model** for the entire area. This involved identifying geotechnical **constraints** and **opportunities**. The investigation focused on the areas that are likely to represent the extremes of geotechnical conditions on the site as far as implications for the planning of the development are concerned; the ridge lines and the gully lines.

The specific objectives of this investigation were as follows;

- Determine the nature and certain engineering parameters of subsurface strata.

- Assess topsoil depths.
- Assess the groundwater conditions at 3 nominated locations.
- Consider the excavatability of rock in the upper areas of the site.
- Consider the nature and quality of material that will be won from cuts and the implications for its use as structural fill (road embankments, allotment fill) and in water retaining structures.
- Consider the stability of cut and fill batters.
- In lower lying areas, assess the nature and depth of any alluvial and colluvial materials and the implications for construction, including the construction of dams and water retaining structures.

Authorisation to proceed with the investigation was received by email dated 15 March, 2004 and following letter dated 16 March, 2004 from Mr David Meyer representing Delfin Lend Lease Ltd.

This report must be read in conjunction with our attached '*General Notes*' and the ASFE publication '*Important Information About Your Geotechnical Engineering Report*'.

2 SITE DESCRIPTION

The area of the proposed project is large, some 2,000 ha. It is bounded by Waterford Mt Tamborine Road on the west, existing residential development to the north, environmental reserve to the east, and Plunkett Road to the south.

The terrain is mostly gently to medium undulating, with low ridges and gentle slopes separated by shallow gullies and drainage paths. It is more abrupt to the east, with rough terrain and more steep ridges and gullies.

Most of the site was previously used as a pine plantation. The pines have been harvested and most of the vegetation in the proposed development area consisted of eucalypt and pine regrowth. Areas of remnant native vegetation were evident along major drainage gullies through the site.

A regional HV supply corridor with 2 existing rows of pylons traversed the site in a general east-west direction.

General views of the site are shown on the photos below:



PLATE 1: GENERAL VIEW OF THE SITE LOOKING SOUTHEAST FROM NEAR THE INTERSECTION OF THE POWER LINES AND WATERFORD TAMBORINE ROAD.



PLATE 2: VIEW FROM NEAR PIT 4 LOOKING SOUTHEAST



PLATE 3: VIEW FROM TRACK BETWEEN PITS 8 AND 9, LOOKING NORTH

3 INVESTIGATION WORK

3.1 Fieldwork

Fieldwork for the investigation was carried out from the 24 to 30 March, 2004 and included the drilling of 10 boreholes and 3 water bores, and the excavation of 10 excavator pits, at the locations shown on the attached investigation location plan, Figure 1. The material encountered at each location is described on borehole/pit log sheets included in Appendix A.

Dynamic Cone Penetrometer tests were carried out beside each borehole/pit and these tabulated test results are included on the borehole/pit logs.

Samples of representative material were recovered for testing, and these sampling locations are shown on the logs.

Boreholes

Boreholes were drilled along drainage gullies to provide information as to likely geotechnical conditions along drainage alignments and low lying areas over the site.

Excavator Pits

Excavator pits were positioned along strategic ridge lines to gather information as to the excavatability of material from the higher areas of the site, the nature of the material that will be won from cuts, and the stability of cuts etc.

Groundwater Boreholes

The locations of the water bores were selected near the upper extremities of possible lakes on the site. It is possible that water bores may be used to 'top up' lake levels. It was necessary to identify the quantity and quality of groundwater available.

Fieldwork was carried out in accordance with Australian Standard, AS1726-1993 '*Site Investigation Code*'.

3.2 Laboratory Testing

Samples of representative strata were recovered and returned to our NATA accredited soils laboratory. The following tests were carried out on selected samples;

- . Particle Size Distribution
- . Atterberg Limits
- . Linear Shrinkage
- . Laboratory Compaction
- . Soaked CBR
- . pH
- . Electrical Conductivity
- . Emerson Class
- . Permeability (by AGL)
- . Water Quality (by ALS)

The laboratory test results are included in Appendix B with the water quality tests in Appendix C. Laboratory testing was carried out in accordance with Australian Standard AS1289 '*Laboratory Testing For Engineering Purposes*'.

4 SUBSURFACE CONDITIONS

4.1 Site Geology

An extract from the Geological Survey of Queensland, Beenleigh map at a scale of 1:100,000 is attached at Figure 2.

The dominant geological mapping unit in the project area is sandstone, siltstone, shale and conglomerate of the Woogaroo sub-group of the Bundamba group. A small slice of the project area on the eastern boundary is underlain by conglomerate, sandstone, shale, tuff and coal seams of the Ipswich Coal measures.

In geotechnical terms, these 2 units are quite similar. They comprise generally quite weathered sequences of fine grained sedimentary rock.

The less weathered sandstone beds can present some difficulties in excavation, but the more weathered sandstone represents a high quality fill material. The finer grained siltstone and shale is generally a poor quality fill material and can be quite erodible.

Slope stability is generally not a significant concern in these formations. The bedding is generally sub-horizontal and the formation has not generally been heavily re-worked.

A characteristic of the surficial soils that form on these fine grained sedimentary sequences is the occurrence of silty sand. This tends to be thicker towards the bottom of slopes and around creeks and gullies.

The silty sand has acceptable engineering properties if it can be compacted and confined by overlying layers. However, it tends to be loose insitu, can carry water after periods of wet weather, can be 'spongy' and cause traffickability problems, and is slow to drain and dry out. It is difficult to compact when wet.

4.2 Subsurface Strata

The investigation work indicated that broadly similar subsurface conditions existed within the two broad target areas of the investigation, the ridges and the gully areas.

The 10 pits excavated along the ridges all encountered a thin (0.1m) silty sand topsoil over silty sand, sand and silty sandy gravel. At just over half the pits (Pits 2, 3, 5, 7, 8, and 9) sandy silty clay and silty clay was also encountered. In all pits an extremely weathered sandstone was encountered at depths varying from 0.7m (Pit 1) to 2.7m (Pit 3). A ripper attachment was used on the excavator to assess excavatability in the weathered sandstone. Generally excavation refusal was reached at relatively shallow penetration into the sandstone, within about 0.1m to 1.0m. The exception was Pit 10, where the sandstone was encountered at 2.2m and was able to be excavated to 4.5m.

The 10 boreholes drilled in the lower lying areas of the site encountered much deeper soil profiles as expected.

BH1 encountered a deep deposit of loose to medium dense sand over the full borehole profile to 6m. The remaining boreholes encountered predominantly silty sand and clayey sand with some sandy silty clay. Extremely weathered sandstone was encountered in BH's 2, 3, 5, 9 and 10.

At the water bores, a drillers log only was recorded and is included in Appendix A. These showed similar soil strata as encountered in the boreholes, overlying interbedded sandstone and shale. Water was encountered in each water bore, but it varied in terms of quality and quantity.

The borehole/pit logs in Appendix A should be referred to for the detailed description of material encountered at each investigation location.

4.3 Laboratory Test Results

All laboratory test results are included in Appendix B. A summary of laboratory test results is provided in the tables below.

TABLE 1 - CLASSIFICATION TEST RESULTS						
PARTICLE SIZE DISTRIBUTION, ATTERBERG LIMITS, LINEAR SHRINKAGE						
TP/ Bore No	Depth (m)	% Sand & Gravel	% Clay & Silt	Liquid Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
BH2	1.1-1.5	68	32	38	24	11.0
BH7	0.3-0.6	40	60	40	26	15.0
BH10	0.8-1.1	59	41	28	21	15.0
TP1	0.0-0.1	99	1	-	-	-
TP1	0.2-0.4	85	15	ND	ND	ND
TP2	1.0-1.2	41	59	74	47	16.5
TP5	0.2-0.4	84	16	ND	ND	ND
TP7	0.2-0.4	49	51	59	34	11.0
TP8	0.1-0.4	93	7	ND	ND	ND
TP9	0.5-0.7	64	36	42	25	13.0
TP10	1.1-1.3	63	37	62	41	17.5

TABLE 2 - CBR TEST RESULTS			
TEST PIT/ BH	Depth (m)	Material Description	CBR (%)
TP5	0.2-0.4	Sand	35
TP6	0.3-0.5	Sand	25
TP8	0.1-0.4	Silty sandy gravel	150
BH10	0.8-1.1	Sandy silty clay	2.5

TABLE 3 – EROSION AND SEDIMENT CONTROL TEST RESULTS				
BH/TP NO.	Depth (m)	Emerson	pH	EC(ms) ⁽¹⁾
TP1	0.0-0.1	3	4.7	0.029
TP1	0.2-0.4	3	-	-
TP2	1.0-1.2	5	-	-
TP4	0.0-0.1	3	4.4	0.041
TP5	0.0-0.4	3	4.7	0.081
TP6	0.0-0.1	3	4.5	0.032
TP7	0.0-0.1	8	4.4	0.058
TP8	0.0-0.1	8	4.2	0.042
TP9	0.0-0.1	3	4.2	0.032
TP10	0.0-0.1	8	4.7	0.028
BH10	0.0-0.1	3	3.7	0.263

Note: (1) – EC – electrical conductivity.

TABLE 4 – PERMEABILITY TEST RESULTS		
Test Pit/BH	Depth(m)	Permeability (m/s)
TP2	1.0-1.2	4×10^{-9}
TP6	0.2-0.4	2×10^{-9}
BH10	0.8-1.1	1×10^{-9}

TABLE 5 – WATER QUALITY TEST RESULTS				
Parameter	Bore No.			LIMITS ⁽¹⁾
	1	2	3	
pH	7.9	7.9	7.3	6.5-8.5
Electrical Conductivity (µs/cm)	2900	7100	995	-
Suspended Solids (mg/L)	206	6950	19	<15 ⁽²⁾
Turbidity (NTU)	160	5200	21	<20 ⁽²⁾
Iron (dissolved) (mg/L)	<0.01	<0.01	<0.01	-
Iron (total) (mg/L)	6.9	175	2.1	<0.3-1.0
Aluminium (dissolved) (mg/L)	<0.01	<0.01	<0.01	-
Aluminium (total) (mg/L)	3.3	94.2	0.4	<0.2
Arsenic (total) (mg/L)	0.002	0.043	<0.001	<0.05

Note: (1) – Limits from ANZECC water quality guidelines for recreational purposes except as noted ⁽²⁾

(2) – From BCC “Guideline on Identifying and Applying Water Quality Objectives in Brisbane (Version 1)”

5 GEOTECHNICAL ASSESSMENT

5.1 Earthworks

All site preparation work should generally be carried out in accordance with AS3798.1996 '*Guidelines on Earthworks for Commercial and Residential Developments*'.

The site should be stripped of all topsoil from the cut and fill areas and road alignments, and stockpiled for later use. A stripping depth in the order of 0.1m to 0.2m is indicated from the information gathered at the investigation locations.

Prior to the placement of any structural fill, the fill foundation area should be proof rolled using a minimum 10 tonne vibrating padfoot roller to identify any soft spots. It is likely that the colluvial silty sand that exists on the site towards the lower level of slopes and around drainage paths and gullies would be loose in place (e.g. BH1) and would require excavation and recompaction prior to the placement of fill.

Depressions formed by the removal of vegetation, should have all disturbed soil cleaned out and be backfilled with compacted select fill material.

No problems should be encountered in excavating the near surface soil material on site. Most soils encountered on site should be within the excavation limits of a small dozer (eg Cat D6 or similar) in bulk excavations or medium size backhoe (eg Case 580 or similar) in trench excavations.

At all the test pits, the limit of ripper excavation is noted on the logs, and varied from 1m to around 2m to 3m, with the exception being TP10, which was able to be excavated to 4.5m. Excavation below the limit achieved using the 13T excavator would probably be able to be achieved using large dozers (D9/D10) working in open excavation. However, there may be some hard rock bars or zones of less weathered

sandstone which cannot be ripped. Rock breakers or explosives would be necessary in this case.

The soil and weathered rock material cut from the higher areas of the site would be suitable for use as structural fill. Some of the material would be high quality fill (e.g. the silty sandy gravel at TP8 which had a CBR of 150%), but overall it would be "average" quality. The weathered sandstone below the limit of test pits would be expected to produce high quality fill, but any shale or weathered siltstone would probably break down to poor quality clay fill.

To minimise the potential for post compaction volume change due to moisture content variations, any structural clay fill should be placed in loose layers not greater than 200mm thick at a moisture content in the range -1% to +3% of the standard optimum moisture content, and be compacted to a minimum dry density ratio of 95% standard compaction as per AS1289 5.1.1.

Measures should be adopted to ensure that this clay fill material is not allowed to dry out prior to the placement of succeeding layers of fill and final covering with building slabs and road pavements.

Any structural sand fill should be placed in loose layers not greater than 200mm thick, and be compacted to a minimum density index of 80% as per AS1289 5.5.1 using a vibrating smooth drum roller not less than 10 tonne in static weight.

It is recommended that the placement of all structural fill be inspected, tested and certified during the earthworks operations to ensure that all fill is placed in a 'controlled manner', in accordance with AS3798-1996.

The near surface silty sand encountered on the site is known to be particularly difficult to work and compact, especially if it becomes wet. The material has relatively good engineering properties if it is compacted in place to the required density and confined

by overlying layers. However, if the moisture content is too high at the time of site preparation work, it tends to be spongy and will heave under the load of construction equipment, can be difficult to traffic and compact, and is slow to drain and dry out.

5.2 Batter Stability

Cut and fill batters in sand material should be no steeper than 1V:3H, and in cohesive soil strata should be no steeper than 1V:2H.

The stability of cuts in rock will be determined to a large degree by the orientation of the cut in relation to bedding and jointing in the rock.

Cuts in rock of limited height (say up to 3m or so) should be able to be cut reasonably steeply, say 40 to 60 degrees from the horizontal. Cuts in the overlying soil mantle should be cut at no steeper than 2H:1V. Deeper cuts in rock would need to be studied in more detail.

An important issue in relation to long term performance of cuts will be the degree of fretting and erosion that is tolerable. It is evident from the test pits that the fine grained sedimentary rock would be easily erodible and would fret upon exposure to the air. In sensitive areas, some form of slope protection (shotcrete etc?) would probably be required on steep batters. Flatter batters could of course be landscaped.

5.3 Pavement Subgrade

Four bulk samples were selected for CBR testing to provide some indication of likely subgrade strength. The soaked California Bearing Ratio (CBR) tests sampled from these areas produced results of 25% to 150% in the sand and gravel samples, and a CBR of 2.5% in a sample of sandy silty clay. The CBR tests were performed on samples

compacted to a target density ratio of 100% of standard maximum dry density at about standard optimum moisture content.

These test results highlight the extreme variability in the strength of the granular and clay material on site.

The results in the granular material are high, and previous experience with similar sandy subgrade material suggests that they should not be relied upon as a basis for pavement thickness design. The reason for this is that the CBR is a quasi-static test, and the behaviour of this type of material in the CBR test is not a reliable prediction of how it will perform under dynamic wheel loads. Because of the silt content, drainage is poor, and under dynamic loads, if the subgrade is wet, the subgrade can become “quick” and lose strength, leading to premature pavement failure.

It is recommended that a preliminary subgrade CBR of 10% be used to determine pavement thickness requirements for the design of internal roads for the estate where sandy subgrade material is prevalent. On clay subgrade, the CBR of 2.5% would be reasonable for preliminary pavement design.

5.4 Groundwater

All 3 water bores drilled encountered groundwater, but all 3 locations were different in respect of quantity and quality (salinity) of water.

The information obtained during the drilling work is as follows:

TABLE 6 – SUMMARY OF WATER BORE INFORMATION			
Bore No.	Total Depth (m)	Estimated Supply (l/s)	TSS (ppm)
1	33	12.2	1330
2	33	2.5	3400
3	32.75	12.6	520

Notes: TSS – total soluble salts.

The estimated supply is based on a lift test during the drilling process. Based on previous experience, the driller indicated that long term supply would be expected to be at least 1 to 2 l/s less than the estimated supply based on the test conducted during drilling. This would need to be confirmed by a full scale pump test.

Samples from each of the bores were also delivered to Australian Laboratory Services for a more comprehensive suite of chemical tests to be carried out. These test results are included in Appendix C and are summarised in Table 5 in Section 4.3.

What these test results show is that the best bore, in terms of supply quantity and water quality, was Bore 3.

The future use of this water for filling a recreational dam was investigated, hence Table 5, also contains recommended values for the relevant analytes from two sources, namely the ANZECC Water Quality Guidelines and Brisbane City Council Guidelines for Freshwater.

As evident from Table 5, Bore 2 contains higher levels for conductivity (EC), suspended solids, turbidity, total iron, and total aluminium, than the other 2 bores. In general, it is not unusual for groundwater to contain high levels of EC, iron and aluminium. Though not contained in the guidelines, either the ANZECC or Brisbane

City Council, the EC of freshwater is generally below 1500 μ s/cm. The high values of suspended solids, turbidity, total iron and total aluminium in Bore 2 may be as a result of the suspended clay particles contained in the water sampled. This would possibly be reduced if the bore was developed.

