

Central Coast Office 6/6 Morton Close, Tuggerah NSW 2259 Telephone (02) 4351 6200 Facsimile (02) 4351 6300 Email gosnetgeo@bigpond.com

FORBES RIGBY PTY LTD

PROPOSED VINCENTIA COASTAL VILLAGE NAVAL COLLEGE ROAD, VINCENTIA

ALTERNATIVE SHOPPING CENTRE & COMMERCIAL PRECINCT

GEOTECHNICAL ASSESSMENT

REPORT G24048/1-A JUNE 2004



Central Coast Office 6/6 Morton Close, Tuggerah NSW 2259 Telephone (02) 4351 6200 Facsimile (02) 4351 6300 Email gosnetgeo@bigpond.com

G24048/1-A GP:KW 8th June 2004

Forbes Rigby Pty Ltd 278 Kiera Street WOLLONGONG NSW 2500

Attention: Mr Martin Wells

Dear Sir

Re: Proposed Vincentia Coastal Village, Naval College Road, Vincentia, Alternative Shopping Centre and Commercial Precinct: Geotechnical Assessment for Masterplanning Study.

Find enclosed our geotechnical assessment report for the above project site.

This report presents the results of field and laboratory testing and describes surface, subsurface and geotechnical conditions. The report provides an assessment of geotechnical constraints and guidelines on earthworks, footings, pavements and drainage.

Please contact Mr Gary Peake or the undesigned if you require further assistance.

For and on behalf of Network Geotechnics Pty Ltd

R J King *BE((divil)* Principal Geotechnical Engineer

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1.0 INTRODUCTION

As requested, Network Geotechnics Pty Ltd has carried out geotechnical studies at an alternative site for a proposed shopping centre and commercial precinct fronting Naval College Road (Jervis Bay Road), Vincentia.

The alternative commercial precinct is identified as part of Lot 802 Jervis Bay Road and occupies an area of about 10 hectares bound by Naval College Road to the south-west and elsewhere by undeveloped bushland. The Bay and Basin Leisure Centre is situated about 400m further to the east. The site extends about 300 to 400m north-south and 300 to 350m east-west. A proposed layout plan of the site is shown on the attached Drawing No. G24048/1-1.

We have recently completed a Geotechnical Assessment on behalf of The Riverview Group for the originally proposed shopping centre and commercial precinct site adjacent to the Bay and Basin Leisure Centre (our Report G23129/1-A of 14/1/04). Prior to that, we had completed a Geotechnical Masterplanning Study on behalf of Forbes Rigby Pty Ltd for a larger 115 hectare site which includes both the original and alternate commercial precincts and undeveloped bushland to the north-west (our Report G23085/1-D of 16/12/03).

Based on review of the latest masterplan by Annand Alcock and B & N Architects, key elements of the proposed development are understood to be as follows:

- Stage 1 of the shopping centre/commercial precinct occupies the southern half of the site and includes carparking (974 spaces), supermarket, bulky goods building, medical centre, food outlets and specialty retail.
- Stage 2 of the shopping centre/commercial precinct occupies the northern half of the site and includes carparking for about 401 vehicles, supermarket, bulky goods buildings, food outlets, specialty retail and a 4950m² pond/water feature.

The aims of this study were to assess surface, subsurface and geotechnical conditions at the site in order to provide recommendations and advice on shallow and deep footing options, earthworks, surface/subsurface drainage, retaining walls and pavements.

We are currently conducting ongoing groundwater monitoring, the results of which will be presented in a subsequent report.

This report should be read in conjunction with the attached General Notes.

2.0 FIELDWORK

Fieldwork from previous studies considered of relevance to the current site included four machine excavated test pits (TPG1, TPG2, TPF8 and TP10) and four machine auger borehole (BHI3 and TH11 to TH13) taken to depths of 2.4m to 4.0m. A slotted standpipe piezometer was installed within BHI3 to allow ongoing measurement of groundwater levels.

Fieldwork for this current study was undertaken on 20th, 21st, 22nd and 30th April and 2nd June, 2004 and comprised:



- Seven truck mounted auger boreholes (BH1 to BH7) to depths ranging from 2.45 to 8.5m; three skid steer auger boreholes (BH8 to BH10) to 2.6m to 6.0m depth. BH1 to BH7 were continued by NMLC coring to depths ranging from 10.0m to 10.2m. BH8 and BH9 were positioned within a central gully between two proposed residential areas to the west.
- Dynamic Cone Penetrometer (DCP) soundings adjacent to BH1 to BH7 to depths ranging from 0.9m to 1.5m and Standard Penetration Tests (SPT's) within BH1 to BH7 to depths ranging from 1.95 to 3.45m.
- Slotted standpipe piezometers installed within eight boreholes (BH2 to BH5 and BH7 to BH10) and within five shallow (1.5m) boreholes adjacent to BH2 to BH5 and BH7. The upper 3 to 4m of the deep piezometers were backfilled with bentonite to allow measurement of deep groundwater table. The upper 0.5 to 0.75m of the shallow boreholes were backfilled with bentonite to allow measurement of a possible perched water table.
- Groundwater measurement within the thirteen piezometers on 20/4, 21/4, 22/4, 30/4 and 2/6/04.

The fieldwork was carried out by one of our Senior Geotechnical Engineers, one of our Geotechnical Engineers and our Principal Geotechnician, who located the nominated boreholes by hand held GPS (reported sub 5m accuracy), carried out insitu testing, sampling and groundwater measurements and prepared field logs of the boreholes.

Engineering logs of the boreholes from the current site and boreholes/test pits from the original site (considered relevant to this) are presented in Appendix A, together with an explanation sheet defining the terms and symbols used. The borehole/test pit locations are shown on the attached Drawing No. G24048/1-1. A summary of groundwater levels is presented in Attachment C.

3.0 LABORATORY TESTING

Laboratory testing carried out on samples obtained during this study included:

- Atterberg Limits (2) and Gradings (2) to aid assessment of soil classification;
- California Bearing Ratio (CBR) including Standard Compaction (3) to aid assessment of field and optimum soil moisture conditions, subgrade strength and pavement thickness requirements;
- Shrink-Swell (3) to aid assessment of soil volume change characteristics with changes in soil moisture (reactivity) and AS2870 classifications;
- Chemical analysis (2) to aid assessment of soil aggression to buried concrete and steel elements; and
- Point Load Strength Index (57) on selected rock core specimens to aid assessment of rock strength.

The Point Load Strength Index (I_{s50}) results are indicated on the engineering logs. The balance of the test results are presented in Appendix B, summarised in Attachment B and are discussed in Section 5.0.



4.0 SITE CONDITIONS

4.1 Surface

Site topography includes a broad north-east draining valley and the lower to mid slopes of two similar trending ridges. Surface slopes generally range from about 3° to 6°. Vegetation comprises native scrubland on the western slope and sedgeland vegetation within the valley and eastern slope. Surface soils are predominantly Silty SAND.

Mona Creek Road (unformed) extends north from Jervis Bay Road along the western site boundary.

An electricity easement extends through the south-west portion of the site and is defined by a bare access track. The access track is trafficable by most vehicles in dry weather, however soft wet soils may prevent access across the valley after wet weather.

4.2 Subsurface

Geological maps of the area indicate the site to be underlain by mainly Wandrawandian Siltstone. The valley extends to a low lying area to the north of the site underlain by Quaternary Alluvium.

Subsurface conditions encountered at the **boreholes/test pits within/near the shopping centre and commercial precinct** may be summarised as follows:

Layer	Description	Depth to Base of Layer (m)
TOPSOIL:	Silty SAND, fine to medium grained, grey-brown, low plasticity fines, some roots, dry to moist	
		0.1 to 0.6 (typically 0.25)
ALLUVIUM/ SLOPEWASH:	Sandy CLAY, Clayey SAND, Silty SAND, Silty Clayey SAND, SAND/Clayey SAND & SAND at BH1, BH2, BH3, TPG2, TPF8, TP10, BHI3 & TH11 to TH13; fine to medium grained, brown and pale grey mottled yellow-brown, medium dense: low and medium plasticity, brown and grey, fine to medium sand, firm/stiff (BH1 & BH3)	(τγρισαιγ 0.25)
		0.6 to 2.2
RESIDUAL:	CLAY, Sandy CLAY, Sandy Silty CLAY and Clayey SAND, low and medium and medium to high plasticity, brown and grey and grey mottled red/orange, fine to medium sand, M≤Wp becoming M>Wp with depth (west side of valley) and M>Wp becoming M <wp (east="" depth="" of<br="" side="" with="">valley), stiff/very stiff becoming very stiff/hard with depth: the soil profile thickness generally increases northwards and towards the valley.</wp>	
ROCK:	CLAYSTONE and SANDSTONE at BH1, BH2, BH5, TPG1, TPG2, TP10 & TH12; extremely to highly weathered, fine to medium grained, brown-grey-orange, very low to low rock strength	1.5 to 8.5
		>2.4 to 6.0
	SILTSTONE at BH1 to BH7, distinctly to slightly weathered, dark grey, low and low to medium rock strength	
		>10.0

6

Donth to Doon

Layer	Description	•	to Base /er (m)
TOPSOIL:	Clayey SILT (BH8) : Silty CLAY (BH9)	<u>BH8</u>	<u>BH9</u>
SLOPEWASH/ ALLUVIUM:	Clayey SAND (BH8), dry/moist becoming moist/wet, est. medium dense : SAND, Sandy CLAY (BH9), dry/moist becoming wet, est loose/medium dense and stiff/very stiff	0.2	0.1
RESIDUAL:	Sandy CLAY and Clayey SAND, wet becoming dry with depth, stiff/very stiff and medium dense/dense	1.0	5.0
Rock:	SANDSTONE (BH8 only), moderately weathered, brown, est. low rock strength, auger refusal on rock	2.2	6.0+
		2.6+	-

Subsurface conditions encountered **at Boreholes BH8 and BH9 within the central valley** may be summarised as follows:

Groundwater was measured at depths of 0.8m to 4.0m after installation of boreholes within the alternative site. The depths at this time are affected by water used for coring. The latest readings (2/6/04) range from 1.38m to 5.25m within the deep piezometers and the shallow piezometers were dry. Groundwater depths from existing surface levels within the alternative site generally increase to the east and west from the valley.

Groundwater was measured at depths of 2.0m and 1.9m within the central valley at BH8 & BH9 after installation. The latest readings (2/6/04) were 1.38m and 2.17m.

The initial groundwater readings and ongoing monitoring readings to date are presented in Attachment C. Groundwater levels and seepages may vary with fluctuations in rainfall, temperature and other factors. The results of water aggression testing and ongoing groundwater monitoring will be presented in a subsequent report.

5.0 DISCUSSION & RECOMMENDATIONS

5.1 General

Survey long sections of proposed roads/carparks and design elevation of buildings were not available at the time of reporting. However, it is anticipated that earthworks will involve a balanced cut to fill of up to about 3m. It is anticipated that pavement subgrade materials close to cut/fill transitions will generally comprise loose/medium dense and dense SAND/Clayey SAND slopewash/alluvium, stiff Sandy CLAY slopewash or stiff/very stiff residual CLAY and Sandy CLAY. It is anticipated that subgrade materials within areas of significant (>1.5 to 3.0m) cut may include extremely to highly weathered CLAYSTONE or SANDSTONE. Pavement subgrade in areas of fill may include a combination of the above.

Laboratory tests indicate the Sandy CLAY slopewash to be low plasticity (LL 26%, Pl 12%), and the residual Sandy CLAY to be low to medium plasticity (LL 32 to 43%, Pl 20 to 30%). Laboratory tests have also indicated CBR values of 25% for SAND/Clayey SAND slopewash, 11% for Sandy CLAY slopewash, and 6%, 7%, 8% and 10% for residual Sandy CLAY at the current site.



Field moisture for the CBR samples ranged from about 1% to 7% wet of Standard Optimum Moisture Content (SOMC) for the Sandy CLAY and SAND/Clayey SAND slopewash and 1% dry to 4.5% wet of SOMC for the residual Sandy CLAY. It is noted that samples obtained from the east side of the valley at the original commercial site were 3.5% to 7% wet of SOMC and samples obtained from the west side of the valley during the current study were 1% dry to 2% wet of SOMC.

Laboratory Shrink-Swell tests have indicated the Clayey SAND alluvium/slopewash and residual Sandy CLAYS to be of low to moderate reactivity with Iss values of 1.1%, 1.2% and 1.2%.

Chemical analysis on samples of Clayey SAND alluvium/slopewash and residual Sandy CLAY and Gravelly Sandy CLAY indicate the soils to be: acidic with pH values in water (1:2) of 4.9, 4.5 and 5.2; low salinity with EC mS/cm (1:2) of 0.07, 0.19 and 0.05; non-aggressive to concrete structures with sulphate (1:2) of 350, 40 and 150 mgSO₄/kg and non-aggressive to steel structures with chloride (1:2) of 99.5, 34.7 and 111.5 Ω m.

The I_{850} results are indicated on the engineering logs. The remaining laboratory results are summarised in Attachment B.

5.2 Pavements

Laboratory CBR values of 6%, 7%, 8% and 10% have been obtained for residual Sandy CLAYS, 11% for Sandy CLAY slopewash and 25% for SAND/Clayey SAND slopewash. However, there is likely to be the need for insitu lime stabilisation or extensive replacement of excessively wet subgrade unless construction is undertaken following a period of extended dry weather. A CBR value of 10% has been assumed for the design of pavements on lime stabilised subgrade or on select subgrade replacement. As a guide, we have considered a CBR value of 6% for the design of pavements on natural subgrade. If exposed, areas of insitu rock should be ripped and recompacted to a depth of not less than 300mm below subgrade level. CBR strength of these materials and the required pavement thickness should be confirmed during earthworks or when road/carpark design levels are known.

Three other potential benefits of lime stabilisation are decreased excavation volumes (due to thinner pavements), lime effectively "dries" wet subgrade, ie. the need for subgrade replacement may be avoided or significantly reduced and that subgrade and pavement deflections should be reduced.

Indicative pavement thickness designs are presented in Attachment A, together with notes covering design assumptions, compaction criteria, pavement material quality, drainage and other construction issues. The recommended pavement designs are in accordance with Austroads (1992) and APRG Report No 21.

5.3 Footings

5.3.1 Shopping Centre/Supermarkets/Bulky Goods Buildings

It is recommended that building footings extend into very stiff residual clay or dense residual clayey sand or to rock in order to reduce the effects of potential differential movement. If rock is encountered beneath part of a building footing system, it may be



necessary to extend all footings for that building to rock in order to reduce the potential for excessive differential settlements.

Conventional strip and pad footings may be used within the mid to upper, western portion of the site where it is anticipated that very stiff residual CLAY will be encountered close to the excavated level. Within the valley and eastern side of the site where fill is anticipated, pier & beam and pier footings may be required, with the depth to very stiff clay or dense Clayey SAND expected to range up to about 0.5 to 2.5m below existing surface levels.

Pad, strip and shallow pier footings founded within very stiff/dense residual CLAY/Clayey SAND or controlled fill (discussed in Section 5.4 Earthworks) may be proportioned for a maximum allowable bearing pressure of up to 100kPa. Settlements for footings not wider that 1m, founded in this strata are estimated to be in the range of about 10mm to 40mm. Bored piers placed at depths >4D (where D is the pier diameter) may be proportioned for a maximum allowable bearing pressure of 300kPa. Based on results of point load strength tests carried out on core samples from BH1 to BH7, it is assessed that footings founded in highly weathered CLAYSTONE or SANDSTONE may be proportioned for a maximum allowable bearing pressure of up to 700kPa and footings founded in distinctly weathered SILTSTONE, up to 1000kPa. Footings founded within either of these strata may be designed for allowable side shear of up to 75kPa within the rock socket.

