REPORT ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED BYRON SHIRE CENTRAL HOSPITAL

EWINGSDALE ROAD, BYRON BAY, NSW
DESCRIBED AS LOT 3 ON DP 848007

PREPARED FOR

AURORA PROJECTS PTY LTD
on behalf of
HEALTH INFRASTRUCTURE NSW

PROJECT REF: **GI 1375-A**

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The undersigned, for and on behalf of Geotechnical Investigations Pty Ltd, confirm that this document and all attached drawings, logs, and test results have been checked and reviewed for errors, omissions and inaccuracies.

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1. INTRODUCTION

As requested by Aurora Projects Pty Ltd (Aurora) on behalf of Health Infrastructure NSW, Geotech Investigations Pty Ltd (GI) has undertaken a geotechnical investigation for the proposed development of the 'Byron Shire Central Hospital' (BSCH) at Lot 17 on DP 816451 Ewingsdale Road, Byron Bay.

It is understood that the proposed BSCH will provide a boost to private and public services for the Byron Bay community, and surrounding neighbouring towns of Bangalow, Ocean Shores, Mullumbimby and Suffolk Park. The construction of the BSCH facility will significantly reduce the travel distance for patients, which currently requires the journey to Lismore, Tweed Heads or Ballina.

The proposed BSCH will comprise the construction of three (3) mixed use single and double storey buildings, probably constructed with a concrete frame with suspended concrete floors on a concrete slab-on-ground. Design column loads for the double storey buildings are anticipated to be in the order of 800 kN to 1000 kN maximum. The structures will be inter-connected through a series of 'link structures'.

Specific details regarding earthworks for the proposed BSCH were not known at the time of preparing this report. However, given the existing slope, and proposed slab-on-ground construction, earthworks for the building platforms are anticipated to comprise cut and fill to 1 m to 2 m depth, followed by excavations for the installation of footings and in-ground services. Furthermore, retaining walls will be required throughout the BSCH facility.

A series of interlinked internal roads and car parking is proposed to encompass the three large buildings. The southern portion of Ewingsdale Road will be widened to provide access and egress into the BSCH facility.

2. SCOPE OF WORKS

The scope of the geotechnical services provided by GI was directed towards evaluating the following items as outlined in the proposal GI 0878-a dated 16 May 2014. The geotechnical report was to detail information regarding the project, site description, observations, and investigation methods, and will summarise the laboratory testing. In summary, the geotechnical reporting would provide discussion on the following:-

- Subsurface conditions, including groundwater;
- Earthworks, excavations, trafficability, site preparation, compaction and re-use of excavated material for fill;
- Temporary and long term batter slopes, for excavations up to 3 m depth;
- Geotechnical retaining wall design parameters including earth pressure coefficients;
- Characteristic surface movements in cohesive soils;

- Site classification in accordance with AS 2870 – 2011 (Ref 1) for small structures and slabs, and to assist with any slab on ground structures;
- Suitable foundation types, ultimate bearing pressures and estimated settlements for high level footings (if suitable);
- Suitable pile types, ultimate design parameters and comments on piling rig suitability;
- Infiltration testing and comments;
- Earthquake provisions;
- Comments on slope instability (if required); and
- Indicative pavement design parameters.

The investigation comprised the drilling and sampling of eight (8) boreholes to depths between 4 m and 10.3 m, four (4) pavement boreholes / test pits to a depth of 1 m, followed by laboratory testing, engineering analysis and reporting.

3. SITE DESCRIPTION

The site covers an approximate area of 6 hectares and is located on the southern side of Ewingsdale Road, Byron Bay, in northern NSW, approximately 260 m east of the intersection with the Old Pacific Highway.

The proposed building area, internal roads and car parking is proposed to be positioned in the central to north-western portion of the site, and is referred to as the ‘proposed BE’ from this point forward (refer Figures 1 and 2).

The topography of the site was slightly sloping (less than 7 degrees) in a slightly shaping ‘gully’ from the north-western portion towards the eastern boundary, beyond the existing ambulance station and pond (refer Figure 1).

Some of the existing conditions are detailed on the attached site plan by GI (*See Appendix A)*, and site observations can be described as:-

- At the time of the investigation, the site was vacant and was currently being used for grazing. The northern road boundary was vegetated with a row of trees (hedges), with long grass and isolated mature trees present in the eastern vicinity of the site (refer Figure 2).
- A recently constructed ambulance station and associated car parking facilities was positioned in the north-eastern portion of the site, along with an existing pond / dam further east. As part of the construction of the ambulance facility, existing drainage channels and subsurface drains for surface water flow were present.

- Ewingsdale Road, which transects between the east and west, is located to the north of the subject site with approximately 292 m of road frontage. The road is slightly sloping in a easterly direction, with a well grassed shoulder approximately 3 m in width consistent along the southern site boundary. The presence of numerous in-ground services is noted in this shoulder area.

Figures 1 to 5 show some site features observed and described above.

Figure 1: Facing south-east in the location of BH 8

Figure 2: South-east facing in the location of BH 2

Figure 3: East facing in the location of GWMW 1

Figure 4: West facing in the location of BH 11 in the OWP of Ewingsdale Road.

Figure 5: North facing in the location of test pit TP 12.

4. FIELD WORK METHODOLOGY

4.1 Proposed Subject BE

Field work for the proposed BE investigation was undertaken between the 26th May 2014 and 5th June 2014, and comprised the drilling and sampling of a total of 8 boreholes (designated BH 1 to BH 8). The boreholes were drilled using a 4wd mounted drill rig and truck mounted Explora85 drill rig. Dynamic cone penetrometer tests (DCPs) were carried out adjacent to most boreholes, with pocket penetrometer tests (PPs) on returned cuttings in others, to provide an estimate of the strength consistency of the subsurface profile.

Table 1 below provides the coordinates of the engineering boreholes for the subject BE, which were collected using a hand-held GPS with an accuracy of approximately 5 m.

Table 1: Borehole Locations – ***Proposed Subject BE***

Borehole Number	Date Drilled	Terminated Depth (m)	GPS Coordinates	
			S	E
BH 1	26 May 14	4.0	28° 38′ 13.6″	153° 33′ 18.6″
BH 2	5 June 14	10.15	28° 38′ 14.0″	153° 33′ 21.8″
BH 3	26 May 14	4.0	28° 38′ 14.1″	153° 33′ 27.6″
BH 4	26 May 14	4.0	28° 38′ 15.3″	153° 33′ 18.4″
BH 5	4 June 14	10.30	28° 38′ 15.4″	153° 33.2′ 21.0″
BH 6	26 May 14	4.0	28° 38′ 16.0″	153° 33.0′ 23.0″
BH 7	26 May 14	4.0	28° 38′ 17.1″	153° 33.0′ 18.3″
BH 8	4 June 14	6.35	28° 38′ 17.1″	153° 33.0′ 21.2″

Boreholes BH 1, BH 3, BH 4, BH 6 and BH 7, were drilled using solid flight auguring to a termination depth of 4 m. Boreholes BH 2, BH 5, and BH 8 were drilled to 0.8 m depth using solid flight augers, where steel casing was installed and the boreholes continued using rotary wash boring techniques to depths between 5.4 m and 9.1 m. The boreholes were then continued using NMLC rock coring techniques to recover continuous samples of the rock to the terminated depths between 6.35 m and 10.3 m. The approximate locations of the boreholes are shown on Site Plan S01 in Appendix A.

Dynamic cone penetrometer tests (DCPs) were carried out adjacent to most boreholes to provide an estimate of the strength consistency of the subsurface soils. Standard penetration tests (SPTs) were carried out at regular depth intervals within the boreholes BH 2, BH 5 and BH 8 to collect samples and to provide an estimate of the strength consistency of the soils encountered, and strength of weathered rock, based on SPT 'N' values. "Undisturbed" 50 mm tube samples were collected to recover samples of cohesive soils. Pocket Penetrometer (PP) tests were undertaken on the returned "undisturbed" samples to provide an estimate of shear strength of the cohesive soils.

A groundwater monitoring well (GWMW) was installed at the location of GWMW 1 to a depth of 4.5 m, and was constructed using "Class 18" PVC piping with internal diameter of 50 mm. The lower 1.5 m of the PVC was machined slotted. The annulus of the well was backfilled with coarse granular sands and natural fill to 0.5 m below surface level, where the upper 500 mm was bentonite sealed. Attempts were made to install a second GWMW 70 m to the south of GWMW 1, however due to encountering anticipated weathered basalt or boulders, the installation was not able to be achieved.

At the request of the client, GWMW 1 was decommissioned on the 8th July 2014 by backfilling the well with a grout mix to existing surface level

Two (2) constant head field permeability tests (PT) were undertaken at PT 1 and PT 2 on the 8th of July 2014, to a depth of 0.5 m below surface level. The PTs were carried out in accordance with AS/NZS 1547 – 2000 (Ref 9) using a permeameter purpose built apparatus.

This investigation has been carried out in accordance with AS 1726 – 1993 (Ref 2) in terms of soil and rock description, with the fieldwork supervised by experienced geotechnical personnel, who positioned and logged the boreholes. At the completion of drilling, the boreholes were backfilled with drill spoil after checking for groundwater levels. The approximate locations of the boreholes are shown on the attached site plan *(see Appendix A)*.

4.2 Proposed Road Upgrade

Field work for the proposed road upgrade investigation was undertaken on the 8th July 2014, and comprised the drilling, excavation and sampling of four boreholes / test pits (designated BH 9, TP 10, BH 11 and TP 12) using a 4 tonne rubber tracked hydraulic excavator. Boreholes BH 9 and BH 11 were drilled using a 450 mm diameter auger attachment in the outer wheel path (OWP) on the west bound lane of Ewingsdale Road. Test pits TP 10 and TP 12 were excavated using a 600 mm wide toothed bucket, which were offset to the south of Ewingsdale Road, in the approximate location of the proposed road shoulder.

Dynamic cone penetrometer tests (DCPs) were carried out within the subgrade of the pavement boreholes, and pocket penetrometer tests (PPs) within the test pits, to provide an estimate of the strength consistency of the subgrade profile.

Table 2 below provides the coordinates of the pavement boreholes and test pits for the proposed road upgrade, which were collected using a hand-held GPS with an accuracy of approximately 5 m.

Table 2: Borehole Locations – ***Proposed Road Upgrade***

Borehole / Test Pit Number	Date Drilled	Terminated Depth (m)	GPS Coordinates S	E
BH 9	8 July 14	1.0 m	28° 38´ 12.1˝	153° 33´ 17.8˝
TP 10	8 July 14	1.0 m	28° 38´ 12.8˝	153° 33´ 18.3˝
BH 11	8 July 14	1.0 m	28° 38´ 13.1 ˝	153° 33´ 24.5˝
TP 12	8 July 14	1.0 m	28° 38´ 13.7˝	153° 33´ 24.1˝

Bulk sampling was carried out in the base coarse, sub base and sub grade layers within the pavement boreholes, in order to collect samples for laboratory testing.

At the completion of drilling and excavation, the boreholes and test pits were appropriately backfilled and compacted, followed by re-instatement of the wearing surface with compacted bitumen seal (cold mix) on Ewingsdale Road.

5. GEOTECHNICAL CONDITIONS

5.1 Regional Geology

Reference to geological mapping by the Geological Survey of New South Wales 1:250,000 series 'Tweed Heads' sheet indicates the site is underlain by soils from the Tertiary aged Lismore Basalt of the Lamington Volcanics, which typically comprise "basalt (agglomerate, bole)".

The results of the field work revealed areas of topsoil over residual clays, with weathered basalt at depth, which are considered part of the Lamington Volcanic series.

5.2 Field Work Results

The results of the fieldwork are detailed on the Engineering Logs attached in Appendix B, along with explanatory notes.

In summary, the subsurface conditions within the proposed building area may be described as **residual** clays / silts and extremely weathered **basalt**, then weathered **basalt**. In more detail, the subsurface conditions can be described as follows:-

Residual A sequence of stiff to hard silty clay of high plasticity was encountered in all boreholes from surface level to depths between 2.5 m and 4 m. Underlying the silty clay material in boreholes BH 1, BH 3 and BH 6 a sequence of stiff to very stiff clayey silt was encountered. Underlying the silty clays and clayey silts, extremely weathered (EW) basalt, remoulding stiff to hard silty clays and clayey silts were encountered.

Underlying the residual soils and EW basalt in BH 2, BH 3 and BH 5, silty clay and clayey silt were encountered which were identified as being firm to stiff, likely as a result of higher moisture content from potential seepage. These layers were typically between 0.3 m and 1.2 m thick.

Basalt: Underlying the residual soils and EW basalt, highly weathered (HW) to distinctly weathered (DW) basalt of low strength were encountered in BH 2, BH 5 and BH 8 to at depths between 5.55 m and 9.1 m, where rock roller refusal on low strength basalt was refused in BH 8. Underlying these materials, moderately weathered to fresh basalt of medium to high strength was encountered to termination depths between 6.35 m and 10.3 m.

Groundwater seepage was initially observed at depths between 5.8 m and 6.1 m in BH 2 and BH 5. Groundwater levels were measured in the monitoring well in GWMW 1 at 3.2 m depth following installation. It should be noted that groundwater is affected by climatic conditions, soil permeability, and will vary.

5.3 In-situ Permeability Testing

As requested, testing to determine the permeability (K_{sat}) of the sub-surface material for the bio retention/infiltration system east of the existing ambulance station was carried out. Two (2) constant head field permeability tests were undertaken at PT 1 and PT 2 on the 8th of July 2014, and the results presented in Table 3 below, with the locations shown on Site Plan S01 attached in Appendix C, and a photo of PT 1 in Figure 6 below.

Table 3: Summary of Insitu Permeability Tests

Sample Location	GPS Coordinates		Depth of Hole below Surface Level (m)	Soil Description	Permeability K_{sat} (m/sec)
	S	E			
PT 1	28° 38′ 14.6″	28° 38′ 12.1″	0.0 - 0.64	Sandy CLAY	4.2×10^{-6}
PT 2	153° 33′ 27.9″	153° 33′ 17.7″	0.0 - 0.51	Sandy CLAY	3.3×10^{-6}

These results collate with typical presumptive values between ‘silts and silty sands’ and ‘clayey silts’ (Ref 3). These values are considered the higher bound value for the materials likely to be encountered, and based on sandy clay and silty clay material encountered in the area, it is suggested that a design permeability in the order of 1×10^{-7} to 1×10^{-9} be adopted.

Figure 6: East facing in the location of PT 1, adjacent to GWMW 1.

6. LABORATORY TESTING

Laboratory testing was carried out as part of the geotechnical investigation for the BSCH development. Testing for the proposed BE (i.e. vicinity of proposed structures, internal roads and car parking) is detailed in Section *6.1 Proposed BE*. Laboratory testing for the proposed pavement road upgrade to the north of the proposed BE is detailed in Section *6.2 Proposed Road Widening*.

6.1 Proposed BE

6.1.1 Shrink- Swell Testing

Shrink swell laboratory testing was undertaken on selected samples from boreholes BH 3 and BH 4 at 0.5 – 0.9 metres depth to give a guide to the materials reactivity, determine material properties and allow design theories to be established. The results are presented on NATA accredited laboratory reports attached to this report (See Appendix C). The results indicated a shrink swell potential Iss of between 3.5% / pF and 3.9% / pF indicating the materials to be moderately to highly reactive. The detailed laboratory report sheets are attached in Appendix C, and the results are summarised in Table 4 below.

Table 4: Summary of Shrink Swell Tests

Sample Location	Depth (m)	Description	Swell (%)	Shrinkage (%)	Iss Value (%)
BH 4	0.5-0.9	Silty CLAY	N/A (1)	6.3	3.5
BH 5	0.5-0.9	Silty CLAY	No swell	7.0	3.9

Notes: Due to the insufficient length of sample within BH 4, swell testing could not be undertaken.

6.1.2 California Bearing Ratio Testing

Three disturbed samples collected during the fieldwork for the proposed BE (CBR 1 to CBR 3) were subjected to California Bearing Ratio (CBR) testing by Border-Tek Pty Ltd. The samples were initially screened to remove particles greater than 19 mm, and then compacted to determine Maximum Dry Density (MDD) and Optimum Moisture Content (OMC). The samples were then prepared to approximately 100% of MDD using the Standard effort at near to OMC. The detailed laboratory reports sheet is attached in Appendix C, and the results are summarised in Table 5 below.

