3) Results

3.1 Site location

The site location is shown on Drawing No GJ0901.5.1. The site occupies the north-eastern section of the Tweed Shire Terranora Area E and abuts Fraser Drive along its eastern boundary.

3.2 Topography and drainage

The slopes on the site vary from 0-5% in areas associated with the alluvial zones in the northern parts of the development adjoining the SEPP 14 wetland (Terranora Broadwater) to 15-25 % in the higher elevation areas in the southern part. The site drains to a central waterway that flows from the south to north through the site and finally into the SEPP 14 wetland of the site.

3.3 Geology and soils

The geology of the investigation site is described by the Geological Survey of Queensland Moreton Geology 1:500,000 geology map[6], as overlying Tertiary Basalt and sections of the Neranleigh-Fernvale beds. These groups consist of basalt, mudstone, shale, greywacke, chert, jasper, conglomerate, basic metavolcanics and pillow lava.

The 15 boreholes constructed for investigations undertaken by Morrison Geotechnics give an overview of the distribution of geologic groups on the site. Drawing No. GJ0901.5.4. The Morrison Geotechnics bore logs are attached in Appendix 1. The site may be divided into 3 distinct land unit origins:

- Basaltic materials
- Neranleigh-Fernvale materials
- Alluvial infill.

The soil landscape belongs to the Carool colluvial landscape group (Morand 1996[7]). Soil found on the site was characterised by light to medium dark and dark-reddish brown clays overlying medium to heavy reddish brown and dark reddish brown clays (Ferrosol). Basalt boulders/floaters were clearly visible in the site area and at depths of 0.3 to 0.6m, especially on steeper portions.

The basaltic land unit has deep clays overlying colluvial basalt boulders, decomposing basalt and in some location hard rock basalt. The depth of the soil mantle overlying the basalt varied between 2.6m and >7.5m. The Neranleigh-Fernvale unit demonstrated shallower soils varying between 0.7 and 3.0m deep. The alluvial infill soils showed soils in excess of 3.0m deep (Table 3.3.1).

Table 3.3.1 Borelogs[8] associated with each land unit descriptions

Borehole	Soil depth (m)	Material type (and wet layer depth mNSL)
Basaltic land unit		
1	>3.0	Silty clays (some grey mottles at 2.7-3.0m)
2	>3.0	Silty clays (trace of grey mottle at 3.0 m)
3	>3.0	Silty clays
4	2.6-2.8	Silty clays (1.7m)
5	7.5	Silty clays (5.1m)
6	>7.5	Silty clays (4.8m)
7	7.0	Silty clays (>7.0m)
9	>3.5	Silty clays **1** (2.7m)
14	>3.0	Silty clays (grey mottle at 2.2 m)
15	>6.0	Silty clays (blue grey mottles at 2.6m)
GSMB1a	10	Clay (6.5m)
GCMB1b	10	Clay over basalt (>25m)
GSMB2a	8.5	Clay (0.87m)
GSMB2b	8.5	Clay over basalt (7.67m)
Neranleigh-Fernvale land unit		
8	1.6-3.0	Silty clays (1.3-1.6m mottles in interface layer above NF materials
11	2.7	Silty clays **2** (indistinct layer, 0.9m, above bedrock at 3.4m depth)
12	3.0	Silty clays (grey mottle at 1.8m)
13	0.7	Silty clays (not evident)
Alluvial infill		
10	>3.0	Silty clays and sandy clays (1.0m)
1- near land unit boundary - refusal on basalt boulders **2**- on boundary – thin basalt over argillite		

[6] Queensland Government (1980) *Geological Survey of Queensland, Moreton Geology, 1:500,000 geology map.*

[7] Morand D.T. *Soil landscapes of the Murwillumbah – Tweed Heads 1:100000 (Fingal, Pottsville, Green Pidgeon, Tygalum)* NSW Soil Conservation Service pp 30-33.

[8] Morrison Geotechnics borelogs 1-15.

Typically the Neranleigh-Fernvale beds do not contain significant water bearing materials and do not have any significant water tables associated with them.[9] However, some significant supplies may be obtained from this group in areas associated with large fracture zones or in low-lying locations associated with freshwater swamps. [10] The borelogs from BH8, 11, 12 & 13 identified no wet layers that may indicate the presence of shallow water table.

The basalts contain high quality low salinity water and have a potential to give a yield varying from 0.5 - 15L s^{-1}.[11] The Morrison Geotechnics borelogs identify wet layers at depth ranging from 1.7 to 5.1m below surface level (BH4, 5, 6 & 9). The remainder of the borelogs identified no wet layers that may indicate a water table.

The bores installed in 2010 by Gilbert & Sutherland show heavy clays to depths between 8.5m and 10m. The completed borelogs and details of the bore installation are attached in Appendix 2.

The water tables and aquifers associated with the basalts are the most important in economic and environmental terms. The basalt aquifer and its associated interface drainage in the overlying soil mantle is the prevalent groundwater system operating on the site.

The alluvial infill deposits may have localised ground water derived from hillside and foot slope seepage areas and groundwater connected to the SEPP 14 wetland (Terranora Broadwater). Borehole 10 in Table 3.3.1 demonstrated a wet layer indicative of a water table at a depth of 1.0m below surface level.