The suitability of borewater for filling a dam, will be dependent on the existing water quality of the dam, the dilution factor taking into consideration runoff entering the dam, as well as the quality of water leaving the dam and entering other properties and affecting environmental values of the existing water bodies, in the event of releases.

The EC of 7100 μ s/cm (4600TDS) water in Bore 2 indicates high levels of salinity. Upper limit levels of EC of 5000 μ s/cm for used of water for irrigation and stock are included in the guidelines (ANZECC) therefore will limit the use of dam water for such purpose.

5.5 Dam Construction

Several earth dams are included in the conceptual layout for the Yarrabilba project. The key geotechnical issues that need to be addressed in the construction of an earth dam are as follows;

- Dam foundation material
 - bearing capacity
 - permeability
- Availability of construction materials
 - clay core
 - filter zones
 - structural zone
 - rip rap protection
- Stability of dam.

Dam Foundations

No investigation work was carried out specifically at particular proposed dam locations. However, it can be said from the information gathered at the boreholes (which were drilled generally along gully lines), that there generally should be no real issue in identifying competent foundation strata upon which to support on earth dam. The exception to this was BH1, where sand was encountered over the full depth of the borehole. At all other boreholes competent residual material was identified. In some boreholes (e.g. BH's 6 and 7) a significant thickness of silty sand was identified and once the dam alignments are chosen, an important issue to be investigated will be the assessment of the permeability of foundation strata.

Construction Materials

The investigation work identified a number of locations with a substantial thickness of sandy silty clay (e.g. BH's 4, 8 and 10) and it is likely that deposits of clay would be able to be identified on site that could be used as clay core material. The 3 permeability tests carried out on representative samples of sandy clay and clayey sand produced results between 1×10^{-9} m/s and 4×10^{-9} m/s. This is quite low permeability and indicates that these material would be suitable for use as a clay core material in dam construction on the basis of permeability.

Filter sand would be relatively expensive to import, and it is not common that natural deposits of sand are sufficiently uniform to be used as dam filter material, at least not without some processing. BH1, did encounter a deep deposit of sand and additional investigation work would be necessary to determine if the quality and quantity of sand necessary for use in dam construction was available on site.

General dam construction material, the "shell" of the dam around the core which provides its structural capacity, would be available on site and could include the residual soils and weathered rock materials.

The dispersiveness of a particular strata will be a critical issue that will need to be addressed once a preferred area to win dam construction material from has been identified.

A dispersive soil is one which readily breaks down in water, with the clay fraction forming a suspension in the water. This soil breakdown is generally caused by a high percentage of sodium present in the absorbed cations. Sodium cations are positively charged, loosely bound, and cause relatively large expansions when the soil is saturated. Because of this loose binding and high expansion activity, the soil tends to dissolve into colloidal form when placed in water.

Dispersive soils have long been recognised as the cause of piping failures in earth dams (particularly non-engineered farm dams) and for turbidity in reservoir storage. There are a number of techniques and measures which can be adopted to allow the use of dispersive clays in dam construction, and this would have to be an important focus of any further investigation work.

There was no rock encountered during the investigation that appeared strong and durable enough to be considered for use as rip rap. It is not considered likely that in the geological formation that exists in the project area, that material suitable for use as rip rap would be found.

Dam Stability

The stability of a particular dam will be a matter for detailed investigation and design once the locations of the dams and the source of construction material etc are known. It will be a function of the nature of the dam foundation material and the strength of the material used in the dam structural zones.

5.6 Erosion and Sediment Control

Soil erodibility potential is the likelihood that erosion will occur when soils are exposed to water (and/or wind) during earthworks.

The erosion potential of a particular site is determined both by the nature of the soil that will be exposed by the development activity, and the slope of the land. An assessment of the dispersiveness and characteristic gradation of the soils that will be disturbed by the development is necessary to determine what erosion and sediment control measures need to be implemented.

The assessment for this project was generally carried out in accordance with the Brisbane City Council "Soil Sampling and Testing Guideline for Erosion Potential", Draft Version 3-2001, except that the number of investigation locations did not comply with the number required due to the broadscale nature of the investigation.

It was considered that the subject development was in the sub-base Group 2 which requires a Level 2 site assessment.

The Emerson Class test provides an indication of the dispersiveness of the soil, with Class 1 being the most dispersive, ranging to Class 8 being the least dispersive. The Emerson Class Test Results (Table 3) indicated that the predominant result was Class 3, with one Class 5 and three Class 8 results.

The grading test results suggest that the percentage finer than 0.02mm was probably less than 35% in the sand samples but greater than 35% in the clay material, as expected. The BCC guidelines indicate that "fine grained soils" are those with more than 35% finer than 0.02mm. Overall, and looking at the other classification tests carried out, it is considered that the characteristic soils on the site would be a combination of fine grained and non-fine grained soils. This indicates that Type C and F sediment basins (with possibly Type D basins) would probably be required in

accordance with the Brisbane City Council document "Sediment Basin Design, Construction and Maintenance Guidelines" January, 2001.

The pH tests carried out on representative samples indicated acidic material, with pH results of between 4.7 and 3.7 (refer Table 3). This, with the electrical conductivity test results, provides information as to the plant species that would be best (acid tolerant) to revegetate disturbed areas.

As mentioned in Section 2 much of the site was previously used as a pine plantation. It is understood that one of the implications of pine plantation activities is the increase in acidity in the soils caused by the pines. This is a natural mechanism of pines to fend off invasion by other species. What is also known is that if the soils were not naturally acidic prior to the pine plantation being there, they will gradually revert to the more neutral characteristics once the plantation activities stop.

While it is not possible to generalize as to the likely natural pH of soils in this area prior to pine forestation, it is considered that the natural acidity would have been less (higher pH) than that recorded by the investigation. It would be possible to investigate this further by carrying out pH tests on samples from adjacent properties that had not been subjected to pine cultivation.

To assist in the completion of the Brisbane City Council erosion hazard assessment form, the following geotechnical data is provided;

Item No.	Description	Results	Points
2	Soil Classification group	SM, SP and MH, CH	1 and 2
3	Emerson Class	3	4
12	pH	<5	1

5.7 Site Classifications

To provide a rough indication of possible site classifications for individual house allotments, based on the classification test results, the estimated surface movement of the existing soil profile due to seasonal variations in moisture content would vary from less than 20mm up to 70mm. This indicates that particular sites in their present condition may be classified Class 'S', 'M' or 'H' in accordance with AS2870-1996 "Residential Slabs and Footings" on the basis of shrink/swell potential.

The classification tests in Table 2 indicated that the clay fines on the site are moderately to highly reactive, which indicates that if any thick clay seams are encountered on particular blocks, then Class 'M' or 'H' sites would result. The predominant site classification should be 'S' and 'M'. This has implications for the cost of footing and slab systems for houses ultimately constructed on the site. All other things being equal, Class S would be the least costly and Class H would be the most costly.

The final site classifications will be a function of the earthworks carried out on particular blocks and the final soil profile that exists at a particular house location.

6 CONCLUSIONS AND RECOMMENDATIONS

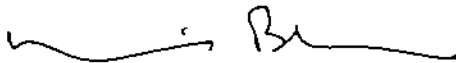
The following conclusions and recommendations are made in regard to the initial broadscale geotechnical investigation for the proposed Yarrabilba development;

1. The dominant geology of the project site consisted of sandstone, shale, tuff and conglomerate of the Bundamba Group and Ipswich Coal Measures.
2. The excavator pits located along the ridge lines encountered silty sand, sand and silty sandy gravel, with some silty clay strata, over extremely weathered rock at relatively shall depth (from 0.7m to 2.7m).
3. Deeper and variable soil profiles were revealed in the boreholes drilled along the gully lines, but weathered rock was also encountered at 5 of the 10 boreholes drilled.
4. Groundwater was encountered in all 3 waterbores drilled, which extended to 33m each. Supply varied from 2.5 to 12.6 l/sec and the quality of water also varied. Bore 3 in the southeast of the site produced the greatest supply and best quality of water.
5. Heavy ripping will be necessary for excavation deeper than that achieved with the 13T excavator at the test pits along the ridge lines, below depths generally around 2m to 3m.
6. All material won from excavations will be suitable for general structural fill material. The silty sand strata is known to be particularly difficult to work and compact when wet.
7. Soil cut and fill batters should be no steeper than between 1V:3H in sand and 1V:2H in clay. Rock cuts will be able to be steeper, but fretting and erosion of the surface will be an issue.

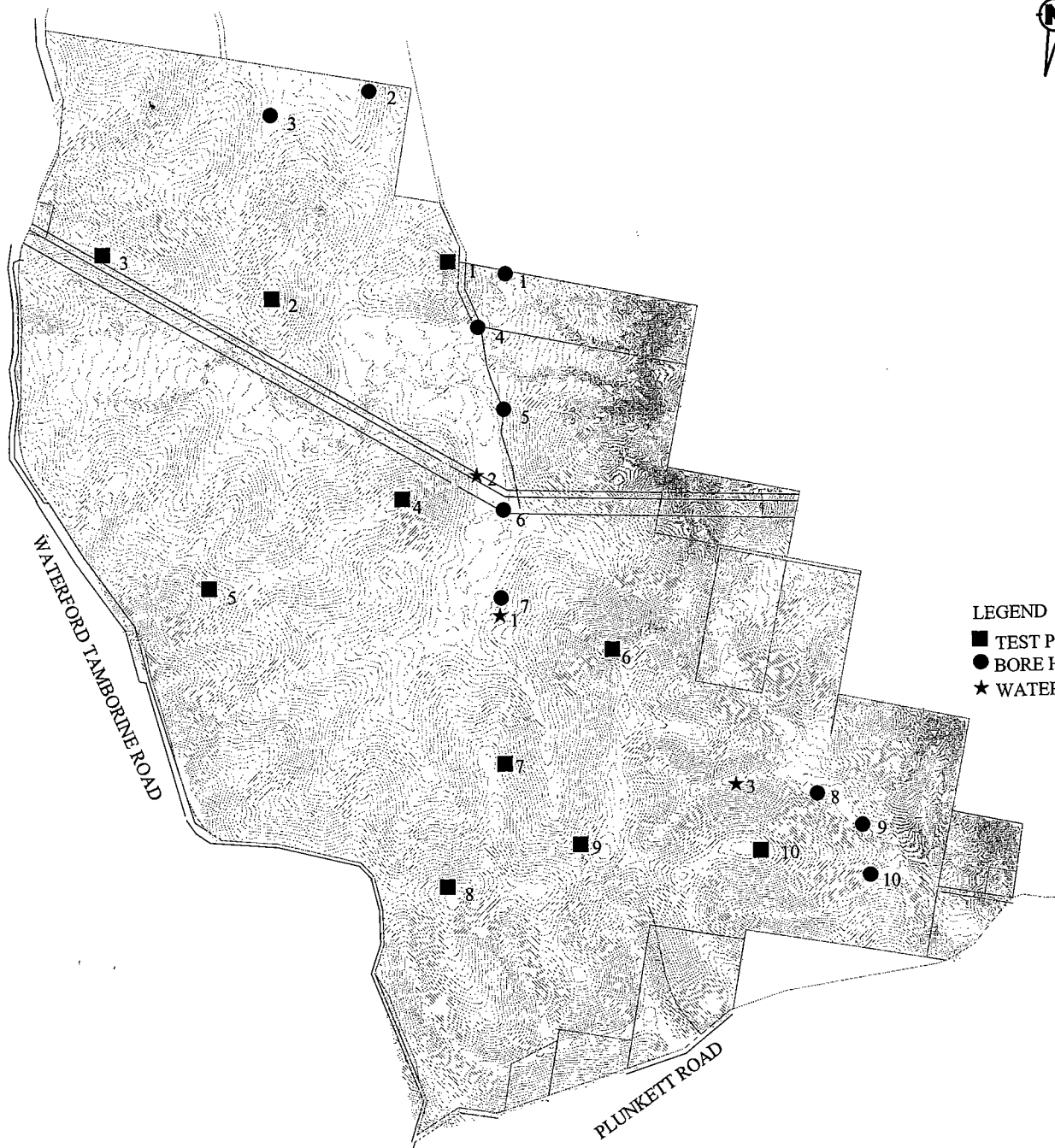
8. Most of the material necessary to construct zoned earth dams should be available on site, with the possible exception of rip rap and filter sand.
9. Erosion and sediment control measures that will need to be implemented during construction will involve Type C and F basins, with possibly Type D basins.
10. The topsoils on site are predominantly acidic and this will have implications for the selection of plant species used for revegetation.
11. Individual house site classifications should predominantly be Class S and M, with some Class H sites.

Yours faithfully

BOWLER GEOTECHNICAL PTY LTD



David Bowler
DIRECTOR



LEGEND
■ TEST PIT
● BORE HOLE
★ WATER BORE

NOT TO SCALE

B BOWLER
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Also at Gold Coast, Geelong, Sunshine Coast, Gladstone, Rockhampton, Mackay, Townsville, Cairns, Mt Isa, Sydney and Bendigo (Vic). Associated Offices in Melbourne, Adelaide, Perth, Vietnam and Papua New Guinea.

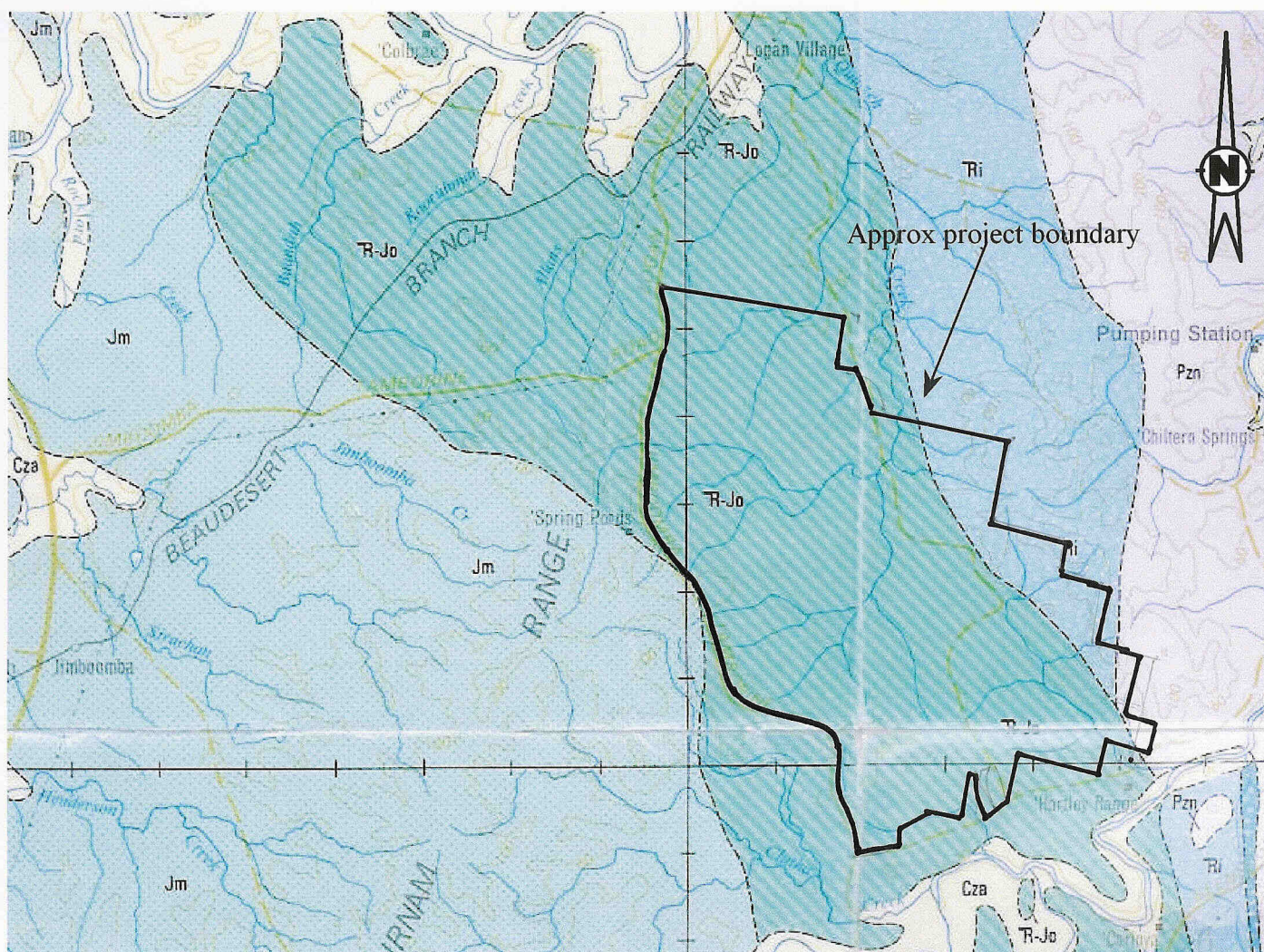
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Telephone 3800 6446 Facsimile 3800 0616

INVESTIGATION LOCATION PLAN

YARRABILBA

JOB NO.:
5928

FIGURE 1



MESOZOIC	JURASSIC	Bundamba Group	Woolloomoolloo Coal Measures	Jw	Shale, siltstone, sandstone, coal seams
			Marburg Formation	Jm	Sandstone, conglomerate, some shale, siltstone
			Woogaroo Sub-Group	R-Jo	Sandstone, siltstone, shale, conglomerate
	TRIASSIC-JURASSIC		Ipswich Coal Measures	Ri	Conglomerate, sandstone, shale, tuff, coal seams
			Brisbane Tuff	Rt	Rhyolite tuff, welded tuff and agglomerate, minor sediments
			Chillingham Volcanics	Rc	Rhyolite flows and tuff
	TRIASSIC		Neranleigh-Fernvale Beds	Pzn	Greywacke, argillite, quartzite, chert, shale, sandstone, greenstone
			Bunya Phyllite	Pzb	Phyllite, schist, minor lenses of greenstone
	UNDIFFERENTIATED				

APPROX SCALE 1 : 769

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SITE GEOLOGY

YARRABILBA

GEOLOGY BEENLEIGH 1:100 000 SERIES

JOB NO.:

5928

FIGURE 2

GENERAL**GENERAL NOTES**

August, 1999

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the introduction section(s) of the document. The report should not be used by other parties or for other purposes as it may not contain adequate or appropriate information.