Table 5: Summary of California Bearing Ratio Tests – ***Proposed Subject BE***

Sample Location	Depth (m)	Description	MDD (t/m^3)	OMC (%)	Swell (%)	CBR Value (%)
CBR 1	0.2-0.5	Silty CLAY	1.262	36.8	0.0	7
CBR 2	0.2-0.5	Silty CLAY	1.272	35.5	1.5	8
CBR 3	0.2-0.5	Silty CLAY	1.315	35.2	0.5	11

6.2 Proposed Road Widening

6.2.1 California Bearing Ratio Testing

Six disturbed samples collected during the fieldwork for the proposed road widening were subjected to California Bearing Ratio (CBR) testing by Border-Tek Pty Ltd. The samples were initially screened to remove particles greater than 19 mm, and then compacted to determine Maximum Dry Density (MDD) and Optimum Moisture Content (OMC). The samples were then prepared to approximately 100% of MDD using the Standard effort at near to OMC. The detailed laboratory report sheets for the proposed road widening are attached in Appendix C, and the results are summarised in Table 6 below.

Table 6: Summary of California Bearing Ratio Tests – ***Proposed Road Upgrade***

Sample Location	Depth (m)	Description	MDD (t/m^3)	OMC (%)	Swell (%)	CBR Value (%)
CBR 4	0.5-0.7	Silty CLAY	1.294	37.2	0.2	8
CBR 5	0.5-0.8	Silty CLAY	1.277	38.2	0.3	12
BH 9	0.06-0.25 (Base Course)	Silty Clayey GRAVEL	2.088	9.3	0.0	9
BH 9	0.25-0.45 (Sub Base)	Silty Sandy GRAVEL	2.011	10.5	0.1	13
BH 11	0.07-0.25 (Base Course)	Silty Clayey GRAVEL	2.176	8.0	0.1	25
BH 11	0.25-0.45 (Sub Base)	Silty Clayey GRAVEL	2.207	7.6	-0.1	25

6.2.2 Material Quality Testing

Material Quality testing was undertaken by Border-Tek Pty Ltd on samples to confirm material classification descriptions, material properties and allow design theories to be established for the proposed road widening. The detailed laboratory report sheets are attached in Appendix C, and the results are summarised in Table 7 below.

Table 7: Summary of Quality of Subgrade Material – *Proposed Road Upgrade*

Test Location	Soil Description (USC)	Depth (m)	LL	PI	PL	LS
BH 9	GRAVEL (GW)	0.06-0.25 (Base Course)	24.6	8.4	16.4	1.6
BH 9	GRAVEL (GW)	0.25-0.45 (Sub Base)	28.8	11.0	17.8	1.6
BH 11	Sandy GRAVEL (GW)	0.07-0.25 (Base Course)	21.8	5.8	16.0	1.0
BH 11	GRAVEL (GW)	0.25-0.45 (Sub Base)	19.4	4.4	15.0	0.6

Notes: LL – Liquid Limit (%) PL – Plastic Limit (%)
PI – Plasticity Index (%) LS - Linear Shrink (%)

7. PROPOSED DEVELOPMENT

The proposed development of the BSCH will comprise the construction of three (3) mixed use single and double storey buildings, and inter-connected with 'link structures'. The double storey buildings are proposed to be constructed with a concrete frame and suspended concrete floors on a concrete slab-on-ground, with design column loads in the order of 800 kN to 1000 kN maximum.

As mentioned above, the actual extent of earthworks for the proposed BSCH were not known at the time of preparing this report. However, given the existing slope, and proposed slab-on-ground construction, earthworks for the building platforms are anticipated to comprise cut and fill to 1 m to 2 m depth. Furthermore, it is likely that retaining walls will be required to be constructed throughout the BSCH facility.

A series of interlinked internal roads and car parking is proposed to encompass the three large buildings, in addition to widening of Ewingsdale Road to provide access and egress into the BSCH facility.

8. EARTHWORKS

8.1 Earthworks and Retaining Structures

8.1.1 General

It is anticipated that excavations for cut and fill construction would not extend beyond approximately 2 m depth. Bulk earthworks will also comprise the removal of sacrificial topsoil material.

8.1.2 Excavations

Based on the results of the investigation, it is considered that bulk excavation of the residual clays and silts and extremely weathered basalt could be undertaken using traditional excavation equipment (ie 10 – 20 tonne excavator). Excavation of the low strength or stronger basalt, if encountered, will require large equipment probably with pneumatic rock breaker attachments. The use of pneumatic rock hammers and/or a tyne may also be required to assist in the removal of any buried boulders.

The assessment of excavations is based on the conditions encountered at the borehole locations, and different conditions may be encountered in areas outside of the investigation locations.

8.1.3 Site Preparation and Fill Placement

In order to provide a suitable base for the placement of 'controlled' fill and to provide support under buildings and pavements, any existing topsoil containing organics (typically 0.05 m to 0.1 m depth) will need to be removed and replaced with compacted suitable material.

Generally, all earthworks are to be carried out in accordance with AS 3798 (Ref 4). The following earthworks procedures can be used as a guide to support slab-on-ground and pavements:-

- The building and pavement areas, and areas to accept new fill, should be prepared by removing soils that are wet, or contain vegetation or deleterious materials.
- The exposed subgrade should be test rolled using a 12 tonne roller (or similar), loaded water truck or dump truck to determine the presence of any soft spots, which should be excavated out and replaced with compacted select fill. The surface should be tyned to 0.2 m depth, moisture conditioned and then compacted. New fill material should be placed in layers not exceeding 250 mm loose thickness, or less depending on compaction equipment.
- Structural filling for bulk earthworks should be placed in layers having a loose thickness of 250 mm and uniformly compacted to 98% Standard MDD, with moisture content within 2% wet or dry of OMC. Material within 0.5 m of a pavement subgrade level should be compacted to 100% Standard, depending on local authority requirements. Where backfill for service trenches is carried out, the above layer thickness applies however if hand operated compaction equipment are used, the layers are to be placed in 100mm loose thickness, typical.

- The placement of fill material to support building loads and pavements must be placed and compacted under 'Level 1' full-time geotechnical inspections and testing as per AS 3798.
- Field testing must be carried out to confirm the standard of compaction achieved and the moisture content during the construction. The test frequency and extent of testing is to be carried out as per AS 3798, Section 8.0 and compaction testing is to be carried out by a NATA accredited laboratory.

Maintaining adequate surface drainage conditions across bulk earthworks platforms is essential. It should be ensured that runoff is diverted away from the construction area to prevent any ponding of water. The clayey and silty materials will be susceptible to moisture changes, and it is suggested that stripping be staged to limit the extent of exposed subgrade.

To improve trafficability of the site for rubber tyred vehicles, it is suggested that a minimum of 150mm of compacted granular fill be placed over the prepared subgrade where necessary (i.e. access and egress areas).

The contractors should be completely aware of the ground conditions, any water drainage or sediment issues and topography of the site prior to the commencement of earthworks.

8.1.4 Recommended Embankment and Batter Slope Angles

For the purpose of preliminary design, the batter / embankment slopes presented in Table 8 are considered to be suitable for the different soil conditions encountered on the site. Where soil conditions vary from those presented in Table 8, GI may provide guidance and alternative slope angles on site during construction. These slopes assume that construction loads, including traffic, are not located near the batter crest. If batters will be subject to significant surcharge loads, site specific geotechnical advice on batter stability should be obtained, and likely positive support options considered. At these batter slopes, some movement at and behind the slope crest, as well as some localised slumping of batter faces may occur.

All filled batter slopes should be overfilled and cut back to profile to ensure compaction of the edge of the batter faces. The surface of the batter must be protected from erosion (i.e. mulching, etc.), and concrete lined spoon drains should be constructed at the crest and toe of all cut and filled batters.

All permanent batter slopes should be protected from erosion and scour by appropriate drainage, mulching, and vegetation.

Table 8: Slopes Angles for Batter Heights < 3 m (Unsurcharged, Horizontal Ground Behind Crest) (1)

Material Description	Short Term(2) (Maximum)	Long Term (Maximum)(1)
Very Low strength (and better) basalt	1V:0.6H(60°)	1V: 1H(45°)
Residual Stiff or better Clays/Silts	1V:1H(45°)	1V:2H(26°)
'Controlled' Fill Batters(3)	1V:1.2H(40°)	1V: 2H(26°)

Notes: *(1) Short term (i.e. temporary during construction up to 3 weeks), dry, batter slopes for excavations up to a maximum height of 3 m*

(2) A geotechnical engineer from GI is required to be on site during excavations of embankments and placement of fill batters to confirm safe batter slopes. These slopes assume the batters are not underlain by lower bearing strata.

(3) All 'controlled' fill batters should be overfilled, compacted and cut back at a maximum angle given in Table 8 for filled batters. These slope angles are dependent on the fill material used.

Much shallower batters may be required if water seeps from the face, or the excavation will need to be positively supported. For batters greater than 3 m vertical height, a 1 m wide horizontal bench at half height should be constructed.

8.1.5 Geotechnical Retaining Wall Design Parameters

It is anticipated that retaining structures will be required as part of the development. If retaining structures are adopted, they will likely be supporting gravel backfill, new fill, stiff to hard clays and extremely weathered rock.

Flexible retaining walls (i.e., those free to rotate or tilt) may be designed using a triangular pressure distribution, adopting the earth pressure parameters and 'active' earth pressure coefficient (K_a) provided in Table 9 below. These include cantilevered, single propped or anchored retaining walls. Walls that are rigid and unable to rotate or tilt (i.e., wall that is tied to an upper level concrete floor), the 'at-rest' earth pressure coefficient (K_O) should be adopted for design. The values provided in Table 9 are ultimate values, and appropriate safety factor or strength reduction factor should be included.

Table 9: Earth Pressure Design Parameters (non-sloping crest)

Soil Stratum	Unit weight (kN/m^3)	K_O	K_A	K_P
'Controlled' clay fill	17	0.57	0.41	2.46
Stiff residual clays and silts	18	0.56	0.40	2.56
Very stiff or better residual clays and silts	19	0.53	0.36	2.77

The design of all retaining walls will need to take into account any sloping ground surface behind the walls, as well as the usual design constraints and issues. The lateral earth pressure coefficients provided in Table 9 have not made allowances for surcharge loadings from future structures and these should be taken into consideration when designing the retaining wall system. Any backfill placed behind the wall should be loose granular material.

Footing sizes for retaining walls could be designed using the parameters given in Sections 9.2 and 9.3. The parameters adopted for footings for cantilevered retaining walls should be reduced by one third to account for lateral loads.

9. FOUNDATION COMMENTS

9.1 Shrink-Swell Movements and Site Classification

The proposed large structures are outside the scope of AS 2870, being structures exceeding a length of 30 m with suspended concrete floor slabs, and a Site Classification does not apply to the buildings specifically. However, a Site Classification may be relevant to other isolated lightly loaded structures and assist in the design of the footings and slab.

A Site Classification is provided to allow the determination of appropriate footing sizes and slab details to be designed, and is based on the soil profile, the soil reactivity, and the climatic conditions at the site. The soil profile is identified by the site investigation drilling and in-situ testing, while the soil reactivity is determined from laboratory testing to provide the Shrink-Swell Index (I_{SS}). This information is used to calculate the characteristic surface movement (y_S), which is an estimation of the amount of movement at the surface of the site, subject to normal seasonal wetting and drying. These calculations are also based on knowledge of the site history and the proposed works, as earthworks have the effect of changing how the soil reacts to seasonal moisture changes.

Climatic conditions for this site are based on published data by Barnett (Ref 5), which is located within Climatic Zone 1 ‘Alpine/wet coastal’. A value for the change in soil suction at the surface (Δu) of 1.2 picofarads (pF) and a design depth of soil suction change (H_S) value of 1.5 m has been adopted in calculations to determine y_S. AS 2870 indicates that seasonal cracking to a ‘crack depth’ of $H_S/2$ should be considered for natural sites not subject to earthworks, and ignored for sites subject to proposed earthworks, which is most likely the case on the subject site.

Based on laboratory testing a shrink-swell Index (I_{SS}) of 3.5 to 3.9 % / pF has been adopted in the y_S calculations. The results of these calculations reveal that under normal soil moisture variations (i.e. seasonal), y_S values in the order of 35 mm to 45 mm can be anticipated, increasing to 60 mm to 70 mm following earthworks greater than 0.75 m depth. These values are consistent with a Site Classification of 'Class M' (moderately reactive) to ‘Class H2’ (very highly reactive) in accordance with AS 2870.

This classification is relevant to sites subject to seasonal moisture changes only. Abnormal moisture conditions, such as from the removal or planting of trees (including on adjacent sites), poor site drainage, or the development of gardens adjacent to the footings, may cause higher movements to occur, probably resulting in unacceptable damage.

9.2 High Level Footings and Ground Slabs

Based on the results of the fieldwork, the exposed subgrade in the area of the proposed structures following anticipated earthworks is likely to comprise areas of newly placed fill, residual soils (clays and silts) and possibly extremely weathered basalt.

Typically, shallow footings such as strip and pad footings could be designed for an allowable bearing pressure of 100 kPa in ‘stiff’ residual soils, 150 kPa in the ‘very stiff’ residual soils and 200 kPa in the ‘hard’ residual soils. Settlements of footings loaded to these pressures can be estimated in the order of 1% to 2% of footing width.

All footings, edge beams and internal beams should be founded in uniform material to limit the potential for differential settlements that are likely to damage the structures, i.e. not partially in fill and partly in residual soils or weathered rock. This will require the use of deepened footings, bored piers or excavation bucket piers to transfer loads where the ‘very stiff’ or better residual soils are not exposed in the footings. Construction loads **are not** to be supported in any proposed builders fill or topsoil.

Inspection of footing trenches, bored piers or founding subgrade level should be carried out by GI for confirmation of the above bearing pressures prior to placement of concrete.

9.3 Piles

As an alternative, where the building loads are too high, or the movements and settlements cannot be tolerated, the buildings may be founded on piles founded into the weathered basalt. Suitable pile types will include bored piles, steel screw piles or driven timber or concrete piles, subject to noise and vibration assessments. The potential for corrosive soil conditions should also be considered in pile design in relation to durability. The evaluation of the aggressiveness of the soil and groundwater in relation to piles was beyond the scope of this investigation.

Piles should be design and installed in accordance with AS 2159 – 2009 (Ref 6).

Preliminary bored pile design may be based on the ultimate geotechnical design parameters presented in Table 10. For limit state design, a geotechnical strength reduction factor of 0.5 should be applied to the values presented in Table 10 in accordance with AS2159-2009 Table 4.3.2. This reduction factor may be reduced following communication with the pile design engineers and pile contractors, based on the Average Risk Rating.

Table 10: Ultimate Unfactored Geotechnical Parameters for Pile Design

Soil Stratum	Ultimate Unfactored Shaft Adhesion (kPa)	Ultimate Unfactored End Bearing (kPa)
Stiff residual soils	25	-
Very stiff and hard residual soils	40	500*
Very low strength basalt	150	2500
Low strength basalt	250	3500
Medium strength basalt	350	5000#
High strength (or stronger) basalt	600	7500#

Notes: * - Limited by the underlying soft to firm residual soils (punching failure)

\# - High strength rock must be confirmed by core drilling below socket depth, check for serviceability of pile

These values assume a minimum penetration of at three pile diameters into the corresponding residual soil material, and one pile diameter into basalt. The upper 1 m of pile shaft should be ignored to allow for pile load development loads, and soil shrinkage.

The lower strength firm residual material identified in the subsurface profile needs to be considered in the pile design and construction. Punching through the competent residual soils into the firm soils should be considered. As a general rule, if a pile is founded at less than 4 pile diameters above a particular layer, then the design parameters of the lower layer should be adopted.

It should be noted that piling into medium strength and high strength (or stronger) basalt will require the use of large bored piling rig, and bit wear could be excessive.

Groundwater seepage was observed during the drilling of the boreholes, and it is anticipated that temporary or permanent liners may be required to control groundwater inflow into pile excavations, and to allow concrete placement.

Piling contractors should be contacted to confirm suitable pile types and pile capacities.