The alluvial infill land unit is located within the mapped Class 2 Acid Sulphate constraints map of the Tweed Shire LEP 2010. The map suggests Potential Acid Sulfate Soils (PASS) occur between 0.5m and 1.0m from the soil surface. Any excavations will require an acid sulfate management plan. An Acid Sulfate Management Plan is provided as a separate report.

3.4 Groundwater levels and flows

The groundwater level within the soil mantle and interface drainage zone respond to rainfall events and the general topography of the site. The description of the likely depths of water tables within the soil mantle is given in Table 3.3.1 above and Table 3.4.1.1.

Table 3.4.1.1 Standing water level for Gilbert & Sutherland bores 1a, 1b, 2a and 2b

Bore	Ground [12]Level (mAHD)	Water level (mNSL)	Water level (m AHD)
17/2/2010			
2a	12.5	0.87	11.63
2b	12.5	7.67	4.83
20/4/2010			
1a	50	7.73	42.27
1b	50	>25.0	NA
2a	12.5	0.62	11.88
2b	12.5	7.20	5.3

Notes - Rain for previous 2 weeks:
17/2/2010 – 203mm
20/4/2010 – 144mm

The standing water level in the upper slope zone associated with the basalt land unit surrounding Gilbert & Sutherland borehole 1a indicates the water table is located at a depth of approximately 7m below the existing soil surface. Interpretation of the Morrison Geotechnics borelogs indicates there may be watertable varying between 1.7m and 5.1m below the existing soil surface in the upper slopes. The lower portions of the slopes have varying water table depths with a highest being 0.62m NSL at Gilbert & Sutherland borehole 2a to greater that 7m (at BH6).

Flow direction of the groundwater will be dominated by the topography of the site due to the high gradients (5-25%) of the slope.

The soils associated with the Neranleigh-Fernvale land unit showed some evidence

[9] McKibbin, D. 1995 Upper North Coast Groundwater Resource Study, NSW Dept of Land and Water Conservation (Water Resources), Technical Services Division, August 1995.

[10] Environmental Hydrology Associates (EHA Pty Ltd) 2008 Tweed District Water Supply Augmentation Options Study. Input to stage 1 – identification of feasible options – groundwater supply. Report Number GW-08-02-REP-001 Rev A.

[11] McKibbin, D. 1995 Upper North Coast Groundwater Resource Study, NSW Dept of Land and Water Conservation (Water Resources), Technical Services Division, August 1995.

[12] Estimated from location on contour plan.

of minor water tables positioned directly above the underlying weathered and hard bedrock. These water tables are shallow and the flow direction dominated by the topography.

The alluvial infill land unit demonstrates a water table within 1.0 m of the soil surface and it is expected that surface expression of the water table would be evident at scattered locations from time to time. Recharge of this water table would be from the surrounding slopes to the east south and west and the flow would be expected to discharge towards the wetland and drainage canal to the north of the proposed development site.

3.4.1 Construction phase drawdown

To estimate the groundwater drawdown associated with the construction of the wetlands, Hooghoudt's Equation was used. This approach is conservative given the assumed hydraulic conductivity (0.03m/day) and inflow rate (1.9mm/day). Accordingly, the result provides a 'worst case scenario' estimates outline in Table 3.4.1.1.

Table 3.4.1.1 Estimated extent of watertable drawdown - basalt and alluvial infill land units

Basalt land unit	Draw down distance (m) Excavation depth (m)			
Permeability ($m\ d^{-1}$)	1	2	3	4
0.020	9	15	20	26
0.031[13]	11	18	25	32
0.040	13	21	29	36
Alluvial infill unit				
Permeability ($m\ s^{-1}$)	1	2	3	4
0.2	28	40	64	82
0.3	35	56	78	100
0.4	40	65	90	115

Table 3.4.1.1 shows a series of scenarios with permeability varying by 50% higher and lower than that measured by the rising head method for bore hole 2a. Similarly, the estimation of the alluvial infill area impact is based on an assumed permeability based on the soil texture class and varied by 50% higher and lower.

During the detailed design phase, modelling of the proposed development situation would be undertaken to determine the expected drawdown associated with the construction of the storm water treatment devices.

3.4.2 Operational phase

The wetlands and constructed wetlands will been elevated to minimise the effect (if any) of operational phase groundwater drawdown on acid sulfate soils.

3.4.3 Seepage construction phase

To determine a likely seepage rate into the excavation following the initial excavation and storage release the Darcian flow rate was calculated and shown in Table 3.4.3.1.

Table 3.4.3.1 Estimated seepage into excavations in basalt and alluvial infill land units

Basalt land unit	Seepage rate (L per linear m of excavated face) Excavation depth (m)			
Permeability ($m\ s^{-1}$)	1	2	3	4
0.020	2	4	6	8
0.031[14]	3	6	9	12
0.040	4	8	12	16
Alluvial infill unit				
Permeability ($m\ s^{-1}$)	1	2	3	4
0.2	4	8	12	16
0.3	6	12	18	24
0.4	8	16	24	32

The groundwater management strategy adopted for the construction phase for all works components would need to control and store and dispose of the accumulated seepage in accord with a groundwater management plan.