TEST HOLE LOGGING

The information on the Test Hole Logs (Boreholes, Backhoe Pits, Exposures etc.) has been based on a visual and tactile assessment except at the discrete locations where test information is available (field and/or laboratory results).

Reference should be made to our standard sheets for the definition of our logging procedures (Soil and Rock Descriptions).

GROUNDWATER

Unless otherwise indicated the water levels given 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. Further variations of this level could occur with time due to such effects as seasonal and tidal fluctuations or construction activities. Final confirmation of levels can only be made by appropriate instrumentation techniques and programmes.

INTERPRETATION OF RESULTS

The discussion and recommendations contained within this report are normally based on a site evaluation from discrete test hole data. Generalised or idealised subsurface conditions (including any cross-sections contained in the report) have been assumed or prepared by interpolation/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 used for this report can occur, particularly between discrete test hole locations. Furthermore, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site.

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

FOUNDATION DEPTH

Where referred to in the report, the recommended depth of any foundation (piles, caissons, footings, etc.) is an engineering estimate of the depth to which they should be constructed. 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 depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications based upon this report should provide for variations in the final depth depending upon the ground conditions at each point of support.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in this report for the inclusion in the contract documents or engineering specification of the subject development, such reproduction 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.

This report is the subject of copyright and shall not be reproduced either totally or in part without the express permission of this firm.



IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities; and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geo-

technical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.*

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or ground-water fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report prepared or authorized for their use.* Those who do not provide such access may proceed un-

* 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.

der the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

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APPENDIX A
FIELDWORK RESULTS

SOIL DESCRIPTION

August, 1999

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 the Site Investigation Code AS1726-1993.

SOIL TYPE

The soil is described on the basis of the grain size composition of the constituent particles, and the plasticity of the fraction of material passing the 425µm sieve.

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

SILT OR CLAY AS MINOR COMPONENT		GRAVEL OR SAND AS MINOR COMPONENT	
% 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	describe as "with sand/gravel" as applicable
>12	prefix soil as "silty/clayey" as applicable	>30	prefix soil as "sandy/gravelly" as applicable

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 classification group symbol for soil classification is also given before the soil type description in accordance with AS1726-1993, Table A1.

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

COLOUR

Colour is important for correlation of data between test holes and for subsequent excavation operations. The prominent colour is noted, followed by (spotted, mottled, streaked etc.) secondary colours as applicable. Colour should be described in the "moist" condition, though both wet and dry colours may also be appropriate.

MOISTURE

The moisture condition of the soil is described by the appearance and feel of the soil using one of the following terms:

Dry cohesive soils - hard, friable or powdery; granular soils - cohesionless, free funning.
Moist soil cool, darkened colour: cohesive soils - can be moulded; granular soils - tend to cohere.
Wet soil cool, darkened colour: cohesive soils - usually weakened, free water on hands when handling; granular soils - tend to cohere.

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

CONSISTENCY/RELATIVE DENSITY

Granular soils are generally described in terms of relative density (density index) as listed in Table A5 AS1726. These soils are inherently difficult to assess and normally a penetration test procedure (SPT, DCP or CPT) is used in conjunction with published correlation tables. Alternatively, insitu 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 insitu moisture content and the possible variations of moisture with time.

Term	Tactile Properties	Undrained Shear Strength (kPa)
Very Soft	Exudes between the fingers when squeezed in the hand.	≤12
Soft	Easily penetrated by thumb about 30-40mm. Pick head can be pushed in up to shaft. Moulded by light finger pressure.	>12 ≤25
Firm	Penetrated by thumb 20-30mm with moderate effort. Sharp end of pick pushed in some 30-40mm. Moulded by strong finger pressure.	>25 ≤50
Stiff	Indented by thumb about 4mm with moderate effort. Pick pushed in up to 10mm. Cannot be moulded in fingers.	>50 ≤100
Very Stiff	Readily indented by thumb nail. Slight indentation produced by pushing pick into soil.	>100 ≤200
Hard	Difficult to indent with thumb nail. Requires power tools for excavation.	>200

STRUCTURE/OTHER FEATURES

The structure of the soil may be described with reference to: zoning, where soils consist of separate zones differing in colour, grain size or other properties; defects, including fissures, cracks, root-holes and the like; cementing, with the strength (weakly to strongly), and nature of the cementing agent; additional observations including geological origin, odour and the like. In addition, the presence of other features (ferrirete nodules, organic inclusions) should also be noted as applicable.

BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TPI
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 385' E: 153° 07, 432'	Surface Elevation:	
Date Started:	25/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				2	SM, SILTY SAND, fine to medium grained, dark brown, moist, TOPSOIL
				5	SP, SAND, fine to coarse grained, orange/brown, with silt, moist
				5	
				5	
0.5				7	Clayey
				12	
				20	
				REFUSAL	XW, EXTREMELY WEATHERED SANDSTONE
1.0					
					Ripper used at 1.2m
1.5					RIPPER REFUSAL AT 1.3m
					TEST PIT TERMINATED
2.0					
2.5					
3.0					
3.5					
4.0					

BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TP2
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 497' E: 153° 06, 786'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					SM, SILTY SAND, fine to medium grained, dark brown, moist, TOPSOIL
		Bulk Sample			SM, SILTY SANDY GRAVEL, fine to coarse grained, fine to coarse grained sand, orange/brown, moist, NATURAL
0.5					
		PP- 250kPa			
					CI, SILTY CLAY, medium plasticity, orange/brown, with fine to coarse grained sand, moist
1.0		PP- 600kPa			
		D			
1.5					CI, SILTY CLAY, medium plasticity, pale grey, mottled pale orange/brown, with fine to coarse grained sand, moist
					XW, EXTREMELY WEATHERED ROCK, SANDSTONE, pale grey
2.0					Ripper used at 1.8m RIPPER REFUSAL AT 1.9m TEST PIT TERMINATED
2.5					
3.0					
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TP3
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 347' E: 153° 06, 173'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					SM, SILTY SAND, fine to medium grained, dark brown, moist, TOPSOIL
					SM, SILTY SAND, fine to coarse grained, pale brown, moist, NATURAL
0.5					With clay
					CI, SANDY SILTY CLAY, medium plasticity, fine to coarse grained sand, orange/brown, mottled brown, NATURAL
1.0		PP- 270kPa	D		Orange/brown
1.5					
2.0					SC, CLAYEY SAND, fine to coarse grained, medium plasticity clay, mottled pale grey, orange/brown, moist, very dense, NATURAL
2.5					
3.0					XW, EXTREMELY WEATHERED ROCK, SANDSTONE, pale grey, Ripper used at 2.8m mottled orange/brown
					RIPPER REFUSAL AT 2.8m
					TEST PIT TERMINATED
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TP4
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 49, 158' E: 153° 07, 253'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					SM, SILTY SAND, fine to medium grained, dark brown, moist, TOPSOIL
					GP, SANDY GRAVEL, fine to coarse grained gravel, fine to coarse grained sand, orange/brown, dry to moist, trace of cobbles
0.5					
					SP, SAND, fine to coarse grained, orange/brown, with medium plasticity clay, moist, NATURAL
1.0					
					XW, EXTREMELY WEATHERED SANDSTONE
					Ripper used at 1.4m
1.5					
2.0					RIPPER REFUSAL AT 1.9m
					TEST PIT TERMINATED
2.5					
3.0					
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TP5
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 49, 442' E: 153° 06, 545'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	BYT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					SM, SILTY SAND, fine to coarse grained, dark brown, moist, TOPSOIL
					SP, SAND, fine to coarse grained, grey, brown, dry to moist
		Bulk Sample			
0.5					
		PP- 350kPa			CH, SANDY SILTY CLAY, high plasticity, fine to coarse grained sand, mottled orange/brown, brown, NATURAL
1.0					Grey, mottled orange/brown
					XW, EXTREMELY WEATHERED ROCK
					Ripper used at 1.1m
					RIPPER REFUSAL AT 1.2m
1.5					TEST PIT TERMINATED
2.0					
2.5					
3.0					
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TP6
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 49, 657' E: 153° 08, 016'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	B/T	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				3	SM, SILTY SAND, fine to medium grained, dark brown, moist, TOPSOIL
				4	SP, CLAYEY SAND, fine to coarse grained, orange/brown, medium plasticity clay, moist
				4	
				5	
0.5				8	
				8	
				9	
				17	
				REFUSAL	XW, EXTREMELY WEATHERED SANDSTONE
1.0					Ripper used at 0.9m
					RIPPER REFUSAL AT 1.0m
					TEST PIT TERMINATED
1.5					
2.0					
2.5					
3.0					
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TP7
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 024' E: 153° 07, 618'	Surface Elevation:	
Date Started:	25/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					SP, SAND, fine to coarse grained, dark brown, moist, TOPSOIL
					CI, SANDY SILTY CLAY, medium plasticity, fine to coarse grained sand, orange/brown, mottled brown, moist
0.5		PP- 220kPa			
					SC, CLAYEY SAND, fine to coarse grained, medium plasticity clay, dry to moist, very dense
1.0					
					SP, SAND, fine to coarse grained, mottled dark grey, orange/brown, trace of clay, dry to moist, very dense
1.5					
2.0					XW, EXTREMELY WEATHERED SANDSTONE, mottled orange/brown, red/grey Ripper used at 1.7m
2.5					RIPPER REFUSAL AT 2.4m TEST PIT TERMINATED
3.0					
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TP8
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 425' E: 153° 07, 402'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					SM, SILTY SAND, fine to medium grained, dark brown, TOPSOIL
					GP, SILTY SANDY GRAVEL, fine to medium grained, fine to coarse grained sand, orange/brown, moist, dense, NATURAL
0.5		Bulk Sample			
					CH, SANDY SILTY CLAY, high plasticity, fine to coarse grained sand, mottled orange/brown, brown, moist
1.0		PP- 370kPa			
1.5		PP- 400kPa			
					SC, CLAYEY SAND, fine to coarse grained, medium plasticity clay, mottled orange/brown, pale grey, very dense
2.0					
					XW, EXTREMELY WEATHERED SANDSTONE, orange/brown, very weak
2.5					Ripper used at 2.3m
					RIPPER REFUSAL AT 2.6m TEST PIT TERMINATED
3.0					
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TP9
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 292' E: 153° 07, 892'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					SP, SAND, fine to coarse grained, dark brown, TOPSOIL
					SP, SAND, fine to coarse grained, pale brown, moist, NATURAL
0.5					
		PP- 230kPa			CI, SANDY SILTY CLAY, medium plasticity, fine to coarse grained sand, red/brown, mottled brown
1.0		PP- 250kPa			
		PP- 520kPa			Red/brown, mottled grey
1.5					
					XW, EXTREMELY WEATHERED SANDSTONE, pale grey
2.0					
					Ripper used at 1.8m
2.5					
					RIPPER REFUSAL AT 2.2m
					TEST PIT TERMINATED
3.0					
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	TP10
Project:	YARRABILBA	Sheet:	1 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 318' E: 153° 08, 546'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
		D		4	SP, SAND, fine to coarse grained, dark brown, with silt, TOPSOIL
		D		4	SP, SAND, fine to coarse grained, orange/brown, dry to moist
				12	
				20	
0.5				REFUSAL	GM, SILTY SANDY GRAVEL, fine to medium grained, fine to coarse grained sand, orange/brown, moist
		D			
1.0					
		D			SC, CLAYEY SAND, fine to coarse grained sand, medium to high plasticity, orange/brown, mottled pale grey Note: Water seepage at 1.3m
1.5					
					Orange/brown
2.0					Brown
2.5					XW, EXTREMELY WEATHERED SANDSTONE, orange/brown, very weak
3.0					
3.5					
4.0					

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Client:	DELFIN LEND LEASE	Hole No:	TP10
Project:	YARRABILBA	Sheet:	2 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 318' E: 153° 08, 546'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	13 TONNE EXCAVATOR	Contractor:	ALLIED EARTHMOVING

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH1
Project:	YARRABILBA	Sheet:	1 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 355' E: 153° 07,642'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				1	SP, SAND, fine to coarse grained, brown, trace of fine grained gravel, moist
				2	
				3	
0.5			▼	3	Grey, wet
				4	
				4	
			WATER	3	
			TABLE	4	
				2	
1.0				2	
				2	
				3	
				2	
1.5				2	
				2	
				3	
				2	
				2	
2.0				2	
				1	
				1	
				2	
				2	
				3	
2.5				3	
				4	
				3	
				1	
				3	
3.0				3	
				2	
				3	
				3	
				3	
3.5				3	
				4	
				3	
				2	
				1	
4.0				2	

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH1
Project:	YARRABILBA	Sheet:	2 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 355' E: 153° 07,642'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				1	
				2	
				2	
				9	
4.5				8	
				10	
				11	
				13	
				12	
5.0				15	
				15	
				14	
5.5					
6.0					
					BOREHOLE TERMINATED AT 6.0m
6.5					
7.0					
7.5					
8.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH2
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 47, 828' E: 153° 07, 151'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				1	SM, SILTY SAND, fine to coarse grained, pale brown, wet, NATURAL moist
				2	
				1	
				1	
0.5				1	
				4	SC, CLAYEY SAND, fine to coarse grained, medium plasticity clay, mottled orange/brown, brown, moist, NATURAL
				4	
				3	
1.0				3	
				3	
				3	Orange/brown, mottled grey
				5	
				6	
1.5				7	
				7	
				8	
				9	
				11	
				14	
2.0				17	
				27	XW, EXTREMELY WEATHERED SANDSTONE, orange/brown, very weak
				25+	
2.5					
					BOREHOLE TERMINATED AT 2.5m
3.0					
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH3
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 346' E: 153° 06, 178'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				13	SP, SILTY SAND, fine to coarse grained, pale brown, dry
				20	
				20+	
0.5					CI, SANDY SILTY CLAY, medium plasticity, fine to coarse grained sand, mottled orange/brown, brown, grey, moist
1.0		D		4	
				4	
				3	
				4	
				7	
				9	XW, EXTREMELY WEATHERED SANDSTONE, pale grey
1.5				REFUSAL	
					TC BIT REFUSAL AT 1.6m BOREHOLE TERMINATED
2.0					
2.5					
3.0					
3.5					
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH4
Project:	YARRABILBA	Sheet:	1 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 597' E: 153° 07, 539'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
		D			SM, SILTY SAND, fine to medium grained, pale grey, dry, very dense,
		D			TOPSOIL
					SM, SILTY SAND, fine to medium grained, pale grey, dry, very dense,
				2	TOPSOIL
0.5				2	CI, SANDY SILTY CLAY, medium to high plasticity, fine to coarse
				3	grained sand, mottled brown, orange/brown, moist
				5	
				6	
1.0		D		6	Brown
				6	
				5	
				6	
				10	
				12	
1.5				20	SC, CLAYEY SAND, fine to coarse grained, medium plasticity clay,
				25+	pale brown, with brown seams, dry to moist
2.0					
					SP, SAND, fine to coarse grained, brown, with medium plasticity clay,
					moist
2.5					
					Dark brown
3.0					Trace of clay
3.5					
					SC, CLAYEY SAND, fine to coarse grained, medium plasticity clay,
					pale brown, moist
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH4
Project:	YARRABILBA	Sheet:	2 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 597' E: 153° 07, 539'	Surface Elevation:	
Date Started:	24/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
4.5					Orange/brown
5.0					Grey
5.5					SM, SILTY SAND, fine to coarse grained, grey, trace of clay, moist
6.0					
6.5					BOREHOLE TERMINATED AT 6.0m
7.0					
7.5					
8.0					