It is essential that pile excavations be inspected to ensure the ground conditions agree with the design assumptions.

9.4 Earthquake Site Sub-Soil Classification

In accordance with AS 1170.4-2007 (Ref 7) the site sub soil classification is Class C_e – Shallow soil site using the layered soil profile as per AS 1170-4 Section 4.2.

10. PAVEMENT COMMENTS

10.1 Pavement Soil Profiles and Strength Parameters of the Existing Soil Strata

The results of the pavement fieldwork are detailed on the Engineering Logs attached in Appendix B, along with explanatory notes.

In summary, the subsurface conditions within the existing pavement may be described as an asphaltic concrete (AC) layer over similar **base course** and **sub base** layers then **subgrade**, with the road widening area encountering natural subgrade from near surface levels In more detail, the subsurface conditions can be described as follows:-

Base Course

The base course layer 190 to 200 mm thickness of well-graded gravels and fine to coarse sand was encountered beneath the AC within BH 9 and BH 11. The base course material was consistent between the two boreholes, and CBR of 9 % and 25 % was reported.

Sub Base

A sub base layer of approximately 200 mm thickness comprising well-graded gravels and fine to coarse sand was encountered within BH 9, with a CBR of 13 %. The sub base layer encountered within BH 11 demonstrated similar material characteristics and strength properties to the overlying base coarse layer, with 200 mm of well graded sandy gravel and a CBR of 25 %.

Subgrade

The sub grade materials within BH 9 in the existing pavement encountered a layer of dark brown mottled dark grey clayey gravel from 0.45 m to 0.6 m depth. This subgrade layer was viewed as fill, possibly as a result of re-use of previous asphalt material. Underlying the above filled subgrade layer at 0.6 m, and the sub base layer within BH 11 at 0.45 m, very stiff residual dark red / brown silty clay of high plasticity was encountered and continued to the termination depths of 1 m. The results of the DCP tests performed revealed the sub-grade to be stiff to hard clays.

The subgrade materials encountered within the proposed area of the road widening in the locations of test pits TP 10 and TP 12 comprised residual dark red / brown silty clay of high plasticity to the terminated depth of 1 m. The pocket penetrometer test results infer that the subgrade was hard. CBR tests from the subgrade were undertaken with CBR results of 8 % and 12 %. These values are considered the higher bound values for the encountered materials, and should not be entirely relied upon for the purpose of preliminary design. This is due to limited soakage occurring in the very low permeable material. Typically, a design subgrade CBR value of 2 to 4 % could be adopted for the highly plastic silty clay materials with low permeability in accordance with Table 13.4 *Typical Values for Subgrade CBR* (Ref 8).

It is expected that the above silty clay subgrades will exhibit poor subsurface drainage, and it is recommended that subsoil drains be installed early in the works, particularly where pavements adjoin landscaped areas or other water sources.

Profiles and pictures of the pavement layers are shown in the attached engineering logs.

11. REFERENCES

Ref 1: Australian Standard AS2870-2011 *'Residential footings and slabs - Construction'*, Standards Australia

Ref 2: Australian Standard AS 1726-1993 *'Geotechnical site investigations'*, Standards Australia

Ref 3: Whitlow, R., 2001: "*Basic Soil Mechanics*", Fourth Edition, Table 5.1 '*Range of Values of k (m/s)*', Essex, England

Ref 4: Australian Standard AS 3798-2007 *'Guidelines on earthworks for residential and commercial developments'*, Standards Australia

Ref 5: Barnett, I. C. and Kingsland, R.I., 1999: *"Assignment of AS2870 Soil Suction Change Profile Parameters to TMI Derived Climatic Zones for NSW"* Australian Geomechanics, Volume 34, No 3, September 1999, Australian Geomechanics Society, Barton ACT

Ref 6: Australian Standard AS 2159-2009 *'Piling – Design and installation'*, Standards Australia

Ref 7: Australian Standard AS 1170.4-2007 *'Structural design actions: Part 4 Earthquakes in Australia'*, Standards Australia

Ref 8: Look, B.G., 2007: *"Handbook of Geotechnical Investigation and Design Tables"* Taylor & Francis Group, Chapter 13, Leiden, The Netherlands

Ref 9: Australian / New Zealand Standard AS/NZS 1547 – 2000 *'On-site domestic-wastewater management'*, Standards Australia and New Zealand

12. LIMITS OF INVESTIGATION

Recommendations given in this report are based on the information supplied regarding the proposed building/s construction in conjunction with the findings of the investigation. Any change in the construction type or building locations may require additional testing and/or make recommendations invalid.

Every reasonable effort has been made to locate test sites as per the client's preferred test locations so that the boreholes are representative of the soil conditions within the area to be investigated. The client should be made aware, however, that this assessment has been based on limited site data using small diameter boreholes, and that subsurface conditions will vary between test locations.

APPENDIX A

SITE PLAN S01

GEOTECH INVESTIGATIONS PTY LTD

Unit 3 / 42 Machinery Drive
PO Box 6885
Tweed Heads South NSW 2486
PH: 0755 233 979
FAX: 0755 233 981
EMAIL: admin@geotechinvestigations.com
WEB: www.geotechinvestigations.com

CLIENT:
AURORA PROJECTS

PROJECT:
PROPOSED BYRON BAY CENTRAL HOSPITAL
AT EWINGSDALE ROAD,
BYRON BAY

DRAWING REF:
S01: SITE PLAN

LEGEND

◑ Borehole, CBR and Test pit Locations

⊞ Groundwater Monitoring Well (GWMW) and Perm Test (PT) Locations

Topographical image
provided by Google Earth 2014

APPROXIMATE NORTH

NORTH

DATE:
May to July 2014

OUR REF / JOB No.:
GI 1375-a sp

DRAWN BY:
AOC

Drawing not to scale.
Printed dimensions only.

APPENDIX B

ENGINEERING LOGS – BOREHOLE PROFILES BH 1 TO BH 8
PAVEMENT LOGS – PAVEMENT ENGINEERING PROFILES BH 9, TP 10, BH 11 AND TP 12
GEOTECHNICAL REPORT STANDARD NOTES

GEOTECH INVESTIGATIONS PTY LTD

Unit 3/42 Machinery Drive, Tweed Heads South NSW 2486
Ph: 0755 233 979 Fax: 0755 233 981

ENGINEERING LOG – BOREHOLE PROFILE

GPS:	S:	28° 38´ 13.6″	E:	153° 33´ 18.6″

CLIENT:	AURORA PROJECTS	**BOREHOLE I.D.:**	BH 1
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY	**JOB No.:**	GI 1375-a
EQUIPMENT TYPE: MAIDTECH 500	**HOLE DIAMETER:** 110mm	**PAGE:**	1 of 1

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
AD		0.5	▥	(CH) Silty CLAY: High plasticity, With sand, Trace of fine gravel, Moist ($w>w_p$), Dark orange/brown	St		4 4 3 2 2	RESIDUAL Organic material within 0.05m – 0.1m
		1.0 1.5			VSt		4 4 6 6 8 8 10 8 10 12	
		2.0 2.5 3.0	▥	(CH) Silty CLAY: High plasticity, With sand, Moist ($w \geq w_p$), Dark orange/brown with grey and pale red mottling	Hd		14 16 15 14 15	
		3.5 4.0	▤	(CI/MI) Silty CLAY/Clayey SILT: Medium plasticity, Fine to coarse sand, Trace of fine gravel, Moist, ($w<w_p$), Orange/brown with grey and orange mottling				
		4.5						

BH 1 TERMINATED AT 4.0m – LIMIT OF INVESTIGATION

METHOD

AD	auger drilling
RR	rock roller
MS	mud support
NMLC	rock coring
WB	wash bore
TB	tri blade

WATER

▼	water level
►	water seepage
»–	partial loss
–«	complete loss

WEATHERING

XW –	Extremely
HW –	Highly
DW –	Distinctly
MW –	Moderately
SW –	Slightly
F –	Fresh

Consistency / Density / Rock Strength

VS -	Very Soft	VL -	Very Loose
S -	Soft	L -	Loose
F -	Firm	MD -	Medium Dense
St -	Stiff	D -	Dense
VSt -	Very Stiff	VD -	Very Dense
Hd -	Hard	Fb -	Friable
ELw -	Extremely Low	VLw -	Very Low
Lw -	Low	M -	Medium
H -	High	VH -	Very High

SAMPLES / TESTS

U( ) -	Undisturbed (size in mm)
D -	Disturbed
BS -	Bulk Sample
DCP -	Dynamic Cone Penetrometer
SPT -	Standard Penetrometer Test
N -	Number of blows for SPT / 300mm
VS -	Vane Shear
A -	Acid Sulfate Sample
PP -	Pocket Penetrometer (kPa)

Logged By:	DAW	**Date:**	26/05/14	**Checked By:**	AO	**Date:**	15/07/14

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Ph: 0755 233 979 Fax: 0755 233 981

ENGINEERING LOG – BOREHOLE PROFILE

GPS:	S:	28° 38′ 14.0″	E:	153° 33′ 21.8″

CLIENT:	AURORA PROJECTS	**BOREHOLE I.D.:**	BH 2
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY	**JOB No.:**	GI 1375-a
QUIPMENT TYPE: EXPLORA 85	**HOLE DIAMETER:** 110mm	**PAGE:**	1 of 3

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
AD			▨	(CH) Silty CLAY: High plasticity, Trace of fine sand, Moist ($w>w_p$), Dark red/brown	St/ VSt			RESIDUAL Organic material within 0.05m – 0.1m
		0.5	▨			SPT 3,5,7 N = 12		
MS		1.0	▨					
		1.5	▨	(CH) Silty CLAY: High plasticity, Moist ($w>w_p$), Dark red/brown mottled red	VSt	SPT 3,6,9 N = 15		
		2.0	▨					Small 10mm diameter inclusions of (EW) Basalt below 2m depth
		2.5	▨					
		3.0	▨	(EW) BASALT: Remoulds to (CH) Silty CLAY: High plasticity, Trace of gravel, Moist ($w>w_p$), Dark red/brown mottled red, dark grey and dark yellow		SPT 6,7,10 N = 17		
		3.5	▨					
		4.0	▨	(EW) BASALT: Remoulds to (CH) Silty CLAY: High plasticity, Moist ($w>w_p$), Grey/brown mottled orange, dark yellow and brown	St			
		4.5	▨			SPT 4,7,4 N = 11		
		5.0	▨					

GEOTECH INVESTIGATIONS PTY LTD

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ENGINEERING LOG – BOREHOLE PROFILE

CLIENT: AURORA PROJECTS

BOREHOLE I.D.: BH 2

PROJECT: BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY

JOB No.: GI 1375-a

EQUIPMENT TYPE: EXPLORA 85

HOLE DIAMETER: 110mm

PAGE: 2 of 3

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
MS		5.5	▥	(EW) BASALT: Remoulds to (CH) Silty CLAY: High plasticity, Moist (w>w_P), Grey/brown mottled orange, dark yellow and brown	St			RESIDUAL Inclusions of dark grey silty clay
	▶	6.0 6.5	▥	(CH) Silty CLAY: High plasticity, With sand, Wet (w<w_P), Dark grey mottled brown		SPT 1,-,2 N = 2 U50 PP > 400		Hammer weight first 300mm of SPT. Cleaned hole to 6.7m and carried out U(50) tube.
		7.0 7.5 8.0	▤	(EW) BASALT: Remoulds to (CI) Sandy Silty CLAY: High plasticity, With fine to medium gravel, Wet (w<w_P), Grey and brown mottled orange	Hd			
		8.5 9.0	▦	(DW) BASALT: Fine grained, Dark grey mottled brown and dark orange	Lw	SPT		No sample returned in SPT
NMLC			▦	(SW) BASALT: Fine grained, Massive, Dark grey mottled pale grey and brown.	M / H	30/80mm N > 50		Start of NMLC Coring
		9.5 10.0	▦	(FR) BASALT: Dark grey mottled pale grey.	H	Pick		Fractured seam 0.03m at 9.25 m Smooth planar joints at 9.6m, 9.72m 9.81m, 9.92m and 10.02m

METHOD

AD	auger drilling
RR	rock roller
MS	mud support
NMLC	rock coring
WB	wash bore

WATER

▼	water level
▶	water seepage
»—	partial loss
—«	complete loss

WEATHERING

EW –	Extremely
HW –	Highly
DW –	Distinctly
MW –	Moderately
SW –	Slightly
F –	Fresh

Consistency / Density / Rock Strength

VS -	Very Soft	VL -	Very Loose
S -	Soft	L -	Loose
F -	Firm	MD -	Medium Dense
St -	Stiff	D -	Dense
VSt -	Very Stiff	VD -	Very Dense
Hd -	Hard	Fb -	Friable
ELw -	Extremely Low	VLw -	Very Low
Lw -	Low	M -	Medium
H -	High	VH -	Very High

SAMPLES / TESTS

U( ) -	Undisturbed (size in mm)
D -	Disturbed
BS -	Bulk Sample
DCP -	Dynamic Cone Penetrometer
SPT -	Standard Penetrometer Test
N -	Number of blows for SPT / 300mm
VS -	Vane Shear
A -	Acid Sulfate Sample
PP -	Pocket Penetrometer (kPa)

Logged By:	AO	**Date:**	05/06/14	**Checked By:**	AO	**Date:**	15/07/14

GEOTECH INVESTIGATIONS PTY LTD

Unit 3/42 Machinery Drive, Tweed Heads South NSW 2486
Ph: 0755 233 979 Fax: 0755 233 981

ENGINEERING LOG – BOREHOLE PROFILE

CLIENT: AURORA PROJECTS		**BOREHOLE I.D. :**	BH 2
PROJECT: BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY		**JOB No.:**	GI 1375-a
EQUIPMENT TYPE: EXPLORA 85	**HOLE DIAMETER:** 110mm	**PAGE:**	3 of 3

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
NMLC		10.15	▩	(FR) BASALT: Dark grey mottled pale grey.	H	Pick		RESIDUAL
		11.0						
		12.0						
		13.0						
		14.0						

BH 2 TERMINATED AT 10.15m – LIMIT OF INVESTIGATION

METHOD
- AD auger drilling
- RR rock roller
- MS mud support
- NMLC rock coring
- WB wash bore

WATER
- ▼ water level
- ► water seepage
- »– partial loss
- –« complete loss

WEATHERING
- XW – Extremely
- HW – Highly
- DW – Distinctly
- MW – Moderately
- SW – Slightly
- F – Fresh

Consistency / Density / Rock Strength

VS	Very Soft	VL	Very Loose
S	Soft	L	Loose
F	Firm	MD	Medium Dense
St	Stiff	D	Dense
VSt	Very Stiff	VD	Very Dense
Hd	Hard	Fb	Friable
ELw	Extremely Low	VLw	Very Low
Lw	Low	M	Medium
H	High	VH	Very High

SAMPLES / TESTS
- U( ) - Undisturbed (size in mm)
- D - Disturbed
- BS - Bulk Sample
- DCP - Dynamic Cone Penetrometer
- SPT - Standard Penetrometer Test
- N - Number of blows for SPT / 300mm
- VS - Vane Shear
- A - Acid Sulfate Sample
- PP - Pocket Penetrometer (kPa)

Logged By:	AO	**Date:**	05/06/14	**Checked By:**	AO	**Date:**	15/07/14

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ENGINEERING LOG – BOREHOLE PROFILE

GPS:	S:	28° 38′ 14.1″	E:	153° 33′ 27.6″

CLIENT:	AURORA PROJECTS	**BOREHOLE I.D.:**	BH 3
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY	**JOB No.:**	GI 1375-a
EQUIPMENT TYPE: MAIDTECH 500	**HOLE DIAMETER:** 110mm	**PAGE:**	1 of 1

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
AD		0.5 1.0 1.5	▥	(CH) Silty CLAY: High plasticity, With fine sand, Moist, ($w>w_p$), Dark orange/brown	St/ VSt VSt	U(50)		RESIDUAL Organic material within 0.05m – 0.1m
		2.0 2.5	▥	(CH) Silty CLAY: High plasticity, With fine sand, Moist, ($w>w_p$), Orange/brown				
		3.0	▨	(MI) Clayey SILT: Medium plasticity, Fine to coarse sand, With fine gravel, Moist ($w\geq w_p$), Orange/brown with grey mottling				Pockets of (EW) basalt within material
		3.5	▨	(MI) Clayey SILT: Medium plasticity, Fine to coarse sand, With fine gravel, Moist ($w\geq w_p$), Grey	St			
		4.0	▨	(MI) Clayey SILT: Medium plasticity, Fine to coarse sand, Fine to medium gravel, Very moist to wet ($w\geq w_p$), Grey	F			Estimated strength from hand test
		4.5						