3.5 Groundwater chemistry

The analytical results for each parameter are discussed in this section. Complete results table for each bore are shown in Table 3.5.1 (next page). Copies of the laboratory certificates and in situ sheets are attached as Appendix 2.

Bore 1b was installed to a depth of 25m and showed no groundwater within the

[13] Permeability estimated in Section 3.6.

[14] Permeability estimated in Section 3.6.

basaltic layer below the interface drainage zone sampled by bore 1a. The termination point of the bore was within a large void or extensive fracture zone that did not contain any water. No water samples were extracted from this bore.

Bore 2b sampled the water associated with the basalt materials at depths greater than 15m. The water quality test show the water is high in iron and magnesium in comparison with the surface dominated interface drainage zone of the shallow bores (1a and 2a). This is not an unexpected result considering basalt is a mafic rock and consider ferro-magnesic in chemistry. (Note: Figure 3.5.1 cross plots of Fe and Mg for the three bore samples).

The piper plots in figure 3.5.2 show the relationship between the ratios of major ions of each water sample.

3.6 Permeability testing

The results of the falling head tests conducted within three of the four groundwater bores are summarised in Table 3.6.2.

Table 3.6.2 Rising head test results

Borehole	Permeability	
	m s^{-1}	m d^{-1}
GW2a	3.55 x 10^{-7}	0.031
GW2b	2.52 x 10^{-7}	0.022

Bore 1a contained no water to use a rising head test. At the end of the drilling to 25 m a total of 500L of water was used with no measurable water at the bottom of the bore to facilitate measurement and calculation of a permeability. The end of the bore appears to be connected to a large void.

Table 3.5.1 Summary of laboratory and in-situ measurement results for water quality at bores 1a, 2a and 2b.

Analyte	Sample date LOR	Borehole 2a 16/2/10	Borehole 2b 16/2/10	Borehole 1a 26/3/10
Hydroxide Alkalinity as $CaCO_3$ (mg L^{-1})	1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$ (mg L^{-1})	1	<1	<1	<1
Bicarbonate Alkalinity as $CaCO_3$ (mg L^{-1})	1	25	170	93
Total Alkalinity as $CaCO_3$ (mg L^{-1})	1	25	170	93
Sulfate as SO_4^{2-} (mg L^{-1})	1	8	10	24
Chloride (mg L^{-1})	1	31	55	22
Calcium (mg L^{-1})	1	6	25	20
Magnesium (mg L^{-1})	1	6	16	8
Sodium (mg L^{-1})	1	34	54	32
Potassium (mg L^{-1})	1	1	4	3
Aluminium (mg L^{-1})	0.01	<0.01	0.13	0.05
Arsenic (mg L^{-1})	0.001	<0.001	0.002	<0.001
Cadmium (mg L^{-1})	0.0001	<0.0001	<0.0001	<0.0001
Chromium (mg L^{-1})	0.001	<0.001	<0.001	<0.001
Copper (mg L^{-1})	0.001	<0.001	0.001	<0.001
Nickel (mg L^{-1})	0.001	<0.001	0.011	0.003
Lead	0.001	<0.001	<0.001	<0.001
Zinc	0.005	0.015	0.012	0.026
Manganese (mg L^{-1})	0.001	0.024	0.368	0.293
Iron (mg L^{-1})	0.05	0.05	3.47	0.33
Total Anions (meq L^{-1})	0.01	1.56	5.15	2.97
Total Cations (meq L^{-1})	0.01	2.27	5.02	3.17
EC (µs cm^{-1})		271	498	
pH		7.11	7.34	
EC (µs cm^{-1})		315	920	604
pH		3.76	3.7	3.79