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Client:	DELFIN LEND LEASE	Hole No:	BH5
Project:	YARRABILBA	Sheet:	1 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 866' E: 153° 07, 630'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				15	SM, SILTY SAND, fine to medium grained, dark brown, TOPSOIL
				20+	SM, SILTY SAND, fine to coarse grained, pale brown, trace of fine to medium grained gravel, dry to moist
0.5				/	CH, SANDY SILTY CLAY, high plasticity, fine to coarse grained sand, mottled grey, orange/brown, moist
				4	
				4	
				5	
1.0		D		7	
				7	
				5	
				6	
				5	
1.5				12	
				9	Mottled pale brown, pale grey
				8	
				7	
				7	
2.0				17	
				12	
				14	
				REFUSAL	Pale grey, dry
2.5					
3.0					Pale brown
3.5					
					XW, EXTREMELY WEATHERED SANDSTONE, orange/brown, very weak
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH5
Project:	YARRABILBA	Sheet:	2 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 48, 866' E: 153° 07, 630'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					XW, EXTREMELY WEATHERED SANDSTONE, orange/brown, very weak
					BOREHOLE TERMINATED AT 4.2m CLOSE TO REFUSAL
4.5					
5.0					
5.5					
6.0					
6.5					
7.0					
7.5					
8.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH6
Project:	YARRABILBA	Sheet:	1 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 49, 196' E: 153° 07, 625'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				8	SM, SILTY SAND, fine to medium grained, dark brown, TOPSOIL
				9	SM, SILTY SAND, fine to coarse grained, pale brown, trace of fine
				7	to medium grained gravel, dry to moist
				7	
0.5				5	CH, SANDY SILTY CLAY, high plasticity, fine to coarse grained sand,
				5	mottled grey, orange/brown, moist
				5	
				8	
				8	
1.0				8	
				5	
				5	
				4	
				4	
1.5				4	
				4	With fine to coarse grained sand
				3	
				3	
				4	
2.0				5	
				5	
				8	
				12	
				13	Grey
2.5				15	
				18	
				18	
				18	
				21	
3.0				19	
				20	
				25	
3.5					SM, SILTY SAND, fine to medium grained, grey, trace of clay, moist
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH6
Project:	YARRABILBA	Sheet:	2 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 49, 196' E: 153° 07, 625'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					SM, SILTY SAND, fine to medium grained, grey, trace of clay, moist
					No Clay, wet
4.5					
5.0					
5.5					
6.0					
					BOREHOLE TERMINATED AT 6.0m
6.5					
7.0					
7.5					
8.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH7
Project:	YARRABILBA	Sheet:	1 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 49, 483' E: 153° 07, 611'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				2	SM, SILTY SAND, fine to medium grained, dark brown, TOPSOIL
				2	
				2	CH, SANDY SILTY CLAY, high plasticity, fine to coarse grained sand,
				2	mottled grey, orange/brown, moist
0.5		D		2	
				5	
				3	
				3	
				3	
1.0				4	
				4	
				7	
				12	SC, CLAYEY SAND, fine to coarse grained, grey, moist, NATURAL
1.5				12	
				12	
				12	
				12	
				11	
2.0				18	SM, SILTY SAND, fine to coarse grained, pale brown, dry
				15	
				13	
				13	
				17	
2.5				25	
				22	
				21	With medium plasticity clay, orange/brown
				29	
3.0					
					Grey
3.5					
					Orange/brown, mottled grey
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH7
Project:	YARRABILBA	Sheet:	2 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 49, 483' E: 153° 07, 611'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
					SM, SILTY SAND, fine to coarse grained, orange/brown, dry
					SC, CLAYEY SAND, fine to coarse grained, medium plasticity clay, orange/brown, mottled grey, moist
4.5					
					SP, SILTY SAND, fine to coarse grained, mottled orange/brown, grey, with medium plasticity clay, moist
5.0					
5.5					
6.0					
					BOREHOLE TERMINATED AT 6.0m
6.5					
7.0					
7.5					
8.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH8
Project:	YARRABILBA	Sheet:	1 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 135' E: 153° 08, 757'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				8	SM, SILTY SAND, fine to medium grained, dark brown, TOPSOIL
				11	CH, SANDY CLAY, high plasticity, fine to coarse grained sand, mottled
				14	orange/brown, brown, moist
				6	
0.5		Bulk Sample		3	
				3	
				3	
				3	
				3	
1.0				2	
				2	CH, SANDY SILTY CLAY, high plasticity, fine to coarse grained sand,
				3	mottled grey, orange/brown, moist
				4	
				5	
1.5				10	Grey
				19	
				20	
				21	
				32	
2.0					
2.5					Orange/brown
3.0					
3.5					CI, SILTY CLAY, medium plasticity, grey, trace of fine to coarse grained
					sand, moist
4.0					

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH8
Project:	YARRABILBA	Sheet:	2 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 135' E: 153° 08, 757'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
4.5					
5.0					
5.5					
6.0					
6.5					
7.0					
7.5					
8.0					

CH, SILTY CLAY, high plasticity, grey, trace of fine to coarse grained sand, moist

Dark grey

BOREHOLE TERMINATED AT 6.0m

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BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH9
Project:	YARRABILBA	Sheet:	1 of 1
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 239' E: 153° 08, 923'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				9	SM, SILTY SAND, fine to medium grained, dark brown, TOPSOIL
				9	
				9	CI, SILTY CLAY, medium plasticity, mottled orange/brown, grey, with
				9	fine to coarse grained sand, moist
0.5				6	
				6	
				7	
				9	
				9	
1.0				9	
				9	
				7	
				6	
				REFUSAL	Dry
1.5					Orange/brown
2.0					
					XW, EXTREMELY WEATHERED ROCK,, SANDSTONE, pale orange/brown
2.5					
					TC BIT REFUSAL AT 2.4m
					BOREHOLE TERMINATED
3.0					
3.5					
4.0					

BOWLER GEOTECHNICAL Pty Ltd	7/98 Anzac Ave
	HILLCREST QLD 4118
	Ph: 3800 6446 Fax: 3800 0816
	Form 26c Rev: 1 14/7/97

BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH10
Project:	YARRABILBA	Sheet:	1 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 403' E: 153° 08, 948'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
				12	SM, SILTY SAND, fine to medium grained, dark brown, TOPSOIL
				9	
				9	
				9	SM, SILTY SAND, fine to coarse grained, pale brown, trace of fine
0.5		D		8	to medium grained gravel, dry to moist
				9	
				4	
				5	CH, SANDY SILTY CLAY/CLAYEY SAND, high plasticity clay,
				7	fine to coarse grained sand, mottled grey, orange/brown, moist
1.0		D		5	
				8	
				8	
				9	
				11	
1.5				17	Grey (low clay content)
				20	
				20	
		D		22	
				25	
2.0					
					Grey, mottled grey, brown
2.5					
					Wet
3.0					
					Brown
3.5					
4.0					CH, SILTY CLAY, high plasticity, grey, trace of fine to coarse grained sand, moist, NATURAL

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	HILLCREST QLD 4118
	Ph: 3800 6446 Fax: 3800 0816
	Form 26c Rev: 1 14/7/97

BOREHOLE LOG SHEET

Client:	DELFIN LEND LEASE	Hole No:	BH10
Project:	YARRABILBA	Sheet:	2 of 2
Location:	WATERFORD TAMBORINE ROAD	Job No:	5928
Position:	S: 27° 50, 403' E: 153° 08, 948'	Surface Elevation:	
Date Started:	30/3/04	Logged By:	RK
Rig Type (Mounting):	TRUCK MOUNTED AUGER	Contractor:	BOWLER GEOTECHNICAL

Depth (m)	BIT	Sample or Test	Depth (RL) (m)	DCP Test	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
4.5					
5.0					
5.5					
6.0					
6.5					
7.0					
7.5					
8.0					

BOWLER GEOTECHNICAL Pty Ltd	7/98 Anzac Ave HILLCREST QLD 4118 Ph: 3800 6446 Fax: 3800 0816 Form 26c Rev: 1. 14/7/97
------------------------------------	--

KA & LC Dippel
90 Sunland Road
CHAMBERS FLAT Q 4133
PH (07) 3297 1441

YARRABILBA WATER BORE LOG

BORE # 1

DEPTH (m)	STRATA DESCRIPTION
0.0-0.450	Sandy topsoil
0.450-2.4	Yellow clay
2.4-5.9	Sandy clay yellowish
5.9-7.0	Firmer sandy clay
7.0-7.6	Gravelly sandstone, wet
7.6-9.75	Yellow sandstone
9.75-10.35	Grey sandstone
10.35-10.65	Yellow sandstone
10.65-12.2	Yellow sandstone water bearing 600GPH TSS 1200PPM
12.2-15.2	Grey sandstone medium
15.2-	750GPH TSS 1300PPM
15.2-16.5	Grey sandstone fine
16.5-26.2	Grey sandstone and grey shale mixed
26.2-29.6	Grey sandstone laminated with thin black, shale layers
29.6-33.0	Black shale and grey sandstone
33.0	970 GP 1330 PPM TSS

Yield approximately 970 GPH at time of drilling
Water quality approximately 1330 PPM TSS

Note:

GPH – gallons per hour

TSS – total soluble salts

PPM – parts per million

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90 Sunland Road
CHAMBERS FLAT Q 4133
PH (07) 3297 1441

YARRABILBA WATER BORE LOG

BORE # 2

DEPTH (m)	STRATA DESCRIPTION
0.0-0.3	Sandy topsoil
0.3-1.5	Hard fine gritty clay
1.5-2.2	Dark grey clay
2.2-3.65	Yellow clay
3.65-4.6	Grey sandy clay
4.6-5.2	Yellow sandy clay, damp
5.2-6.7	Grey sandy clay, some fine gravel, very soft, small flow water TSS 6200 PPM
6.7-7.6	Soft yellow, sandy clay
7.6-8.4	Yellow sandstone
8.4-9.75	Yellow clayey sandstone
9.75-10.7	Grey shale
10.7-11.9	Grey shale and yellow sandstone, mixed layers
11.9-14.35	Grey shale
14.35-17.4	Grey sandstone
17.4-19.5	Dark grey shale
19.5-	Some water approx. 150 GPH TSS 3000PPM
19.5-20.7	Grey shale
20.7-28.9	Light grey shale
28.9-30.8	Grey sandstone
30.8-33.0	Grey shale and grey sandstone – mixed

Yield approximately 200 GPH at time of drilling
Water quality TSS 3400 PPM

Note:

GPH – gallons per hour
TSS – total soluble salts
PPM – parts per million

KA & LC Dippel
90 Sunland Road
CHAMBERS FLAT Q 4133
PH (07) 3297 1441

YARRABILBA WATER BORE LOG

BORE # 3

DEPTH (m)	STRATA DESCRIPTION
0.0-0.6	Sandy topsoil
0.6-5.5	Yellow clayey
5.5-7.0	Grey shale
7.0-	Soak 4000PPM TSS
7.0-7.6	Hard, grey sandstone
7.6-16.75	Sticky clayey sandstone grey – damp
16.75-22.25	Grey sandstone, dry, less clay content
22.25-	Coarser grey sandstone and some pale yellow
-26.8	Water TSS 520PPM
26.8-30.2	Fine grey sandstone
30.2-31.4	Dark grey shale
31.4-32.75	Fine and tight grey sandstone

Yield approximately 1000 GPH at time of drilling
Water quality approximate Total Soluble Salts 520PPM

Note:

GPH – gallons per hour
TSS – total soluble salts
PPM – parts per million

APPENDIX B
LABORATORY TEST RESULTS

LABORATORY TESTING

August, 1999

GENERAL

Samples extracted during the fieldwork stage of a site investigation may be "disturbed" or "undisturbed" (as generally indicated on the test hole logs) depending upon the nature and purpose of the sample as well as the method of extraction. Nominally "undisturbed" samples may suffer a varying degree of disturbance during extraction, transportation, extrusion and testing. This aspect should be taken into account when assessing test results which must of necessity reflect the effects of such disturbance.

All soil properties (as measured by laboratory testing) exhibit inherent variability and thus a certain statistical number of tests is required in order to predict an average property with any degree of confidence. The site variability of soil strata, future changes in moisture and other conditions, and the discrete sampling positions must also be considered when assessing the representative nature of the laboratory programme.

Certain laboratory test results provide interpreted soil properties as derived by conventional mathematical procedures. The applicability of such properties to engineering design must be assessed with due regard to the site, sample condition, procedure and project in hand.

TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 as amended, or Queensland Transport Standards when specified. The routine Australian Standard tests are as follows:

Sample Preparation	Test 1
Moisture Content	Test 2.1.1
Liquid Limit	Test 3.1.1)
Plastic Limit	Test 3.2.1) collectively known as Atterberg Limits
Plasticity Index	Test 3.3.1)
Linear Shrinkage	Test 3.4.1
Particle Density	Test 3.5.1
Particle Size Distribution	Tests 3.6.1, 3.6.2, 3.6.3
Emerson Class Number	Test 3.8.1)
Percent Dispersion	Test 3.8.2) collectively, Dispersion Classification
Pinhole Dispersion Classification	Test 3.8.3)
Organic Matter	Test 4.1.1
Sulphate content	Test 4.2.1
pH Value	Test 4.3.1
Resistivity	Test 4.4.1
Standard Compaction	Test 5.1.1
Modified Compaction	Test 5.2.1
Dry Density Ratio	Test 5.4.1
Minimum/Maximum Density	Test 5.5.1
Density Index	Test 5.6.1
California Bearing Ratio	Tests 6.1.1, 6.1.2
Undrained Triaxial Shear	Test 6.4.1
One Dimensional Consolidation	Test 6.6.1
Constant Head Permeability	Test F7.1
Shrink Swell Index	Test 7.1.1

Where tests are used which are not covered by appropriate standard procedures, details are given in the report.

LABORATORY

Our laboratory is a Registered Laboratory with the National Association of Testing Authorities (NATA).



Test Report

California Bearing Ratio

Customer: DELFIN LAND LEASE LTD
PO Box 4403
Forest Lake

Report Number: 1

Job Number: 5928

Customer Reference: 0

Sample No: 57949

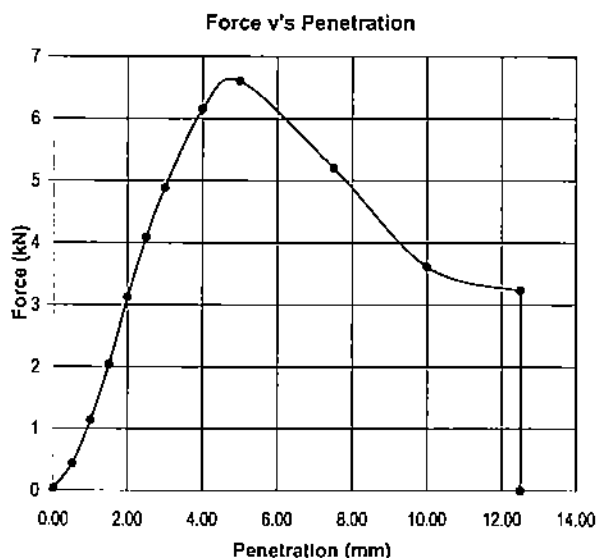
Test Specification: Australian Standard 1289.6.1.1 - 1998

Soil Description	DISTURBED
Sample Location	TP5 0.2-0.4m
Project	YARRABILBA GEO ENG CONSULTANCY

Compaction Criteria	STD
---------------------	-----

Condition of Specimen		Soaked
Surcharge	g	4500
Period of Soak		4 DAYS
Percentage Retained 19 mm		0
(Not Included In Sample)		
Moisture Content of Top 30 mm	%	11
Swell/Consolidation	%	-0.4
Laboratory Moisture Ratio	%	97
Laboratory Density Ratio	%	100

Optimum Moisture Content	%	10.0
Maximum Dry Density	t/m ³	1.87
CBR Penetration	mm	3.0
CBR VALUE	%	35.0



Comments:

Testing Officer:	DAVID HAMMELSWANG	Date:	13.04.2004
Reported By:	MJS	Date:	14.04.04
NATA Signatory:		Date:	14.04.04

M. J. SANDILANDS

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The tests reported herein have been performed in accordance with its terms of accreditation.
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Associated Offices in Melbourne, Adelaide, Perth, Vietnam, Papua New Guinea

Test Report

California Bearing Ratio

Customer: DELFIN LEND LEASE LTD
PO Box 4403
Forest Lake

Report Number: 2

Job Number: 5928

Customer Reference: 0

Sample No: 57951

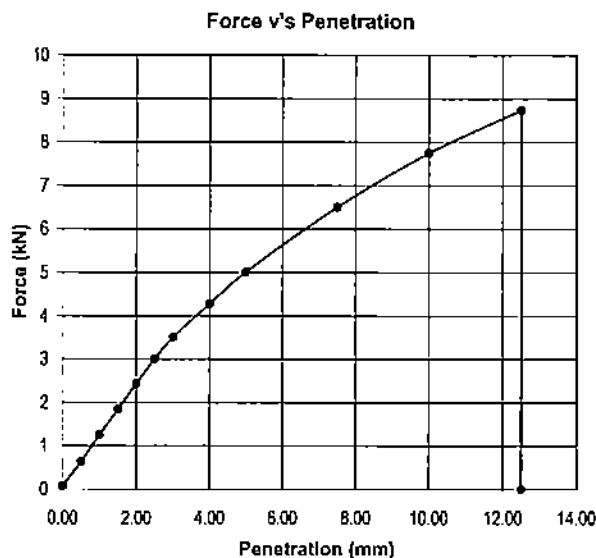
Test Specification: Australian Standard 1289.6.1.1 - 1998