Shallow groundwater is known to have been an issue during the design and construction of the Bay and Basin Leisure Centre and also appears to be present within anticipated footing depths over much of the low part of this site. If groundwater levels cannot be sufficiently lowered locally by stormwater or subsoil drainage or similar, techniques such as temporary liners, dewatering and rapid blinding of the drilled cleaned base with about 0.1m thickness of concrete could be considered. Alternatively, consideration should be given to insitu grout injected piles, driven timber piles or steel screw piles instead of bored piers.

Timber piles of 300mm dia driven to an effective set within very stiff/dense residual CLAY/Clayey SAND have an allowable capacity of about 50kN. Screw piles of typically 90mm shaft dia and 250mm helix diameter, founded within strata of similar stiffness have an allowable capacity of about 75kN to 95kN. Higher capacities should be achievable with deeper installation.

Footings should be designed by a Structural Engineer and should be inspected and approved by a Structural or Geotechnical Consultant prior to placement of concrete.

Footings should be founded below the zone of influence of all sewer and drainage easements (ie a line that extends up at 45° from invert) unless the service is concrete encased. The zone of influence of possible future open table drains should be considered as a line that extends up at 2H:1V from the toe of batter.

5.3.2 Other Buildings

Based on the laboratory Shrink Swell results discussed in Section 5.1, an Iss value of 1.2% has been adopted for design.



Adopting a soil surface suction change (Δu)pF of 1.5 and a suction depth (H_s)m of 1.5 (suitable for a wet coastal climate such as Vincentia) site classification in accordance with AS2870-1996 "Residential Slabs and Footings" is assessed as follows:

- ExistingClass S (slightly reactive) maximum allowable bearing
pressure of 100kPa for high level footings on slopewash
or residual soils.
- Site modified by cut or controlled fill earthworks (refer Note 1
 Class M (moderately reactive) – maximum allowable bearing pressure of 100kPa for high level footings on slopewash, residual soils or controlled fill.
- Site modified by non-controlled
 Class P (problem) – requires not less than Class M footing piered to suitable natural ground beneath the fill.

<u>Note 1</u>

and 5.4): Section

Substantial cut/fill earthworks (>0.4m depth) will alter the classification from Class S to Class M due to removal of an existing surficial cracked zone which currently mitigates surficial shrink-swell movements.

The above classifications are provided on the basis that the performance expectations set out in Appendix B of AS2870 – 1996 are acceptable and that future site maintenance is in accordance with the recommendations and advice contained in CSIRO Sheet BTF 18, a copy of which is attached.

Further advice should be sought if imported fill is used within the building areas in order to verify that the above classifications remain valid. A more reactive material when placed as controlled fill may raise the classification to Class H (highly reactive).

5.4 Earthworks

Prior to any controlled fill earthworks, vegetation, root affected soil and other deleterious materials should be removed to spoil or stockpiled for future landscaping. Stripped depths of typically 100 to 200mm should be considered, however localised deeper stripping should be anticipated.

The exposed surfaces should be proof rolled and any areas of localised softening should be excavated and replaced with an approved preferably granular fill. An initial select fill bridging layer about 0.5m thickness may be required if extensive wet ground is exposed at the time of construction. The bridging depth should be verified by the Geotechnical Testing Consultant after conducting trials.

Approved fill should be placed in layers of generally 200 to 300mm loose thickness and thoroughly and uniformly rolled. Fill should be compacted to a minimum Dry Density Ratio (AS1289 5.4.1 – 1993) of 98% Standard. Within pavement areas, compaction within the upper 300mm to subgrade level should be increased to not less than 100% Standard. All fill should be compacted within a moisture content range of about \pm 2% from Standard Optimum. Fill required to support buildings or pavements should be



tested in accordance with AS3798 – 1996 "Guidelines on Earthworks for Commercial and Residential Developments".

Unsupported cuts and fills should be limited to a height of 1m, battered no steeper than 3H:1V within sandy topsoil, slopewash and similar fill soils, 2H:1V within residual clay/clayey sand or similar fill soils and 1H:1V within sandstone. Trimmed batters should be vegetated or otherwise protected against erosion. Unsupported temporary batters during construction should not be steeper than 1.5H:1V (sands) 1H:1V (clays) and 0.5H:1V (sandstone). Cuts and fills exceeding 1m height should be supported by engineered retaining walls constructed with generous provision for subsoil drainage and designed for surcharge loads from sloping ground and/or adjacent structures or loads.

Retaining walls may be designed using the following parameters:

	Soil Layer	Unit Weight (kN/m ³)	Coefficient of active earth pressure (Ka)	Coefficient of passive earth pressure (Kp)
Slopewash:	SAND or Clayey SAND	20	0.33	3
Residual:	Clayey SAND	19	0.4	2.5
	Sandy CLAY or Silty CLAY	18	0.4	2.5

Collected surface and runoff water should be discharged in a controlled manner as required by Council.

For and on behalf of Network Geotechnics Pty Ltd

Gary Peake BE (Civil), GCE

Senior Geotechnical Engineer

Reviewed by

King BÉ (Civil)

M Principal Geotechnical Engineer





GENERAL

Geotechnical reports present the results of investigations carried out for a specific project and usually for a specific phase of the project (e.g. preliminary design). The report may not be relevant for other phases of the project (e.g. construction), or where project details change.

SOIL AND ROCK DESCRIPTIONS

Soil and rock descriptions are based on AS 1726 – 1993, using visual and tactile assessment except at discrete locations where field and / or laboratory tests have been carried out. Refer to the terms and symbols sheet for definitions.

GROUNDWATER

The water levels indicated on the logs are taken at the time of measurement and depending on material permeability may not reflect the actual groundwater level at those specific locations. Also, groundwater levels can vary with time due to seasonal or tidal fluctuations and construction activities.

INTERPRETATION OF RESULTS

The discussion and recommendations in the accompanying report are based on extrapolation / interpolation from data obtained at discrete locations. The actual interface between the materials may be far more gradual or abrupt than indicated. Also, actual conditions in areas not sampled may differ from those predicted.

CHANGE IN CONDITIONS

Subsurface conditions can change with time and can vary between test locations. Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations can also affect subsurface conditions.

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This report is the subject of copyright and shall not be reproduced either totally or in part without the express permission of this firm. Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimise the likelihood of misinterpretation from logs.

FURTHER ADVICE

Network Geotechnics would be pleased to further discuss how any of the above issues could affect your specific project. We would also be pleased to provide further advice or assistance including:

- assessment of suitability of designs and construction techniques;
- contract documentation and specification;
- construction control testing (earthworks, pavement materials, concrete);
- construction advice (foundation assessments, excavation support).

Foundation Maintenance and Footing Performance: A Homeowner's Guide



BTF 18 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a boglike suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES						
Class	Foundation					
Α	Most sand and rock sites with little or no ground movement from moisture changes					
S	Slightly reactive clay sites with only slight ground movement from moisture changes					
М	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes					
Н	Highly reactive clay sites, which can experience high ground movement from moisture changes					
Е	Extremely reactive sites, which can experience extreme ground movement from moisture changes					
A to P	Filled sites					
Р	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise					

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred. The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.

Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

 Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.

- · Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter

It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

 The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

 The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

 Further professional advice needs to be obtained before taking any action based on the information provided.

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ATTACHMENT A

Indicative Pavement Thickness

Proposed Alternative Shopping Centre & Commercial Precinct Naval College Road, Vincentia

--- Indicative Pavement Thickness (mm) ---

	Assumed Design Traffic		Design Subgrade						
Location	(ESA's)	(CVAG's)	(CBR %)	Select	Sub- base	Base- course	Wearing Course	TOTAL	
HEAVY TRAFFIC Flexible	(say)	-	10 (lime stab or	(Note 3)	100 (U)	160 (U)	40 (AC)	300	
Construction	5x10 ⁶		select) 6 (natural)		220 (U)	160 (U)	40 (AC)	420	
Rigid Construction	-	(say) 3x10 ⁷	10 (lime stab or select)	(Note 3)	125 (B)	-	200 (C)	325	
			6 (natural)	-	125 (B)	-	210 (C)	335	
MODERATE TRAFFIC Flexible Construction	(say) 3x10⁵	-	10 (lime stab or select) 6 (natural)	(Note 3) -	100 (U) 190 (U)	120 (U) 120 (U)	30 (AC) 30 (AC)	250 . 340	
Rigid Construction	-	(say) 2x10 ⁶	10 (lime stab) 6 (natural)	-	125 (B) 125 (B)	- -	180 (C) 190 (C)	305 315	
LIGHT TRAFFIC Flexible Construction	(say) 6x10⁴	-	10 (lime stab or select) 6 (natural)	(Note 3)	100 (U) 150 (U)	120 (U) 120 (U)	30 (AC) 30 (AC)	250 300	
Rigid Construction	-	(say) 4x10 ⁵	10 (lime stab or select) 6 (natural)	-	100 (B) 100 (B)		170 (C) 180 (C)	270 280	

<u>Notes:</u>

- 1. (AC) denotes asphaltic concrete on one-coat flush seal; (C) denotes 32 MPa concrete with joint and reinforcement details by a Civil Design Consultant, (U) denotes unbound pavements in accordance with RTA 3051 or similar; (B) denotes bound pavement materials in accordance with RTA 3052 or similar.
- 2. The indicative pavement thickness designs have been prepared in accordance with Austroads (1992) and APRG Report No 21 based on the design CBR values and assumed traffic loadings noted above. Please contact this office if other design conditions are anticipated.



- 3. The CBR value of 6% refers to natural soils. The CBR value of 10% refers to natural subgrade stabilised to about 300 to 350mm depth by the insitu addition of 3% lime by dry mass, subject to confirmatory testing; or select subgrade (CBR > 10%) placed as a similar to slightly increased thickness.
- 4. There may be the need for further investigation and CBR testing once final road/carparking layout and long section plans are available. Notwithstanding the above, subgrade conditions, the depth of possible select subgrade replacement and the recommended pavement thickness designs should be verified after proof roll inspection of preliminary boxing.
- 5. The following minimum dry density ratios (AS1289 5.4.1 1993) should be achieved during construction:

Basecourse	98%	Modified
Sub-base	95%	Modified
Subgrade (natural or select)	100%	Standard
Subgrade Fill (below 300mm)	98%	Standard

6. Subsoil drainage lines should be installed to a depth preferable not less than 600mm below design subgrade level beneath/behind all kerblines and garden perimeters. Consideration should be given to the installation of upslope subsoil lines prior to subgrade boxing to facilitate pavement construction.

ATTACHMENT B

Soil Test Results Summary

	Ē r			Γ			
	Aggression to Steel or	Concrete	t	1	None	None	1
	S/S	(lss%)		I	1.1	1.2	1.2
	CBR 2 5mm	reading		9	I	10	I
		MV (%)	+1.0	+2.0	ŧ	-1.0	•
CBR Data	CMA	(%)	14.5	22.0	1	14.0	ı
	OMO	(%)	13.5	20.0	1	15.0	-
		(t/m ³)	1.85	1.65	1	1.84	1
Atterberg		PI (%)	12	1	1	20	1
Atter		(%) TT	26	1	I	32	I
	Abbrev.	Description	(CL) Sandy CLAY	(CL) CLAY	(SC) Clayey SAND	(CL) Sandy CLAY	(CL) Sandy CLAY
		Layer	0.3-0.6 Slopewash	Residual	0.4-0.8 Alluvium/Slopewash	Residual	Residual
	Depth	(m)	0.3-0.6	0.7-1.0	0.4-0.8	0.5-0.9	0.5-0.9
		Location	BH1	BH1	BH2	BH4	BH7
		١D٨	UTS -	LNE	 1997	I)	

1	None	F
ł	1	1
25	2	ω
+7.0	+4.5	+3.5
16.5	20.0	· 21.5
9.5	15.5	18.0
1.97	1.83	1.74
F	43 30	ı
4	43	1
(SP/SC) SAND/Clayey SAND	(CL) Gravelly Sandy CLAY	(CL) Sandy CLAY
0.5-0.8 Slopewash	Residual	Residual
0.5-0.8	0.9-1.2	1.0-3.0
TP10	TP10	TH13
λC SNC	NUS STUI	d



ATTACHMENT C

Summary Groundwater Readings

Piezometer		Surface to Groundwater Depth (m)							
Location		After In:	stallation	30/	4/04	2/6/04			
		Deep	Shallow	Deep	Shallow	Deep	Shallow		
۵.	BHF9	1.4	dry	1.24	1.24	1.25	1.16		
r Site	BHI1	1.5	dry	1.08	1.11	1.61	1.11		
Earlier Site	BH3	dry	dry	4.79	dry	5.08	dry		
Ш	BH5	dry	dry	3.96	dry	4.76	dry		
	BH2	2.4	dry	2.12	dry	2.35	dry		
ite	BH3	1.7	dry	1.33	dry	1.38	dry		
Alternative Site	BH4	2.8	dry	2.61	dry	2.76	dry		
rnat	BH5	2.2	dry	4.79	dry	5.25	dry		
Alte	BH7	0,8	dry	2.10	dry	2.40	dry		
	BH10	4.0	-	0.80	-	1.08	-		
idential Site	BH8	2.0	-	0.97	-	1.38	-		
Residential Site	BH9	1.9	-	1.87	-	2.17	-		

<u>Note</u>:

- **Deep** piezometers were installed to the depth of the borehole with the upper 3 to 4m backfilled with bentonite and the lower screened portion backfilled with sand.
- **Shallow** piezometers were installed to 1.5m depth with the upper 0.5 to 0.75m backfilled with bentonite and the lower screened portion backfilled with sand.



APPENDIX A

Field Investigation Results



TERMS AND SYMBOLS

				[
SOIL DE	SCRIPTIONS			FZ SZ	Fractured Shear zor		st ir	Stepped Irregular
Moisture	Condition			SZ VN	Shear Zor Vein	ie	11	megulai
WOIStard	D	Dry			VOIT			
	M	Moist		Infill o	or Coating		Rough	ress
	W	Wet		Cn	Clean		pol	Polished
	Wp	Plastic Limit		Cl	Clay		slk	Slickensided
	wi	Liquid Limit		Ca	Calcite		smo	Smooth
	MC	Moisture Content		Fe	Iron oxide)	rou	Rough
				Mi	Micaceou	IS	vro	Very rough
Consister	псу		Qu (kPa)	Qz	Quartz			
	VS	Very Soft	<25					
	S	Soft	25 – 50	EXCA	AVATION/DRILL	ING ME	THOD AN	D CASING
	F	Firm	50 - 100					
	St	Stiff	100 - 200		BH			ator bucket
	VSt	Very Stiff	200 - 400		NE		al exposi	
	Н	Hard	>400		HE		excavatio	
	Fb	Friable			AS		r Screwing] ^
					AD		r Drilling *	
Density Ir		., ,	I _D (%)		R		r/Tricone	
	VL	Very Loose	< 15		W * day	Wash		1 ouffin
	L	Loose	15 – 35				t shown bj	7 SUMX
	MD	Medium Dense	35 - 65		В	Blank		
	D	Dense	65 - 85		V T		haped Bit	ido Pit
	VD	Very Dense	> 85		I	rung	sten Carb	
ROCK D	ESCRIPTIONS	5			NMLC		C Core Dr	
				1 N	IQ/HQ	Wireli	ne Core E)rilling
Weatheri		D / 1 . 0 . 1			0	0		
	Rs	Residual Soil			С	Casir	ıg	
	XW	Extremely Weathe			М	Mud		
	HW	Highly Weathered		CANA	PLES/TESTS			
	MW	Moderately Weath		SAIVI	PLES/IESIS			
	DW	Distinctly Weather			D	Dulk	omplo	
	SW	Slightly Weathere Fresh	a		B D		sample rbed sam	
	FR				U50			e sample
	(Dw covers b	oth HW & MW)			000		m diamet	
Strength			ls (50) MPa		PP			meter (kPa)
Silengin	EL	Extremely Low	< 0.03		N*		blows pe	
	VL	Very Low	0.03 - 0.1	1			mple take	
	L	Low	0.1 - 0.3		Nc		with solid	
	M	Medium	0.3 – 1		R		efusal	
	Н	High	1-3					
	VH	Very High	3 - 10	VAN	E SHEAR TEST	S		
	EH	Extremely High	> 10					
		, 0						
Structure			Spacing		Su	Vane	shear str	ength
	Thinly Lamina	ted	< 6mm				/residual (
	Laminated		6 – 20mm			Vane	size (mm)
	Very thinly be	dded	20 – 60mm	ľ				
	Thinly bedded		60 – 200mm					
	Medium bedc	led	0.2 – 0.6m					
	Thickly bedde	ed	0.6 – 2.0m					
	Very thickly be	edded	> 2.0m					
NOTE:		k descriptions are t	based on AS 1726 -					
1993				WAT	ER MEASUREN	MENTS		
Natural F	ractures				V	Wate	r level	
Type JT	Joint	Shape	Planar		A		r inflow	
BP	Bedding plan	pl e cu	Curved		A			
SM	Seam	un	Undulose		···· #84	Wate	r outflow	