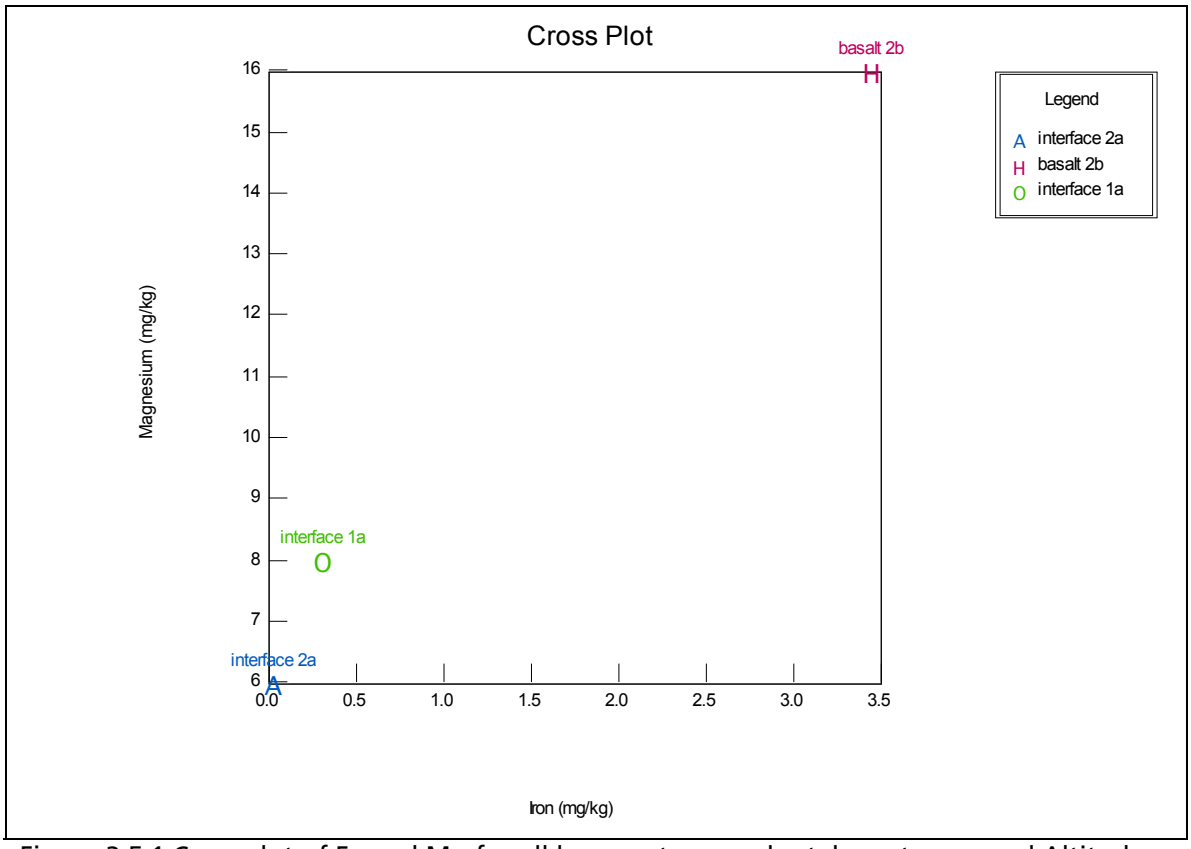


Figure 3.5 1 Cross plot of Fe and Mg for all bore water samples taken at proposed Altitude Aspire development site.

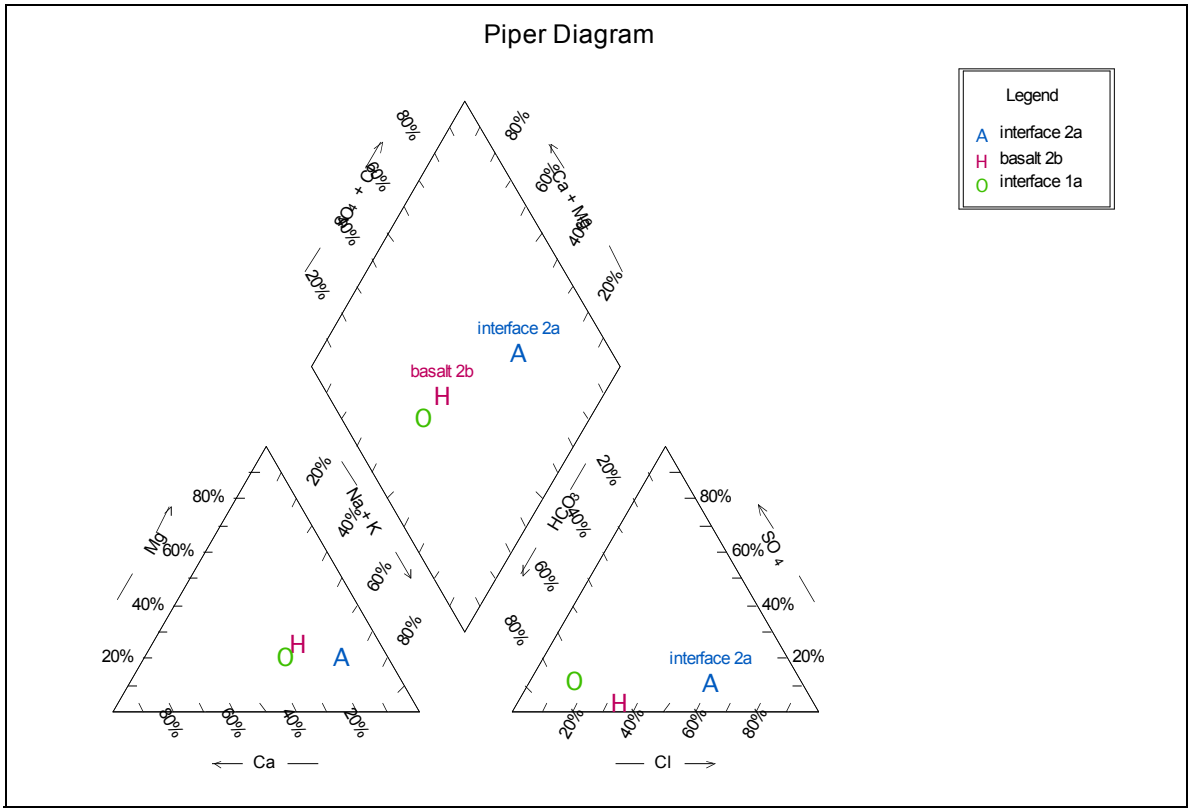


Figure 3.5.2 Piper plot of water chemistry for bores 1a, 2a and 2b.

3.7 Recharge estimation

The estimate (using Cook's method) of the recharge potential for the water bearing materials on the undeveloped site is shown in Table 3.7.1 below.