Soil Description	DISTURBED
Sample Location	TP6 0.3-0.5m
Project	YARRABILBA GEO ENG CONSULTANCY

Compaction Criteria	STD
---------------------	-----

Condition of Specimen		Soaked
Surcharge	g	4500
Period of Soak		4 DAYS
Percentage Retained 19 mm (Not Included In Sample)		0
Moisture Content of Top 30 mm	%	16
Swell/Consolidation	%	0.2
Laboratory Moisture Ratio	%	96
Laboratory Density Ratio	%	101

Optimum Moisture Content	%	14.5
Maximum Dry Density	t/m ³	1.83
CBR Penetration	mm	5.0
CBR VALUE	%	25.0



Comments:

Testing Officer:	DAVID HAMMELSWANG	Date:	13.04.2004
Reported By:	MJS	Date:	14.04.04
NATA Signatory:		Date:	14.04.04

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Associated Offices in Melbourne, Adelaide, Perth, Vietnam, Papua New Guinea

Test Report

California Bearing Ratio

Customer: DELFIN LAND LEASE LTD
PO Box 4403
Forest Lake

Report Number: 3

Job Number: 5928

Customer Reference: 0

Sample No: 57955

Test Specification: Australian Standard 1289.6.1.1 - 1998

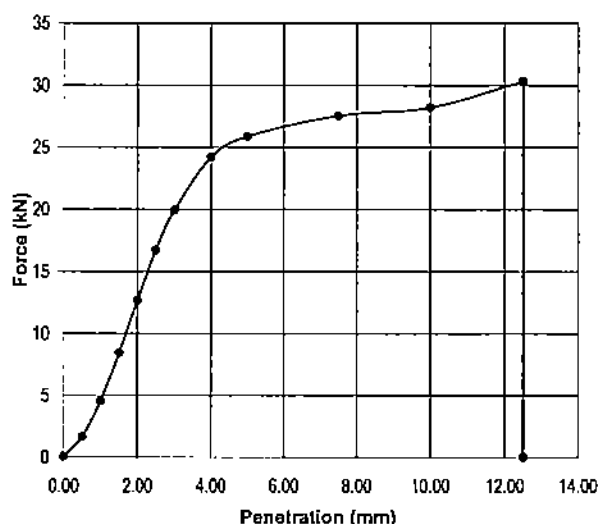
Soil Description	DISTURBED
Sample Location	TP8 0.1-0.4m
Project	YARRABILBA GEO ENG CONSULTANCY

Compaction Criteria	STD
---------------------	-----

Condition of Specimen	Soaked
Surcharge g	4500
Period of Soak	4 DAYS
Percentage Retained 19 mm (Not Included in Sample)	0
Moisture Content of Top 30 mm %	8
Swell/Consolidation %	-0.3
Laboratory Moisture Ratio %	101
Laboratory Density Ratio %	100

Optimum Moisture Content %	8.0
Maximum Dry Density t/m ³	2.15
CBR Penetration mm	3.0
CBR VALUE %	150.0

Force v's Penetration



Comments:

Testing Officer:	DAVID HAMMELSWANG	Date:	13.04.2004
Reported By:	MJS	Date:	14.04.04
NATA Signatory:		Date:	14.04.04

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Associated Offices in Melbourne, Adelaide, Perth, Vietnam, Papua New Guinea

Test Report

California Bearing Ratio

Customer: DELFIN LEND LEASE LTD
PO Box 4403
Forest Lake

Report Number: 4

Job Number: 5928

Customer Reference: 0

Sample No: 57963

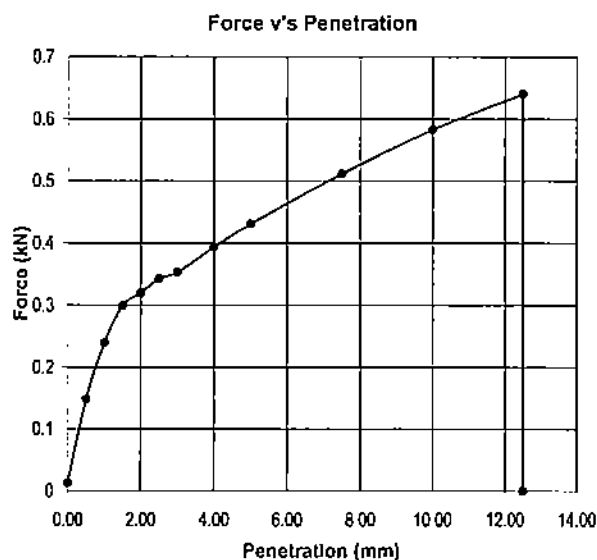
Test Specification: Australian Standard 1289.6.1.1 - 1998

Soil Description	DISTURBED
Sample Location	BH10 0.8-1.1m
Project	YARRABILBA GEO ENG CONSULTANCY

Compaction Criteria	STD
---------------------	-----

Condition of Specimen		Soaked
Surcharge	g	4500
Period of Soak		4 DAYS
Percentage Retained 19 mm (Not Included In Sample)		0
Moisture Content of Top 30 mm	%	24
Swell/Consolidation	%	1.5
Laboratory Moisture Ratio	%	96
Laboratory Density Ratio	%	101

Optimum Moisture Content	%	21.0
Maximum Dry Density	t/m ³	1.64
CBR Penetration	mm	2.5
CBR VALUE	%	2.5



Comments:

Testing Officer:	DAVID HAMMELSWANG	Date:	13.04.2004
Reported By:	MJS	Date:	14.04.04
NATA Signatory:		Date:	14.04.04

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Associated Offices in Melbourne, Adelaide, Perth, Vietnam, Papua New Guinea

Geotechnical Engineering Consultants
Soils Laboratory Services
Environmental Consultants
ABN 49 050 401 771

Email: lab@bowlergeotechnical.com.au
Website: www.bowlergeotechnical.com.au

Also at Gold Coast Geebung Sunshine Coast Gladstone Rockhampton Mackay
Townsville Cairns Mount Isa Bendigo (Vic) and Sydney • Associated Offices
in Melbourne Adelaide Perth Vietnam and Papua New Guinea

SOIL CLASSIFICATION TEST REPORT

CLIENT: Delfin Lend Lease Ltd
ADDRESS: PO Box 4403
Forest Lake
PROJECT: Yarrabilba Geo Eng Consultancy
JOB No.: 5829
REPORT No: 5
DATE ISSUED: —
SITE TEST No.: — LOCATION: TP 1
SAMPLE No.: 57944 SAMPLE DEPTH m: 0.0-0.1
DATE SAMPLED: — SOIL DESCRIPTION: —

ATTERBERG LIMITS & LINEAR SHRINKAGE

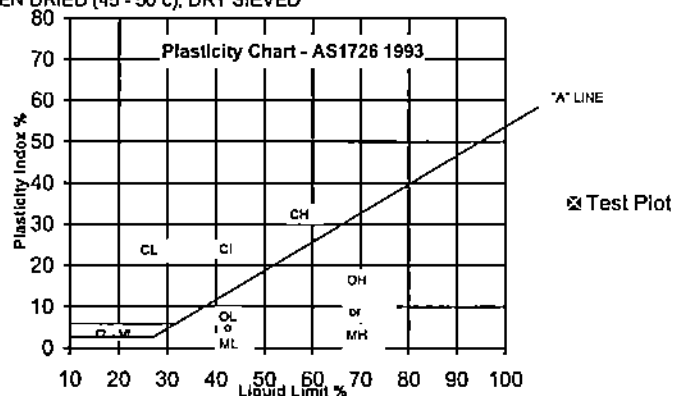
TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1,
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT: — %
PLASTIC LIMIT: — %
PLASTICITY INDEX: — %
LINEAR SHRINKAGE: — %
FIELD MOISTURE CONTENT: — %

PLASTICITY

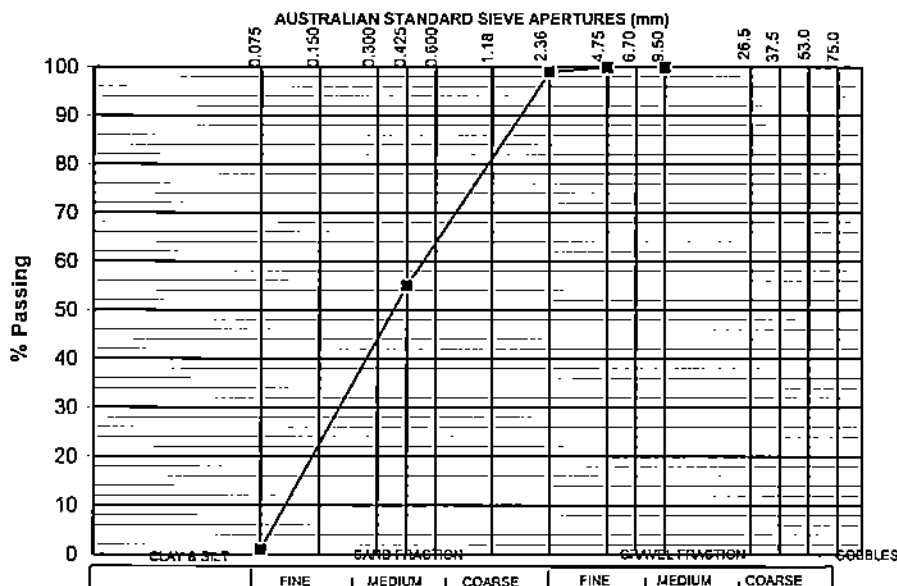
Descriptive Term	Range of L.L.
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
9.5	100
4.75	100
2.36	99
0.425	55
0.075	1



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Number: 1986

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APPROVED BY:

[Signature]

M. J. SANDILANDS

Geotechnical Engineering Consultants
Soils Laboratory Services
Environmental Consultants
ABN 49 050 401 771

Email: lab@bowlergeotechnical.com.au
Website: www.bowlergeotechnical.com.au

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Townsville Cairns Mount Isa Bendigo (Vic) and Sydney • Associated Offices
in Melbourne Adelaide Perth Vietnam and Papua New Guinea

SOIL CLASSIFICATION TEST REPORT

CLIENT: Delfin Lend Lease Ltd
ADDRESS: PO Box 4403
Forest Lake
PROJECT: Yarrabilba Geo Eng Consultancy
SITE TEST No.: -
SAMPLE No.: 57945
DATE SAMPLED: -
LOCATION: TP 1
SAMPLE DEPTH m: 0.2-0.4
SOIL DESCRIPTION: -
JOB No.: 5829
REPORT No: 6
DATE ISSUED: -

ATTERBERG LIMITS & LINEAR SHRINKAGE

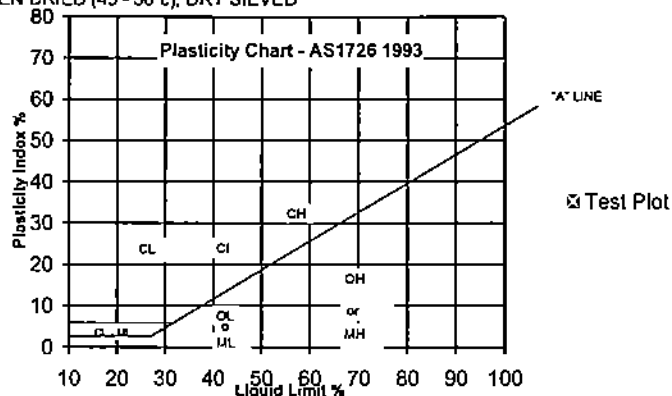
TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1.
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT: ND %
PLASTIC LIMIT: ND %
PLASTICITY INDEX: NP %
LINEAR SHRINKAGE: - %
FIELD MOISTURE CONTENT: - %

PLASTICITY

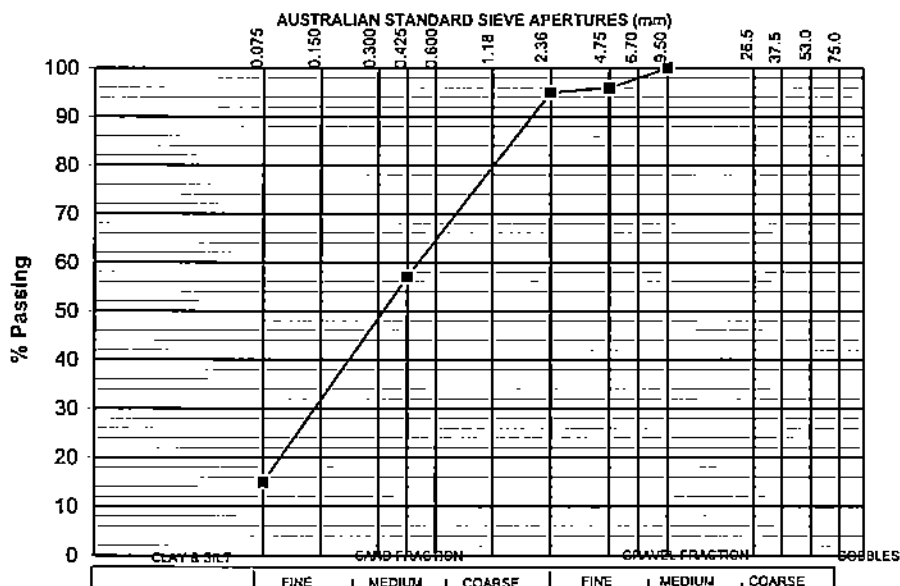
Descriptive Term	Range of I _p
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
9.5	100
4.75	96
2.36	95
0.425	57
0.075	15



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Number: 1986

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APPROVED BY:

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Townsville Cairns Mount Isa Bendigo (Vic) and Sydney - Associated Offices
in Melbourne Adelaide Perth Vietnam and Papua New Guinea

SOIL CLASSIFICATION TEST REPORT

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5829
ADDRESS:	PO Box 4403 Forest Lake	REPORT No.:	7
PROJECT:	Yarrabilba Geo Eng Consultancy	DATE ISSUED:	—
SITE TEST No.:	—	LOCATION:	TP 2
SAMPLE No.:	57946	SAMPLE DEPTH m:	1.0-1.2
DATE SAMPLED:	—	SOIL DESCRIPTION:	—

ATTEBERG LIMITS & LINEAR SHRINKAGE

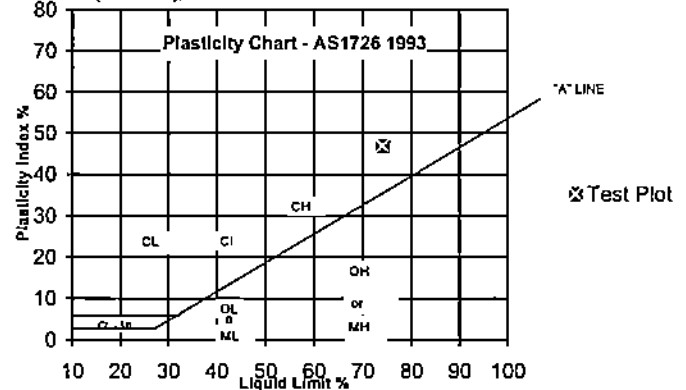
TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1,
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT: 74 %
PLASTIC LIMIT: 27 %
PLASTICITY INDEX: 47 %
LINEAR SHRINKAGE: 16.5 %
FIELD MOISTURE CONTENT: — %

PLASTICITY

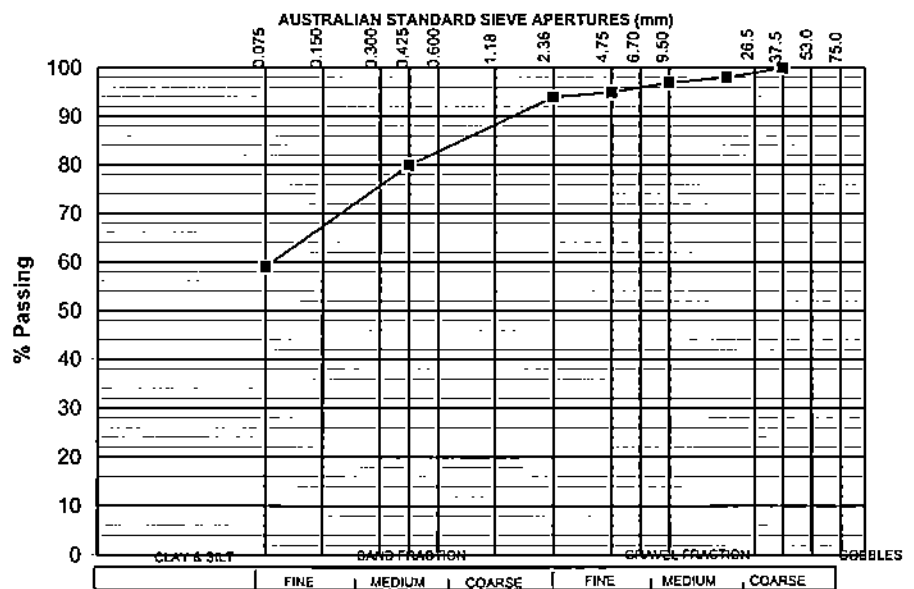
Descriptive Term	Range of I.L.
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
37.5	100
19.0	98
9.5	97
4.75	95
2.36	94
0.425	80
0.075	59


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Number: 1986

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APPROVED BY:

M. J. SANDILANDS

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Soils Laboratory Services
Environmental Consultants
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Also at Gold Coast, Geelong, Sunshine Coast, Gladstone, Rockhampton, Mackay,
Townsville, Cairns, Mount Isa, Bendigo (Vic) and Sydney. Associated Offices
in Melbourne, Adelaide, Perth, Vietnam and Papua New Guinea.