	, ø,											
		A	1				ВО	RE		ΟL	E LOG	
9					ork		ACN 069 211 561 6/6 Morton Close	Jo	bN	o.	G24048/1	
0	Зe	otechi	nic	s P	ty L	td	TUGGERAH NSW 225. TEL: (02) 43516200		ole N	10.	BH1	
							FAX: (02) 43516300	Sh	eet		1/3	
С	liei	nt:	FC	DRBE	ES RIC	ЭВҮ Р	TY LTD	Sta	arte	d :	20/4/04	
Ρr	oje	əct:	AI	LTER	N AT IN	/ESH	OPPING CENTRE SITE	Fir	nish	ed:	20/4/04	
Lc	o c a	ation:					ROAD, VINCENTIA	Lo	gge	d	DS	
			IVI 1	GA:	5628	61896	E, 6116036N	СН	neck	ed:	GP	
E	qu	ipmer	nt t	typ	e :	7	RUCK MOUNTED DRILL RIG	RL	. ธนา	face:		
в	ore	shole	Di	am	eter	-: 1	100 m m	De	tum			
	water	samples, tests etc		depth (m)	graphic log	USCS symbol	Material description Soil type, particle characteristics or fines plasti colour, secondary and minor components	city, Z	condition	Consistency/ relative density	comments notes, structu and additions observations	
F O		f L	3			SM	Silty SAND, fine to medium grained, grey, organics		М	L	TOPSOIL	
A		в –	4	-		CL	Sandy CLAY, low plasticity, brown, fine to medium sand	M >	∙Wp	St	SLOPEWASH	
		в	4	1.0			CLAY, medium plasticity, pale brown to yellow mottled grey, some fine grained sand	< W	< Р	St/ VSt	RESIDUAL	
-		2	B 10									
			Ω mo					-	L			
		N*=38	(Blows/150m					~	qW			
			0101 (B)	2.0								
	V	(3.0			<u>Coring started at 2.45m depth</u> Continued on BH1 sheet 2/3					
	rilling											
	aftor drilling	(°									
				4.0								
				5.0								
			-									
				6.0								
				7.0		-						
				_/.0								
							1 te					
				8.0			· · · · · · · · · · · · · · · · · · ·					

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-		- 7	etwo	ork	6/6 M	069 2 1 1 lorton Clo	ose	_		Jo	ъΡγ	lo. G24048/i
0	<i>ie</i>	otechri	nics P	ty Ltd	TEL:	GERAH (02) 43	516200)	9	н	ole	No. BH1
					FAX:	(02) 43	51630)		sı	nee	t: 2/3
СІ	ier	nt: ^F	ORBES	RIGBY PTY LTD						sı	tarte	eci: 20/4/04
Ρr	oje	əct: A	LTERNA	ATIVE SHOPPING CENTRE SITE						Fi	nist	ned: 20/4/04
Lc	сε	tion: N	AVALC	OLLEGE ROAD, VINCENTIA						Lo	gg	eci: DS
		M	IGA: 56	286189E, 6116036N						с	hec	ked: GP
Ε¢	qu	ipmen	ttype	CRUCK MOUNTED DRILL RIG						R	Lsu	Irface:
в	ore	ehole I	Diam	eter: 100mm Inclination: 0	deg:		ring:	0		D	atur	n :
			0			degree of	ering	f	Mpa			tural fractures and Defects
ethod	-	(L)	phic lo	Roçk substance description		legre	veath	strend	ls (50) M	acinc	(E E)	Description
mett	water	depth	graph	rock type,grain characteristics, structure and minor componen		AND W	NW SW N N N N N N N N N N N N N N N N N			1 4	300 3000 3000	type,inclination,thickness planarity,roughness coating
				Continued from BH1 sheet	1/3							
												-
		1.0										
												-
							-					
		2.0										
			NOCORE	Coring started at 2.45m de	pth	_						
				CLAYSTONE, brown - grey - orang fine grained sand, thickly bedded	э, trace of			××				
		3.0										JT, 20mm, 90 °
												CLAY seam, 10mm, 0° -
	ł											FZ, 50mm, 0°
0		4.0										FZ. 150mm, 0°
۲ N N N												
												JT. 10°
		5.0										GRAVEL and IRONSTONE band, 50mm, 0°
												CLAY seam, 20mm, 0°
				SILTSTONE, pale grey motiled orang								
			and 1 approximate 1 and and 1 approximate 1 and and 1 approximate 1 and and 1 approximate 1 and and 1 approximate 1 and	becoming grey below 7.0m depth, th bedded	юкіу							JT, 1mm, 90 °
									<			ls(50) = 0.24A
			and a measure A are measured a measure and a measure A measurement of any measurement of measurement of a measurement of measurement of any measurement of measurement of any						K			IS(50) = 0.24D
												100mm.0° SILT seam, 20mm,0° FZ, 50mm,0°
		7.0										IRONSTONE band, 70mm-0° SILT seam, 20mm, 0° JT, 45°
		wheeler	And Parameters & and and and an an and an an an and an	х.								
				, <u></u>								-1s(50) = 0.46A -
		8.0		Continued from BH1 sheet	3/3							~

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

		M	1				С)	7	E	ŀ	HOLE LOG
-			etwo		6/6 Ma	69 2 11 561 orton Close				Job	лс	lo. G24048/1
6	<i>ie</i>	otechn	ics P	ty Ltd	TEL: (ERAH NSW (02) 4351620	0	:59	1	-10	le	No. BH1
					FAX: ('02) 4351630	U		5	She	еe	t: 3/3
СІ	ier	nt: F	DRBES	RIGBY PTY LTD						Sta	arte	ed: 20/4/04
Ρr	oj€	ect: A	LTERN	ATIVE SHOPPING CENTRE SITE					1	Fin	ist	ned: 20/4/04
Lo	сa			OLLEGE ROAD, VINCENTIA						Lo	gg	ed: DS
		M	GA: 56	5286189E, 6116036N						Ch	ec	ked: GP
Εc	qu	ipment	type	9: TRUCK MOUNTED DRILL RIG					1	RL	sı	ırface:
В	ore	ehole [Diam	eter: 100mm Inclination: 0	deg:	Bearing	: 0)	1	Da	tur	n :
			D			e of ering		gth Mpa				tural fractures and Defects
ethod	L D	Ē	phic lo	Rock substance description		degree weath		strength Is(50) Mp		pacing	(H H)	Description
met	wate	depth	grapł	rock type,grain characteristics, col structure and minor components	lour	NA HX MAKA MAKA D NA	00	1 2 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2	7 - - 1	300 si	3000	type,inclination,thickness planarity,roughness coating
			· · · · · · · · · · · · · · · · · · ·	Continued from BH1 Sheet 2/3				×				— SILT seam, 5mm, 0° — FZ, 40mm, 90° — Is(50) = 0.35A
				SILTSTONE, grey								
				SELECTORE, groy								→ Is(50) = 0.13D
NMLC		9.0										JT, 300mm, 90°
Z												-
												JT. 45 [°]
			=	BH1 terminated at 10.12m depth								
				No Piezometer Installed								
		11.0										
												-
												-
		12.0										
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		\wedge	ſ	1				EH	ΟL	ELOG
				etw			ACN 069 211 561 6/6 Morton Close	Job N	ο.	G24048/1
G	е	otech	n	ics F	^p ty L	.td	TUGGERAH NSW 2259 TEL: (02) 43516200	Hole N	١٥.	BH2
							FAX: (02) 43516300	Sheet		1/3
Cli	er	nt:	F	FORB	ES RI	GBY	PTY LTD	Starte	d :	20/4/04
^{>} rc	o j∈	ect:	1	ALTER	NATI	VESF	OPPING CENTRE SITE	Finish	ed:	20/4/04
_0	ca	ation:					ROAD, VINCENTIA	Logge	e d	DS
			n	VIGA:	5628	63641	E, 6115905N	Check	ked:	GP
Ξq	ui	ipme	nt	typ	e:	-	TRUCK MOUNTED DRILL RIG	RL su	rface:	
Вc	ore	ehole	D	iam	ete	r:	100 m m	Datum	1	
	water	samples, tests etc		depth (m)	graphic log	USCS symbol	Material description Soll type, particle characteristics or fines plasticity colour, secondary and minor components	Moisture condition	Consistency/ relative density	comments notes, structure and additional observations
F			1			SM	Silty SAND, fine to medium grained, dark grey, low plasticity	у D-м		TOPSOIL
AD		в	3 4 5 8 5	 		SC	Clayey SAND, fine to medium grained, brown, low to medium plasticity fines	м	MD	ALLUVIUM/ SLOPEWASH
-	22/4 after drilling	4,7,9 N*=16	6 8 12 (mmosl/swo	 2.0		CL	CLAY, lowplasticity, white mottled pale red from 1.0 - 2.5m, pale red from 2.5 - 3.0m, grey below 3.0 m, trace of fine sand	< < Wp	St/ VSt	RESIDUAL
	V	4,7,9	ia Cane Panotramotor (B	 3.0				≈ W p		
		N*=16	Dynam					q W <		
				4.0 			Coring started at 3.80m_depth Continued on BH2_sheet 2/3			
				5.0 5						
			-							
				6.0 						-
	*****			7.0						_
				<u>8.0</u>]		TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMB	<u> </u>	L	Į

					OREC) F	२	E	НC	LE L	OG
6			etw		6/6 M	069 211 56 lorton Close	•	1050		Job	No.	G24048/i	
(зe	otechr	nics F	Pty Ltd	TEL:	GERAH N (02) 43510 (02) 43510	5200	259		Hole	No.	BH2	
					FAX:	(02) 43510	1300 			She	et:	2/3	
С	ie	nt: F	ORBES	SRIGBY PTY LTD						Star	ted:	20/4/04	
Pr	oje	ect: A	LTERN	ATIVE SHOPPING CENTRE SITE						Finis	hed:	20/4/04	
Lc	оса	ation: _N	AVAL C	OLLEGE ROAD, VINCENTIA 6286364E, 6115905N						Log	jed:	DS	
		IV	IGA: 5	ULUUUU4E, UI IJUUN						Che	cked:	GP	
E	qu	ipmen	ttyp	e: truck mounted drill rig						RLs	urface	9:	
В	or	ehole	Diam	eter: 100mm Inclination: 0	deg:	Bearin				Datu	m :		
			00			degree of weathering		strength Is(50) Mpa			tural I	fractures and	Defects
ethod	er	m) c	phic lo	Rock substance description	on	degre weath				pacing (mm)		Descrip	
met	water	depth (m)	graph	rock type,grain characteristics structure and minor compone		N N N N N N N N N N N N N N N N N N N	lö		<u>EH</u> 10.0	300 300 1000		e,inclination, narity,roughr ating	
				Continued from BH2 sheet 1,	/3								
													
		1.0											
		-											
		2.0											
		 _											
		-											
		3.0											
				Coring started at 3.8m dept									
		4.0	NO CORE	CLAY, low to medium plasticity, pal grey bedding, trace of fine grained								RESIDUA	L
				medium bedded									
		and and a second second											
		5.0											-
				CLAYSTONE, orange - grey - red, m	edium bedded						F:	ONSTONE band Z, 50mm, 0°	
L L			+ + +	IRONSTONE, pale to dark red, think	v bedded	-						IRONSTONE bai 50)=0.64A	nd,50mm,0°∽
N N		6.0	+ + +					Щ				Z, 700mm, 90° 50) = 0.08D	
				SILTSTONE, dark grey, thickly bedd	60			$\left\ \right\ $				50) = 0.08D Z. 20mm. 0°	
											F:	Z.50mm.0º	
								<u>k</u>				50) = 0.10D 50) = 0.27A	
		7.0									si	LT seam, 100mm ONSTONE band	
								*			`~-i	(50) = 0.85A FZ, 50mm, 40°	
								*				(50) = 0.68D ONSTONE band	- . 5mm, 0°
		8.0		Continued from BH2 sheet	3/3			H					

			 etw		ACN	DB 1 069 211 561 Morton Close	0	R		. -		LE L(G24048/1	D G
6	Зe	otechn	ics F	Pty Ltd		GERAH NS : (02) 435162		9	Но	le	No.	BH2	
						: (02) 43516			sh	ee	t:	3/3	
СІ	ie	nt: F	ORBES	RIGBY PTY LTD					Sta	arte	ed:	20/4/04	
			LTERN	ATIVE SHOPPING CENTRE SITE					Fir	nist	ned:	20/4/04	
Lc	Ca	ation: _N	AVAL C	OLLEGE ROAD, VINCENTIA					Lo	gg	ed:	DS	
		М	GA: 5	6286364E,6115905N					Ch	ec	ked:	GP	
Ed	qu	ipmen	t typ	C: TRUCK MOUNTED DRILL RIG					RL	su	rface:		
В	or	ehole [Diam	eter: 100mm Inclination: 0	deg:	Bearin	g: 0		Da	tur	n:		
			0			e of ering	4	Mpa			ural fra	actures and [Defects
ethod	-	Ű.	0	Rock substance description		egree	t o o t	ls (50) 1	acing	Ê E		Descriptio	on
meth	wate	depth	graphic	rock type,grain characteristics, co structure and minor components	olour	S H X X X X X X X X X X X X X X X X X X	0.00	0.00	s,	~		,inclination,th arity,roughne ing	
				Continued from BH2 Sheet 2/3								and GRAVEL ba	nd, 1mm. 0°
				SILTSTONE, dark grey								JT. 0°	
0												0)≃0.47A JT, 10°	
NMLC		9.0											
2											FZ.	,20mm,0°	
		10.0									ls(50)=0.25D	
		10.0						×			Is(50))= 1.04A	
				BH2 terminated at 10.2m depth	<u>n</u>								-
				Piezometer Installed to 10.0m depth									
				Bentonite 0.0 - 4.0m Sand 4.0 - 10.0m									
				Screen 5.0 - 10.0m Adjacent Piezometer Installed to 1.5n	n depth								
				Bentonite 0.0 - 0.65m Sand 0.65 - 1.5m									
				Screen 0.75 - 1.5m									
		12.0											
													_
		13.0											
		-											
													_
			<u> </u>	L							<u> </u>		