Table 3.7.1 Estimation of average recharge potential[15] for undeveloped site for a range of probable rainfall Cl^- concentrations.

Interface drainage bore	Rainfall Cl^- (mg L^{-1}) 1.5[16]	2	2.5	3[17]
2a (6 mg Cl^- L^{-1})	344	458	573	687
1a (20 mg Cl^- L^{-1})	103	137	172	206
Mean	223	298	372	447
Basalt	**1.5**	**2**	**2.5**	**3**
2b (55 mg Cl^- L^{-1})	37	50	62	75

Notes:
1. Run-off estimated as 250 mm for Ferrosols
2. Average Rainfall 1624 mm[18]

The estimation of recharge for the deep basalt indicates a low level of recharge varying from 37-75 mm per year based on the expected average rainfall and a range of Cl^- contents. This is significantly less that the overlying soil mantle. The soil itself is directly exposed to the rainfall events and will have a diffuse recharge mechanism.

3.8 Other registered bores

There are five registered bores in the vicinity of the proposed development. As shown in Figure 3.8.1. The details of each bore are attached in Appendix 4.

Bore No 63684 is located within the site and will be decommissioned as a result of the development. The bores 65037 and 58144 are located in different parts of the catchment and will b not be influenced by the proposed development.

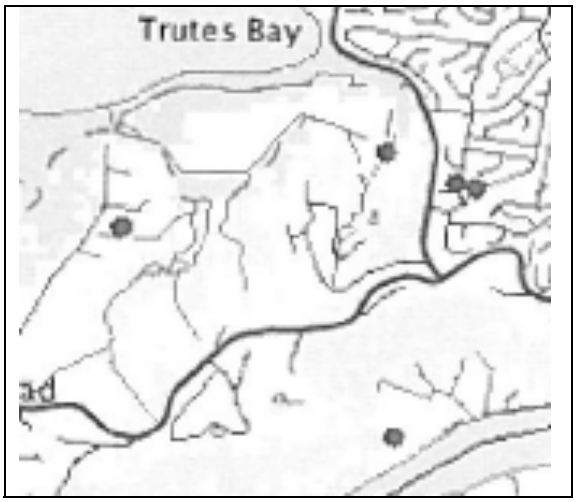


Figure 3.8.1 Registered bores in and around the proposed development site.

Bore numbers 65617 and 63680 are located east of the proposed development near the intersection of Ash drive and Lovat Brae Crt. Bore 65617 is 49m deep with water bearing zones 30-49m below the surface and within the shales of the Neranleigh-Fernvale material. The description of the waterbearing layer is 'hard shale' and the expected yield from the bore would be low. Bore 63680 located near 65617 is 32 m deep with the water bearing layers at 24-32m and located within shale of the Neranleigh-Fernvale deposits. The yield of this bore is low at 0.78 Ls^{-1}.

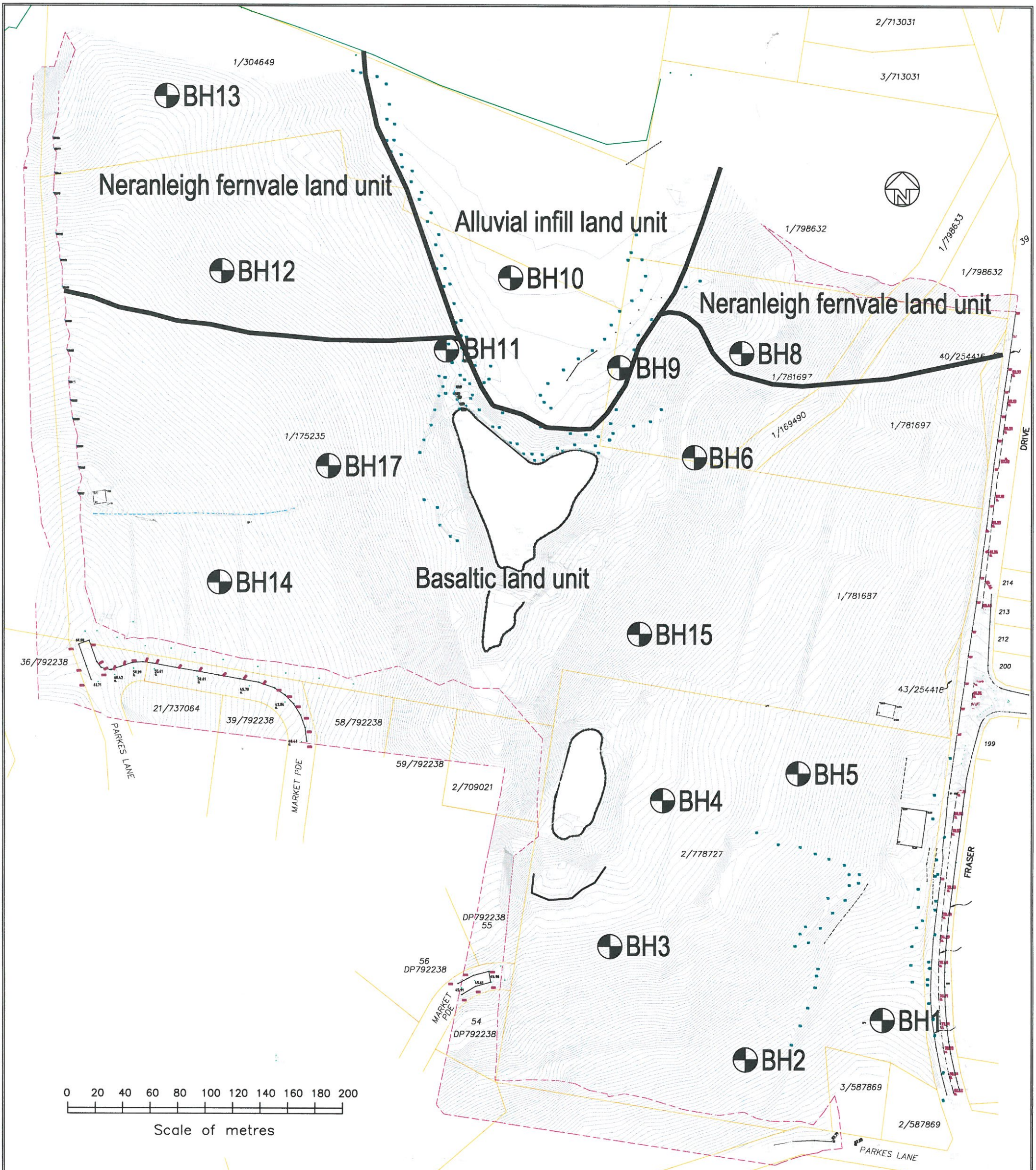
The expected flow direction of the water table would be towards Trutes Bay (Terranora Broadwater) in a NNW direction. The probability that the land associated with the proposed development is contributing to the recharge of these bores is extremely remote.