BH 3 TERMINATED AT 4.0m – LIMIT OF INVESTIGATION

METHOD		WEATHERING	
AD	auger drilling	EW –	Extremely
RR	rock roller	HW –	Highly
MS	mud support	DW –	Distinctly
NMLC	rock coring	MW –	Moderately
WB	wash bore	SW –	Slightly
TB	tri blade	F –	Fresh

WATER
▼ water level
► water seepage
»– partial loss
–« complete loss

Consistency / Density / Rock Strength

VS -	Very Soft	VL -	Very Loose
S -	Soft	L -	Loose
F -	Firm	MD -	Medium Dense
St -	Stiff	D -	Dense
VSt -	Very Stiff	VD -	Very Dense
Hd -	Hard	Fb -	Friable
ELw -	Extremely Low	VLw -	Very Low
Lw -	Low	M -	Medium
H -	High	VH -	Very High

SAMPLES / TESTS

U( ) -	Undisturbed (size in mm)
D -	Disturbed
BS -	Bulk Sample
DCP -	Dynamic Cone Penetrometer
SPT -	Standard Penetrometer Test
N -	Number of blows for SPT / 300mm
VS -	Vane Shear
A -	Acid Sulfate Sample
PP -	Pocket Penetrometer (kPa)

Logged By:	DAW	**Date:**	26/05/14	**Checked By:**	AO	**Date:**	15/07/14

GEOTECH INVESTIGATIONS PTY LTD

Unit 3/42 Machinery Drive, Tweed Heads South NSW 2486
Ph: 0755 233 979 Fax: 0755 233 981

ENGINEERING LOG – BOREHOLE PROFILE

GPS:	S:	28° 38′ 15.3″	E:	153° 33′ 18.4″

CLIENT:	AURORA PROJECTS	**BOREHOLE I.D.:**	BH 4
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY	**JOB No.:**	GI 1375-a
EQUIPMENT TYPE: MAIDTECH 500	**HOLE DIAMETER:** 110mm	**PAGE:**	1 of 1

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
AD		0.5 1.0	▥	(CH) Silty CLAY: High plasticity, With fine sand, Moist ($w>w_p$), Dark orange brown	St/ VSt VSt	U(50)		RESIDUAL Organic material within 0.05m – 0.1m
		1.5 2.0	▥	(CH) Silty CLAY: High plasticity, With fine sand, Moist ($w>w_p$), Dark red brown				
		2.5 3.0 3.5	▥	(CH) Silty CLAY: High plasticity, With fine to coarse sand, Trace of fine gravel, Moist ($w>w_p$), Dark orange/brown				
		4.0	▥	(CH) Silty CLAY: High plasticity, Fine to coarse sand, Trace of fine gravel, Moist ($w>w_p$), Orange/brown				
		4.5						

BH 4 TERMINATED AT 4.0m – LIMIT OF INVESTIGATION

METHOD

AD	auger drilling
RR	rock roller
MS	mud support
NMLC	rock coring
WB	wash bore
TB	tri blade

WATER

▼	water level
►	water seepage
»–	partial loss
–«	complete loss

WEATHERING

EW –	Extremely
HW –	Highly
DW –	Distinctly
MW –	Moderately
SW –	Slightly
F –	Fresh

Consistency / Density / Rock Strength

VS -	Very Soft	VL -	Very Loose
S -	Soft	L -	Loose
F -	Firm	MD -	Medium Dense
St -	Stiff	D -	Dense
VSt -	Very Stiff	VD -	Very Dense
Hd -	Hard	Fb -	Friable
ELw -	Extremely Low	VLw -	Very Low
Lw -	Low	M -	Medium
H -	High	VH -	Very High

SAMPLES / TESTS

U( ) -	Undisturbed (size in mm)
D -	Disturbed
BS -	Bulk Sample
DCP -	Dynamic Cone Penetrometer
SPT -	Standard Penetrometer Test
N -	Number of blows for SPT / 300mm
VS -	Vane Shear
A -	Acid Sulfate Sample
PP -	Pocket Penetrometer (kPa)

Logged By:	DAW	**Date:**	26/05/14	**Checked By:**	AO	**Date:**	15/07/14

ENGINEERING LOG – BOREHOLE PROFILE

		GPS: S:	28° 38′ 15.4″	E: 153° 33.2′ 21.0″
CLIENT:	AURORA PROJECTS		**BOREHOLE I.D.:**	BH 5
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY		**JOB No.:**	GI 1375-a
QUIPMENT TYPE:	EXPLORA 85	**HOLE DIAMETER:** 110mm	**PAGE:**	1 of 3

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
AD				(CH) Silty CLAY: High plasticity, Trace of fine sand, High plasticity, Moist (w>w$_p$), Dark red/brown	Hd			RESIDUAL Organic material within 0.05m – 0.1m
		0.5				U(50) PP > 400		
MS		1.0						
		1.5				U(50) PP > 400		
		2.0						
				(EW) BASALT: Remoulds to (CH) Silty CLAY: High plasticity, With fine to medium gravel, Moist (w<w$_p$), Brown mottled orange/brown, grey and pale grey	VSt/ Hd			Pockets of silty clay within material
		2.5						
		3.0				SPT 7,10,12 N = 22		
		3.5						
		4.0		(EW) BASALT: Remoulds to (ML) Clayey SILT: Low plasticity, With gravel, Moist (w<w$_p$), Grey and brown mottled pale grey and orange	Hd			
		4.5				SPT 8,7,26 N = 33		
		5.0						

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ENGINEERING LOG – BOREHOLE PROFILE

CLIENT:	AURORA PROJECTS	**BOREHOLE I.D.:**	BH 5
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY	**JOB No.:**	GI 1375-a
EQUIPMENT TYPE: EXPLORA 85	**HOLE DIAMETER:** 110mm	**PAGE:**	2 of 3

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
MS		5.5	▨	(EW) BASALT: Remoulds to (ML) Clayey SILT: Low plasticity, With gravel, Moist ($w<w_P$), Grey and brown mottled pale grey and orange	Hd			RESIDUAL Organic material within 0.05m – 0.1m
	▶	6.0 6.5 7.0	▨	(EW) BASALT: Remoulds to (MI) Sandy Silty CLAY: Medium plasticity, With fine to medium gravel, Wet ($w<w_P$), Grey mottled brown/orange and pale grey	VSt	SPT 6,9,7 N = 16		Pockets of silty clay within material
		7.5 8.0	▨	(CI/ML) Silty CLAY/Clayey SILT: Medium/Low plasticity, Trace of sand, With fine gravel, Moist, Grey and brown mottled pale grey and orange	F/St	SPT 1,1,4 N = 5		Inclusions of (EW) Basalt
		8.5 9.09	▨	(HW) BASALT: Fine grained, Grey and brown mottled pale brown	Lw			
NMLC			▨	(MW) BASALT: Fine grained, Massive, Dark grey mottled grey and brown.	M / H	SPT 30/90mm N > 50 Pick		Start of NMLC Coring
		9.5	▨	(SW) BASALT: Dark grey mottled pale grey.				Irregular rough joints at 9.4m to 9.8m
		10.0	▨	(SW) BASALT: Dark grey mottled brown and orange	H			Planar joint at 9.7m

METHOD
AD	auger drilling
RR	rock roller
MS	mud support
NMLC	rock coring
WB	wash bore

WATER
▼	water level
▶	water seepage
›–	partial loss
–«	complete loss

WEATHERING
EW –	Extremely
HW –	Highly
DW –	Distinctly
MW –	Moderately
SW –	Slightly
F –	Fresh

Consistency / Density / Rock Strength
VS -	Very Soft	VL -	Very Loose
S -	Soft	L -	Loose
F -	Firm	MD -	Medium Dense
St -	Stiff	D -	Dense
VSt -	Very Stiff	VD -	Very Dense
Hd -	Hard	Fb -	Friable
ELw -	Extremely Low	VLw -	Very Low
Lw -	Low	M -	Medium
H -	High	VH -	Very High

SAMPLES / TESTS
U( ) -	Undisturbed (size in mm)
D -	Disturbed
BS -	Bulk Sample
DCP -	Dynamic Cone Penetrometer
SPT -	Standard Penetrometer Test
N -	Number of blows for SPT / 300mm
VS -	Vane Shear
A -	Acid Sulfate Sample
PP -	Pocket Penetrometer (kPa)

Logged By:	AO	**Date:**	04/06/14	**Checked By:**	AO	**Date:**	15/07/14

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ENGINEERING LOG – BOREHOLE PROFILE

CLIENT:	AURORA PROJECTS	**BOREHOLE I.D. :**	BH 5
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY	**JOB No.:**	GI 1375-a
EQUIPMENT TYPE: EXPLORA 85	**HOLE DIAMETER:** 110mm	**PAGE:**	3 of 3

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
NMLC		10.3	▩	(SW) BASALT: Dark grey mottled brown and orange	H	Pick		RESIDUAL

11.0
12.0
13.0
14.0

BH 5 TERMINATED AT 10.3m – LIMIT OF INVESTIGATION

METHOD
AD auger drilling
RR rock roller
MS mud support
NMLC rock coring
WB wash bore

WATER
▼ water level
► water seepage
»– partial loss
–« complete loss

WEATHERING
XW – Extremely
HW – Highly
DW – Distinctly
MW – Moderately
SW – Slightly
F – Fresh

Consistency / Density / Rock Strength
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
Hd - Hard
ELw - Extremely Low
Lw - Low
H - High
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense
Fb - Friable
VLw - Very Low
M - Medium
VH - Very High

SAMPLES / TESTS
U( ) - Undisturbed (size in mm)
D - Disturbed
BS - Bulk Sample
DCP - Dynamic Cone Penetrometer
SPT - Standard Penetrometer Test
N - Number of blows for SPT / 300mm
VS - Vane Shear
A - Acid Sulfate Sample
PP - Pocket Penetrometer (kPa)

Logged By:	AO	**Date:**	05/06/14	**Checked By:**	AO	**Date:**	15/07/14

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ENGINEERING LOG – BOREHOLE PROFILE

GPS:	S:	28° 38´ 16.0″	E:	153° 33´ 23.0″

CLIENT:	AURORA PROJECTS	**BOREHOLE I.D.:**	BH 6
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY	**JOB No.:**	GI 1375-a
EQUIPMENT TYPE: MAIDTECH 500	**HOLE DIAMETER:** 110mm	**PAGE:**	1 of 1

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
AD		0.5		(CH) Silty CLAY: High plasticity, With fine sand, Moist (w>w$_p$), Dark orange brown	St/ VSt		4 4 4 4 5 2 2	RESIDUAL Organic material within 0.05m – 0.1m
		1.0			VSt		7 7 7 7	
		1.5 2.0			Hd		8 10 10 12 20 30	
		2.5 3.0		(CH) Silty CLAY: High plasticity, With fine sand, Moist (w>w$_p$), Orange/brown	VSt /Hd			
		3.5 4.0		(MI) Clayey SILT: Medium plasticity, Trace of fine to coarse sand, Moist, Grey/brown	VSt			Pockets of (EW) basalt within material
		4.5						

BH 6 TERMINATED AT 4.0m – LIMIT OF INVESTIGATION

METHOD

AD	auger drilling
RR	rock roller
MS	mud support
NMLC	rock coring
WB	wash bore
TB	tri blade

WATER

▼	water level
►	water seepage
»–	partial loss
–«	complete loss

WEATHERING

EW –	Extremely
HW –	Highly
DW –	Distinctly
MW –	Moderately
SW –	Slightly
F –	Fresh

Consistency / Density / Rock Strength

VS -	Very Soft	VL -	Very Loose
S -	Soft	L -	Loose
F -	Firm	MD -	Medium Dense
St -	Stiff	D -	Dense
VSt -	Very Stiff	VD -	Very Dense
Hd -	Hard	Fb -	Friable
ELw -	Extremely Low	VLw -	Very Low
Lw -	Low	M -	Medium
H -	High	VH -	Very High

SAMPLES / TESTS

U( ) -	Undisturbed (size in mm)
D -	Disturbed
BS -	Bulk Sample
DCP -	Dynamic Cone Penetrometer
SPT -	Standard Penetrometer Test
N -	Number of blows for SPT / 300mm
VS -	Vane Shear
A -	Acid Sulfate Sample
PP -	Pocket Penetrometer (kPa)

Logged By:	DAW	**Date:**	26/05/14	**Checked By:**	AO	**Date:**	15/07/14

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ENGINEERING LOG – BOREHOLE PROFILE

GPS:	S:	28° 38´ 17.1″	E:	153° 33´ 18.3″

CLIENT:	AURORA PROJECTS	**BOREHOLE I.D.:**	BH 7
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY	**JOB No.:**	GI 1375-a
EQUIPMENT TYPE: MAIDTECH 500	**HOLE DIAMETER:** 110mm	**PAGE:**	1 of 1

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
AD		0.5 1.0 1.5		(CH) Silty CLAY: High plasticity, With fine sand, Moist ($w>w_p$), Dark orange/brown	VSt		5 5 4 5 4 4 5 7 7 7 7 7 7 7 7	RESIDUAL Organic material within 0.05m – 0.1m
		2.0 2.5 3.0 3.5			Hd		10 20 20 20	
		4.0		(CH) Silty CLAY: High plasticity, With fine sand, Moist ($w>w_p$), Orange/brown				
		4.5						

BH 7 TERMINATED AT 4.0m – LIMIT OF INVESTIGATION

METHOD
AD auger drilling
RR rock roller
MS mud support
NMLC rock coring
WB wash bore
TB tri blade

WATER
▼ water level
► water seepage
»– partial loss
–« complete loss

WEATHERING
EW – Extremely
HW – Highly
DW – Distinctly
MW – Moderately
SW – Slightly
F – Fresh

Consistency / Density / Rock Strength
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
Hd - Hard
ELw - Extremely Low
Lw - Low
H - High

VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense
Fb - Friable
VLw - Very Low
M - Medium
VH - Very High

SAMPLES / TESTS
U( ) - Undisturbed (size in mm)
D - Disturbed
BS - Bulk Sample
DCP - Dynamic Cone Penetrometer
SPT - Standard Penetrometer Test
N - Number of blows for SPT / 300mm
VS - Vane Shear
A - Acid Sulfate Sample
PP - Pocket Penetrometer (kPa)

Logged By:	DAW	**Date:**	26/05/14	**Checked By:**	AO	**Date:**	15/07/14

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ENGINEERING LOG – BOREHOLE PROFILE

GPS:	S:	28° 38′ 17.1″	E:	153° 33′ 21.2″

CLIENT:	AURORA PROJECTS	**BOREHOLE I.D.:**	BH 8
PROJECT:	BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY	**JOB No.:**	GI 1375-a

QUIPMENT TYPE:	EXPLORA 85	**HOLE DIAMETER:**	110mm	**PAGE:**	1 of 2

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
AD MS		0.5 1.0 1.5		(CH) Silty CLAY: High plasticity, Trace of fine sand, Moist, Dark red/brown	VSt	U(50) PP = 340 -360		RESIDUAL
		2.0		(CH) Silty CLAY: High plasticity, Trace of fine sand, Trace of gravel, Dark red/brown	Hd	U(50) PP > 400		
		2.5 3.0 3.5		(EW) BASALT: Remoulds to (CH) Silty CLAY: High plasticity, With fine to medium gravel, Moist ($w<w_p$), Dark red/brown mottled dark grey,orange and grey	St/ VSt	SPT 3,4,8 N = 12		Inclusions of (HW) Basalt from 2m depth
		4.0 4.5 5.0		(EW) BASALT: Remoulds to (ML) Clayey SILT: Low plasticity, With gravel, Moist ($w<w_p$), Red/brown and grey mottled orange and brown	Hd ELw	SPT 14,18,30/ 120mm N > 50		Encountered bands of weathered basalt from 3.7m