		\wedge		1					ΕH	OL	ELOG
6				etw			ACN 069 21 6/6 Mortaol	lose	Job N	о.	G24048/1
(Ge	oteci	hn	ics F	°ty L	.td	TEL: (02) 4		Hole N	10.	внз
							FAX: (02) 4	3576300	Sheet		1/3
С	lie	nt:		FORB	ES RI	GBYI	PTY LTD		Starte	cl :	21/4/04
Pr	оj	ect:		ALTER	N AT IN	/ES⊦	IOPPING CENTRE SITE		Finish	ed:	21/4/04
Lc	bca	ation					ROAD, VINCENTIA E, 6115972N		Logge	d	DS
							-, 0113372N		Check	ed:	GP
E	qu	ipme	ent	t typ	e:		TRUCK MOUNTED DRILL RIG		RL sur	face:	
В	or	ehole	϶C	Diam	ete		100mm		Datum		
-	water	samples, tests etc		depth (m)	graphic log	USCS symbol	Material description Soil type, particle characteristics or fine colour, secondary and minor compone		Moisture condition	Consistency/ relative density	comments notes, structure and additional observations
DT			2	-		sм	Silly SAND, fine to medium grained, dark grey plasticity fines	/, low	D - M	L	TOPSOIL
A			3 4 5 4			CL	Sandy CLAY, medium plasticity, grey beco mottled orange below 0.7m depth becomin below 1.5m depth, fine to medium sand		q W <	F/ St	ALLUVIUM
	4		7	1.C						St/	
	22/04/04		14							VSt	
	V	2,4,6] an or								
		N * = 10	Penet	2.0							
	or drilling		s Cone 150mm				CLAY, medium plasticity, grey - white, son to medium sand	ne fine	2 W p		PROBABLE RESIDUAL —
	after		Dynamii (Blows/'	i							
	Y		0.9								
			1	З.О							
		4,8,9 N*=17									
			_								
				4.0							
				4.0							
				5.0							
							CLAY, low plasticity, dark grey becoming with white interbedding below 6.0m dep		< W p		RESIDUAL
									-		·
				6.0							
				100° ¥ 100							
								·			
							Coring started at 7.0m depth				
ļ				 			Continued on BH3 sheet 2/3				
											_

Amountain Section 2010 Job No. 0 24048/1 Geolechnics Pty Ltd The Maximum Section 2010 Cilient: Formerse Project: AltERNATIVE SHOPPING CENTRL SITE Loo No. 0 24048/1 Project: AltERNATIVE SHOPPING CENTRL SITE Loo No. 0 24048/1 Project: AltERNATIVE SHOPPING CENTRL SITE Loo Bilderin Maxet coallage Fox D, VIN CENTRA Maxet coallage Fox D, VIN CENTRA Loc good: Geole Diamotoff: tobm of the coallage for DAD. UN CENTRA Borrenole Diamotoff: tobm of the coallage for DAD. UN CENTRA Tege Statistics Fact substance coachplon Tege Statistics Tege Statistics			A	1		COR					0	F	3	E		IOLE LOG	
Act and default Display 2/3 Client: PONBES ANGEV PTY LID Stanted: 2114/94 Project: AltERNATIVE SHOPPING CENTRA SITE Pisithed: 214/94 Location: MAX. ColLEGE ADA.0, WIDCENTIA Dagoet: Dagoet: Default Borehole: Diameter: research Pisithed: 214/94 Borehole: Diameter: research Pisithed: Pisithed: 214/94 Borehole: Diameter: research Pisithed: Pisi	•						6/6 Mo	nton	Close	e				lob	Ν	o. G24048/1	
Sheet: 2/3 Clignt: POABES RIGEY PTV LTD Surface: 31/4/64 Project: AltERNATIVE BHOPPING CERTINE BITE Pritondt: 21/4/64 LOOBILION: HAWL COLLEGE ROAD, VINCENTIA MGA: 562054156, 6115972N Legge: D5 Checkes:: 3P Equipment typo:: Table: Restman: 0 Networksor:	(Зe	otechr	nics I	Pty Ltd		TEL: ((02)	4351	6200		9	ł	101	e١	1o. BH3	
OPTOINT Database Particle Partic							FAX: ('02)	4351	6300			5	She	et	2/3	
LOGBILION: HAVAL COLLEGE ROAD, VINCENTIA MGA: OUBSCARE, 611892/4 Equipment type: Thuck MOUNTED DRILL RIG Borchold Diameter: team results: 0 uco Eduing: Datum: Took type grain characteratics, colour structure and minor components Continued from BH1 sheet 1/2 Continued	С	lie	nt: ^F	ORBES	S RIGBY PTY LTD									Stai	rte	d: 21/4/04	
MAA: 56206445E, 6119972N Checked. 0P Equipment type: rauck Mounted DallLaria Borehole Diameter: 100mm unknown 0 are; nearen 0 Datum: Tool 9 Took ypa grain characteristics.colour Took ypa grain characteristics.colour Took ypa grain characteristics.colour Continues from 8H f anest 1/9 Continues from 8H	Ρr	юj	ect: A	LTERN	ATIVE SHOPPING CENTRE	SITE							F	= in i	sh	ed: 21/4/04	
Equipment type: muck mounted ballung number of dag: number of dag: <td>Lc</td> <td>bCa</td> <td>ation:_N</td> <td>AVAL C</td> <td>COLLEGE ROAD, VINCENTIA</td> <td></td> <td></td> <td></td> <td>*******</td> <td></td> <td>*****</td> <td></td> <td>l</td> <td>_og</td> <td>ge</td> <td>ed: DS</td> <td></td>	Lc	bCa	ation: _N	AVAL C	COLLEGE ROAD, VINCENTIA				*******		*****		l	_og	ge	ed: DS	
Borcholo Diameter: isomm isolase: 0 isolase: 0 Datum:			IV	1GA: 5	6286445E, 6115972N									Che	eck	ed: GP	
Borcholo Diameter: isomm isolase: 0 isolase: 0 Datum:	E	qu	ipmen	ttyp	C: TRUCK MOUNTED DRI	LL RIG							F	าน เ	sui	-face:	*****
0 0						0	g :	в	earii	ng:	0		Ľ	Dat	um):	
0 0									e of ering		g th	Mpa				ural fractures and Defects	
0 0	poc	1	E		Rock substance d	escription			egree / eathe		streng	s (50)		acing mm)		Description	
Continued from BH1 sneet 1/3 Contin		wate	epth	d L					2			0.0		s G			5
Coring started at 7.0m depth -3.0 -5.0			U		structure and minor c	omponents		a ×s>	N N N N N N N N N N N N N N N N N N N	≷α – n – u	יר≿	되	H G F		8	coating	
Coring started at 7.0m depth 7.0 6.0 6.0 5.0 Coring started at 7.0m depth 7.0 CLAY, tow to medium plasticity, dark gray, minub boards. SILT, tow to medium plasticity, dark gray, minub boards. SILT, tow to medium plasticity, dark gray, minub boards. SILT scale of the sand, think bodded SILT, tow to medium plasticity, dark gray, minub boards. SILT scale of the sand, think bodded SILT scale of the sand scale of the s					Continued from BH	1 sheet 1/3											
Charling started at 7.0m depth 7.0 Coring started at 7.0m depth 7.0 Charling started starte																	
Charling started at 7.0m depth 7.0 Coring started at 7.0m depth 7.0 Charling started starte																	
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OT Coring started at 7.0m depth 2.0 Coring started at 7.0m depth 3.0 Silt scan, 100mm, 0° 3.1. Now to medium plasticity, grey moltiled brown , trace of fine sand, thinly bedded Silt. Storne, 100mm, 0°																	
OT Coring started at 7.0m depth 5.0 Suff seam. 100mm. 0* 6.0 Suff seam. 100mm. 0*																	
OT Coring started at 7.0m depth 5.0 Suff seam. 100mm. 0* 6.0 Suff seam. 100mm. 0*																	
Coring started at 7.0m depth 6.0 Clay, low to medium plasticity, grey motiled brown, trace of fine sand, thinly bedded SILT seam. 100mm. 0* - Isl(50)= 0.33A - Isl(50)= 0.34A - Isl(50)=			3.0														
Coring started at 7.0m depth 6.0 Clay, low to medium plasticity, grey motited brown, trace of fine sand, thinly bedded SILT start, low to medium plasticity, dark grey, SILT start, 100mm, 0° - Is(50) = 0.33A - Is(50) = 0.34B - Is(50) = 0.3																	
Coring started at 7.0m depth 6.0 Clay, low to medium plasticity, grey motited brown, trace of fine sand, thinly bedded SILT start, low to medium plasticity, dark grey, SILT start, 100mm, 0° - Is(50) = 0.33A - Is(50) = 0.34B - Is(50) = 0.3																	
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6.0 6.0 Coring started at 7.0m depth Z CLAY, low to medium plasticity, grey mottled brown , trace of fine sand, thinly bedded SILT seam. 100mm. 0* SILT, low to medium plasticity, dark grey, thinly bedded SILT Seam. 100mm. 0* SILT Seam. 100mm. 0* SILT Seam. 100mm. 0*			4.0													-	
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Coring started at 7.0m depth 7.0 CLAY, low to medium plasticity, grey mottled brown, trace of fine sand, thinly bedded SILT, low to medium plasticity, dark grey, thinly bedded SILTSTONE, dark grey, some fine to medium			5.0														
Coring started at 7.0m depth 7.0 CLAY, low to medium plasticity, grey mottled brown, trace of fine sand, thinly bedded SILT, low to medium plasticity, dark grey, thinly bedded SILTSTONE, dark grey, some fine to medium																	
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Coring started at 7.0m depth 7.0 CLAY, low to medium plasticity, grey mottled brown, trace of fine sand, thinly bedded SILT, low to medium plasticity, dark grey, thinly bedded SILTSTONE, dark grey, some fine to medium																	
Z.0 Z			6.0														
Z.0 Z																	
Z.0 Z																	
U Image: Start seam. Homm. 3			7.0	ļ.,.,.,.,	Coring started at 7	0m depth											
SILTSTONE, dark grey, some fine to medium	U U						Å		- - - -	+-	*				+ -		
SILTSTONE, dark grey, some fine to medium	NML					aity, dark grey,	/				ЦЦ k					JT, 150mm, 90°	
8.0 3 Sand, mickly bedded						e fine to medium	'									SILT_seam, 100mm, 0° SILT_seam, 100mm, 0°	

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-			etw		6/6 Mc	69 211 56 inton Close	9			Job	No.	G24048/1	
6	<i>ie</i>	otechn	ics F	Pty Ltd	TEL:	ERAH N (02) 4351	6200	2259		Hole	No.	внз	
					FAX: ('02) 4351	0300			She	et:	3/3	
СІ	ie	nt: FC	ORBES	RIGBY PTY LTD						Star	ted:	21/4/04	
Ρr	оj	ect: A	LTERN	ATIVE SHOPPING CENTRE SITE						Fini	shed:	21/4/04	
Lc	оса	ation: _N	AVAL C	OLLEGE ROAD, VINCENTIA						Log	ged:	DS	
		M	GA: 5	6286445E, 6115972N						Che	cked	GP	
É¢	qu	ipment	t typ	C: TRUCK MOUNTED DRILL RIG						RL	urfac	:e:	
В	or	ehole [Diam	eter: 100mm Inclination: 0	deg:	Beari	ng:	0		Dati	.im :		
			 D			e of sering		5	α. Σ		atura	fractures and D	efects
ethod	10	E)	hic lo	Rock substance description		degree weathe		strengt	(0c)st	acing (mm)		Description	ı
meth	wate	depth	graph	rock type,grain characteristics, c structure and minor components		H M M M M M M M M M M M M M M M M M M M	FR FR FL-0.03	-00	20.8	ŝ		pe,inclination,thic anarity,roughnes pating	
				Continued from BH3 Sheet 2/3	/			X			—-Is (50)=0.15A	
		<u> </u>		SILTSTONE, dark grey, some fine to m	edium							- GRAVEL cobbie 30m 50) = 0.25A	im —
				sand								SILT seam, 20mm, 0 '	
NMLC		9.0						ļ				FZ, 100mm. 0° 50) = 0.17D	
Z												- JT, O°	
			•									— JT, Ф	_
							>					50) = 0.03D (50) = 0.11A	
		10.0											
				BH3 terminated at 10.0m depth									
				Piezometer Installed to 10.0m dep	<u>th</u>								
		11.0		Bentonite 0.0 - 3.0m Sand 3.0 - 10.0m									
				Screen 5.0 - 10.0m Adjacent Piezometer Installed to 1	5m depth								
				Bentonite 0.0 - 0.7m Sand 0.7 - 1.5m	<u>.om copur</u>								
				Screen 0.75 - 1.5m									
		12.0											
		13.0											
		-											
		14.0											
		15.0											
													-
													-
													_

		N	1			BOR	EH	οι	ELOG
6			etw			ACN 069 211 561 6/6 Morton Close	N doL	o.	G24048/1
(3 <i>e</i>	otechn	ics F	^{>} ty L	td	TUGGEPAH NSW 2259 TEL: (02) 43516200	Hole N	10.	BH4
						FAX: (02) 43516300	Sheet		1/3
С	lie	nt:	FORB	ES RIO	ЗΒΥΙ	PTY LTD	Starte	d :	21/4/04
Ρr	oj	əct:	ALTER	ΝΑΤΙ	/E SH	10PPING CENTRE SITE	Finish		21/4/04
Lc	оса					ROAD, VINCENTIA	Logge	d	DS
			MGA:	5628	6406	E, 6116180N	Check	ed:	G P
E	qu	ipment	typ	е:	•	TRUCK MOUNTED DRILL RIG	RL su	face:	22/1/1/11/11/22/11/11/22/11/22/22/22/22/
В	or	ehole [Diam	eter	-:	100m m	Datum	•	
	water	samples, tests etc	depth (m)	graphic log	USCS symbol	Material description Soil type, particle characteristics or fines plasticity colour, secondary and minor components	M a isture condition	Consistency/ relative density	comments notes, structure and additional observations
D T	V	5			SM	Silty SAND, fine to medium grained, dark grey, low	D-M	02	TOPSOIL
ΔA	after drilling	10 12 11 9 6 6 7 14 7	4		CL	plasticityfines Sandy CLAY, low plasticity, grey to dark grey, fine to medium sand	q W ≥	St/ VSt	ALLUVIUM
		5.9.6 N*=15 0 0000 0 0000			CL	CLAY, low to medium plasticity, grey mottled red, trace of fine to medium sand	q W <		
	22/04	čo G G 4.5.6 N * = 11	3.0			Sandy CLAY, medium plasticity, grey, fine to medium sand	⊻wp		
	ç Drilling		5.0			Sandy CLAY, medium plasticity, orange becoming pale brown below 4.9m becoming red below 6.0m	> W p		
	During		8.0			CLAY, medium plasticity, brown, some fine to medium sand Continued on BH4 Sheet 2/3	-		RESIDUAL

6			etw	ork	r		ACN 069 211 561 6/6 Morton Close	Job N	ο,	G24048/1
C	<i>iec</i>	otechi	nics I	^D ty L	.td		TUGGERAH NSW 2259 TEL: (02) 43516200	Hole		BH4
							FAX: (02) 43516300	Sheet		2/3
	ier	 n t :	FORB	ESRI	ЗВҮР	TY LTD		Starte		21/4/04
² r	oje	ect:	ALTEF	NATI	/E SH	OPPING CENTRE SITE		Finish		21/4/04
_ 0	са	tion:				ROAD, VINCENTIA		Logge	эd	DS
			MGA:	5628	6406E	, 6116180N		Check	ked:	GP
Ξc	qui	pmen	ttyp	e:	Т	RUCK MOUNTED DRILL RIG		RL su	rface:	
В	ore	hole	Diam	netei	r: ¹	00mm		Datum	ו	
	water	samples, tests etc	depth (m)	graphic log	USCS symbo	Material descrij Soil type, particle characteristic colour, secondary and minor c	cs or fines plasticity	Moisture condition	Consistency/ relative density	comments notes, structur and additional observations
AU						CLAY, medium plasticity, browr medium sand	n, some fine to	>₩p	St/ VSt	RESIDUAL
						Coring started at 8.5m de	aoth			
			9			Continued on BH4 sheet				
			10							
			-							
			11							
			12							
			-							
			_							