SOIL CLASSIFICATION TEST REPORT

CLIENT: Delfin Lend Lease Ltd
ADDRESS: PO Box 4403
Forest Lake
PROJECT: Yarrabilba Geo Eng Consultancy
JOB No.: 5829
REPORT No.: 8
DATE ISSUED: —
SITE TEST No.: — LOCATION: TP 5
SAMPLE No.: 57949 SAMPLE DEPTH m: 0.2-0.4
DATE SAMPLED: — SOIL DESCRIPTION: —

ATTERBERG LIMITS & LINEAR SHRINKAGE

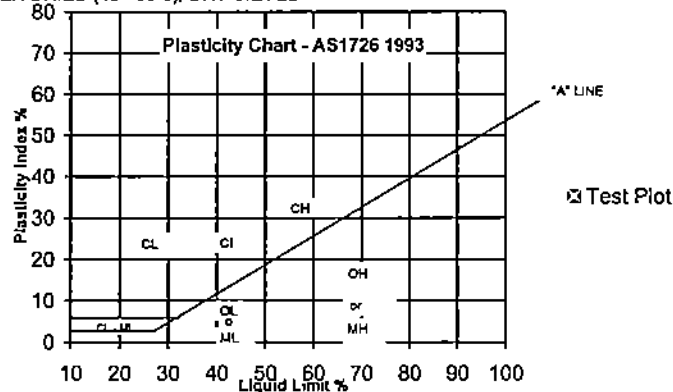
TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1.
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT: ND %
PLASTIC LIMIT: ND %
PLASTICITY INDEX: NP %
LINEAR SHRINKAGE: — %
FIELD MOISTURE CONTENT: — %

PLASTICITY

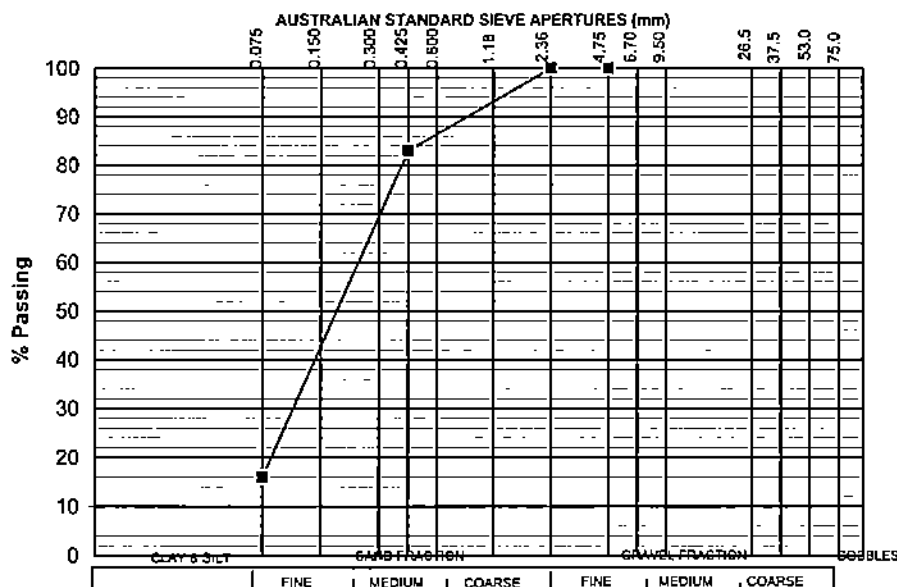
Descriptive Term	Range of L.L.
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
75	100
60	100
425	83
300	83
250	83
200	83
150	83
106	83
75	100
4.75	100
2.36	100
0.425	83
0.075	16



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Townsville Cairns Mount Isa Bendigo (Vic) and Sydney • Associated Offices
in Melbourne Adelaide Perth Vietnam and Papua New Guinea

SOIL CLASSIFICATION TEST REPORT

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5829
ADDRESS:	PO Box 4403 Forest Lake	REPORT No.:	9
PROJECT:	Yarrabilba Geo Eng Consultancy	DATE ISSUED:	—
SITE TEST No.:	—	LOCATION:	TP 7
SAMPLE No.:	57953	SAMPLE DEPTH m:	0.2-0.4
DATE SAMPLED:	—	SOIL DESCRIPTION:	—

ATTERBERG LIMITS & LINEAR SHRINKAGE

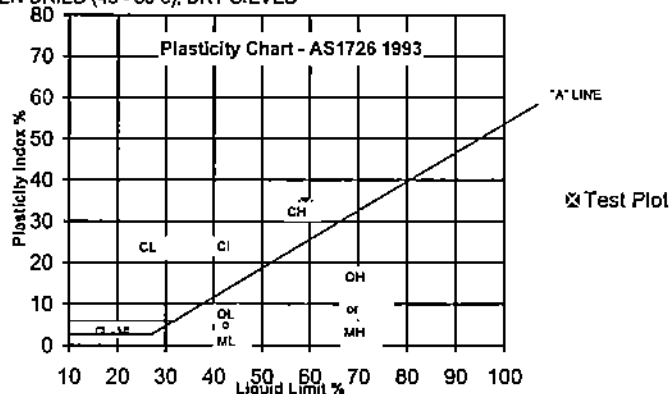
TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1,
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT: 59 %
PLASTIC LIMIT: 25 %
PLASTICITY INDEX: 34 %
LINEAR SHRINKAGE: 11.0 %
FIELD MOISTURE CONTENT: — %

PLASTICITY

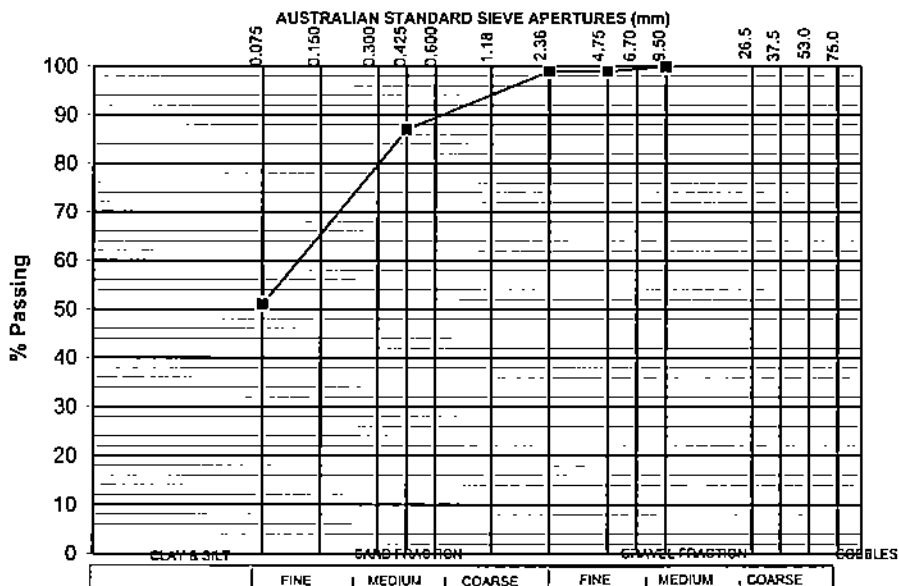
Descriptive Term	Range of I.L.
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
75.0	—
63.0	—
50.0	—
42.5	—
37.5	—
30.0	—
25.0	—
20.0	—
15.0	—
12.5	—
10.0	—
7.5	—
6.3	—
5.0	—
4.75	100
2.36	99
0.425	87
0.075	51



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Townsville Cairns Mount Isa Bendigo (Vic) and Sydney - Associated Offices
in Melbourne Adelaide Perth Vietnam and Papua New Guinea

SOIL CLASSIFICATION TEST REPORT

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5829
ADDRESS:	PO Box 4403 Forest Lake	REPORT No:	10
PROJECT:	Yarrabilba Geo Eng Consultancy	DATE ISSUED:	—
SITE TEST No.:	—	LOCATION:	TP 8
SAMPLE No.:	57955	SAMPLE DEPTH m:	0.1-0.4
DATE SAMPLED:	—	SOIL DESCRIPTION:	—

ATTERBERG LIMITS & LINEAR SHRINKAGE

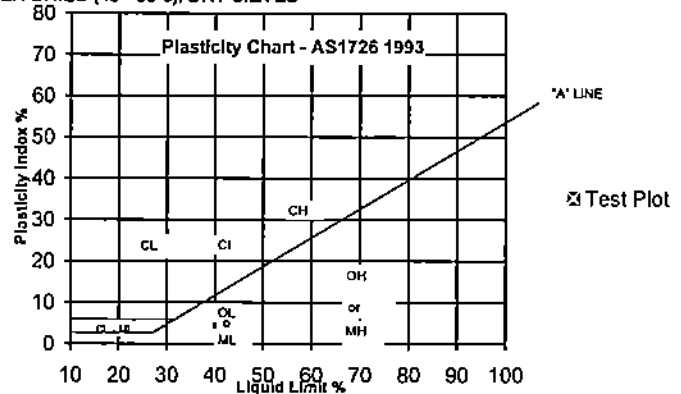
TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1,
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT:	ND	%
PLASTIC LIMIT:	ND	%
PLASTICITY INDEX:	NP	%
LINEAR SHRINKAGE:	—	%
FIELD MOISTURE CONTENT:	—	%

PLASTICITY

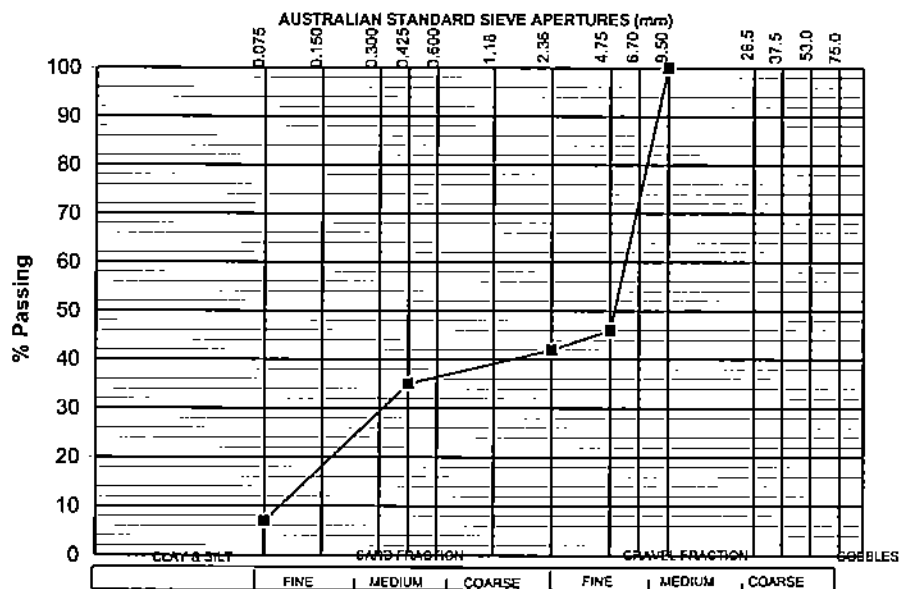
Descriptive Term	Range of L.L.
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
9.5	100
4.75	46
2.36	42
0.425	35
0.075	7



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[Signature]
M. J. SANDILANDS

SOIL CLASSIFICATION TEST REPORT

CLIENT: Delfin Lend Lease Ltd **JOB No.:** 5829
ADDRESS: PO Box 4403 **REPORT No.:** 11
Forest Lake **DATE ISSUED:** _
PROJECT: Yarrabilba Geo Eng Consultancy

SITE TEST No.: _ **LOCATION:** TP 9
SAMPLE No.: 57957 **SAMPLE DEPTH m:** 0.5-0.7
DATE SAMPLED: _ **SOIL DESCRIPTION:** _

ATTERBERG LIMITS & LINEAR SHRINKAGE

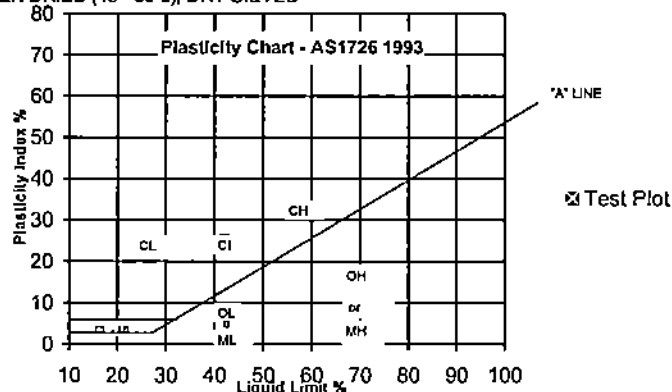
TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1,
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT: 42 %
PLASTIC LIMIT: 17 %
PLASTICITY INDEX: 25 %
LINEAR SHRINKAGE: 13.0 %
FIELD MOISTURE CONTENT: _ %

PLASTICITY

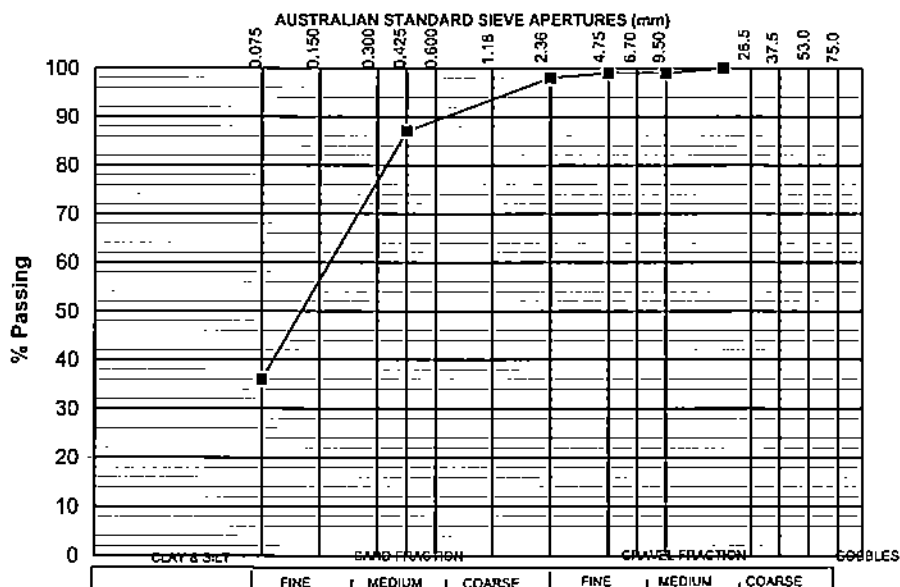
Descriptive Term	Range of L.L.
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
19.0	100
9.5	99
4.75	99
2.36	98
0.425	87
0.075	36



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SOIL CLASSIFICATION TEST REPORT

CLIENT: Delfin Leed Lease Ltd
ADDRESS: PO Box 4403
Forest Lake
PROJECT: Yarrabilba Geo Eng Consultancy
SITE TEST No.: -
SAMPLE No.: 57959
DATE SAMPLED: -
LOCATION: TP 10
SAMPLE DEPTH m: 1.1-1.3
SOIL DESCRIPTION: -

JOB No.: 5829
REPORT No: 12
DATE ISSUED: -

ATTERBERG LIMITS & LINEAR SHRINKAGE

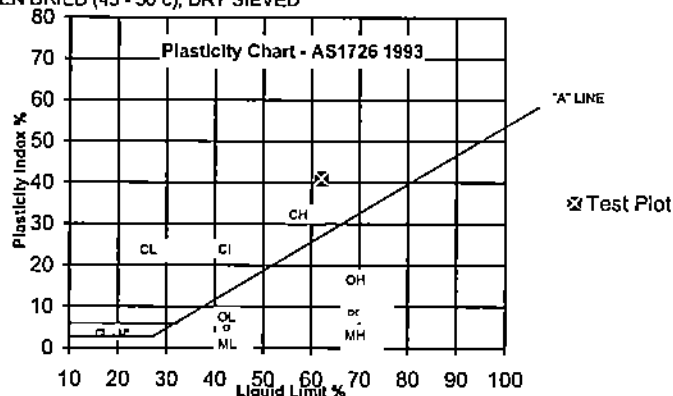
TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1,
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT: 62 %
PLASTIC LIMIT: 21 %
PLASTICITY INDEX: 41 %
LINEAR SHRINKAGE: 17.5 %
FIELD MOISTURE CONTENT: - %