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ENGINEERING LOG – BOREHOLE PROFILE

CLIENT: AURORA PROJECTS		**BOREHOLE I.D.:**	BH 8
PROJECT: BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY		**JOB No.:**	GI 1375-a
EQUIPMENT TYPE: EXPLORA 85	**HOLE DIAMETER:** 110mm	**PAGE:**	2 of 2

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample/ Test	DCP Blows /100mm	Structure and additional observation
MS		5.5 5.55	▦	(HW) BASALT: Fine grained, Red/brown and grey mottled orange and brown	Lw	SPT 10/0mm N > 50		RESIDUAL Rock-roller refusal at 5.55m
NMLC			▦	(MW) BASALT: Fine grained, Massive, Dark grey mottled grey and brown.	Lw / H			Start of NMLC Coring (EW) seam 5.6m to 5.65m Planar joints 5.8m Curved and irregular joints from 6.1m to 6.35m
	–«	6.0 6.35	▦	(SW) BASALT: Fine grained, Massive, Dark grey mottled grey and brown.	M H			
		7.0 7.5 8.0 8.5 9.0 9.5 10.0						

BH 8 TERMINATED AT 6.35m – LIMIT OF INVESTIGATION

METHOD
AD auger drilling
RR rock roller
MS mud support
NMLC rock coring
WB wash bore

WATER
▼ water level
► water seepage
»– partial loss
–« complete loss

WEATHERING
EW – Extremely
HW – Highly
DW – Distinctly
MW – Moderately
SW – Slightly
F – Fresh

Consistency / Density / Rock Strength
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
Hd - Hard
ELw - Extremely Low
Lw - Low
H - High
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense
Fb - Friable
VLw - Very Low
M - Medium
VH - Very High

SAMPLES / TESTS
U( ) - Undisturbed (size in mm)
D - Disturbed
BS - Bulk Sample
DCP - Dynamic Cone Penetrometer
SPT - Standard Penetrometer Test
N - Number of blows for SPT / 300mm
VS - Vane Shear
A - Acid Sulfate Sample
PP - Pocket Penetrometer (kPa)

Logged By:	AO	**Date:**	04/06/14	**Checked By:**	AO	**Date:**	15/07/14

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ENGINEERING LOG – PAVEMENT BOREHOLE PROFILE

CLIENT: AURORA PROJECTS	**GPS:** S 28˚38´12.1˝ E 153˚33´17.8˝		**JOB No.:** GI 1375-a
PROJECT: BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY			**OFFSET:** OWP
EQUIPMENT TYPE: 4 TONNE EXCAVATOR	**AUGER SIZE:** 450mm Auger		**BOREHOLE No:** 9

Method	Water	Depth (m)	Material Description	Consistency / Rel. Density	Sample / Test	Estimated CBR	DCP Blows /100mm	Structure and additional observation
AD		0.01_	Seal					PAVEMENT
		0.06_	(GW) GRAVEL: With fine to coarse sand, Fine to coarse gravel, Dry, Grey mottled pale grey	VD				ASPHALT
		0.25_	(GW) GRAVEL: With sand and silt, Trace of cobbles, Fine to coarse gravel, Moist, Pale brown mottled grey and dark grey		BS			BASE COURSE
		0.45_	(GW) GRAVEL: With sand and silt, Trace of cobbles, Fine to coarse gravel, Moist, Dark brown mottled pale brown, grey and dark grey		BS			SUB-BASE
		0.5_	(GW) Clayey GRAVEL: Fine to coarse gravel, Trace of cobbles and silt,				3	SUB-GRADE
		_	Moist, Dark brown mottled dark grey				7	Old asphalt inclusions
		_	(CH) Silty CLAY: High plasticity, Trace of gravel, Trace of cobbles,	VSt			5	RESIDUAL
		_	Trace of boulders, Moist ($w > w_p$), Dark red/brown				4	
		_					4	
		1.0_					7	
		_					6	
		_					7	
		_					7	
		_					8	
		1.5_					10	
		_					14	
		_						
		_						
		_						
		2.0_						
		_						
		_						
		_						
		_						
		2.5_						
		_						
		_						
		_						
		_						
		3.0_						
		_						
		_						
		_						
		_						
		3.5_						

BOREHOLE 9 TERMINATED AT 1.0m – LIMIT OF INVESTIGATION

METHOD

AD	auger drilling
RR	rock roller
MS	mud support
NMLC	rock coring
WB	wash bore

WATER

▼	water level
►	water seepage
»–	partial loss
–«	complete loss

WEATHERING

XW –	Extremely
HW –	Highly
DW –	Distinctly
MW –	Moderately
SW –	Slightly
F –	Fresh

Consistency / Density / Rock Strength

VS	- Very Soft	VL	- Very Loose
S	- Soft	L	- Loose
F	- Firm	MD	- Medium Dense
St	- Stiff	D	- Dense
VSt	- Very Stiff	VD	- Very Dense
Hd	- Hard	Fb	- Friable
ELw	- Extremely Low	VLw	- Very Low
Lw	- Low	M	- Medium
H	- High	VH	- Very High

SAMPLES / TESTS

D	- Disturbed
MC	- Moisture Content
DCP	- Dynamic Cone Penetrometer
CBR	- California Bearing Ratio estimated using QTMR Method Q114D, AS1289.6.3.2, and RTA Method T161, CCB 24 Jan 2010
OMC	- Estimated Optimum Moisture Content
Note:	% dry/wet of OMC is an estimate only

Logged By:	AO'C	**Date:**	08/07/14	**Checked By:**	AO	**Date:**	15/07/14

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ENGINEERING LOG – PAVEMENT TEST PIT PROFILE

CLIENT: AURORA PROJECTS	**GPS:** S 28˚38΄12.78˝ E 153˚33΄18.31˝		**JOB No.:** GI 1375-a
PROJECT: BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY			**OFFSET:** -
EQUIPMENT TYPE: 4 TONNE EXCAVATOR	**BUCKET SIZE:** 600mm		**TEST PIT No:** 10

Method	Water	Depth (m)	Material Description	Consistency / Rel. Density	Sample / Test	Estimated CBR	DCP Blows /100mm	Structure and additional observation
TB		_	(CH) Silty CLAY: High plasticity, Moist ($w>w_p$), Red/brown					TOPSOIL
		0.2_						
		_	(CH) Silty CLAY: High plasticity, Trace of sand, Moist ($w>w_p$), Dark red/brown	Hd				RESIDUAL
		_						
		0.5_				PP		
		_			BS	>400		
		_				PP		
		_				>400		
		_						
		1.0_				PP		
		_				>400		
		_						
		_						
		_						
		1.5_						
		_						
		_						
		_						
		2.0_						
		_						
		_						
		_						
		2.5_						
		_						
		_						
		_						
		3.0_						
		_						
		_						
		_						
		3.5_						
		_						
		_						
		_						

TEST PIT 10 TERMINATED AT 1.0m – LIMIT OF INVESTIGATION

METHOD

AD	auger drilling
RR	rock roller
MS	mud support
NMLC	rock coring
WB	wash bore

WATER

▼	water level
►	water seepage
»–	partial loss
–«	complete loss

WEATHERING

XW –	Extremely
HW –	Highly
DW –	Distinctly
MW –	Moderately
SW –	Slightly
F –	Fresh

Consistency / Density / Rock Strength

VS -	Very Soft	VL -	Very Loose
S -	Soft	L -	Loose
F -	Firm	MD -	Medium Dense
St -	Stiff	D -	Dense
VSt -	Very Stiff	VD -	Very Dense
Hd -	Hard	Fb -	Friable
ELw -	Extremely Low	VLw -	Very Low
Lw -	Low	M -	Medium
H -	High	VH -	Very High

SAMPLES / TESTS

D	- Disturbed
MC	- Moisture Content
DCP	- Dynamic Cone Penetrometer
CBR	- California Bearing Ratio estimated using QTMR Method Q114D, AS1289.6.3.2, and RTA Method T161, CCB 24 Jan 2010
OMC	- Estimated Optimum Moisture Content
Note:	% dry/wet of OMC is an estimate only

Logged By:	AO'C	**Date:**	08/07/14	**Checked By:**	AO	**Date:**	15/07/14

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ENGINEERING LOG – PAVEMENT BOREHOLE PROFILE

CLIENT: AURORA PROJECTS	GPS: S 28˚38´13.1˝ E 153˚33´24.5˝	**JOB No.:** GI 1375-a
PROJECT: BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY		**OFFSET:** OWP
EQUIPMENT TYPE: 4 TONNE EXCAVATOR	**AUGER SIZE:** 450mm Auger	**BOREHOLE No:** 11

Method	Water	Depth (m)	Material Description	Consistency / Rel. Density	Sample / Test	Estimated CBR	DCP Blows /100mm	Structure and additional observation
AD		0.01_	Seal					PAVEMENT
		0.07_	(GW) GRAVEL: With fine to coarse sand, Fine to coarse gravel, Dry, Grey mottled pale grey	VD				ASPHALT
		0.25_	(GW) GRAVEL: With sand and silt, Fine to coarse gravel, Trace of cobbles, Moist, Pale brown mottled grey and dark grey		BS			BASE COURSE
		0.45_	(GW) Sandy GRAVEL: Fine to coarse gravel, Trace of clay and silt, Moist, Pale brown mottled grey and dark grey		BS			SUB-BASE
		0.5_	(CH) Silty CLAY: High plasticity, Trace of gravel, Trace of cobbles, Trace of boulders, Moist ($w>w_p$), Dark red/brown	VSt	DS		6	SUB-GRADE
		_					4	(RESIDUAL)
		_					4	
		_					4	
		_					5	
		1.0_					4	
		_					5	
		_					5	
		_					5	
		_					5	
		1.5_					5	
		_						
		_						
		_						
		_						
		2.0_						
		_						
		_						
		_						
		_						
		2.5_						
		_						
		_						
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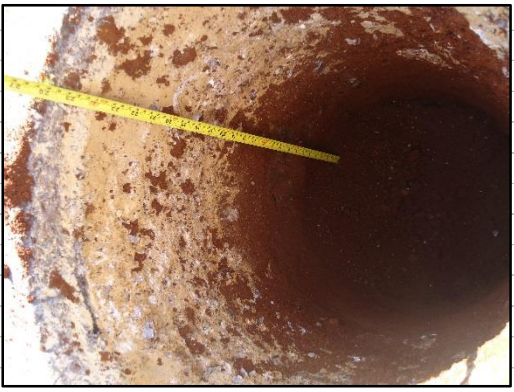
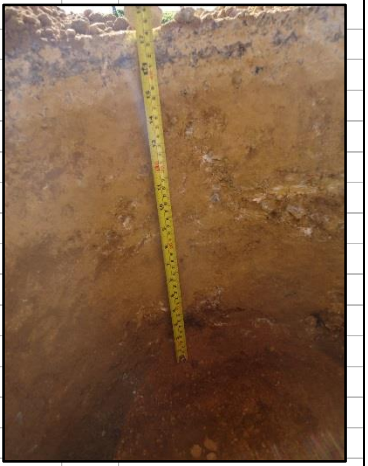
		_						
		3.0_						
		_						
		_						
		_						
		_						
		3.5_						





BOREHOLE 11 TERMINATED AT 1.0m – LIMIT OF INVESTIGATION

METHOD

AD	auger drilling
RR	rock roller
MS	mud support
NMLC	rock coring
WB	wash bore

WATER

▼	water level
►	water seepage
»–	partial loss
–«	complete loss

WEATHERING

XW –	Extremely
HW –	Highly
DW –	Distinctly
MW –	Moderately
SW –	Slightly
F –	Fresh

Consistency / Density / Rock Strength

VS	- Very Soft	VL	- Very Loose
S	- Soft	L	- Loose
F	- Firm	MD	- Medium Dense
St	- Stiff	D	- Dense
VSt	- Very Stiff	VD	- Very Dense
Hd	- Hard	Fb	- Friable
ELw	- Extremely Low	VLw	- Very Low
Lw	- Low	M	- Medium
H	- High	VH	- Very High

SAMPLES / TESTS

D	- Disturbed
MC	- Moisture Content
DCP	- Dynamic Cone Penetrometer
CBR	- California Bearing Ratio estimated using QTMR Method Q114D, AS1289.6.3.2, and RTA Method T161, CCB 24 Jan 2010
OMC	- Estimated Optimum Moisture Content
Note:	% dry/wet of OMC is an estimate only

Logged By:	AO'C	**Date:**	08/07/14	**Checked By:**	AO	**Date:**	15/07/14

ENGINEERING LOG – PAVEMENT TEST PIT PROFILE

CLIENT: AURORA PROJECTS	GPS: S 28˚38´13.7˝ E 153˚33´24.08˝	**JOB No.:**	GI 1375-a
PROJECT: BYRON BAY HOSPITAL - EWINGSDALE ROAD, BYRON BAY		**OFFSET:**	-
EQUIPMENT TYPE: 4 TONNE EXCAVATOR	**BUCKET SIZE:** 600mm	**TEST PIT No:**	12

Method	Water	Depth (m)	Material Description	Consistency / Rel. Density	Sample / Test	Estimated CBR	DCP Blows /100mm	Structure and additional observation
TB		_	(CH) Silty CLAY: High plasticity, Moist ($w>w_p$), Red/brown					TOPSOIL
		0.2_						
		_	(CH) Silty CLAY: High plasticity, Trace of sand, Moist ($w>w_p$), Dark	Hd				RESIDUAL
		_	red/brown			PP		Organic ringlets
		0.5_				>400		within upper 0.7m
		_			BS			
		_				PP		
		_				>400		
		_				PP		
		1.0_				>400		
		_						
		_						
		_						
		_						
		1.5_						
		_						
		_						
		_						
		_						
		2.0_						
		_						
		_						
		_						
		_						
		2.5_						
		_						
		_						
		_						
		_						
		3.0_						
		_						
		_						
		_						
		_						
		3.5_						
		_						
		_						
		_						

TEST PIT 12 TERMINATED AT 1.0m – LIMIT OF INVESTIGATION

METHOD

AD	auger drilling
RR	rock roller
MS	mud support
NMLC	rock coring
WB	wash bore

WATER

▼	water level
►	water seepage
»–	partial loss
–«	complete loss

WEATHERING

XW –	Extremely
HW –	Highly
DW –	Distinctly
MW –	Moderately
SW –	Slightly
F –	Fresh

Consistency / Density / Rock Strength

VS -	Very Soft	VL -	Very Loose
S -	Soft	L -	Loose
F -	Firm	MD -	Medium Dense
St -	Stiff	D -	Dense
VSt -	Very Stiff	VD -	Very Dense
Hd -	Hard	Fb -	Friable
ELw -	Extremely Low	VLw -	Very Low
Lw -	Low	M -	Medium
H -	High	VH -	Very High

SAMPLES / TESTS

D	- Disturbed
MC	- Moisture Content
DCP	- Dynamic Cone Penetrometer
CBR	- California Bearing Ratio estimated using QTMR Method Q114D, AS1289.6.3.2, and RTA Method T161, CCB 24 Jan 2010
OMC	- Estimated Optimum Moisture Content
Note:	% dry/wet of OMC is an estimate only

Logged By:	AO'C	**Date:**	08/07/14	**Checked By:**	AO	**Date:**	15/07/14

SCOPE These standard notes may be of assistance when understanding terms and recommendations given in this report. These notes are for general conditions and not all terms given may be of concern to the report attached. The descriptive terms adopted by Geotech Investigations Pty Ltd are given below and are largely consistent with Australian Standards AS1726-1993 'Geotechnical Site Investigations'.

CLIENT can be described and is limited to the financer of this geotechnical investigation.

LEGALITY and privacy of this document is based on communication between Geotech Investigations Pty Ltd and the client. Unless indicated otherwise the report was prepared specifically for the client involved and for the purposes indicated by the client. Use by any other party for any purpose, or by the client for a different purpose, will result in recommendations becoming invalid and Geotech Investigations Pty Ltd will hold no responsibility for problems which may arise.

GEOTECHNICAL REPORTS are predominantly derived using professional estimates determined from the results of fieldwork, in-situ and laboratory testing and experience from previous investigations in the area, from which geotechnical engineers then formulate an opinion about overall subsurface conditions. The client must be made aware that the investigations are undertaken to ensure minimal site impact using test-pits or small diameter boreholes and soil conditions on-site may vary from those encountered during the investigation.