			1						>	R	E	:	HOLE LOG
6			etw		ACN 0 6/6 Mc	orton C	Close		are		Jo	Ь١	G 24048/1
(<i>ie</i>	otechn	ics P	Pty Ltd	TUGG TEL: FAX:	(02) 4	13516	200	259		Нc	le	No. BH4
					PAX	(02) 4	13370	000			Sh	еe	t: 3/3
С	iei	nt: F	ORBES	RIGBY PTY LTD							St	arte	ed: 21/4/04
Ρr	oj€	əct: A	LTERN	ATIVE SHOPPING CENTRE SITE							Fir	nist	ned: 21/4/04
Lc	оса			OLLEGE ROAD, VINCENTIA 6286406E, 6116108N							Lo	gg	ed: DS
											Ch	iec	ked: GP
Ε¢	qu	ipmen	t typ	e: truck mounted drill rig							RL	. sı	Irface:
В	ore	ehole (Diam	eter: 100mm Inclination: 0 de	g :	80		g:			Dε	tur	n :
		<u> </u>	0				degree of weathering		ig th	: 1			tural fractures and Defects
ethod	ter	ш ц	hic	Rock substance description		1	weat		strengt		spacing	ш ш	Description
e H	× ۵	depth	grap	rock type,grain characteristics, colour structure and minor components			3	EL 0.03	N N N	VH 3.0 EH 10.0	30	3000	type,inclination,thickness planarity,roughness coating
				Continued from BH4 sheet 2/3									
	, ,			Coring started at 8.5m depth		+			$\left \right $		+		
				SILTSTONE, dark grey, trace of fine grained s thickly bedded	ano				X				
N L O		9.0					1						Is(50)= 0.05D SILT seam, 10mm, 0° Is(50)= 0.58A
z									X				Is(50) == 0.20D
									×				$ \begin{array}{c} JT, 0^{\circ} \\ JT, 0^{\circ} \\ Is(50) = 0.60A \\ Is(50) = 0.14D \end{array} $
													-
				<u>BH4 terminated at 10.0m depth</u>									
		11.0		<u>Piezometer Installed to 10.0m depth</u> Bentonite 0.0 - 3.0m									
				Sand 3.0 - 10.0m Screen 5.0 - 10.0m									
				Adjacent Piezometer Installed to 1.5m d Bentonite 0.0 - 0.7m	epth								
				Sand 0.7 - 1.5m Screen 0.75 - 1.5m									
		12.0											
		13.0											
													-
		14.0											
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Geotechnics Pty Ltd							ACN 069 211 561 6/6 Morton Close TUGGERAH NSW 2259 TEL: (02) 43516200	Job No Hole N		G 24048/1 B H 5	
	10	01001		007	<i>ly L</i>	10	FAX: (02) 43516200	Sheet		1/3	
							тү цтр				
•••••		nt:					OPPING CENTRE SITE	Starte		21/4/04	
		ect:						Finish:		DS	
LC	o C a	ation					ROAD, VINCENTIA 2, 6116179N	Logge	~		
								Check	ed:	GP	
Equipment type: TRUCK MOUNTED DRILL RIG								RL sur	face:		
В	or	ehole) D	iam	etei	· :	00mm	Datum		·	
	water	samples, tests etc		depth (m)	graphic log	USCS symbo	Material description Soil type, particle characteristics or fines plasticity colour, secondary and minor components	Moisture condition	Consistency/ relative density	comments notes, structure and additional observations	
μ			3 8			sм	Silly SAND, fine to medium grained, dark grey, low	D-M	L	TOPSOIL	
AL			8 5 6 7 9 Joint	 1.C		CL	plasticity fines CLAY, medium plasticity, pale brown, trace of fine to medium sand CLAY, low to medium plasticity, pale grey to while, trace of fine to medium sand	< W p	St/ ∨St	RESIDUAL	
	22/4 🛋 after drilling 🛋	7R N*=7+	Dynamic Cone Ponotrome (Blower150mm)	2.0			CLAY, low to medium plasticity, pale brown, trace of fine to medium sand <u>Coring started at 3.6m depth</u> <u>Continued on BH5 sheet 2/3</u>	Ywp	VSt/ H		
				6.0							

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4			etw		6/6 M	069 211 8 orton Cla	se	a -	-0	J	ob I	No. (G24048/1
0	гe	otechi	nics P	Yty Ltd	TEL	ERAH (02) 435	516200)	59	н	ole	No. E	3H5
					FAX	(02) 438	10300	,		s	hee	t: 2	2/3
С	ie	nt: ^F	ORBES	RIGBY PTY LTD						s	tart	ed: :	21/4/04
Ρr	o je	əct: 4	ALTERN	ATIVE SHOPPING CENTRE SITE	<u></u>					F	inisl	ned: 2	21/4/04
Lc	OCATION : NAVAL COLLEGE ROAD, VINCENTIA							L	Logged: DS				
		Ν	/IGA: 50	5286306E, 6116179N						С	hec	ked: (3 P
E	qu	ipmen	ittyp	9: TRUCK MOUNTED DRILL RIG						R	Lsu	urface:	
в	or	ehole	Diam	eter: 100mm Inclination: 0	deg:	Bea	ring:	0		D	atu	m :	
			0			ě	sring	ž	Mpa			tural fra	ctures and Defects
pot	water	E)	0 2	Rock substance description rock type,grain characteristics, colour structure and minor components	ı	egre	eath	tren.	ls(50) Mpa		(mm)		Description
metho		depth (m)	graphic		H WD W d		0.0 0.0	200	0.01	3000	nlana	inclination,thickness rity,roughness 19	
		 1.0 		Continued from BH5 Sheet 1/3	_/								-
		2.0											-
		3.0 	NO CORE	Coring started at 3.6m dep CLAYSTONE, brown mottled orange, to medium sand, medium bedded									
				SANDSTONE, fine to medium graine mottled orange, some low to medium fines, medium bedded				X				ls(50)= J	0mm,0° 0102A 7,0° 7,0° ey SAND seam,100mm,ď
LC		5.0		CLAYSTONE, pale brown mottled ora fine to medium grained sand, mediur	-								. 30 m m . 0°
NM		6.0	And I provide the state of the	SILTSTONE, dark grey, medium bede	ded			*				Is(50)=	JT. 45° ∈0.10D
		7.0						X				— Is(50) —	250mm.0° = 0.14A GRAVEL cobble 50mmd d of EW SANDSTONE, 50mm.0° JT.0° P (SILT).20mm.0° JT. 60°
				Continued on BH5 Sheet 3/3									
		N	/					0	R	RE	E	HOLE LOG	
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			etw		6/6 M	069 211 lorton Cl	ose		20	Jo	ЬN	lo. G24048/1	
6	<i>ie</i>	otechn	ics P	ty Ltd	TEL:	GERAH (02) 43 (02) 43	851620	0	99	Нс	le	No. BH5	
					rAX:	102) 43				Sh	ee	t: 3/3	
СІ	ie	nt: F	ORBES	RIGBY PTY LTD						St	arte	ad: 21/4/04	
Ρr	oj	ect: A	LTERN	ATIVE SHOPPING CENTRE SITE			_			Fir	nist	ned: 21/4/04	
Lo	ca	ation: N	AVAL C	OLLEGE ROAD, VINCENTIA 6286306E, 6116179N						Lo	gg	ed: DS	
										CI	iec	ked: GP	
Ec	qu	ipmen	t typ	e: Truck mounted drill rig	i					RL	. su	rface:	
В	or	ehole I	Diam	eter: 100mm Inclination:	0 deg:	Bea	ring			Da	tur	n :	
ethod	ater	(m) th	hic log	Rock substance descrip	tion		weathering		ls (50) Mpa	pacing		ural fractures and Defects Description type,inclination,thickness	
е Е	× a	depth	grap	rock type,grain characterist structure and minor compo		RS XW H	N W N S N F B N		M H H H H H H H H H H H H H H H H H H H	1 00 1 00 1 00	3000	planarity,roughness coating	
				Continued from BH5 Sheet : SILTSTONE, dark grey	2/3			1.781	NA/			JT,800mm.90° Is(50) = 0.32D Is(50) = 0.41A	
NMLC		9.0 							- *			JT. 45° ls(50) = 0.70D ls(50) = 1.5A	
		10.0							*			JT, 0 ² !s(50) = 0.60A	
		110.0		BH2 terminated at 10.0m der Piezometer Installed to 10.0m Bentonite 0.0 - 4.0m Sand 4.0 - 10.0m Screen 5.0 - 10.0m Adjacent Piezometer Installe Bentonite 0.0 - 0.6m Sand 0.6 - 1.5m Screen 0.75 - 1.5m	<u>depth</u>								

			1				BOR	ΕH	O L	ELOG
			etw	ork	-		069 211 561 orton Close	Job No		G24048/1
6	<i>aec</i>	otechn	ics F	ty L	td	T'EL:	ERAH NSW 2259 (02) 43516200	Hole N	ο.	BH6
				v		FAX	(02) 43516300	Sheet		1/3
	ier	nt:	FORBE	ES RIG	ЗВУ Г	YTY LTD		Starteo	d :	22/4/04
		ect:	ALTER	ΝΑΤΙ	/ESH	IOPPING CENTRE SITE		Finishe		22/4/04
						ROAD, VINCENTIA		Logge	d	DS
			MGA:	5628	62851	E, 6116069N		Check	ed:	GP
E	gui	pmen	ttyp	e :		TRUCK MOUNTED DRILL RIG		RLsur	face:	
		ehole l			r:	100mm		Datum		
	water	samples, tests etc	depth (m)	graphic log	USCS symbol	Material description Soil type, particle characteristics or colour, secondary and minor compo	fines plasticity onents	Moisture condition	Consistency/ relative density	comments notes, structure and additional observations
 		6		NWN NWN	sм	Silty SAND, fine to medium grained, dark	grey, low	D-M		TOPSOIL
AD		13 18	3		CL	plasticityfines Sandy CLAY, medium plasticity, brown		2₩p	VSt	RESIDUAL -
		9 8	3			medium sand CLAY, low to medium plasticity, grey m	ottled orange	-	VSt/	
		8	1.0	Ķ//		becoming becoming grey mottled red I depth becoming red below 1.2m depth	below 0.8m		н	
		elrome				mottled grey below 1.6m depth		>Wp		
			Ē							
		5.11.21 N*=32	s/150r							
	drilling	Dynar	.2.0							
	after d									
	V									
		108	з.с							
	1	N*>10								
	1									
			4.0			CLAY, low plasticity, grey		> > W p		
-				¥///	1					
			6.0			Coring started at 5.5m depth				
						Continued on BH6 sheet 2/3	-			-
										-
										-
			7.0	o						
										-
										-
			8.	0						-

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		N	1) F	3		10	LE L	O G
6			etwc		6/6 Moi	59 2 11 56 1 rton Close			J	ob 1	۷٥.	G24048/1	
6	i e	otechn	ics Pi	ty Ltd	TEL: (C	ERAH NS 02) 43516	200	259	н	lole	No.	BH6	
					FAX: ((02) 43516	300		s	hee	t:	2/3	
СІ	ie	nt: F	ORBES	RIGBY PTY LTD					s	tart	ed:	22/4/04	
Ρr	oje	əct: A	LTERNA	TIVE SHOPPING CENTRE SITE					F	inisi	ned:	22/4/04	
Lo	Са	ation: _N	AVALCO	DLLEGE ROAD, VINCENTIA					L	.ogg	ed:	DS	
		М	GA: 56	286285E, 6116069N					c	Chec	ked:	GP	
E	 qu	ipmen	ttype	TRUCK MOUNTED DRILL RIG					F	IL SI	urface	:	
					deg:	Bearin	g: (5	С) a tu	m :		
			5			of ring		Mpa		Na	tural f	ractures and	Defects
o q	r.	Э.	<u> </u>	Rock substance description		degree weathe		strength Is(50) Mp		oacing (mm)		Descrip	tion
metho	wate	depth	graphic	rock type,grain characteristics, colou structure and minor components	۱r	R K K K M M M M M M M M M M M M M M M M	10,00	m `	2	100 spa 300 (1 1000 (1 3000		e,inclination, narity,roughi uting	
			-	Continued from BH6 Sheet 1/3									
													_
		1.0											
													_
		2.0											
		-											
													-
		_											-
		3.0											
		4.0											
		5.0											
				Coring started at 5.5m depth									-
			NOCORE	SUITSTONE dark grov some line is man								CLAY seam, 10n	
				SILTSTONE, dark grey, some fine to mec sand, thickly bedded	a isa ti t			*				50)=0.35A *Z,40mm,0°	
		6.0										-∠,40mm,0 JT.1mm,0° JT.0° 0)≂0.60DA	
								×			<u>s(5)</u>	0)=0.60DA JT, 0°	-
MLC													
z		7.0										⁻ Z, 30mm, 0 °	
		/ .0											
								*			ls(5 ls(5	50)=0.46D 50)=0.90A JT, 0°	-
				,								JT, 45° JT, 45°	
			· · · · · · · · ·	Continued on BH6 Sheet 3/3									

		N	1	CC					0	F	{ [H	OLE L	OG
-			etw		6	ACN 069 3/6 Morte	xı Clo	se	000	'n	J	ob	No.	G24048/1	
(<i>ने </i>	otechn	ics F	Pty Ltd	7	TUGGEF TEL: (02 FAX: (02	9 435	1620)	J	Н	ole	No.	BH6	
						=AX: (02	./ 435		,		s	he	ət:	3/3	
С	ie	nt: ^{FC}	DRBES	RIGBY PTY LTD					_		s	tar	ted:	22/4/04	
Ρr	оj	ect: A	LTERN	ATIVE SHOPPING CENTRE SITE							F	inis	hed	22/4/04	
Lc	са	ation: N	AVAL C	OLLEGE ROAD, VINCENTIA							L	og	ged:	DS	
		M	GA: 5	6286285E,6116069N							C	he	cked	I: GP	
E	qu	ipment	t typ	C: TRUCK MOUNTED DRILL RIG							F	L s	urfa	сө:	
В	or	ehole E	Diam	eter: 100mm Inclination: 0	deg:	I	Зеа	ing:			C	atı	ım :		
			D				e of	6 ui a	Ę	is (50) M pa			atura	I fractures and	Defects
poc	L 0	(m)	hic lo	Rock substance description			degree	veatu	strend	ls (50)		(mm)		Descrip	tion
metho	water	depth (m)	graph	rock type,grain characteristics, c structure and minor components		S a	Š		0.00	200 10 10 10 10 10	2.0	300 300 1000		/pe,inclination lanarity,rough oating	
				Continued from BH6 Sheet 2/3	/				,				T	s(50) = 0.30A	
				SILTSTONE, dark grey, some fine to m sand	edium				×	-				<u>s(50)=0.04D</u> s(50)=0.13A	m,50mm,0°
0														JT, O°	
NMLC		9.0												JT, 45° JT, 150mm, 90°	
										ł				s(50)= 4.00A	
														°0,TL °0,TL ° °0,TL °	-
		10.0											Is	$\frac{JT}{S(50) = 0.60A}$ JT, 0	• •
				BH6 terminated at 10.0m depth											
				No Piezometer Installed											
		11.0													
															-
		12.0													
		13.0													
		and the second													
		14.0													
		15.0													
															-
		_									$\left \right \right $				-