PLASTICITY

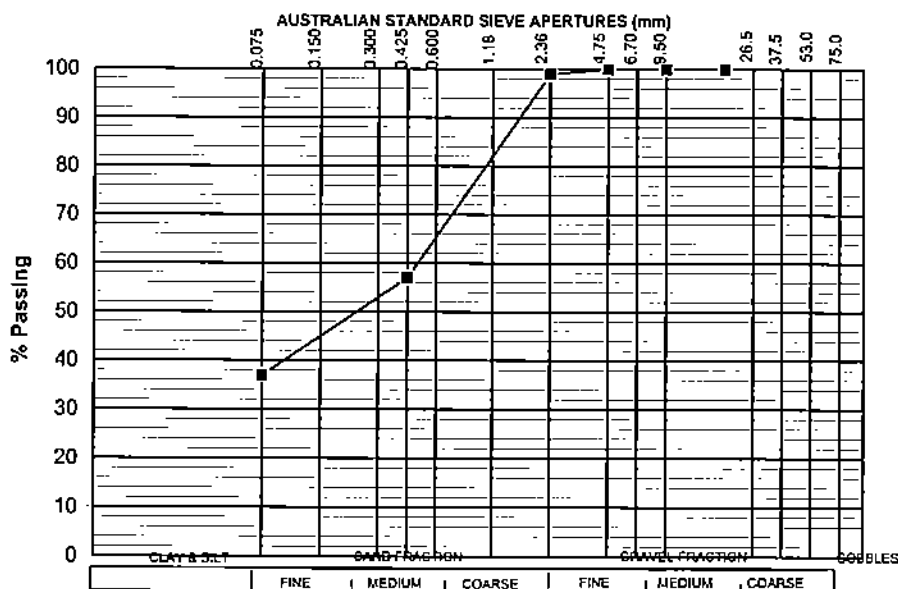
Descriptive Term	Range of LL
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
19.0	100
9.5	100
4.75	100
2.36	99
0.425	57
0.075	37



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SOIL CLASSIFICATION TEST REPORT

CLIENT: Delfin Lend Lease Ltd **JOB No.:** 5829
ADDRESS: PO Box 4403 **REPORT No:** 13
Forest Lake **DATE ISSUED:** —
PROJECT: Yarrabilba Geo Eng Consultancy
SITE TEST No.: — **LOCATION:** BH 2
SAMPLE No.: 57960 **SAMPLE DEPTH m:** 1.1-1.5
DATE SAMPLED: — **SOIL DESCRIPTION:** —

ATTERBERG LIMITS & LINEAR SHRINKAGE

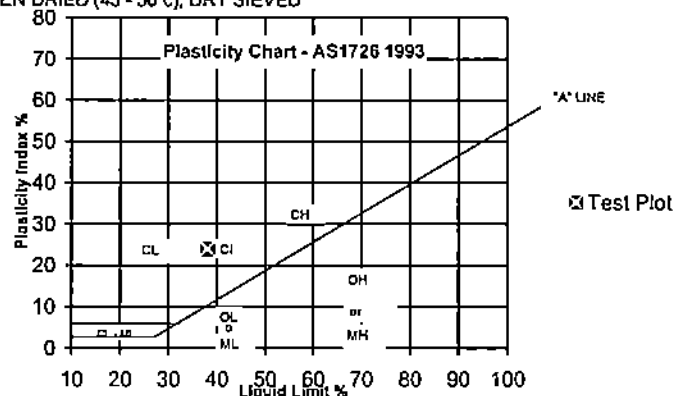
TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1.
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT: 38 %
PLASTIC LIMIT: 14 %
PLASTICITY INDEX: 24 %
LINEAR SHRINKAGE: 11.0 %
FIELD MOISTURE CONTENT: — %

PLASTICITY

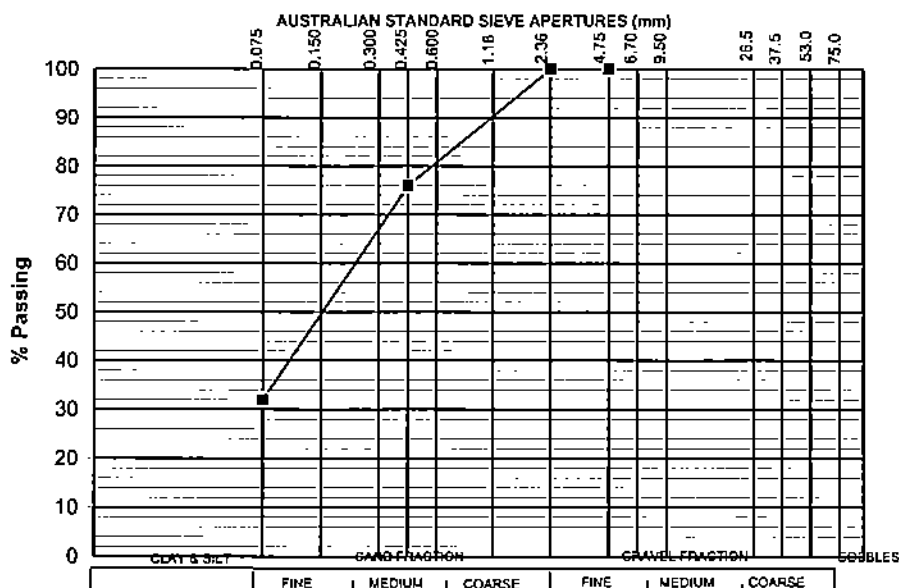
Descriptive Term	Range of L.L.
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
75	100
60	100
42.5	100
30	100
25	100
20	100
15	100
12.5	100
10	100
7.5	100
4.75	100
2.36	100
0.425	76
0.075	32



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Townsville Cairns Mount Isa Bendigo (Vic) and Sydney - Associated Offices
in Melbourne Adelaide Perth Vietnam and Papua New Guinea**SOIL CLASSIFICATION TEST REPORT**

CLIENT: Delfin Lend Lease Ltd **JOB No.:** 5829
ADDRESS: PO Box 4403 **REPORT No:** 14
Forest Lake **DATE ISSUED:** _
PROJECT: Yarrabilba Geo Eng Consultancy

SITE TEST No.: _ **LOCATION:** BH 7
SAMPLE No.: 57961 **SAMPLE DEPTH m:** 0.3-0.6
DATE SAMPLED: _ **SOIL DESCRIPTION:** _

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURES: AS1289.2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1.

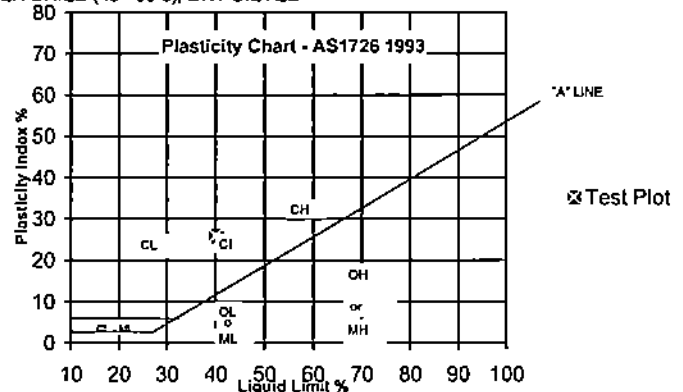
SAMPLE HISTORY: OVEN DRIED (45 - 50°C), DRY SIEVED

RESULTS

LIQUID LIMIT: 40 %
PLASTIC LIMIT: 14 %
PLASTICITY INDEX: 26 %
LINEAR SHRINKAGE: 15.0 %
FIELD MOISTURE CONTENT: _ %

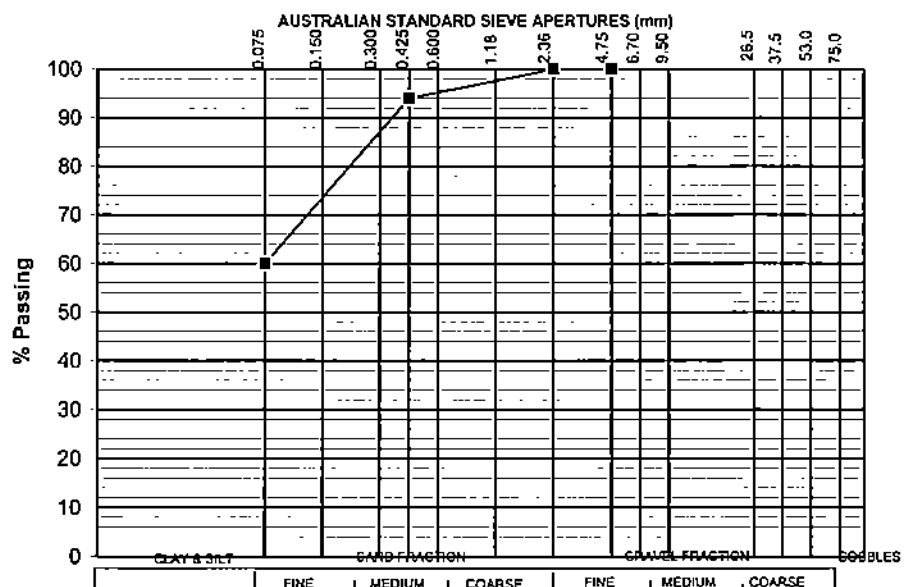
PLASTICITY

Descriptive Term	Range of L.L.
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50

**PARTICLE SIZE DISTRIBUTION**

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
75	60
150	94
300	100
4.75	100
2.36	100
0.425	94
0.075	60

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in Melbourne Adelaide Perth Vietnam and Papua New Guinea

LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5928
ADDRESS:	PO Box 4403	REPORT No:	16
	Forest Lake	DATE ISSUED:	14.04.04
PROJECT:	Yarrabilba Geo Eng Consultancy		
SITE TEST No.:	—	LOCATION:	TP 1
SAMPLE No.:	57944	SAMPLE DEPTH m:	00.0-0.1
DATE SAMPLED:	—	SOIL DESCRIPTION:	—
TESTED BY:	jm	DATE TESTED:	13.04.04
CHECKED BY:	MJS	DATE CHECKED:	14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL
(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****4.7****DETERMINATION OF THE EMERSON CLASS
NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER****DISTILLED****TEMPERATURE OF WATER °C****26****CLASS NUMBER****3****ELECTRICIAL CONDUCTIVITY *****28.9uS****NATA Accredited Laboratory
Number: 1986**

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LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5928
ADDRESS:	PO Box 4403 Forest Lake	REPORT No:	17
PROJECT:	Yarrabilba Geo Eng Consultancy	DATE ISSUED:	14.04.04
SITE TEST No.:	—	LOCATION:	TP 1
SAMPLE No.:	57945	SAMPLE DEPTH m:	0.2-0.4
DATE SAMPLED:	—	SOIL DESCRIPTION:	—
TESTED BY:	jm	DATE TESTED:	13.04.04
CHECKED BY:	MJS	DATE CHECKED:	14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL
(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****DETERMINATION OF THE EMERSON CLASS
NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER****DISTILLED****TEMPERATURE OF WATER °C**

26

CLASS NUMBER

3

ELECTRICIAL CONDUCTIVITY *NATA Accredited Laboratory
Number: 1986

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LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5928
ADDRESS:	PO Box 4403	REPORT No:	18
	Forest Lake	DATE ISSUED:	14.04.04
PROJECT:	Yarrabilba Geo Eng Consultancy		
SITE TEST No.:	—	LOCATION:	TP 2
SAMPLE No.:	57946	SAMPLE DEPTH m:	1.0-1.2
DATE SAMPLED:	—	SOIL DESCRIPTION:	—
TESTED BY:	Jm	DATE TESTED:	13.04.04
CHECKED BY:	MJS	DATE CHECKED:	14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL****(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****DETERMINATION OF THE EMERSON CLASS****NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER****DISTILLED****TEMPERATURE OF WATER °C**

26

CLASS NUMBER**ELECTRICIAL CONDUCTIVITY *****NATA Accredited Laboratory**
Number: 1986

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LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5928
ADDRESS:	PO Box 4403 Forest Lake	REPORT No:	19
PROJECT:	Yarrabilba Geo Eng Consultancy	DATE ISSUED:	14.04.04
SITE TEST No.:	—	LOCATION:	TP 4
SAMPLE No.:	57947	SAMPLE DEPTH m:	0.0-0.1
DATE SAMPLED:	—	SOIL DESCRIPTION:	—
TESTED BY:	jm	DATE TESTED:	13.04.04
CHECKED BY:	MJS	DATE CHECKED:	14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL****(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****4.4****DETERMINATION OF THE EMERSON CLASS****NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER****DISTILLED****TEMPERATURE OF WATER °C****26****CLASS NUMBER****3****ELECTRICIAL CONDUCTIVITY *****41uS****NATA Accredited Laboratory**
Number: 1986

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LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5928
ADDRESS:	PO Box 4403	REPORT No.:	20
	Forest Lake	DATE ISSUED:	14.04.04
PROJECT:	Yarrabilba Geo Eng Consultancy		
SITE TEST No.:	—	LOCATION:	TP 5
SAMPLE No.:	57948	SAMPLE DEPTH m:	0.0-0.4
DATE SAMPLED:	—	SOIL DESCRIPTION:	—
TESTED BY:	jm	DATE TESTED:	13.04.04
CHECKED BY:	MJS	DATE CHECKED:	14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL
(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****4.7****DETERMINATION OF THE EMERSON CLASS
NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER****DISTILLED****TEMPERATURE OF WATER °C****26****CLASS NUMBER****3****ELECTRICIAL CONDUCTIVITY *****81uS****NATA Accredited Laboratory
Number: 1986**

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LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.: 5928
ADDRESS:	PO Box 4403	REPORT No: 21
	Forest Lake	DATE ISSUED: 14.04.04
PROJECT:	Yarrabilba Geo Eng Consultancy	
SITE TEST No.:	—	LOCATION: TP 6
SAMPLE No.:	57950	SAMPLE DEPTH m: 0.0-0.1
DATE SAMPLED:	—	SOIL DESCRIPTION: —
TESTED BY:	jm	DATE TESTED: 13.04.04
CHECKED BY:	MJS	DATE CHECKED: 14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL
(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****4.5****DETERMINATION OF THE EMERSON CLASS
NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER
TEMPERATURE OF WATER °C****DISTILLED
26****CLASS NUMBER****3****ELECTRICIAL CONDUCTIVITY *****31.9uS****NATA Accredited Laboratory
Number: 1986**

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LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5928
ADDRESS:	PO Box 4403	REPORT No.:	22
	Forest Lake	DATE ISSUED:	14.04.04
PROJECT:	Yarrabilba Geo Eng Consultancy		
SITE TEST No.:	—	LOCATION:	TP 7
SAMPLE No.:	57952	SAMPLE DEPTH m:	00-0.1
DATE SAMPLED:	—	SOIL DESCRIPTION:	—
TESTED BY:	jm	DATE TESTED:	13.04.04
CHECKED BY:	MJS	DATE CHECKED:	14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL
(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)**

4.4

**DETERMINATION OF THE EMERSON CLASS
NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER****DISTILLED****TEMPERATURE OF WATER °C**

26

CLASS NUMBER

8

ELECTRICIAL CONDUCTIVITY *

57.7uS

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Number: 1986

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LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.: 5928
ADDRESS:	PO Box 4403	REPORT No: 23
	Forest Lake	DATE ISSUED: 14.04.04
PROJECT:	Yarrabilba Geo Eng Consultancy	
SITE TEST No.:	—	LOCATION: TP 8
SAMPLE No.:	57954	SAMPLE DEPTH m: 0.0-0.1
DATE SAMPLED:	—	SOIL DESCRIPTION: —
TESTED BY:	jm	DATE TESTED: 13.04.04
CHECKED BY:	MJS	DATE CHECKED: 14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL
(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****4.2****DETERMINATION OF THE EMERSON CLASS
NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER
TEMPERATURE OF WATER °C****DISTILLED
26****CLASS NUMBER****8****ELECTRICIAL CONDUCTIVITY *****42uS****NATA Accredited Laboratory
Number: 1986**