CLIENTS RESPONSIBILITY to notify this office should there be adjustments in proposed structure/location or inconsistencies with material descriptions given in this report and those encountered on site. Geotech Investigations Pty Ltd is able to provide a range of services from on-site inspections to full project supervision to confirm recommendations given in the report.

CSIRO Publication BTF 18 'Foundation Maintenance and Footing Performance: A Homeowner's Guide' explains how to adequately maintain drainage during and post construction which lies as the responsibility of the client. Suitable drainage ensures recommendations given in this report remain valid.

INVESTIGATION METHODS adopted by Geotech Investigations Pty Ltd are designed to incorporate individual project-specific factors to obtain information on the physical properties of soil and rock around a site to design earthworks and foundations for proposed structures. The following methods of investigation currently adopted by this company are summarised below:-

HAND AUGER – investigations enable field work to be undertaken where access is limited. The materials must have sufficient cohesion to stand unsupported in an unlined borehole and there must be no large cobbles boulders or other obstructions which would prevent rotation of the auger.

TEST-PITS – investigations are carried out with an excavator or backhoe, allowing a visual inspection of sub-surface material in-situ and from samples removed. The limit of investigation is restricted by the reach of the excavator or backhoe.

CONTINUOUS SPIRAL FLIGHT AUGERING TECHNIQUES – investigations are advanced by pushing a 100mm diameter spiral into the sub-surface and withdrawing it at regular intervals to allow sampling or testing as it emerges.

WASH BORING – investigations are advanced by removing the loosened soil from the borehole by a stream of water or drilling mud issuing from the lower end of the wash pipe which is worked up and down or rotated by hand in the borehole. The water or mud carries the soil up the borehole where it overflows at ground level where the soil in suspension is allowed to settle in a pond or tank and the fluid is re-circulated or discharged to waste as required.

NON-CORE ROTARY DRILLING – investigations are advanced using a rotary bit with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from feel and rate of penetration.

ROTARY MUD DRILLING – is carried out as above using mud as support and circulating fluid for the borehole drilling. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling.

CONTINUOUS CORE DRILLING – investigations are carried out in rock material, specimens of rock in the form of cylindrical cores are recovered from the drill holes by the means of core barrel. The core barrel is provided at its lower end with a detachable core bit which carries industrial diamond chips in a matrix of metal. Rotation of the barrel by means of the drill rods causes the core bit to cut an annulus in the rock, the cuttings being washed to the surface by a stream of pumped down the hollow drill rods.

TESTING METHODS adopted by Geotech Investigations Pty Ltd to determine soil properties include but not limited to the following:-

U50 – Undisturbed samples are obtained by inserting a 50mm diameter thin-walled steel tube into the material and withdrawing with a sample of the soil in a moderately undisturbed condition.

PP – Pocket Penetrometer tests are commonly used on thin walled tube samples of cohesive soils to evaluate consistency and approximate unconfined compressive strength of saturated cohesive soils. They may also be used for the same purpose in freshly excavated trenches.

VS – Vane Shear test are commonly used in-situ or on thin walled tube samples of cohesive soils by introducing the vane into the material where the measurement of the undrained shear strength is required. Then the vane is rotated and the torsional force required to cause shearing is calculated.

DCP – Dynamic Cone Penetrometer tests are commonly used in-situ to measure the strength attributes of penetrability and compaction of sub-surface materials.

SPT – Standard Penetration Tests are commonly uses to determine the density of granular deposits but are occasionally used in cohesive material as a means of determining strength and also of obtaining a relatively undisturbed sample. Samples and results are obtained by driving a 50mm diameter split tube through blows from a slide hammer with a weight of 63.5kg falling through a distance of 760mm. Blow counts are recorded for 150mm intervals with the sum of the number of blows required for the second and third 150mm of penetration is termed the "standard penetration resistance" or the "N-value".

GEOLOGICAL ORIGINS of sub-surface material plays a considerable role in the development of engineering parameters and have been summarised as follows:-

FILL – materials are man made deposits, which may be significantly more variable between test locations than naturally occurring soils.

RESIDUAL – soils are present in a region as a result of weathering over the geological time scale.

COLLUVIAL – soils have been deposited recently, on the geological time scale, as soils being transported slowly down slope due to gravitational creep.

ALLUVIAL – soils have been deposited recently, on the geological time scale, as water borne materials.

AEOLIAN – soils have been deposited recently, on the geological time scale, as wind borne materials.

SOIL DESCRIPTION is based on an assessment of disturbed samples, as recovered from boreholes and excavations, and from undisturbed materials. Soil descriptions adopted by Geotech Investigations Pty Ltd are largely consistent with AS 1726-1993 '*Geotechnical Site Investigation*'. Soil types are described according to the predominating particle size, qualified by the grading of other particles present on the following bases detailed in Table 1.

COHESIVE SOILS ability to hold moisture known as its liquid limit is the state of a soil when it goes from a solid state to a liquid state described in Table 2

TABLE 1

Soil Classification	Particle Size
Clay	< 0.002 mm
Silt	0.002 – 0.06 mm
Sand	0.06 – 2.00 mm
Gravel	2.00 – 60.0 mm

TABLE 2

Descriptive Type	Range of Liquid Limit %
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50

Furthermore to soil description cohesive soils are described on there strength (assessed in conjunction with penetration tests) and liquid limit. Non-cohesive soil strengths are described by there density index. With descriptions for cohesive and non-cohesive soils summarised in Table 3.

TABLE 3

COHESIVE SOILS		NON-COHESIVE SOILS	
Term	**Undrained Shear Strength kPa**	**Term**	**Density Index %**
Very soft	≤ 12	Very Loose	≤15
Soft	> 12 ≤25	Loose	> 15 ≤35

Firm	> 25 ≤50	Medium Dense	> 35 ≤65
Stiff	> 50 ≤100	Dense	> 65 ≤85
Very Stiff	> 100 ≤200	Very Dense	> 85
Hard	> 200		

Description of terms used to describe material portion are summarised in Table 4.

TABLE 4

COARSE GRAINIED SOILS		**FINE GRAINED SOILS**	
% Fines	**Modifier**	**% Coarse**	**Modifier**
≤ 5	Omit or ‘trace’	≤ 15	Omit or ‘trace’
> 5 ≤12	Describe as ‘with’	> 15 ≤30	Describe as ‘with’
> 12	Prefix soil as ‘silty/clayey’	> 30	Prefix soil as ‘sandy/gravelly’

ROCK DESCRIPTIONS are determined from disturbed samples or specimens collected during field investigations. A rocks presence of defects and the effects of weathering are likely to have a great influence on engineering behaviour.

Rock Material Weathering Classification is summarised in Table 5.

TABLE 5

Term	**Symbol**	**Definition**
Residual Soils	-	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported
Extremely Weathered Rock	XW	Rock is weathered to such an extent that it has ‘soil’ properties, i.e. it either disintegrates or can be remoulded, in water
Distinctly Weathered Rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to decomposition of weathering products in pores
Slightly Weathered Rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock
Fresh rock	FR	Rock shows no signs of decomposition or staining

Rock Material Strength Classification is summarised in Table 6.

TABLE 6

Term	**Symbol**	**Point load index (MPa) I_s50**	**Field guide to strength**
Extremely Low	EL	≤0.03	Easily remoulded by hand to a material with soil properties
Very Low	VL	>0.03 ≤0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 3cm thick can be broken by finger pressure
Low	L	>0.1 ≤0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling
Medium	M	>0.3 ≤1.0	Readiy scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty
High	H	>1.0 ≤3.0	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer
Very High	VH	>3.0 ≤10	Hand specimen breaks with pick after more than one blow; rock rings under hammer
Extremely High	EH	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer

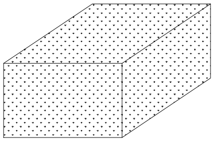
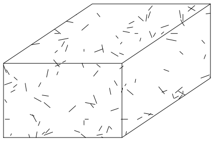
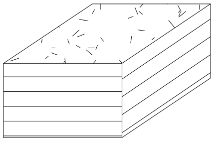
Rock Material Defect Shapes are summarised in Table 7.

TABLE 7

Term	Description
Planar	The defect does not vary in orientation.
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps.
Irregular	The defect has many sharp changes of orientation
Smooth	The defect has a flat even finish
Rough	The defect has a irregular disoriented finish

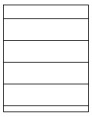
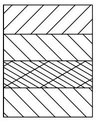
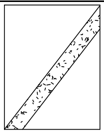
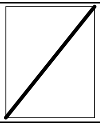
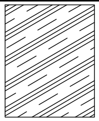
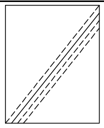
Rock Material Texture and Fabric are summarised in Table 8.

TABLE 8

Geological Description	Massive		Layered (Bedded foliate cleaved)
Diagram			
Fabric Type	Effectively homogenous and isotropic. Bulky or equi-dimensional grains uniformly distributed	Effectively homogeneous and isotropic. Elongated	Effective homogeneous with planar anisotropy. Elongated or tabular grains or pores in a layered arrangement

Rock Material Defect Type is summarised in Table 9

TABLE 9

Term	Definition	Diagram
Bedding	Signifying existence of beds or laminate. Planes dividing sedimentary rocks of the same or different lithology. Structure occurring in granite and similar rocks evident in a tendency to split more or less horizontally to the land surface	
Cross Bedding	Also called cross-lamination or false bedding. The structure commonly present in granular sedimentary rocks, which consists of tabular, irregularly lenticular or wedge-shaped bodies lying essentially parallel to the general stratification and which them selves show pronounced lamination structure in which the laminae are steeply inclined to the general bedding.	
Crushed Seam	A fracture at a more or less acute angle to applied force generally with some pulverized material along its surface	
Joint	A fracture in rock, generally more or less vertical or transverse to bedding, along which no appreciable movement has occurred.	
Parting	A small joint in rock or a layered rock where the tendency of crystals to separate along certain planes that are not true cleavage planes.	
Sheared Zone	A fracture that results from stresses which tend to shear one part of a specimen past the adjacent part	

APPENDIX C

LABORATORY TEST REPORTS

– CALIFORNIA BEARING RATIO REPORTS
– MATERIAL QUALITY REPORTS
– SHRINK SWELL REPORTS

BORDER-TEK PTY LTD
GEOTECHNICAL TESTING SERVICES
Border-Tek Pty Ltd • ABN 35 154 498 156

Office & Laboratory
Address: Unit 11, 21 Enterprise Avenue,
Tweed Heads South, NSW, 2486
Postal: PO Box 6340, Tweed Heads South, NSW, 2486
Phone: 0755 246 199
Fax: 0755 246 533
Email: info@bordertek.com.au

California Bearing Ratio Report (1 Point)

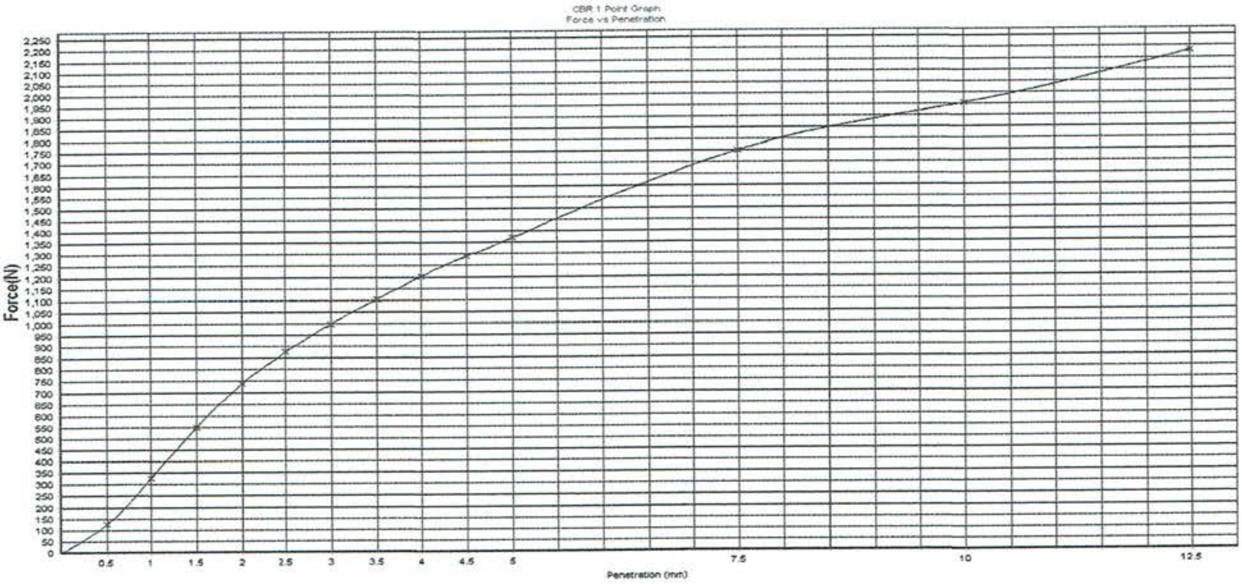
Client: **Geotech Investigations Pty Ltd**
Client address: **PO Box 6885 Tweed Heads South NSW 2486**
Job Number: **BTK 138**
Project: **Various Projects 2014**
Location **Byron Bay Hospital**

Report Number: **K2914**
Report Date: **3/06/2014**
Order Number:
Page 1 of 1

Lab No: **108982**
Date Sampled: **26/05/2014**
Date Tested: **2/06/2014**
Sampled By: **Brad James**
Sample Method: **AS1289 1.2.1 Earthworks**
Site Selection : **Geotech Inv**
For Use As: **General Fill**
Remarks: **The tests reported have been carried out at our Tweed Heads South Laboratory**

Sample Location
CBR 1
Borehole 3

Test Method : AS1289.6.1.1
Lot Number: -
Item Number : -



Maximum Dry Density - MDD (t/m³) :	**1.262**	Dry Density after Soak (t/m³) :	**1.258**
Optimum Moisture Content - OMC (%) :	**36.8**	Moisture Content after Soak (%) :	**44.1**
Compactive Effort :	**Standard**	Density Ratio after Soak (%) :	**100**
Nominated % Maximum Dry Density Compaction :	**100**	Field Moisture Content (%) :	**40.2**
Nominated % Optimum Moisture Content Compaction :	**100**	Moisture Content (Top) after Penetration (%) :	**44.9**
Achieved Dry Density before Soak (t/m³) :	**1.259**	Optional Moisture Content (Remainder) after Penetration (%) :	**35.6**
Achieved Percentage of Maximum Dry Density (%) :	**100**	CBR 2.5mm (%) :	**7**
Achieved Moisture Content (%) :	**37.5**	CBR 5.0mm (%) :	**7**
Achieved Percentage of Optimum Moisture Content (%) :	**102**	Minimum Specified CBR Value (%) :	**-**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**	**CBR Value (%) :**	**7**
Swell (%) / Surcharge (kg):	**0.0 / 4.5 kg**	+19mm Material (%) 0	Oversize replacement Nil

Soil Description : Silty CLAY

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

Approved Signatory
Tim Dick
NATA Accred No:2851

Form Number
RP902-7

BORDER-TEK PTY LTD
GEOTECHNICAL TESTING SERVICES
Border-Tek Pty Ltd • ABN 35 154 498 156

Office & Laboratory
Address: Unit 11, 21 Enterprise Avenue,
Tweed Heads South, NSW, 2486
Postal: PO Box 6340, Tweed Heads South, NSW, 2486
Phone: 0755 246 199
Fax: 0755 246 533
Email: info@bordertek.com.au