		\wedge		7				BOR	EH	OL	ELOG
			W.	etw	ork		ACN 069 6/6 Morto		Job Ne		G 24048/1
6	<i>ae</i>	oteci	hn	ics F	ty L	td		AH NSW 2259) 43516200	Hole N	lo.	BH7
					•		FAX: (02,) 43516300	Sheet		1/3
	ier			FORBE	ES RIG	GBY F	ידץ נדם		Starte	d :	22/4/04
·		ect:		ALTER	N AT IN	/E SH	OPPING CENTRE SITE		Finishe		22/4/04
		ation	: 1	N AVA L	COLI	EGE	ROAD, VINCENTIA		Logge	d	DS
			I	MGA:	5628	6296E	E, 6116037N		Check	ed:	GP
Ec	qui	ipm e	ent	typ	e:	٦	RUCK MOUNTED DRILL RIG		RL sur	face:	
		ehole				-: 1	00mm		Datum		
	water	samples, tests etc		depth (m)	graphic log	USCS symbol	Material description Soil type, particle characteristics or fir colour, secondary and minor compon	nes plasticity rents	M o isture condition	Consistency/ relative density	comments notes, structure and additional observations
Ъ			2			SМ	Silty SAND, fine to medium grained, dark gr plasticity fines	ey, low	D-M	1	TOPSOIL
AD	After Drilling	В	4 6 4 4 8 6 8	 1.0		CL	Sandy CLAY, medium plasticity, brown b orange-red below 0.5m depth, fine to me		q W <	St St/ VSt	RESIDUAL
	<	5,8,12 N'= 20	Dynamic Cone Penetrometer 8 (Blows/150mm)	2.0		CH	CLAY, medium to high plasticity, grey be orange below 3.1m depth CLAY, medium plasticity, brown - dark g		<u>∨</u> W p < W p > W p	VSt/ H	
		4		6.0			<u>Coring started at 4,9m der</u> <u>Continued on BH7 sheet 2</u>				

etwork Geotechnics Pty Ltd ACM0821802 Statistics Job No. G24048/1 Hole No. BH7 Statistics Statistics 2/3 Client: FORBES RIGBY PTY LTD Statistics Statistics Project: ALTERNATIVE SHOPPING CENTRE SITE Finished: 22/4/04 Location: NAVAL COLLEGE ROAD, VINCENTIA MGA: Logged: DS Checked: GP Equipment type: TRUCK MOUNTED DRILL RIG RL surface: Borehole Diam eter: 100 mm Inclination: 0 Image: Structure and minor componants Structure and minor componants Structure and minor componants Image: Structure and minor componants Structure and minor componants Image: Structure and minor componants Image: Structure and minor componants Structure and minor componants Image: Structure and minor componants Image: Structure and minor componants Structure and minor componants Image: Structure and minor componants			N	7		ED	В	C) F	२		HO	DLE LOG
Geotechnics Pty Ltd TE: 09 451600 FX: (09 430600 Hole No. BH7 Sheet: 2/3 Client: FORBES RIGBY PTY LTD Started: 22/4/04 Project: ALTERNATIVE SHOPPING CENTRE SITE Finished: 22/4/04 Location: NAVAL COLLEGE ROAD, VINCENTIA MGA: 552862956, 6116037N Logged: DS Equipment type: TRUCK MOUNTED DRILL RIG RL surface:	ø			etwo	ork	6/6 Mo	rton Close			J	do	No.	G24048/1
Sheet: 2/3 Client: FORBES RIGBY PTY LTD Started: 22/4/04 Project: ALTERNATIVE SHOPPING CENTRE SITE Finished: 22/4/04 Location: NAVAL COLLEGE ROAD, VINCENTIA MGA: 56286296E, 6116037N Logged: DS Equipment type: TRUCK MOUNTED DRILL RIG RL surface:	6	<i>ae</i>	otechn	ics P	ty Ltd				259	+	lole	No.	BH7
Project: ALTERNATIVE SHOPPING CENTRE SITE Finished: 22/4/04 Location: NAVAL COLLEGE ROAD, VINCENTIA MGA: 56286296E, 6116037N Logged: DS Equipment type: TRUCK MOUNTED DRILL RIG RL surface:						FAX: (02) 435163	100		s	hee	ət:	2/3
Location : NAVAL COLLEGE ROAD, VINCENTIA MGA: 56286296E, 6116037N Logged: DS Checked: GP Equipment type: TRUCK MOUNTED DRILL RIG Borehole Diameter: 100mm inclination: 0 deg: Bearing: 0 Datum:	СІ	ier	nt: FC	DRBES	RIGBY PTY LTD					S	tar	ted:	22/4/04
MGA: 56286296E, 6116037N Checked: GP Equipment type: TRUCK MOUNTED DRILL RIG RL surface:	Pr	oje	ect: A	LTERNA	ATIVE SHOPPING CENTRE SITE					F	inis	hed:	22/4/04
Checked: GP Equipment type: TRUCK MOUNTED DRILL RIG RL surface: Borehole Diameter: 100mm Inclination: 0 deg: Bearing: 0 Datum: Natural fractures and Defects	Lo	Се	tion: N	AVALC	OLLEGE ROAD, VINCENTIA					L	.og	ged:	DS
Borehole Diameter: 100mm Inclination: 0 deg: Bearing: 0 Datum: u (E) 0; Prock substance description 100mm 100mm Natural fractures and Defects u (E) 100mm Prock substance description 100mm 100mm u 100mm Prock substance description 100mm 100mm 100mm u 100mm Prock substance 100mm 100mm 100mm u 100mm Prock substance			M	GA: 56	5286296E, 6116037N					0	Che	cked	GP
Borothere Didning Doming Monadom dog Dodning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning Image: Didning </td <th>Ec</th> <td>qui</td> <td>ipment</td> <td>ttyp€</td> <td>S: TRUCK MOUNTED DRILL RIG</td> <td></td> <td></td> <td></td> <td></td> <td>F</td> <td>≀L s</td> <td>urfac</td> <td>:e:</td>	Ec	qui	ipment	ttyp€	S: TRUCK MOUNTED DRILL RIG					F	≀L s	urfac	:e:
0 0 0 rock type,grain characteristics, colour structure and minor components ≥ 0	В	ore	ehole E	Diam	eter: 100mm Inclination: 0 deg	:		g: '		E) a tu	ım:	
0 0 0 rock type,grain characteristics, colour structure and minor components ≥ 0				D			e of ering		55	_		tura	I fractures and Defects
0 0 0 rock type,grain characteristics, colour structure and minor components ≥ 0	poc			ic lo	Rock substance description		legre. veath		streng Is (50)		acing (mm)		Description
Continued from BH7 Sheet 1/3	meth	wate	depth	graph			s n s s s s s s s s s s s s s s s s s s			9	s,		anarity,roughness
					Continued from BH7 Sheet 1/3								
			·										-
			1.0										-
2.0													
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			_										
3.0			3.0										
4.0			4.0										
Coring started at 4.9m depth			5.0		Coring started at 4.9m depth			╬					
SILTSTONE, dark grey, medium bedded					SILTSTONE, dark grey, medium bedded								
			6.0										
U J Z Z													
	Z			NO CORE									
												1	(50) = 0.35A
7.0			7.0					>	¥				BP, 10mm, 0 ° (50) = 0.60D
													JT, 150mm, 90°
			anyona						 				s(50) = 0.21AD
Continued on BH7 Sheet 3/3			data and a		Continued on BH7 Sheet 3/3								JT. 0º

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REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

		N	7				C)	R		Ξ.	ЧC	LE LC) G
4			etw		6/6 M	069 211 561 lorton Close				Jc	bl	۷٥.	G24048/1	
(Зe	otechn	ics F	Pty Ltd	TEL:	GERAH NSV (02) 435162	00	259		н	ole	No.	BH7	
					FAX	(02) 435163	00			sł	төе	et:	3/3	
С	lie	nt: F	ORBES	RIGBY PTY LTD						St	art	ed:	22/4/04	
Ρr	oj	ect: A	LTERN	ATIVE SHOPPING CENTRE SITE						Fi	nis	hed:	22/4/04	
Lc	bCa	ation: _N	AVAL C	OLLEGE ROAD, VINCENTIA 6286296E, 6116037N						Lc	o g ç)ed:	DS	
		IVI	ал. э	5255250L, 011000/N						С	hec	ked:	GP	
E	qu	ipment	ttyp	e: truck mounted drill rig						RI	_ S	urface		
в	or	ehole [Diam	eter: 100mm Inclination: 0	deg:	Bearing	g: (0		Di	atu	m :		
method	water	depth (m)	graphic log	Rock substance description rock type,grain characteristics, colo structure and minor components	ur	RS HW MW SS SS SS SS SS SS SS SS SS SS SS SS SS	lòċ	<u>M</u> _0.3 strength H_1.0 ls(50) Mpa	<u> </u>	spacing	3000 (mm) NA	typ	ractures and D Descriptio e,inclination,thi narity,roughnes tling	n ckness
NMLC		9.0 9.10		Continued from BH7 Sheet 2/3								G	JT. 0° Z. 150mm. 0° RAVEL cobble. 50m JT. 0° JT. 0° JT. 0°	m d 0
		11.0 12.0 12.0 13.0 13.0 13.0 14.0 15.0		BH7 terminated at 10.2m depth Piezometer Installed to 10.0m depth Bentonite 0.0 - 3.5m Sand 3.5 - 10.0m Screen 5.0 - 10.0m Adjacent Piezometer Installed to 1.5m of Bentonite 0.0 - 0.7m Sand 0.7 - 1.5m Screen 0.75 - 1.5m	<u>depth</u>									

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TREEMENT INSU 229 TEL (00) 456/200 TEL (00) 46/200 TEL (00) 46/	O G	E LO	OL	ΞH	BOR	ВО)	N		
Geolecinics Pily Lia The majesteem Mix (mi) assesses Mix (mi) assessessessessessessessessessessessesse	1	G24048/1	ə.	Job No			•	ork	ətw			
Sheet 1/1 Client: FORBES RIGBY PTY LTD Started: 21/4/64 Project: ALTERNATIVE SHOPPING CENTRE SITE Finished: 21/4/64 Location: NAVAL COLLEGE ROAD, VINCENTIA MGA: S6285901E, 6115822N Logged 0P Equipment type: DINGO 950P DRILL RL surface:		B H 8	10.	Hole N			.td	ty L	ics F	techn	<i>ae</i>	
Orient: Startas: 21/0/04 Project: Atternative SHOPPING CENTRE SITE Finished; 21/4/04 Location: NAVAL COLLEGE ROAD, VINCENTIA MGA: 56265901E, 6116382N Logged QP Checkad: RJK Borehole Diameter: 100mm Datum		1/1		Sheet	516300	FAX: (02) 43516300		-				
Project: ALTERNATIVE SHOPPING CENTRE SITE Finished: 21/4/04 Location: NAVAL COLLEGE ROAD, VINCENTIA MGA: S5265901E, 6118362N Logged GP Checked: RJK Equipment type: DINGO 950P DRILL RL surface:		21/4/04		Starter		YTY LTD	GBY	ES RIG	FORBI	t:	lier	
LOCATION: NAVAL COLLEGE ROAD, VINCENTIA MGA: 56285901E, 6116382N Loggod GP Checkad: RJK Equipment type: DINGO 950P DAILL Borehole Diameter: 100mm Dalum Dalum Dolum Dol		21/4/04				IOPPING CENTRE SITE	/E SH	ΝΑΤΙ	ALTER			
MGA: 56285901E, 6116382N Checkad: RJK Checkad: RJK Borehole Diameter: 100mm Dalum		GP				ROAD, VINCENTIA	LEGE	COLI	N AVA L			
Borehole Diam eter: 100mm Datum — a generation of the problem		вјк	ed:	Check		E, 6116382N	5901	5628	MGA:			
Borehole Diameter: 100mm Datum Image: State of the			face:	RL sur		DINGO 950P DRILL		e :	tvp	omen	aui	E
Image: Section of the section of th		*****				100mm	r:					
Image: Secondary and minor components I	*****		ity		<u></u>			[
Image: Series of the series	ments	commei	ncy/ lens	ure tion		Material description	туs	으		te te		
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Image: Construction of the second strength Image: Construction of the second strength<		and additi observatio	Con: elati	≥o			S S	0	ס	etc	3	
a	L	TOPSOIL		< W p		Clayey SILT, low plasticity, pale grey					ation	μ
Image: Section of the section of th	ASH -	SLOPEWAS	(MD)	D-M			sc				instal	A
Image: Service of the service of th											piczo	
Image: Service of the service of t		-,·,·		M-W					1.0		n after	
Image: Service of the service of t	۹L	RESIDUAL	(St)	qW<	/n		CL				g. 2.0n	
Image: Series of the series											đrillin	
m	 			D	grey,		sc				a ftor	
SANDSTONE, moderately weathered, line grained, brown becoming orange-brown, est low rock strength TC bit re TC bit re BH8 terminated at 2.6m depth ~ Auger refusal on rock 			2,						2.0		5.3 1	
	usal 2.2m	ROCK TC bit refusal									.	C
No sur Piezometer Installed to 2.6m depth 0.0 - 1.6m Bentonite 1.6 - 2.6m Screen & Sand 0.5m Stick up 	am	Central Gul Upstream Centraline							3.0			
0.0 - 1.6m Bentonite 1.6 - 2.6m Screen & Sand 0.5m Stick up 		No surface			1-							
0.5m Stick up					<u>.m.</u>	0.0 - 1.6m Bentonite						
Image: Section of the section of th	-											
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LOG				ACN 069 211 561			etwo			
4048/1).	Job No	6/6 Morton Close TUGGERAH NSW 2259					•	4
9	В	ο.	Hole N	TEL: (02) 43516200 FAX: (02) 43516300	ta	ty L	ncs P	otechi	iec	(
	1,		Sheet							
/4/04	2	d :	Starte		ВҮ Р	S RIG	FORBE	nt:	ier	С
/4/04	2	əd:	Finishe	NTRE SITE	ESH	VITAV	ALTER	oct:	oje	> r
	G	d	Logge	ENTIA			NAVAL. MGA:	tion:	са	_ (
K	R	ed:	Check							
		face:	RL sur	DRILL	E	e :	ttype	pmer	qui	E
			Datum			eter	Diam	ehole	ore	В
comments otes, structure nd additional bservations		Consistency/ elative density	Moisture condition	Material description , particle characteristics or fines plasticity econdary and minor components	USCS symbo	graphic log	depth (m)	samples, tests etc	water	
PSOIL OPEWASH		02 (L/ MD)	D-M M	fine grained, brown, roots D, fine to medium grained, yellow-brown grey, low plasticity						ADT
LUVIUM	A		D-M	to coarse grained, pale grey-white	SP		1.0		stallation	
				o medium grained, orange-brown , some low to medium plasticity clay of fine gravel (ironstone)			2.0		2.2m after drilling. 1.9m after piezo installatio	
-		(St)	> W p	r, high plasticity, pale grey, fine to nd increasing below about 2.5m depth	СН		3.0			
-	-	(VSt) (L/ MD)	≥Wp W	to medium grained, pale grey	SP	<u> </u>	4.0			
ESIDUAL	/	(MD/ D)	w	D, fine to medium grained, orange-brown e grey, low to medium plasticity	SC		5.0			
)	(VSt)	≤Wp	/, medium plasticity, orange-brown y, trace fine gravel	CL		6.C			
Central Gully Downstream Approx. CL (very broard)				BH9 terminated at 6.0m depth <u>Piezometer Installed to 6m depth</u> 0.0 - 3.0m Bentonite 3.0 - 6.0m Screen & Sand			7.0			
C e D c A F		(VSt)	≤ W p	e grey, low to medium plasticity (, medium plasticity, orange-brown y, trace fine gravel BH9 terminated at 6.0m depth <u>Piezometer Installed to 6m depth</u> 0.0 - 3.0m Bentonite	CL		5.0			