[15] Using Cooks method described in Section 2.4.3

[16] Based on the estimates used for the Atherton tablelands.

[17] Measured at Robina during December 2009 by Gilbert & Sutherland and analysed by Tweed Shire Laboratory as >3.0 mg L^{-1}.

[18] Mean derived from BOM data drill rainfall for Cobaki - years 1889-2008.



Source: Morrison Geotechnic, 2010

GILBERT+SUTHERLAND
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PROJECT

METRICON QLD PTY LTD

ALTITUDE ASPIRE, TERRANORA AREA E

DISTRUBUTION OF GEOLOGICAL GROUPS

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN J.J.T	DRAWING No.
		DATE 23/04/10	CHECKED	GJ0901.5.4

4) Discussion

In response to the DGR 11.1 there are eight relevant issues:

- Groundwater level and flow direction.
- Potential contamination.
- Proposed use of groundwater.
- Changes in groundwater recharge.
- Changes in groundwater discharge.
- Impacts on groundwater dependant ecosystems.
- Impacts on groundwater quality.
- Impact on Acid Sulphate Soil.

4.1 Groundwater level and flow direction

The topography of the urban portion of the site is elevated with slopes varying between 5% and 25%. The landform will dictate the groundwater level and the flow direction irrespective of the earthworks associated with the either the basalt or Neranleigh-Fernvale land units.

Cut batters in excess of 2m height on the upper slopes associated with the basalt land unit may intercept shallow groundwater associated with the interface drainage zone in some locations (for instance around BH4). However, it would be expected that much of the upper slopes would have water tables greater than 3.0m below the existing soil surface.

Cut batters on the lower portions of the slope adjacent to the central drainage area would intercept water tables that are close to the surface (<0.8m at G&S bore 1a). Seepage and drainage control would be required to facilitate the earthworks program and stabilise the site.

The earthworks in areas associated with the Neranleigh-Fernvale land unit will encounter very minor and localised water tables that would be located immediately above the weathering and hard bedrock. These water tables would not be a constraint to the works on site.

In general the earthworks program on the hillside areas during construction would require:

- Seepage and drainage control plans for works that intercept water tables (especially in the Basalt land unit).
- Erosion and sediment control plans to control run-off during rainfall events and longer-term interflow drainage after rainfall.
- Batter stabilisation as per assessment and advice from a qualified geotechnical engineer.

The deeper basalt related water table is separated from the development site by a low permeability clay layer. The proportion of recharge to this water table from the overlying soil mantle is relatively small and the development will have minor impact on the deep regional water table of the basalt.

The alluvial infill land unit has a shallow water table that would require management during construction of infrastructure such as roads, water and sewage infrastructure and water treatment devices. A groundwater management plan in particular addressing dewatering, seepage and acid sulphate soil, will be required for the construction phase of the development.

4.2 Potential contamination

The proposed development contains no potentially contaminating industries. The soil material under the urban footprint is of low permeability and forms an effective retarding barrier to water movement.

Within the alluvial infill land unit, bio-retention and stormwater treatment devices will be separated from the groundwater by compacted clay barrier. [19] The design of the water treatment devises separates them from the ground water. However, a groundwater-monitoring program should be undertaken to validate the integrity of the water treatment structures.

4.3 Proposed use of groundwater

The proposed development does not involve any uses of the site's groundwater.