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M. J. SANDILANDS

LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5928
ADDRESS:	PO Box 4403	REPORT No:	24
	Forest Lake	DATE ISSUED:	14.04.04
PROJECT:	Yarrabilba Geo Eng Consultancy		
SITE TEST No.:	—	LOCATION:	TP 9
SAMPLE No.:	57956	SAMPLE DEPTH m:	0.0-0.1
DATE SAMPLED:	—	SOIL DESCRIPTION:	—
TESTED BY:	jm	DATE TESTED:	13.04.04
CHECKED BY:	MJS	DATE CHECKED:	14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL
(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****4.2****DETERMINATION OF THE EMERSON CLASS
NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER****DISTILLED****TEMPERATURE OF WATER °C****26****CLASS NUMBER****3****ELECTRICIAL CONDUCTIVITY *****31.9uS****NATA Accredited Laboratory
Number: 1986**

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* Non NATA Accredited Test

M. J. SANDILANDS

LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5928
ADDRESS:	PO Box 4403	REPORT No:	25
	Forest Lake	DATE ISSUED:	14.04.04
PROJECT:	Yarrabilba Geo Eng Consultancy		
SITE TEST No.:	—	LOCATION:	TP 10
SAMPLE No.:	57958	SAMPLE DEPTH m:	0.0-0.1
DATE SAMPLED:	—	SOIL DESCRIPTION:	—
TESTED BY:	Jm	DATE TESTED:	13.04.04
CHECKED BY:	MJS	DATE CHECKED:	14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL****(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****4.7****DETERMINATION OF THE EMERSON CLASS****NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER****DISTILLED****TEMPERATURE OF WATER °C****26****CLASS NUMBER****8****ELECTRICIAL CONDUCTIVITY *****28uS****NATA Accredited Laboratory**
Number: 1986

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LABORATORY TESTING REPORT SHEET

CLIENT:	Delfin Lend Lease Ltd	JOB No.:	5928
ADDRESS:	PO Box 4403 Forest Lake	REPORT No:	26
PROJECT:	Yarrabilba Geo Eng Consultancy	DATE ISSUED:	14.04.04
SITE TEST No.:	—	LOCATION:	Bh 10
SAMPLE No.:	57962	SAMPLE DEPTH m:	0.0-0.1
DATE SAMPLED:	—	SOIL DESCRIPTION:	—
TESTED BY:	jm	DATE TESTED:	13.04.04
CHECKED BY:	MJS	DATE CHECKED:	14.04.04

TEST RESULTS**TEST METHOD****RESULT****DISPERSION OF SOIL (AS1289 3.8.3-1997)****DETERMINATION OF THE PH OF A SOIL
(ELECTROMETRIC METHOD) (AS 1289 4.3.1-1997)****3.7****DETERMINATION OF THE EMERSON CLASS
NUMBER OF A SOIL (AS 1289 3.8.1-1997)****TYPE OF WATER
TEMPERATURE OF WATER °C****DISTILLED
26****CLASS NUMBER****3****ELECTRICIAL CONDUCTIVITY *****263uS****NATA Accredited Laboratory
Number: 1986**

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PERMEABILITY BY FALLING HEAD	
NATA Laboratory 9926 TEST PROCEDURE: KH2 (in house method) based on K H Head (1988) Manual of Laboratory Testing, 10.7	
Client: Bowler Geotechnical	Certificate No. 404144-P
Project: 5928 Permeability Material Check	Date: 30/04/2004
	Page 1 of 1
Sample No.	404144
Sample Identification	TP 2
Depth (m)	1.0-1.2
Field Moisture Content (%):	8.6
Maximum Dry Density (tm^3)	1.97
Optimum Moisture Content (%)	12.0
Placement Wet Density (tm^3):	2.17
Placement Moisture Content (%)	11.5
Placement Density Ratio (%):	98.5
PERMEABILITY: $k_{20} = 4 \times 10^{-9} \text{ m/s}$	
Classification: (CI) Sandy Clay, brown, moist.	
Remarks: Sample, maximum dry density and density ratio supplied by the client.	

GT010



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NATA Accredited Laboratory Number 9926

Authorised Signatory

G. Hamilton

Page 1 of 1

PERMEABILITY BY FALLING HEAD	
NATA Laboratory 9926	
TEST PROCEDURE: KH2 (in house method) based on K H Head (1988) Manual of Laboratory Testing, 10.7	
Client: Bowler Geotechnical	Certificate No. 404145-P
Project: 5928 Permeability Material Check	Date: 30/04/2004
	Page 1 of 1
Sample No.	404145
Sample Identification	TP 6
Depth (m)	0.0-0.4 0.2-0.4 0.4-0.6
Field Moisture Content (%):	11.7
Maximum Dry Density (tm ³)	1.83
Optimum Moisture Content (%)	14.5
Placement Wet Density (tm ³):	2.05
Placement Moisture Content (%)	14.4
Placement Density Ratio (%):	98.5
PERMEABILITY: $k_{20} = 2 \times 10^{-9} \text{ m/s}$	
Classification: (CI) Sandy Clay, red/brown, moist.	
Remarks: Sample, maximum dry density and density ratio supplied by the client.	

GT010



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NATA Accredited Laboratory Number 9926

Authorised Signatory

G. Hamilton

Page 1 of 1

PERMEABILITY BY FALLING HEAD	
NATA Laboratory 9926 TEST PROCEDURE: KH2 (in house method) based on K H Head (1988) Manual of Laboratory Testing, 10.7	
Client: Bowler Geotechnical	Certificate No. 404146-P
Project: 5928 Permeability Material Check	Date: 30/04/2004
	Page 1 of 1
Sample No.	404146
Sample Identification	BH TP 10 pb.
Depth (m)	0.8-1.1
Field Moisture Content (%):	12.0
Maximum Dry Density (tm^3)	2.06
Optimum Moisture Content (%)	8.5
Placement Wet Density (tm^3):	2.01
Placement Moisture Content (%)	9.3
Placement Density Ratio (%):	97.5
PERMEABILITY:	$k_{20} = 1 \times 10^{-9} \text{ m/s}$
Classification: (SC) Clayey Sand with sandy clay patches, brown moist.	
Remarks: Sample, maximum dry density and density ratio supplied by the client.	

GT010



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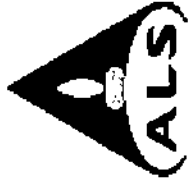
NATA Accredited Laboratory Number 9926

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APPENDIX C
WATER QUALITY TEST RESULTS



ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: BOWLER GEOTECHNICAL	Laboratory	: ALS Environmental Brisbane	Page	: 1 of 6
Contact	: DAVID BOWLER	Contact	: Michael Heery	No. of samples	: 3
Address	: 7/98 ANZAC AVENUE HILLCREST QLD AUSTRALIA 4118	Address	: 32 Shand Street Stafford QLD Australia 4053	Data received	: 8 Apr 2004
Project	: YARRABILBA	Quota number	: EB20030009	Work order	: EB0401332
Order number	: - Not provided -	Unique Report ID	: 00701		
C-O-C number	: - Not provided -				
E-mail	: db@bowlergeotechnical.com.au	E-mail	: Michael.Heery@alsenviro.com		
Telephone	: (07)3800-6446	Telephone	: 61-7-32437222		
Facsimile	: (07)3809-3578	Facsimile	: 61-7-32437259		

This final report was issued on Tuesday, April 27, 2004 for the ALS work order reference EB0401332 and supersedes any reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

ALSE - QUALITY, SERVICE and TECHNOLOGY provided GLOBALLY



NATA Accredited Laboratory
Inorganics number: 825 - 818 (Brisbane)

The Laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its scope of accreditation. This document shall not be reproduced except in full.

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

Signatory	Position
Kim McCabe	Inorganics Supervisor
Shaun Crabb	Metals Team Leader



Client : BOWLER GEOTECHNICAL
Project : YARRABILBA

Work Order : EB0401332
ALS Quote Reference : EB20030009

Page Number : 2 of 6
Issue Date : 27 Apr 2004

ALS Environmental

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extractions/digestion dilution and/or insufficient sample amount for analysis. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting, # indicates a raised LOR.

Analytical Results

Client Sample ID :		Sample Matrix Type / Description :		Sample Date / Time :	
Laboratory Sample ID :		LOR		Units	
Analyte	CAS number	BORE 1		BORE 2	
EA005F: pH by PC Titrator		WATER / WATER 5 Apr 2004 15:00 EB0401332-001		WATER / WATER 5 Apr 2004 15:00 EB0401332-002	
pH Value	12408-02-5	7.87		7.93	
EA010P: Conductivity by PC Titrator		2900		7100	
Electrical Conductivity @ 25°C		1		995	
EA025: Suspended Solids		206		6950	
Suspended Solids (SS)		1		19	
EA045: Turbidity		160		5200	
Turbidity		0.1		21.0	
EG005F: Dissolved Metals by ICP-AES		<0.01		<0.01	
Iron	7439-89-6	0.01		<0.01	
EG005T: Total Metals by ICP-AES		6.94		175	
Iron	7439-89-6	0.01		2.11	
EG020F: Dissolved Metals by ICP-MS		<0.01		<0.01	
Aluminium	7429-90-5	0.01		<0.01	
EG020T: Total Metals by ICP-MS		3.34		94.2	
Aluminium	7429-90-5	0.01		0.38	
Arsenic	7440-38-2	0.001		<0.001	
EP025: Oxygen - Dissolved (DO)		3.5		3.1	
Dissolved Oxygen		0.1		7.5	



Quality Control Report - Laboratory Duplicates

The quality control term Laboratory Duplicate refers to an in-laboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
 - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. Abbreviations: LOR = Limit of Reporting, RPD = Relative Percent Difference.
 • Indicates failed QC. Refer to the Summary of all QC Outliers within the Interpretive Quality Control Report.

The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWL-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:-
 - Result < 10 times LOR, no limit
 - Result between 10 and 20 times LOR, 0% - 50%
 - Result > 20 times LOR, 0% - 20%

Matrix Type: WATER

Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Original Result	Duplicate Result	RPD
EA003P: pH by PC Titrator - (QC Lot: 4369)				pH Unit	pH Unit	%
pH Value	EB0401312-002	- Anonymous -	0.01 pH Unit	6.77	6.78	0.1
pH Value	EB0401351-004	- Anonymous -	0.01 pH Unit	6.68	6.70	0.2
EA010P: Conductivity by PC Titrator - (QC Lot: 4370)				µS/cm	µS/cm	%
Electrical Conductivity @ 25°C	EB0401312-002	- Anonymous -	1 µS/cm	1910	1910	0.00
EA025: Suspended Solids - (QC Lot: 4111)				mg/L	mg/L	%
Suspended Solids (SS)	EB0401332-001	BORE 1	1 mg/L	206	201	2.4
Suspended Solids (SS)	EB0401342-008	- Anonymous -	1 mg/L	29	28	3.5
EA045: Turbidity - (QC Lot: 4108)				NTU	NTU	%
Turbidity	EB0401160-001	- Anonymous -	0.1 NTU	3.6	3.3	8.7
Turbidity	EB0401332-001	BORE 1	0.1 NTU	160	180	11.8
EG005F: Dissolved Metals by ICP-AES - (QC Lot: 4457)				mg/L	mg/L	%
Iron	EB0401332-001	BORE 1	0.01 mg/L	<0.01	<0.01	0.00
Iron	EB0401392-005	- Anonymous -	0.01 mg/L	0.06	0.06	1.1
EG005T: Total Metals by ICP-AES - (QC Lot: 4115)				mg/L	mg/L	%
Iron	EB0401308-001	- Anonymous -	0.01 mg/L	15.3	15.3	0.2
Iron	EB0401353-007	- Anonymous -	0.01 mg/L	1.12	1.13	1.1
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 4212)				mg/L	mg/L	%
Aluminium	EB0401332-002	BORE 2	0.01 mg/L	<0.01	<0.01	0.00
EG020T: Total Metals by ICP-MS - (QC Lot: 4114)				mg/L	mg/L	%
Aluminium	EB0401308-001	- Anonymous -	0.01 mg/L	0.58	0.60	3.7
Arsenic			0.001 mg/L	0.002	0.002	34.1
Aluminium	EB0401353-006	- Anonymous -	0.01 mg/L	0.25	0.26	5.1
Arsenic			0.001 mg/L	0.001	<0.001	37.0



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

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits based on statistical evaluation of actual laboratory data. Abbreviations: LOR = Limit of reporting.

* Indicates failed QC. Refer to the Summary of all QC Outliers within the Interpretive Quality Control Report.

Matrix Type: WATER

Analyte name	LOR	Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Low	High
EA010P: Conductivity by PC Titrator - (QC Lot: 4370)		µS/cm		%	%	%
Electrical Conductivity @ 25°C	1 µS/cm	<1	4000	100	70	130
EA025: Suspended Solids - (QC Lot: 4111)		mg/L		%	%	%
Suspended Solids (SS)	1 mg/L	<1	150	98.7	70	130
EA045: Turbidity - (QC Lot: 4108)		NTU		%	%	%
Turbidity	0.1 NTU	<0.1	40.0	101	70	130
EG005F: Dissolved Metals by ICP-AES - (QC Lot: 4457)		mg/L		%	%	%
Iron	0.01 mg/L	<0.01	---	---	---	---
EG005T: Total Metals by ICP-AES - (QC Lot: 4115)		mg/L		%	%	%
Iron	0.01 mg/L	<0.01	1.00	111	70	130
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 4212)		mg/L		%	%	%
Aluminium	0.01 mg/L	<0.01	0.10	101	70	130
EG020T: Total Metals by ICP-MS - (QC Lot: 4114)		mg/L		%	%	%
Aluminium	0.01 mg/L	<0.01	1.00	102	70	130
Arsenic	0.001 mg/L	<0.001	1.000	107	70	130



Quality Control Report - Matrix Spikes (MS)

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

* Indicates failed QC. Refer to the Summary of all QC Outliers within the Interpretive Quality Control Report.

Matrix Type: WATER

Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration mg/L	Actual Results		Recovery Limits	
					Sample Result	Spike Recovery MS	Low	High
EG005F: Dissolved Metals by ICP-AES - (QC Lot: 4457)	EB0401332-001	BORE 1	0.01 mg/L	1.00	mg/L	%	%	%
Iron					<0.01	102	70	130
EG005T: Total Metals by ICP-AES - (QC Lot: 4115)	EB0401308-001	- Anonymous -	0.01 mg/L	1.00	mg/L	%	%	%
Iron					15.3	Not determined	70	130
EG020T: Total Metals by ICP-MS - (QC Lot: 4114)	EB0401308-001	- Anonymous -	0.01 mg/L	1.00	mg/L	%	%	%
Aluminium					0.58	102	70	130
Arsenic					0.002	111	70	130



Client : BOWLER GEOTECHNICAL
Project : YARRABILBA

Work Order : EB0401332
ALS Quote Reference : EB20030009

Page Number : 6 of 6
Issue Date : 27 Apr 2004

ALS Environmental

Method Reference Summary

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

EA005-P: pH by PC Titrator

(APHA 20th ed., 2540D, ALSQWI-EN/EA005) pH is a measure of the Hydrogen ion concentration or more simplistically, the acidity/alkalinity of a sample. ALS determines pH on water samples by both pH meter or automated pH measurements (eg. PC Titrator)

EA010-P: Conductivity by PC Titrator

(APHA 20th ed., 2510, ALSQWI-EN/EA010) Conductivity is a measure of the ability of an aqueous solution to carry an electric current. ALS determines conductivity by both manual measurement (QWI-EN/EA010) and automated measurement (eg. PC Titrator, QWI-EN/EA010P).

EA025: Suspended Solids

(APHA 20th ed., 2540D, ALSQWI-EN/EA025) Suspended solids is a gravimetric procedure employed to determine the amount of 'non-filterable' residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis.

EA045: Turbidity

APHA 20th ed., 2130 B

EG005F: Dissolved Metals by ICP-AES

(APHA 20th ed., 3120; USEPA SW 846 - 6010; ALS QWI-EN/EG005) The ICPAES technique quickly breaks the sample down into atoms and ions under extremely hot plasma. Atoms are then ionized, emitting a characteristic spectrum. The spectrometer then separates the wavelengths, prior to comparison of intensities against matrix matched standards for quantification.

EG005T: Total Recoverable Metals by ICP-AES

(APHA 20th ed., 3120; USEPA SW 846 - 6010; ALS QWI-EN/EG005) The ICPAES technique quickly breaks the sample down into atoms and ions under extremely hot plasma. Atoms are then ionized, emitting a characteristic spectrum. The spectrometer then separates the wavelengths, prior to comparison of intensities against matrix matched standards for quantification.

EG020A-F: Dissolved Metals by ICP-MS - Suite A

(APHA 20th ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020) The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

EG020A-T: Total Metals by ICP-MS - Suite A

(APHA 20th ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020) The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

EN25: Digestion for Total Recoverable Metals

(USEPA SW846-3005, ALSQWI-EN/25) Method 3005 is an acid digestion procedure used to prepare surface and ground water samples for analysis by inductively coupled plasma spectroscopy (ICP-AES or ICPMS). Samples prepared by Method 3005 may be analysed for the determination of a wide range of metals.

EP025: Oxygen - Dissolved

APHA 20th ed., 4500 O - G