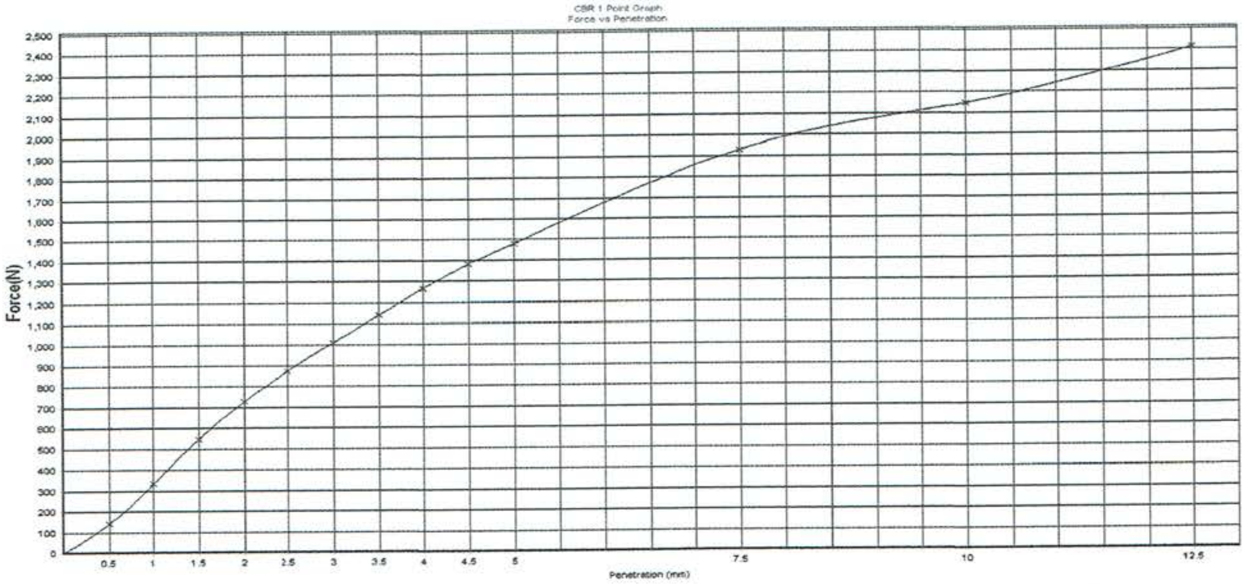
California Bearing Ratio Report (1 Point)

Client: **Geotech Investigations Pty Ltd**
Client address: **PO Box 6885 Tweed Heads South NSW 2486**
Job Number: **BTK 138**
Project: **Various Projects 2014**
Location **Byron Bay Hospital**
Lab No: **108984**
Date Sampled: **26/05/2014**
Date Tested: **2/06/2014**
Sampled By: **Brad James**
Sample Method: **AS1289 1.2.1 Earthworks**
Site Selection : **Geotech Inv**
For Use As: **General Fill**
Remarks: **The tests reported have been carried out at our Tweed Heads South Laboratory**

Report Number: **K2916**
Report Date: **3/06/2014**
Order Number:
Page 1 of 1

Sample Location
CBR 2
Borehole 4

Test Method : AS1289.6.1.1
Lot Number: -
Item Number : -



Maximum Dry Density - MDD (t/m^3) :	**1.272**	Dry Density after Soak (t/m^3) :	**1.252**
Optimum Moisture Content - OMC (%) :	**35.5**	Moisture Content after Soak (%) :	**43.6**
Compactive Effort :	**Standard**	Density Ratio after Soak (%) :	**98**
Nominated % Maximum Dry Density Compaction :	**100**	Field Moisture Content (%) :	**39.1**
Nominated % Optimum Moisture Content Compaction :	**100**	Moisture Content (Top) after Penetration (%) :	**44.1**
Achieved Dry Density before Soak (t/m^3) :	**1.270**	Optional Moisture Content (Remainder) after Penetration (%) :	**35.9**
Achieved Percentage of Maximum Dry Density (%) :	**100**	CBR 2.5mm (%) :	**7**
Achieved Moisture Content (%) :	**35.6**	CBR 5.0mm (%) :	**8**
Achieved Percentage of Optimum Moisture Content (%) :	**100**	Minimum Specified CBR Value (%) :	**-**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**	**CBR Value (%) :**	**8**
Swell (%) / Surcharge (kg):	**1.5 / 4.5 kg**	+19mm Material (%) 0	Oversize replacement Nil

Soil Description : Silty CLAY

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

Approved Signatory
Tim Dick
NATA Accred No:2851

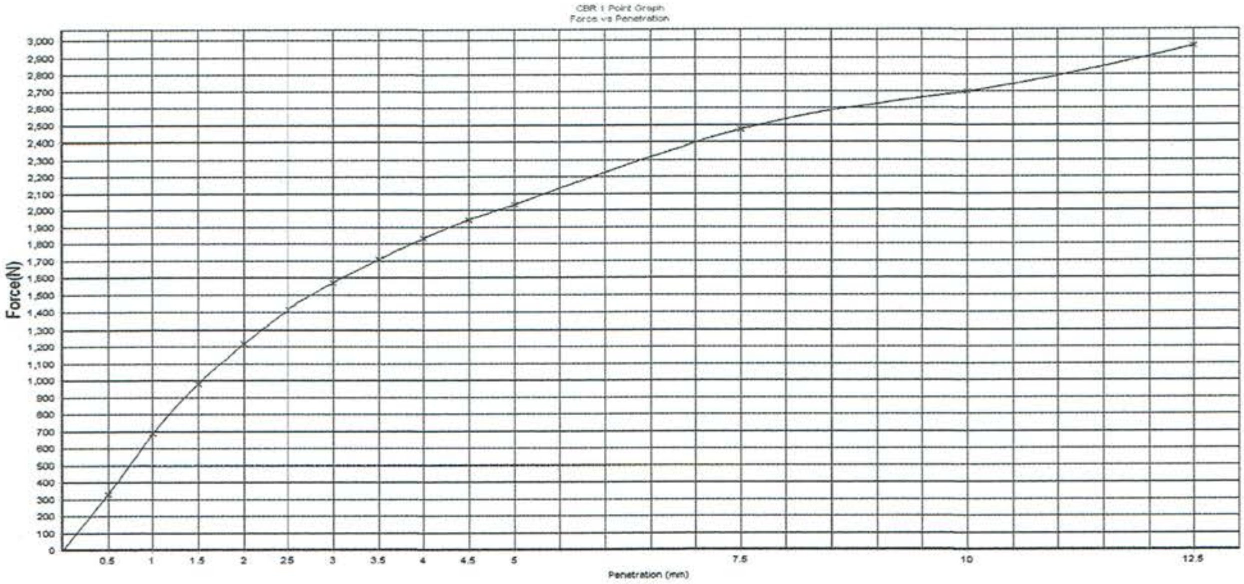
Form Number
RP902-7

BORDER-TEK PTY LTD
GEOTECHNICAL TESTING SERVICES
Border-Tek Pty Ltd • ABN 35 154 498 156

Office & Laboratory
Address: Unit 11, 21 Enterprise Avenue,
Tweed Heads South, NSW, 2486
Postal: PO Box 6340, Tweed Heads South, NSW, 2486
Phone: 0755 246 199
Fax: 0755 246 533
Email: info@bordertek.com.au

California Bearing Ratio Report (1 Point)

Client:	**Geotech Investigations Pty Ltd**	Report Number:	**K2915**
Client address:	**PO Box 6885 Tweed Heads South NSW 2486**		
Job Number:	**BTK 138**	Report Date:	**3/06/2014**
Project:	**Various Projects 2014**	Order Number:	
Location	**Byron Bay Hospital**		**Page 1 of 1**
Lab No:	**108983**	Sample Location	
Date Sampled:	**26/05/2014**	CBR 3	
Date Tested:	**2/06/2014**	Borehole 8	
Sampled By:	**Brad James**		
Sample Method:	**AS1289 1.2.1 Earthworks**		
Site Selection :	**Geotech Inv**	Test Method :	AS1289.6.1.1
For Use As:	**General Fill**	Lot Number:	-
Remarks:	**The tests reported have been carried out at our Tweed Heads South Laboratory**	Item Number :	-



Maximum Dry Density - MDD (t/m³) :	**1.315**	Dry Density after Soak (t/m³) :	**1.300**
Optimum Moisture Content - OMC (%) :	**35.2**	Moisture Content after Soak (%) :	**41.3**
Compactive Effort :	**Standard**	Density Ratio after Soak (%) :	**99**
Nominated % Maximum Dry Density Compaction :	**100**	Field Moisture Content (%) :	**38.8**
Nominated % Optimum Moisture Content Compaction :	**100**	Moisture Content (Top) after Penetration (%) :	**43.8**
Achieved Dry Density before Soak (t/m³) :	**1.307**	Optional Moisture Content (Remainder) after Penetration (%) :	**35.9**
Achieved Percentage of Maximum Dry Density (%) :	**99**	CBR 2.5mm (%) :	**11**
Achieved Moisture Content (%) :	**35.4**	CBR 5.0mm (%) :	**10**
Achieved Percentage of Optimum Moisture Content (%) :	**101**	Minimum Specified CBR Value (%) :	**-**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**	**CBR Value (%) :**	**11**
Swell (%) / Surcharge (kg):	**0.5 / 4.5 kg**	+19mm Material (%) 0	Oversize replacement Nil

Soil Description : Silty CLAY

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Postal: PO Box 6340, Tweed Heads South, NSW, 2486
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Email: info@bordertek.com.au

California Bearing Ratio Report (1 Point)

Client: **Geotech Investigations Pty Ltd**
Job Number: **BTK 138**
Project: **Various Projects 2014**
Location **Proposed Byron Bay Hospital**

Report Number: **K3045/1**
Report Date: **16/07/2014**
Order Number:
Page 1 of 1

Lab No: **109165**
Date Sampled: **8/07/2014**
Date Tested: **15/07/2014**
Sampled By: **Client**
Sample Method: **AS1289 1.2.1 Pavement**
Material Source: **-**
For Use As: **General Fill**
Remarks: **The tests reported have been carried out at our Tweed Heads**

Sample Location
CBR 4
0.5 - 0.7 metres

Test Method : T117 & T111
Lot Number: -
Item Number : -

Maximum Dry Density - MDD (t/m³) :	**1.294**
Optimum Moisture Content - OMC (%) :	**37.2**
Compactive Effort :	**Standard**
Nominated % Maximum Dry Density Compaction :	**100.0**
Nominated % Optimum Moisture Content Compaction :	**100.0**
Achieved Dry Density before Soak (t/m³) :	**1.293**
Achieved Percentage of Maximum Dry Density (%) :	**99.9**
Achieved Moisture Content (%) :	**36.9**
Achieved Percentage of Optimum Moisture Content (%) :	**99.2**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**
Swell (%) / Surcharge (kg):	**0.2 / 4.75 kg**
Dry Density after Soak (t/m³) :	**1.290**
Moisture Content after Soak (%) :	**40.7**
Density Ratio after Soak (%) :	**99.7**
Field Moisture Content (%) :	**37.3**
Moisture Content (Top) after Penetration (%) :	**50**
Moisture Content (Total) after Penetration (%) :	**40.8**
CBR 2.5mm (%) :	**8**
CBR 5.0mm (%) :	**8.00**
Minimum Specified CBR Value (%) :	**-**
CBR Value (%) :	**8.00**

Soil Description : Silty CLAY

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NATA Accred No:2851

Form Number
REP RCBR-1-7

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California Bearing Ratio Report (1 Point)

Client: **Geotech Investigations Pty Ltd**
Job Number: **BTK 138**
Project: **Various Projects 2014**
Location **Proposed Byron Bay Hospital**

Report Number: **K3044/1**
Report Date: **16/07/2014**
Order Number:
Page 1 of 1

Lab No: **109164**
Date Sampled: **8/07/2014**
Date Tested: **15/07/2014**
Sampled By: **Client**
Sample Method: **AS1289 1.2.1 Pavement**
Material Source: **-**
For Use As: **General Fill**
Remarks: **The tests reported have been carried out at our Tweed Heads**

Sample Location
CBR 5
0.5 - 0.8 metres

Test Method : T117 & T111
Lot Number: -
Item Number : -

Maximum Dry Density - MDD (t/m³) :	**1.277**
Optimum Moisture Content - OMC (%) :	**38.2**
Compactive Effort :	**Standard**
Nominated % Maximum Dry Density Compaction :	**100.0**
Nominated % Optimum Moisture Content Compaction :	**100.0**
Achieved Dry Density before Soak (t/m³) :	**1.275**
Achieved Percentage of Maximum Dry Density (%) :	**99.8**
Achieved Moisture Content (%) :	**37.9**
Achieved Percentage of Optimum Moisture Content (%) :	**99.2**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**
Swell (%) / Surcharge (kg):	**0.3 / 4.5 kg**
Dry Density after Soak (t/m³) :	**1.272**
Moisture Content after Soak (%) :	**42.8**
Density Ratio after Soak (%) :	**99.6**
Field Moisture Content (%) :	**39.7**
Moisture Content (Top) after Penetration (%) :	**45.1**
Moisture Content (Total) after Penetration (%) :	**40.1**
CBR 2.5mm (%) :	**12**
CBR 5.0mm (%) :	**10.00**
Minimum Specified CBR Value (%) :	**-**
CBR Value (%) :	**12**

Soil Description : Silty CLAY

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California Bearing Ratio Report (1 Point)

Client:	**Geotech Investigations Pty Ltd**	Report Number:	**K3046/1**
Job Number:	**BTK 138**	Report Date:	**16/07/2014**
Project:	**Various Projects 2014**	Order Number:	
Location	**Proposed Byron Bay Hospital**	**Page 1 of 1**	
Lab No:	**109166**	Sample Location	
Date Sampled:	**8/07/2014**	Borehole 9	
Date Tested:	**15/07/2014**	0.06 - 0.25 metres	
Sampled By:	**Client**		
Sample Method:	**AS1289 1.2.1 Pavement**	Base Course	
Material Source:	**-**	Test Method :	T117 & T111
For Use As:	**Base Course**	Lot Number:	-
Remarks:	**The tests reported have been carried out at our Tweed Heads**	Item Number :	-

Maximum Dry Density - MDD (t/m³) :	**2.088**
Optimum Moisture Content - OMC (%) :	**9.3**
Compactive Effort :	**Standard**
Nominated % Maximum Dry Density Compaction :	**100.0**
Nominated % Optimum Moisture Content Compaction :	**100.0**
Achieved Dry Density before Soak (t/m³) :	**2.092**
Achieved Percentage of Maximum Dry Density (%) :	**100.2**
Achieved Moisture Content (%) :	**9.2**
Achieved Percentage of Optimum Moisture Content (%) :	**98.9**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**
Swell (%) / Surcharge (kg):	**0.0 / 4.5 kg**
Dry Density after Soak (t/m³) :	**2.092**
Moisture Content after Soak (%) :	**10.1**
Density Ratio after Soak (%) :	**100.2**
Field Moisture Content (%) :	**5.5**
Moisture Content (Top) after Penetration (%) :	**11.2**
Moisture Content (Total) after Penetration (%) :	**10.2**
CBR 2.5mm (%) :	**8**
CBR 5.0mm (%) :	**9.00**
Minimum Specified CBR Value (%) :	**-**
CBR Value (%) :	**9.00**

Soil Description : Silty Clayey GRAVEL

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California Bearing Ratio Report (1 Point)

Client:	**Geotech Investigations Pty Ltd**	Report Number:	**K3047/1**
Job Number:	**BTK 138**	Report Date:	**16/07/2014**
Project:	**Various Projects 2014**	Order Number:	
Location	**Proposed Byron Bay Hospital**	**Page 1 of 1**	
Lab No:	**109168**	Sample Location	
Date Sampled:	**8/07/2014**	Borehole 9	
Date Tested:	**15/07/2014**	0.25 - 0.45 metres	
Sampled By:	**Client**		
Sample Method:	**AS1289 1.2.1 Pavement**	Sub Base	
Material Source:	**-**	Test Method :	T117 & T111
For Use As:	**Sub Base**	Lot Number:	-
Remarks:	**The tests reported have been carried out at our Tweed Heads**	Item Number :	-

Maximum Dry Density - MDD (t/m³) :	**2.011**
Optimum Moisture Content - OMC (%) :	**10.5**
Compactive Effort :	**Standard**
Nominated % Maximum Dry Density Compaction :	**100.0**
Nominated % Optimum Moisture Content Compaction :	**100.0**
Achieved Dry Density before Soak (t/m³) :	**2.018**
Achieved Percentage of Maximum Dry Density (%) :	**100.3**
Achieved Moisture Content (%) :	**10.3**
Achieved Percentage of Optimum Moisture Content (%) :	**98.1**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**
Swell (%) / Surcharge (kg):	**0.1 / 4.5 kg**
Dry Density after Soak (t/m³) :	**2.016**
Moisture Content after Soak (%) :	**11.9**
Density Ratio after Soak (%) :	**100.2**
Field Moisture Content (%) :	**7.5**
Moisture Content (Top) after Penetration (%) :	**11.9**
Moisture Content (Total) after Penetration (%) :	**10.9**
CBR 2.5mm (%) :	**11**
CBR 5.0mm (%) :	**13.00**
Minimum Specified CBR Value (%) :	**-**
CBR Value (%) :	**13.00**