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

		A	1			BOR	ΕH	ΟL	ELOG	
6			etw			ACN 069 211 561 6/6 Morton Close	Job N	о.	G24048/1	
(зe	otechi	nics H	°ty L	.td	TUGGERAH NSW 2259 TEL: (02) 43516200	Hole N	۱٥.	BH10	
						FAX: (02) 43516300	Sheet		1/1	
С	liei	nt:	FORB	ES RIO	GBYI	РТҮ ЦТО	Starte	d:	21/4/04	
Pr	oje	ect:	ALTER	NATI	∕E S⊦	OPPING CENTRE SITE	Finish	ed:	21/4/04	
Lc) C a	ation:	N AVA L	COL	LEGE	ROAD, VINCENTIA	Logge	d	GP	
			MGA:	2864	40E,	6116065N	Check	ed:	RJK	
E (au	ipmen	ttvp	е:		DINGO 950P DRILL	RL su			
		shole			r •	100 m m	Datum			
		sts			, oq		Baran			
		, te	(m)	00	sym	Material description	Moisture condition	isistency/ tive density	comments	
	ater	ples	epth	graphic	S		oistu	iste. Ve d	notes, structur	
	3	sam etc	σ	gra	n si	Soil type, particle characteristics or fines plasticity colour, secondary and minor components	″, ∑ ŭ	Consist relative	and additiona observations	1
					SP	SAND, fine to medium grained, pale grey	D		RECENT	
AI					ML	Clayey SILT, low to medium plasticity, dark brown,	< W p		TOPSOIL	
					CL	trace of roots Sandy CLAY, pale grey mottled orange, fine sand,	> W p	(St)	PROBABLE	
			1.0			some fine to medium sandstone gravel			ALLUVIUM	
			-							
					sc	Clayey SAND, fine to medium grained, pale grey mottled orange, fine to medium sand	M-W	(MD)		
			2.0							
					CL/ CH	- mind, a mind in a main to main presently (bane 31 c)	qW <	(St/	PROBABLE RESIDUAL	
	ation		_		on	mottled red-brown, fine sand, some medium gravel		VSt)	RESIDUAL	
2	installa		3.0							-
	after piczo									
	4.0 m									
	V		4.0							
			-		sc	Clayey SAND, fine to medium grained, pale grey	M-W	(MD/	-	
	6 L					mottled pale brown, low plasticity		D)		
	or drilling									
	.5m aftor		5.0							
	ນ. ນີ້ 19									
	¥									
			6.0							
			-						Commercial	
						BH10 terminated at 6m depth			Centre Creek Line	
						Piezometer Installed to 6m depth 0.0 - 3.0m Bentonite				
			7.0			3.0 - 6.0m Screen & Sand 0.5m Stick up				
]		8.0			TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMB		L	J	

G	ie.	ote	chi	etw nics ,	rork Pty L		ACN 059211561 66 Motor Close TUGGERAH NSW 2259 TEL: (02) 43516200 FAX: (02) 43516300	Job N Pit No	o. G	23085/1 PG1 (SLOPE)
	oje	nt: ∋ct		F E N A	ASIBI	OLLE	BY PTY LTD FOR DEVELOPMENT EGE ROAD & THE WOOL ROAD, VINCENTIA) AMG: 56286106E 6115931N	Sheet Starte Finish Logge	ed: 2	/1 29/7/03 29/7/03 GP
				t typ			EXCAVATOR 7 TONNE	Chec+ RL su	rface:	ΠJK
BH method	d water	u samples, tests 0		depth (m)	www. graphic log	M USCS symbol	Material description Soil type, particle characteristics or fines plasticity colour, secondary and minor components Silty SAND, fine to medium grained, grey-brown, some roots	M A oisture condition W	Z Consistency/ U relative density	comments notes, structure and additional observations TOPSOIL
	None Encountere	D	Panatrometer (blows/1150mm	0		CL	Sandy CLAY, medium plasticity, yellow-brown/pale grey, fine to medium sand, some tree roots Sandy Silty CLAY, low to medium plasticity, pale grey mottled yellow, fine to medium sand	> W p < W p	St VSt	RESIDUAL
			Dynamic Cone P	1.5	5		SANDSTONE, extremely weathered, fine grained, yellow-brown/pale grey, bands of interbedded SILTSTONE: brown, some fine gravel, est. very low rock strength	D		ROCK
				3.0			TPG1 terminated at 2.4m depth			

			k/				TE	EST	r p	IT LOG
63			V.	etw	ork		ACN 069 211 561 6/6 Morton Close	Job N	o. G2	3085/1
6	ìec	ote	chn.	ics F	^p ty L	td	TUGGERAH NSW 2259 TEL: (02) 43516200	PitNo	. ТР	G2 (SLOPE)
							FAX: (02) 43516300	Sheet	1/-	1
	ier	 		FO	RBES	RIGE	BY PTY LTD	Starte	d: 2	9/7/03
		ect	:	FE	ASIBIL	.IŤΥ	FOR DEVELOPMENT	Finish	ed: 2	9/7/03
		tio		ΝA	VALCO	JLLE	GE ROAD & THE WOOL ROAD, VINCENTIA	Logge	ed G	P/GV
				GP	'S (AU	S 66)AMG: 56286231E 6116057N	Check	ked: F	зJК
Εc	qui	ipn	nent	typ	е:	1	EXCAVATOR 7 TONNE	RL su	rface:	
В	uc	ke	t Siz	e:			450 m m	Daturr	3	
method	water	samples, tests	e to	depth (m)	graphic log	USCS symbol	Material description Soil type, particle characteristics or fines plasticity colour, secondary and minor components	Moisture condition	Consistency/ relative density	comments notes, structure and additional observations
ш	ntered	D	4		wwww	SM	Silty SAND, fine to medium grained, grey-brown, some roots	M	MD/D	TOPSOIL -
	None Encou	D	6 7	 0.5			Silty SAND, fine to medium grained, yellow-brown/ pale grey	M-W		PROBABLE SLOPEWASH
	~	в	eter (blows/150mm) G G A A	 1.0			Sandy CLAY, medium to high plasticity, red-brown/ orange-brown/pale grey, fine to medium sand, trace fine gravel	αWp	St	RESIDUAL
			Dynamic Cone Penetrometer 51 6 6 5 5	1.5	5	SC	Clayey SAND, fine to medium grained, pale grey/red- brown/orange-brown, low plasticity, trace fine to medium gravel	M	D	
		D	υΥr	2.0		ML	Clayey SILT, lowplasticity, pale grey mottled red-brown some fine to coarse SILTSTONE gravel, trace fine roots	< W p	(H)	
]		2.8	5		SANDSTONE, extremely weathered, red-brown, inter- bedded pale grey Clayey SILT, est very low rock strength	D		поск
				3.0	5		TPG2 terminated at 2.6m depth			

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	A.				and the second sec	ES	TP	IT LOG
					ACN 069 211 561 6/6 Morton Close	Job M	lo. G	23085/1
Ge	otechr	nics .	Pty i	Ltd	TUGGERAH NSW 2259 TEL: (02) 43516200	PitNo	. т	PF8 (VALLEY)
					FAX: (02) 43516300	Shee	1 1	/1
lie	nt:	FC	DRBES	SRIG	BY PTY LTD	Starte	ed: 🤇	30/7/03
roj	ect:	FE	EASIB	ILITY	FOR DEVELOPMENT	Finist	ned:	30/7/03
эc	ation:					Logg	ed	GP/GV
					-	Chec	ked:	RJK
qu	ipmen	ttyp	pe:			RL su	rface:	
uc		ze:			450mm	Datur		
water	ples, te	depth (m)	graphic log	USCS symbo		Moisture condition	Consistency/ relative density	comments notes, structure and additional observations
	Ê 2			SM	Silty SAND, fine grained, brown, grass and shrub roots	W	L	TOPSOIL
	→ → → → → → → → → → → → → → → → → → →	2	A	SM- SC	Silty Clayey SAND, fine to mediumgrained, pale grey mottled yellow-brown, low plasticity		D	PROBABLE SLOPEWASH — — — — — — — — — — — — — — — — — — —
- verte - vert	D D Vina	1.		CL/ CH	Sandy CLAY, medium to high plasticity, grey mottled red-brown, fine sand, some fine to medium gravel	> W p	(∨St)	RESIDUAL
	D	2.5	5			D	(D)	
♣					mottled orange-brown/red-brown, some fine to	D-M		
		3.5			TPF8 terminated at 3.0m depth			
		lient: roject: pcation: quipmen ucketSiz samples: test samples: test samples: test samples: test au te	Geotechnics	Geotechnics Pty Iient: FORBES roject: FEASIB Docation: NAVALO quipment type: ucket Size:	roject: FEASIBILITY Dcation: NAVAL COLL GPS (AUS 66 Quipment type: Ucket Size: Ucket Size:	Average and a state of the second state o	Portection Port of K Geole chnics Piy Ltd Monotone manual manuu manual manual manual	Arros is an alternative and a state work Arros is an alternative and alternalter

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G	ес	otech			ork ^p ty L		T E ACN 069 211 561 6/6 Morton Closse TUGGERAH NSW 2259 TEL: (02) 43516200 FAX: (02) 43516300	Job No Pit No Sheet	о. ^G	IT LOG 23129/1 1/1
	en			тне в	IVERVIE	WGR	JUP	Starte	d :	9/10/03
		ct:		PROP	OSED S	норр	ING CENTRE & COMMERCIAL PRECINCT	Finishe	ed:	9/10/03
.00	ca	tion:		CNRN	AVAL C	OLLEG	E ROAD & THE WOOL ROAD, VINCENTIA	Logge	d	GP
				GPS ((AUS 66): 562	86332E 6115727N	Check	ed:	GP
- a	ui	pme	nt	tvp	e: ,	јони і	DEERE 315C 4X4 EXTENDAHOE	RL sur	face:	·····
		ket W				500 <i>m</i> m		Datum		
ethod	ater	ples, tests	- Anna an Anna Anna Anna Anna Anna Anna	depth (m)	graphic log	SCS symbo	Material description Soil type, particle characteristics or fines plasticity	Molsture condition	Consistency/ relative density	comments notes, structure and additional
E	3	sam etc		U	ā		colour, secondary and minor components		C O Le Is	observations
н	ared		1			SM	Silty SAND, fine grained, grey, roots	M	МD	SLOPEWASH
	None Encountered		3	 0 . 5		SP	SAND, fine grained, yellow-brown			
	_	в	2			SP/ SC	SAND/Clayey SAND, fine to medium grained, mottled yellow-brown/pale grey, low plasticity		L	PROBABLE SLOPEWASH
		В	1 6 12 7 9 9	1.0		CL	Sandy CLAY, medium plasticity, white mottled red- brown, fine to medium sand, some fine to medium gravel, some silt	≥ W p	St/ VSt	RESIDUAL
			ometer (Blows/150mm)	2.0		SC	Clayey SAND, fine to medium grained, white, low to medium plasticity	D		
			Dynamic Cone Penetro	3.0			SANDSTONE, highly weathered, fine to medium grained, mottled red-brown/pale grey/orange-brown, est very low to low rock strength			ROCK
				3.8 3.8	5		TP10 terminated at 3.2m depth - machine refusal on rock			

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

		A					BOF	REH	10	LE LOG
œ		$\sim 1 \times \epsilon$	etw.	ork			069 211 561 Aorton Close	Job No	G:	23129/1
6	iec	otechni	ics P	vtv L	td		GERAH NSW 2259 : (02) 43516200	Pit No.	τ	Hole 11
				,		FAX	(02) 43516300	Sheet	1	/1
	ier		THER	IVERVIE	W GRO	DUP		Starte	d:	10/10/03
		ect:	PROP	OSED 5	HOPPI	NG CENTRE & COMMERCIAL PRECINCT		Finishe		10/10/03
		tion:	CNRN	AVAL C	OLLEG	E ROAD & THE WOOL ROAD, VINCENTIA		Logge		GP
			GPS (AUS 66): 562	86376E 6115770N		Check	ed:	GP
		pment	typ		SKID S	TEER ~ SOLID FLIGHT AUGERS		RL sur	face:	
		ket Wic						Datum		
		g s		1	100 m m 0 Ω				lt y	
σ		te	(E)	000	symt	Material description		ure Ition	onsistency/ lative dens	comments
etho	ater	e D	epth	phic	S S		fines plasticity	M o isture conditior	siste tive	notes, structure and additional
Ê	Ň	etc etc	σ	gra	US(Soll type, particle characteristics or colour, secondary and minor comp	onents	20	Consis relative	observations
AD		1		513	SM	Silty SAND, fine grained, grey, some ro	ots	M-W	МD	TOPSOIL
		2		SS				-		
		3	<u> </u>		SP	SAND, fine grained, mottled grey/pale low plasticity clay fines	brown, some			SLOPEWASH —
		6	0.5						D	
		9								
								-		RESIDUAL -
	d rillin g	11				SAND, fine to medium grained, white, plasticity fines, trace of roots	some low			
	After drilling	13	1.C							
	¥	13						w		
		15								_
		14	1.5							
		Ê								
1		20 H			CL	Sandy CLAY, low to medium plasticity becoming white mottled red-brown be	white low about 2m	≈Wp		
		ows/1			ļ	depth, fine to medium sand				
		eter (Blo	2.0							
		e trom e								
		Le L		(./.						
		сопе								
		am ic (2.5		CL/	Sandy CLAY/Clayey SAND, low to med	ium plasticity,	-		
		Dyn€			sc	mottled red-brown/pale grey/orange, fi sand, trace fine to medium gravel	ne to medium			
			3.0							
				. /.						
				× /						
			3.5							
				./						
				./.,						
			 4.C	[/./		THole 11 terminated at 4m d	epth			_

REFER TO EXPLANATION SHEFTS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

C Pr Lc	lie roj	iec ati	: t: on	:	F F	EAS AVAL PS (ES R BILIT COL	IGI Y LE	BY PTY LTD FOR DEVELOPMENT GE ROAD & THE WOOL ROAD, VIN) AMG: 56286364E 6115707N CID STEER DRILL	ACN 069 211 561 6'6 Morton Close TUGGERAH NSW 2259 TEL: (02) 43516200 FAX: (02) 43516300	Job Pit N Shee Start Finis Logg Chec	No. G o. E ⇒t 1 :ed: hed:	DLE LO 323085/1 3H13 (LOWER SLO 7/1 31/7/03 31/7/03 GP/GV RJK	
method	water		etc		depth (m)	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-	SCS symbol	0mm DIA SOLID FLIGHT AUGERS Material descript Soil type, particle characteristics	or fines plasticit	isture dition			ıre
AD			ter (blows/150mm) @	2 3 4 4 5	0.	5	SN SN SC		colour, secondary and minor cor Silty SAND, fine grained, yellow-brow 0.25m Clayey SAND, fine grained, pale grey brown, low plasticity	m, roots to abou		1	Observations SLOPEWASH RESIDUAL	
	¥	D	tic Cone Penetrome	7 8 10 12	1. 1. 1. 1. 1. 1.		C L	r	Sandy CLAY/Clayey SAND, fine to me ed-brown/pale grey, low plasticity cla vith depth, some fine to medium grav	av increasing	м			
					2.0		CL/ ML	S	ilty CLAY/Clayey SILT, low plasticity.	pale grey	م W >	(VSt)		
					_3.5			BI	H13 terminated at 3.0m depth Slotted piezometer (0.5 to 3m depth	range) installed				

4

		N				BOF	RE	ΗС	LE LO	G
			e t w	ork	Ś	ACN 069 211 561 6/6 Morton Close	Job N	10.	323129/1	
6	Ge	otechn	ics I	^{>} ty l	Ltd	ТUGGERAH NSW 2259 TEL: (02) 43516200	PitNo	».	THole 12	
						FAX: (02) 43516300	Sheel	t	1/1	
CI	lier	nt:	тне в	IVERVI	EWGR	ουρ	Starte	ed ·	10/10/03	
		ect:	PROP	OSED	ѕнорр	ING CENTRE & COMMERCIAL PRECINCT	Finish		10/10/03	
		ation:	CN.A N	AVAL C	COLLEG	SE ROAD & THE WOOL ROAD, VINCENTIA	Logg		٩Ð	
			GPS ((AUS 60	5): 562	286428E 6115779N	Checi	ked:	GP	
Εc	qu	ipment	typ	e:	SKIDS	TEER ~ SOLID FLIGHT AUGERS	RL su	rface:		
B	uc	ket Wid	th:		100mn	л	Datun	٦		
method	water	sam ples, tests etc	depth (m)	graphic log	USCS symbol	Material description Soil type, particle characteristics or fines plasticity colour, secondary and minor components	M oisture condition	Consistency/ relative density	comments notes, structu and additiona observations	
٩D		4		KID	SM	Silty SAND, fine grained, grey-brown, roots to 0.15m	м	MD	TOPSOIL	
		3				depth	-			-
		6	0.5		SP	SAND, fine to medium grained, grey, some low plasticity fines	M-W	D	SLOPEWASH	
			*****							-
		8	 1.0		SC	Clayey SAND, fine to medium grained, white, low plasticity		-	RESIDUAL	
		10								
		13	1.5		CL	Sandy CLAY, low to medium plasticity, white becoming mottled red-brown/pale grey/orange below 1.4m depth, fine to medium sand, trace fine gravel below 1.4m depth	≥Wp	VSt/ H		
		eter (Blows/150mm)								-
-		eron Hone	2.0 							
		Cone Peri	_	1	sc	Clayey SAND, fine to medium grained, mottled red-	M			
	p ni	Dynamic Co	2.5			brown/white, low plasticity				
	aiter drilling		-		9 M.					
	1.6m 5 mins	-	3.0							
	3m after drilling, 3.		- - 3.5	· · · · · · · · · · · · · · · · · · ·		SANDSTONE, extremely weathered, augers as Sandy Silty CLAY, low to medium plasticity, mottled white/red-brown/orange, est very low rock strength	<wp< td=""><td></td><td>ROCK Note: GW seepage probab ≤ 3.2m depth</td><td></td></wp<>		ROCK Note: GW seepage probab ≤ 3.2m depth	
	8.0 8.0		-							
			4.0	••••]		THole 12 terminated at 4m depth			**************************************	