4.4 Changes in groundwater recharge

The proposed development entails earthworks that will result in cut and fill batters plus the creation of large areas of

[19] Gilbert & Sutherland, *'Conceptual Stormwater Assessment and Management Plan, Altitude Aspire', November 2010*', report No. GJ0901-1-SWA-RAG2F.

zero to low gradient pads for house construction. These works are associated with the basalt and Neranleigh-Fernvale land units on the site. Such changes in landform may result in localised areas of increased recharge and deep percolation into the shallow interface drainage zone on the hillsides. This impact will be most evident during the construction and on-maintenance stages of the proposal. These earthworks will affect 85% of the site.

However, this increase will be balanced by a significant increase in hardstand that will increase the run-off losses to the stormwater delivery and treatment system. The proportion of hardstand will be approximately 50%. The basalt based water table at depth would be unaffected by the changes due to the low permeability of the overlying material.

The recharge of the alluvial infill land unit will remain unchanged. The water treatment devices will have clay liners to separate them from the groundwater and secondary seepage from the adjacent slopes will be maintained to ensure the groundwater levels in the infill area remains similar to the predevelopment conditions.

4.5 Changes in groundwater discharge

The basalt and Neranleigh-Fernvale land units will have localised changes in the discharge characteristics of the slopes. The main changes will be the development of seepage zones associated with the cut batters on site as they intercept the existing water tables in the shallow interface drainage zone. The localised seepage will need to be managed to minimise any impacts on the stability of the cut and fill batters on the site

In general the hillside areas post - construction would require:

- Seepage and drainage control plans for works that intercept water tables (especially in the Basalt land unit)
- Erosion and sediment control plans to control run-off during rainfall events and longer-term interflow drainage after rainfall.
- Batters stabilisation as per assessment and advice from a qualified geo-technical engineer.

The alluvial infill land unit will require no special intervention due to the development design not changing the groundwater flow direction and the and the groundwater discharging from this land unit directly to the adjacent SEPP 14 wetland to the north.

4.6 Impacts on groundwater dependant ecosystems (GDE)

The steep and elevated topography of the area ensures the local catchment conditions dominate the groundwater flows of both shallow and the deeper hard rock water tables. The flow direction is towards the SEPP14 wetland to the north of the site. The proposed development and its associated earthworks do not change the direction of flow of the water tables. Existing flow patterns will be maintained by the development by continuing to direct flows towards the existing central flow path and maintaining the groundwater flows to the alluvial infill zones in the northern portion of the development site.

There will be no impact on the GDE within the SEPP 14 wetland as a result of the development impacts on groundwater.

4.7 Impacts on existing registered bores

The location (different catchments) and depth of the surrounding registered bores near the site suggest there will be no impacts on these bores. The steep and elevated topography of the area ensures the local catchment conditions dominate the groundwater flows of both shallow and the deeper hard rock water tables.

4.8 Impacts on groundwater quality

All stormwater will be treated to control N, P prior to discharge to the environment. The surface soil mantle over the basalt has significant depth (up to 7.5m) and a limited permeability ($0.031md^{-1}$). The underlying basalt based water table is separated from the proposed development activities by this soil layer. No changes in groundwater quality are expected.

5) Conclusions

5.1 Groundwater impacts

In general the earthworks program on the hillside areas during construction would require:

- Seepage and drainage control plans for works that intercept water tables (especially in the Basalt land unit)
- Erosion and sediment control plans to control run-off during rainfall events and longer-term interflow drainage after rainfall.
- Batter require stabilisation as per assessment and advice from a qualified geotechnical engineer.

The deeper basalt related water table is separated from the development site by a low permeability clay layer and will not be affected by the development proposal

The alluvial infill land unit has a shallow water table that would require a ground water management plan or acid sulphate soil management plan.

The proposed development contains no potentially contaminating industries. Stormwater quality treatment devices will be separated from the groundwater by compacted clay barrier. However, a groundwater-monitoring program should be undertaken to validate the integrity of the water treatment structures.

The proposed development does not have any intended uses of the groundwater on the site.

The recharge basalt based water table at depth would be unaffected by the changes due to the low permeability of the overlying material and extensive recharge areas outside of the development site.

The recharge of the alluvial infill land unit will remain unchanged. There will be no impact on the GDE within the SEPP 14 wetland as a result of the development impacts on groundwater.

The location (different catchments) and depth of the surrounding registered bores near the site suggest there will be no impacts on these bores. The underlying basalt based water table is separated from the proposed development activities by its overlying low permeability soil layer and no changes in groundwater quality are expected.

5.2 Groundwater impact management

The identified potential impacts are readily anticipated and manageable. At the detailed design phase for the development detailed groundwater study should be undertaken to refine the understanding of the site and aid in the development of specific groundwater management plans for the site.

6) Limitations of reporting

Gilbert & Sutherland Pty Ltd has attempted to be accurate in providing the information contained in this report. The interpretation of scientific data, however, often involves both professional and subjective judgements. As such, interpretation is open to error.

In recognising the potential for errors in scientific interpretation, Gilbert & Sutherland Pty Ltd does not guarantee that the information is totally accurate or complete and clients are advised not to rely solely on this information when making commercial decisions. Any representation, statement, opinion or advice, expressed or implied is made in good faith and on the basis that the authors, Gilbert & Sutherland Pty Ltd, their agents or employees are not liable (whether by reason of lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement or advice referred to above.