Soil Description : Silty Sandy GRAVEL

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California Bearing Ratio Report (1 Point)

Client: **Geotech Investigations Pty Ltd**
Job Number: **BTK 138**
Project: **Various Projects 2014**
Location **Proposed Byron Bay Hospital**

Report Number: **K3048/1**
Report Date: **16/07/2014**
Order Number:
Page 1 of 1

Lab No: **109170**
Date Sampled: **8/07/2014**
Date Tested: **15/07/2014**
Sampled By: **Client**
Sample Method: **AS1289 1.2.1 Pavement**
Material Source: **-**
For Use As: **Base Course**
Remarks: **The tests reported have been carried out at our Tweed Heads**

Sample Location
Borehole 11
0.07 - 0.25 metres

Base Course
Test Method : T117 & T111
Lot Number: -
Item Number : -

Maximum Dry Density - MDD (t/m³) :	**2.176**
Optimum Moisture Content - OMC (%) :	**8.0**
Compactive Effort :	**Standard**
Nominated % Maximum Dry Density Compaction :	**100.0**
Nominated % Optimum Moisture Content Compaction :	**100.0**
Achieved Dry Density before Soak (t/m³) :	**2.175**
Achieved Percentage of Maximum Dry Density (%) :	**100.0**
Achieved Moisture Content (%) :	**8.1**
Achieved Percentage of Optimum Moisture Content (%) :	**101.3**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**
Swell (%) / Surcharge (kg):	**0.1 / 4.5 kg**
Dry Density after Soak (t/m³) :	**2.173**
Moisture Content after Soak (%) :	**9.2**
Density Ratio after Soak (%) :	**99.9**
Field Moisture Content (%) :	**3.9**
Moisture Content (Top) after Penetration (%) :	**11.5**
Moisture Content (Total) after Penetration (%) :	**8.1**
CBR 2.5mm (%) :	**19**
CBR 5.0mm (%) :	**25**
Minimum Specified CBR Value (%) :	**-**
CBR Value (%) :	**25**

Soil Description : Silty Clayey GRAVEL

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California Bearing Ratio Report (1 Point)

Client:	**Geotech Investigations Pty Ltd**	Report Number:	**K3049/1**
Job Number:	**BTK 138**	Report Date:	**16/07/2014**
Project:	**Various Projects 2014**	Order Number:	
Location	**Proposed Byron Bay Hospital**	**Page 1 of 1**	
Lab No:	**109172**	Sample Location	
Date Sampled:	**8/07/2014**	Borehole 11	
Date Tested:	**15/07/2014**	0.25 - 0.45 metres	
Sampled By:	**Client**		
Sample Method:	**AS1289 1.2.1 Pavement**	Sub Base	
Material Source:	**-**	Test Method :	T117 & T111
For Use As:	**Sub Base**	Lot Number:	-
Remarks:	**The tests reported have been carried out at our Tweed Heads**	Item Number :	-

Maximum Dry Density - MDD (t/m³) :	**2.207**
Optimum Moisture Content - OMC (%) :	**7.6**
Compactive Effort :	**Standard**
Nominated % Maximum Dry Density Compaction :	**100.0**
Nominated % Optimum Moisture Content Compaction :	**100.0**
Achieved Dry Density before Soak (t/m³) :	**2.198**
Achieved Percentage of Maximum Dry Density (%) :	**99.6**
Achieved Moisture Content (%) :	**7.8**
Achieved Percentage of Optimum Moisture Content (%) :	**102.6**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**
Swell (%) / Surcharge (kg):	**-0.1 / 4.5 kg**
Dry Density after Soak (t/m³) :	**2.200**
Moisture Content after Soak (%) :	**8.3**
Density Ratio after Soak (%) :	**99.7**
Field Moisture Content (%) :	**3.2**
Moisture Content (Top) after Penetration (%) :	**7.9**
Moisture Content (Total) after Penetration (%) :	**7.2**
CBR 2.5mm (%) :	**20**
CBR 5.0mm (%) :	**25**
Minimum Specified CBR Value (%) :	**-**
CBR Value (%) :	**25**

Soil Description : Silty Clayey GRAVEL

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Approved Signatory	Form Number
Tim Dick NATA Accred No:2851	**REP RCBR-1-7**

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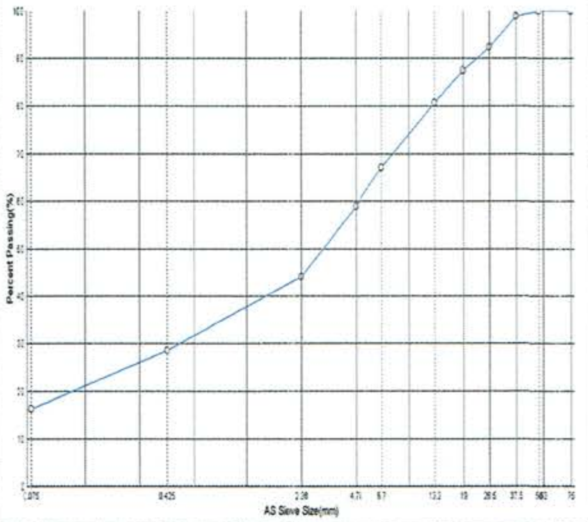
Quality of Materials Report

Client:	**Geotech Investigations Pty Ltd**	Report Number:	**K3040/1**
Client Address:	**PO Box 6885 Tweed Heads South NSW 2486**		
Job Number:	**BTK 138**	Report Date:	**16/07/2014**
Project:	**Various Projects 2014**	Order Number:	-
Location	**Proposed Byron Bay Hospital**	**Page 1 of 1**	
Lab No:	**109167**	Sample Location	
Date Sampled:	**8/07/2014**	Borehole 9	
Date Tested:	**11/07/2014**	0.06 - 0.25 metres	
Sampled By:	**Client**		
Sample Method:	**AS1289 1.2.1 Pavement**	Base Course	
Material Source:	-	Spec Description:	Material Classification
For Use As:	**Base Course**	Lot Number:	-
Remarks:	**The tests reported have been carried out at our Tweed Heads South Laboratory**	Spec Number:	MC

Test Method: **T106**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm		**100**	
53.00 mm		**-**	
37.50 mm		**99**	
26.50 mm		**92**	
19.00 mm		**87**	
9.50 mm		**-**	
4.75 mm		**59**	
2.36 mm		**44**	
0.425 mm		**29**	
0.075 mm		**16**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**T108**		**24.6**	
Plastic Limit (%)	**T109**		**16.4**	
Plasticity Index	**T109**		**8.4**	
Linear Shrinkage (%)	**T113**		**1.6**	
"A" Ratio			**0**	
"B" Ratio			**0**	
"C" Ratio			**0**	

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NATA Accred No:2851

Form Number
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Quality of Materials Report

Client: **Geotech Investigations Pty Ltd**
Client Address: **PO Box 6885 Tweed Heads South NSW 2486**
Job Number: **BTK 138**
Project: **Various Projects 2014**
Location **Proposed Byron Bay Hospital**

Report Number: **K3041/1**
Report Date: **16/07/2014**
Order Number: -
Page 1 of 1

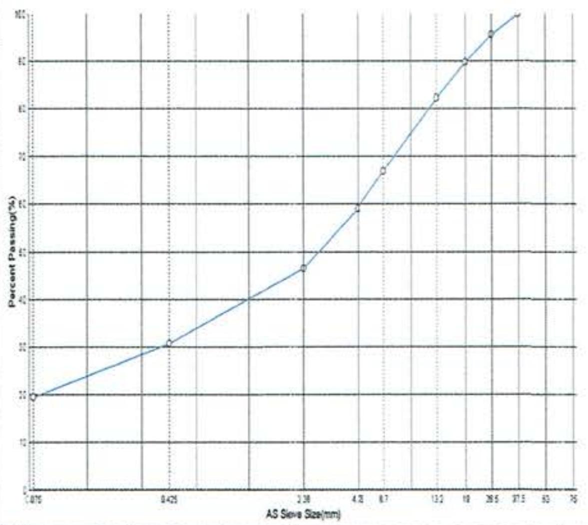
Lab No: **109169**
Date Sampled: **8/07/2014**
Date Tested: **11/07/2014**
Sampled By: **Client**
Sample Method: **AS1289 1.2.1 Pavement**
Material Source: -
For Use As: **Sub Base**
Remarks: **The tests reported have been carried out at our Tweed Heads South Laboratory**

Sample Location
Borehole 9
0.25 - 0.45 metres

Sub Base

Spec Description: Material Classification
Lot Number: -
Spec Number: MC

Test Method: **T106**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm		**100**	
26.50 mm		**96**	
19.00 mm		**90**	
9.50 mm		**-**	
4.75 mm		**59**	
2.36 mm		**47**	
0.425 mm		**31**	
0.075 mm		**19**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**T108**		**28.8**	
Plastic Limit (%)	**T109**		**17.8**	
Plasticity Index	**T109**		**11.0**	
Linear Shrinkage (%)	**T113**		**1.6**	
"A" Ratio				
"B" Ratio				
"C" Ratio				

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Form Number
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Quality of Materials Report

Client: **Geotech Investigations Pty Ltd**
Client Address: **PO Box 6885 Tweed Heads South NSW 2486**
Job Number: **BTK 138**
Project: **Various Projects 2014**
Location **Proposed Byron Bay Hospital**

Report Number: **K3042/1**
Report Date: **16/07/2014**
Order Number: -
Page 1 of 1

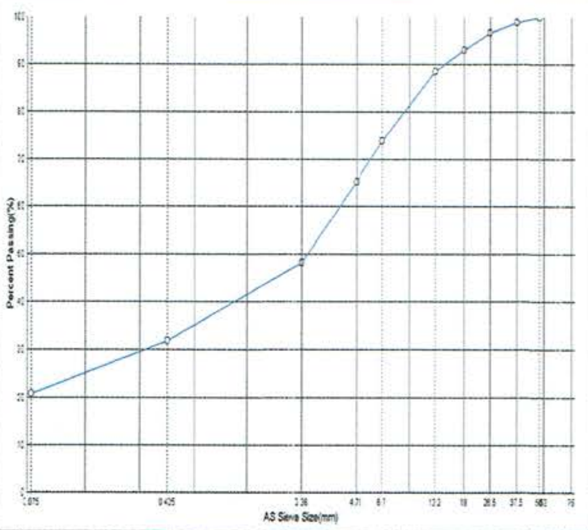
Lab No: **109171**
Date Sampled: **8/07/2014**
Date Tested: **11/07/2014**
Sampled By: **Client**
Sample Method: **AS1289 1.2.1 Pavement**
Material Source: -
For Use As: **Base Course**
Remarks: **The tests reported have been carried out at our Tweed Heads South Laborator**

Sample Location
Borehole 11
0.07 - 0.25 metres

Base Course

Spec Description: Material Classification
Lot Number: -
Spec Number: MC

Test Method: **T106**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm		**100.0**	
37.50 mm		**99**	
26.50 mm		**97**	
19.00 mm		**93**	
9.50 mm		**-**	
4.75 mm		**65**	
2.36 mm		**48**	
0.425 mm		**32**	
0.075 mm		**21**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**T108**		**21.8**	
Plastic Limit (%)	**T109**		**16.0**	
Plasticity Index	**T109**		**5.8**	
Linear Shrinkage (%)	**T113**		**1.0**	
"A" Ratio				
"B" Ratio				
"C" Ratio				

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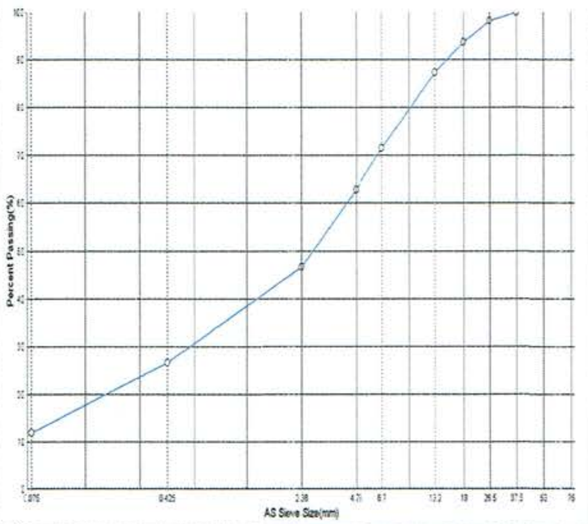
Quality of Materials Report

Client:	**Geotech Investigations Pty Ltd**	Report Number:	**K3043/1**
Client Address:	**PO Box 6885 Tweed Heads South NSW 2486**		
Job Number:	**BTK 138**	Report Date:	**16/07/2014**
Project:	**Various Projects 2014**	Order Number:	-
Location	**Proposed Byron Bay Hospital**		**Page 1 of 1**
Lab No:	**109173**	Sample Location	
Date Sampled:	**8/07/2014**	Borehole 11	
Date Tested:	**11/07/2014**	0.25 - 0.45 metres	
Sampled By:	**Client**		
Sample Method:	**AS1289 1.2.1 Pavement**	Sub Base	
Material Source:	-	Spec Description:	Material Classification
For Use As:	**Sub Base**	Lot Number:	-
Remarks:	**The tests reported have been carried out at our Tweed Heads South Laboratory**	Spec Number:	MC

Test Method: **T106**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm		**100**	
26.50 mm		**98**	
19.00 mm		**94**	
9.50 mm		**-**	
4.75 mm		**63**	
2.36 mm		**47**	
0.425 mm		**27**	
0.075 mm		**12**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**T108**		**19.4**	
Plastic Limit (%)	**T109**		**15.0**	
Plasticity Index	**T109**		**4.4**	
Linear Shrinkage (%)	**T113**		**0.6**	
"A" Ratio				
"B" Ratio				
"C" Ratio				

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Accredited for compliance with ISO/IEC 17025.

Approved Signatory
Tim Dick
NATA Accred No:2851

Form Number
RPO99-3

BORDER-TEK PTY LTD
GEOTECHNICAL TESTING SERVICES
Border-Tek Pty Ltd • ABN 35 154 498 156

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SHRINK - SWELL INDEX TEST REPORT

CLIENT :	GEOTECH INVESTIGATIONS PTY LTD				
CLIENT ADDRESS:	PO BOX 6885, TWEED HEADS SOUTH, NSW, 2486				
PROJECT :	Byron Bay Central Hospital, Lot 3 Ewingsdale Road, Byron Bay, NSW				
REPORT No:	0095	**DATE ISSUED:**	18/07/14	**JOB No:**	BTK138

TEST DATA

Sample Number	1375-1	1375-2		
Date Sampled	26/5/14	26/5/14		
Date Tested	2/6/14	2/6/14		
Test Location and Level	BH 4 0.5 – 0.9 m	BH 3 0.5 – 0.9 m		
Test Site Selected By	CLIENT	CLIENT		

LABORATORY DATA

Material Description	Silty CLAY	Silty CLAY		
Total Shrink (%)	6.3	7.0		
Shrinkage Moisture Content (%)	– (1)	– (1)		
Total Swell (%)	– (2)	Nil		
Swell Moisture Content (%)	– (1)	– (1)		
Percent of Inert Inclusions (%)	5	5		
Extent of Crumbling - Shrink	Nil	Nil		
Extent of Cracking - Shrink	Nil	Nil		
Shrink-Swell Index (I_{ss})	**3.5**	3.9		

Test Methods: AS 1289.2.1.1, 7.1.1

Note: The tests reported have been carried out by our Tweed Heads Laboratory.

The test reports is not in accordance with AS 1289.2.1.1, 7.1.1, due the shrinkage sample being < 75 mm in length.

(1) Moisture content testing not carried out.

(2) Due to the insufficient length of sample within BH 4, swell testing could not be undertaken.

James Walle
Engineering Manager

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Approved Signatory
N.A.T.A. Accreditation Number 2851