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REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

			V	_		,		RE	НС	LELOG
e					ork		AGN 069 211 561 6/6 Morton Close	Job N	lo. ^e	323129/1
(d e	otec	chn	ics I	pty I	Ltd	TUGGERAH NSW 2259 TEL: (02) 43516200	Pit No	»,	THole 13
							FAX: (02) 43516300	Sheet	t .	1/1
СІ	lie	nt:		THER	NVERVI	EW GR	OUP	Starte	ed:	10/10/03
Ρr	оj	ect:		PROF	POSED	SHOPF	ING CENTRE & COMMERCIAL PRECINCT	Finish	ied:	10/10/03
Lс	oci	atior	ר:				SE ROAD & THE WOOL ROAD, VINCENTIA	Logg	ed	GP
				GPS	(AUS 6)	6): 56:	286420E 6115844N	Checl	ked:	GP
Εc	qu	ipm	ent	typ	e:	SKID S	STEER ~ SOLID FLIGHT AUGERS	RL su	rface:	
		ket				100 m n	n	Datum		
		sts			0	0 0			y/ sity	
рc	.	s, te		е ш	<u>_</u>	syml	Material description	کر Moisture condition	Consistency/ elative densit	comments
method	ater	b e		epth	aphic	CS		oist	s is te vec	notes, structure
E	3	sam etc		σ	gra	S ∩	Soll type, particle characteristics or fines plasticit colour, secondary and minor components	γ. Σö	Consis	and additional observations
٩D			1		88	SM	Silty SAND, fine grained, dark grey-brown, roots	w	MD	TOPSOIL
			з			SP	SAND, fine to medium grained, mottled pale brown/	M - W	-	SLOPEWASH
			6				grey, some low plasticity fines		D	
			8	0.5						
			9			sc	Clayey SAND, fine grained, pale grey, low plasticity			RESIDUAL
			13	_						-
					//	CL	Sandy CLAY, medium plasticity, pale grey becoming	> W p	VSt/	. –
			18	1.0	. /.		pale grey mottled red-brown/orange below 2m depth. fine sand		Н	
			20							
			-	_						
		B	ļ	1.5						
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			/150mm)							
			(Blows/1		<u> </u>					
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	p			- .						
	drilling			3.5_	4		Gravelly Silty CLAY, medium plasticity, white mottled	< W p		
	After			k			red-brown, fine to medium gravel	- ""		
	V.				<u>}</u>					
			┢	4.0			THole 13 terminated at 4m depth			

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APPENDIX B

Laboratory Test Results

G24048/1-A



ACN 069 211 561 6/6 Morton Close TUGGERAH NSW 2259 Telephone 4351 6200 Facsimilie 4351 6300

PARTICLE SIZE DISTRIBUTION REPORT SHEET

(Document No R16.2)

ject: ation:		ive Shop College R						Da	te T	este	d:		29	/04	/20)4				
							7	L												
Sample Io		tion										Gradin								
3H2 (0.4 to	o 0.8m)									Sieve	% P	assing			Sie		%	Pa	ssin	
Fest Proc	oduro						1			0mm 3mm					75n 36n					100 100
S1289 3,		nod)								5mm					18n					99
101203 0.	0.1 (Wasi			- MARINE & Land Jacob Pro-]			5mm					001					96
Aaterial [Descripti	on]			9mm					25ι				,	92
SC) Claye			nediu	ım gra	ined, bro	wn,			13.	2mm				Э	100	ım				86
ow to med	lium plas	ticity cla	y							5mm				1	50ι	· · · · · · · ·				69
							J		6.	7mm		100			75ι	ım				46
	Clay	fine		Silt edium	coarse	fin	e li	San		coar	Se	fine		Grav		C	Darse		Cobb	les
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		Sieve]	150		25	1.1		4.75	1	9.5		19		.5	75	4 -
						075		300	.6		2		6.7		13.2	2	26.5	53	»	15
NX	have be	en performed i	in acco	rdance wit	covered by this n NATA require 25 and are trac	ments wh									0:	t-	\supset	U	eni	/



ACN 069 211 561 6/6 Morton Close TUGGERAH NSW 2259 Telephone 4351 6200 Facsimilíe 4351 6300

PARTICLE SIZE DISTRIBUTION REPORT SHEET

(Document No R16.2)

oject: ocation:	Naval (tive Shop College Ro	ping Ceni had Vinci	ne oite ≏ntia			n	te '	Teste	d٠		0	29/0	Al	აიი	л					
	navart	Jollege In					Da	lic	10310	<u>u.</u>			9/0	-+/ 6	200	4					
Sample I		ition				1					Gradi	ng	Re	รเ	Ilts						
BH7 (0.5 I	o 0.9m)								Sieve	% F	Passing				Siev		%	Pa	ssing		
	•				Mutanton Manual I	1			0mm						5m				100		
Test Pro		E1)					53mm 37.5mm					2.36mm 1.18mm							99		
AS 1289 3	289 3.6.1 (washed)											_ _	1								
Material	Descript	ion				1			5mm 9mm)0u 25u				98		
(CL) Sand			lasticity (orande-rea	4				$\frac{9}{2}$ mm		100				:5ui)0ui				95		
fine to me			naotiony, (orango rot	ч,				5mm		100				50u				79		
									7mm		100				'5ui				55		
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	The teste	calibrations or	measuremente	covered by this																	
		, calibrations or in performed in a																			



ACN 069 211 561 6/6 Morton Close TUGGERAH NSW 2259 Telephone 4351 6200 Facsimile 4351 6300 Email: gosnetgeo@bigpond.com

ATTERBERG LIMITS & LINEAR SHRINKAGE TEST REPORT SHEET

 IESTREPURI SHEET
 (Document No R12.1)

 Client: Forbes Rigby Pty Ltd
 Job No: G24048/1

 Project: Alternative Shopping Centre Site
 Date Tested: 4/5/04

 Location: Naval College Road, Vincentia
 Date Tested: 4/5/04

SAMPLE DATA			
Sample Number:	BH1 (0.3 to 0.6m)	BH4 (0.5 to 0.9m)	
Sample Location:	Refer to Drawing	1 No. G24048/1-1	
Date Sampled:	21-4-04	21-4-04	
Sample Description:	(CL) Sandy CLAY, low plasticity, brown, fine to medium sand	(CL) Sandy CLAY, low plasticity, grey to dark grey, fine to medium sand	
Sample History:	Oven Dried	Oven Dried	
Preparation Method:	Dry Sieved	Dry Sieved	

TEST PROCEDU	JRE		TEST RESULTS								
AS1289 3.1.2 - 1995 Liquid Limit (W _L)	%	26	32								
AS1289 3.2.1-1995 Plastic Limit (W _P)	%	14	12								
AS1289 3.3.1-1995 Plasticity Index (I _P)	%	12	20								

Comments:



THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENT. THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL. **NATA ACCREDITED LABORATORY NO. 1318**

Approved Signatory: S Waugh 2 /6/04



ACN 069 211 561 6/6 Morton Close TUGGERAH NSW 2259 Telephone 4351 6200 Facsimilie 4351 6300 gosnetgeo@bigpond.com

(Document No R11.5)

CALIFORNIA BEARING RATIO REPORT SHEET

Client: Forbes Rigby Pty Ltd **Project:** Alternative Shopping Centre Site **Location:** Naval College Road, Vincentia Job No: G24048/1 Tested by: MK Checked by: SW

	on: Naval College Roa	d, Vincentia		Checked by: SV	V
AMPL	E DATA			a an an 100 a sanaga sa sana sana sana arawara sana	La contra de la contra de la bracia.
	ple Number:		BH1 (0.03 to 0.6m)	BH1 (0.7 to 1.0m)	BH4 (0.5 to 0.9m)
Sam	ple Location:		Refe	r to Drawing No. G2404	18/1-1
Date	Sampled:		21-4-04	21-4-04	21-4-04
Sam	ple Description:		(CL) Sandy CLAY, low plasticity, brown, fine to medium sand	(CL) CLAY, medium plasticity, pale yellow brown mottled grey	(CL) Sandy CLAY, low plasticity, grey to dark grey, fine to medium sand
Field	Moisture Content:		14.4	21.8	14.1
BOR	ATORY COMPACTION	I DATA [AS12	289 5.1.1-1993]		
Maxir	num Dry Density	t/m³	1.85	1.65	1.84
Optin	num Moisture Content	%	13.5	20.0	15.0
LIFO	RNIA BEARING RATIO	D TEST RESU	JLTS [AS1289 6.1.1-199	8] (AS1289 2.1.1-1992	2)
Date	Tested		3-5-04	3-5-04	3-5-04
0 –	Dry Density	t/m ³	1.84	1.63	1.83
Before Soakin	Density Ratio	%	100	99	99
	Moisture Content	%	13.9	21.6	15.3
Numb	per of days soaked		4	4	4
Surch	arge	kg	9	9	9
Swell	after soaking	%	0.0	1.0	0.0
r C	Dry Density	t/m³	1.84	1.62	1.82
After Soakin	Density Ratio	%	100	98	99
****	Moisture Content	%	16.0	23.4	16.3
After Tes	Moisture Content Top 3	0mm %	15.5	24.0	16.6
Ϋ́⊢	Moisture Content Whole	e sample %	15.8	22.9	16.2
	alue @ 2.5/5.0mm penel/	tration %	11/13	6/6	10/11

Comments:



THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENT. THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL. **NATA ACCREDITED LABORATORY NO. 1318**

Store Wang

Approved Signatory: S Waugh 2 /6 /04-



ACN 069 211 561 6/6 Morton Close TUGGERAH NSW 2259 Telephone 4351 6200 Facsimile 4351 6300 Email: gosnetgeo@bigpond.com

(Document No R19.1)

SHRINK/SWELL INDEX TEST REPORT SHEET

Client: Forbes Rigby Pty Ltd		Job No: G24048/	1
Project: Alternative Shopping Centre	e Site		
Location: Naval College Road, Vince	entia	Date: 11-5-04	
SAMPLE DATA			
Sample Number:	BH2 (0.4 to 0.8m)	BH4 (0.5 to 0.9m)	BH7 (0.5 to 0.9m)
Sample Location:	Refer	to Drawing No. G240	48/1-1
Date Sampled:	21-4-04	21-4-04	21-4-04
Sample Description:	(SC) Clayey SAND, fine to medium grained, brown, low to medium plasticity clay	(CL) Sandy CLAY, low plasticity, grey to dark grey, fine to medium sand	(CL) Sandy CLAY, medium plasticity, orange-red, fine to medium sand
TEST PROCEDURE		TEST RESULTS	
AS1289 2.1.1-1992 Moisture Content (Field) %	12.8	12.3	15.9
AS1289 2.1.1-1992 Moisture Content (After Test)%	14.1	17.0	18.6

AS1289 7.1.1-1998 Swelling Strain (Esw) 0.0 0.0 0.0 % Shrinkage Strain (Esh) % 2.0 2.1 2.1 Shrink/Swell Index (Iss) 1.2 1.2 % 1.1

Comment:



THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE .THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENT. THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL. **NATA ACCREDITED LABORATORY NO. 1318**

Approved Signatory: S Waugh 2/6/04

Alow young

Sydney Environmental **Corrosion & Scaling Assessment:** and Soil Laboratory Pty Ltd Soil Reporting Profile (inc in NSW) Test Type I CSAS-CS ACN 002 825 569 Job No: G24048/1 Order No Quality ABN 23-002-825-569 Endorsed Company Reference 16 Chilvers Road Sample Name BH2 (0.4-0.8) Thornleigh NSW 2120 Sydney Australia Sample No. 81010 2 (7 MURZ NW 1 -**Environmental and Soil** Address Mail to Date Received 23/04/2004 Total No Pages: 2 Laboratory PO Box 357 Client: Network Geotechnics Pty Ltd Specialists in Soil Chemistry and Agronomy Pennant Hills NSW 1715 18 Brian Oberdorf ABN 70 106 810 708 Telephone (02) 9980 6554 6/6 Morton Close Facsimile (02) 9484 2427 TUGGERAH NSW http://www.sesl.com.au Email: sesl@sesl.com.au

Tests are performed under a quality system certified as complying with ISO 9002. Results & Conclusions assume that sampling is representative. This document shall not be reproduced except in full COMMENTS TEST RESULT acidic - mild to moderately aggressive pH in water (1:2) 4.9 EC mS/cm (1:2) .07 low salinity level loam fine sandy **Texture Class** Soil Permeability Class high SOLUBLE ANION ANALYSIS 350 non-aggressive to concrete Sulphate (1:2) mgSO4/kg non-aggressive to steel Chloride (1:2) mgCl/kg 100

non-aggressive to steel

(Note:- 10,000 mg/L = 1%)

99.5

* Resistivity tested on a saturated sample/paste

Recommendations

* Resistivity Ω.m

н		
	Explanation of the Methods: pH, EC, Soluble SO4: Bradley et al., (1983); CI, (4500-CI-E; APHA, 1998); Texture Class, AS2159:1995; Resistivity, AS1289.4.4.1:1997, Checked by Principal	

Corrosion & Scaling Assessment: Soil Reporting Profile

Test Type I	CSAS-CS			
Order No		Job No: G24048/1		
Reference				
Sample Name	BH4 (0.5-0.9)		
Sample No.	81011			
Date Received	23/04/2004	Total No Pages: 2		
Client:	Network Geo	technics Pty Ltd		
Brian Oberdorf				
6/6 Morton Close				
TUGGERAH NSW				



Sydney Environmental and Soil Laboratory

Specialists in Soil Chemistry and Agronomy ABN 70-106-810-708 Sydney Environmental and Soil Laboratory Pty Ltd (inc in NSW)

ACN-002-825-569__ ABN-23-002-825-569__

16 Chilvers Road Thornleigh NSW 2120 Australia Address Mail to PO Box 357 Pennant Hills NSW 1715 Telephone (02) 9980 6554 Facsimile (02) 9484 2427 http://www.sesl.com.au

Email: sesl@sesl.com.au

Tests are performed under a quality system certified as complying with ISO 9002.

Results & Conclusions assume that sampling is representative. This document shall not be reproduced except in full

TEST	RESULT	COMMENTS
pH in water (1:2)	4.5	acidic - non-aggressive to mildly aggressive
EC mS/cm (1:2)	.19	low salinity level
Texture Class	silty loam	
Soil Permeability Class	low	
SOLUBLE ANION ANALYSIS		
Sulphate (1:2) mgSO₄ / kg	40	non-aggressive to concrete
Chloride (1:2) mgCl/kg	70	non-aggressive to steel
* Resistivity Ω.m	34.7	non-aggressive to steel

2259

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/L = 1%)

Recommendations

п	ecommendations	
	These results suggest this material is not aggressive to either concrete or steel structures.	
	Explanation of the Methods: pH, EC, Soluble SO4: Bradley et al., (1983); CI, (4500-CI-E; APHA, 1998); Texture Class, AS2159:1995; Resistivity, AS1289.4.4.1:1997, Checked by Principal Simon Leake Date of Report 30/04/2004 Consultant	