Furthermore, this information should not be relied upon by any other persons than the client or the relevant statutory authority determining the client's application, for whom this information was compiled. This information reflects the specific brief and the budget of the client concerned, who enjoys an individual tolerance of risk.

7) Appendix 1 – Morrison Geotechnics Borehole logs

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH1

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551595.00
Northing: 6877052.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 11/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1			CI	**Silty CLAY:** Hard, medium plasticity, red brown, some root matter, moist		M	H				
						CH	**Silty CLAY:** As above but high plasticity, and no root matter		M	H		0.3 –	PP	500kPa
			1.0									1 –	PP	>600kPa
			2.0											
			2.7			CH	**Silty CLAY:** As above but red brown with some grey mottling		M	H		2.8 –	PP	450kPa
			3.0 3				**3.00m: BOREHOLE TERMINATED**							
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH2

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551494.00
Northing: 6877621.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 11/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1			CI	**Silty CLAY:** Hard, medium plasticity, red brown mottled brown, some root matter, moist		M	H				
						CH	**Silty CLAY:** As above but high plasticity, red brown and no root matter		M	H		0.3 –	PP	>600kPa
			1.0									1 –	PP	>600kPa
			2.0									1.8 –	PP	450kPa
												2.3 –	PP	>600kPa
			2.6			CH	**Silty CLAY:** As above but a trace of grey mottling		M	H				
			3.0									2.9 –	PP	450-500kPa
							3.00m: BOREHOLE TERMINATED							
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH3

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551393.00
Northing: 6877105.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 11/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			1.0			CH	**Silty CLAY:** Hard, high plasticity, red brown, moist		M	H		0.5 –	PP	>600kPa
			1.5			CH	**Silty CLAY:** As above but red brown mottled orange brown		M	H		1.2 –	PP	>600kPa
			2.0 2			CH	**Silty CLAY:** As above but red brown with minor orange brown mottling		M	H				
			3.0 3				**3.00m: BOREHOLE TERMINATED**							
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH4

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551431.00
Northing: 6877214.00
RL:
Total Depth: 3.60
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 11/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.0	Slopewash		CI	**Sandy CLAY**: Hard, medium plasticity, red brown mottled orange brown with a trace of grey, fine to medium grained sand, moist		M	H				
			0.3			CI	**Sandy CLAY**: As above but with a trace of fine to coarse gravel		M	H		0.5 –	PP	>600kPa
			1.0											
			1.7			CL	**Sandy CLAY (CL/CI)/ Clayey SAND (SC)**: Firm to stiff, low to medium plasticity fines, orange brown mottled grey and purple and red brown, fine to medium grained sand, moist to wet		M-W	F-St		1.8 –	PP	100kPa
			2.0											
			2.1	Residual		/ CL CI	**Sandy CLAY (CL/CI)/ Clayey SAND (SC)**: As above but grey mottled orange brown and res brown		M-W	F-St				
			2.6			SC	**Clayey SAND**: Medium dense, fine to medium grained sand, grey mottled orange brown and red brown, low to medium plasticity fines, moist		M	MD				
			2.8	Bedrock		BAS	**BASALT**: Extremely weathered, very low strength, grey with some orange brown mottling	XW		VLS				
			3.0											
			3.6				**3.60m: BOREHOLE TERMINATED AT MAX. TC BIT REFUSAL**							
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH5

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551532.00
Northing: 6877235.00
RL:
Total Depth: 7.60
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 11/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			1.0	Residual		CH	**Silty CLAY:** Very stiff to hard, red brown, high plasticity moist		M	VSt-H		0.5	PP	450kPa
			1.1			CH	**Silty CLAY:** As above but very stiff		M	VSt		1.6	PP	300kPa
			2.0											
			2.2			CH	**Silty CLAY:** As above but dark grey mottled orange brown, and very stiff to hard		M	VSt-H				
			2.4			CH	**Silty CLAY:** As above but dark grey mottled blue grey with some orange brown mottling, and very stiff		M	VSt		2.4	D	
			3.0											
			3.1			CH	**Silty CLAY:** As above but red brown with some blue grey and orange brown mottling, and stiff		M	St				
			3.7			CH	**Silty CLAY:** As above but firm and wet		M	F				
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH5

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551532.00
Northing: 6877235.00
RL:
Total Depth: 7.60
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 11/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0			CH	**Silty CLAY:** As above but firm and wet		M	F		4	PP	60kPa
			4.5			CH	**Silty CLAY:** As above but moist to wet		M-W	F		4.6	PP	75-100kPa
			5.0											
			5.1			CH	**Silty CLAY:** As above but soft to firm, and wet		W	S-F				
			6.0									6	PP	40-60kPa
			7.0											
			7.5	Bedrock		BAS	**BASALT**: Extremely weathered, low strength, dark grey mottled orange brown	XW		LS				
			7.6				**7.60m: BOREHOLE TERMINATED AT MAX. TC BIT REFUSAL**							
			8.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH6

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551454.00
Northing: 6877469.00
RL:
Total Depth: 7.50
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1	Topsoil		CI	**Silty CLAY:** Hard, medium plasticity, red brown, some root matter, moist		M	H				
				Colluvium		CH			M	H				
			1.0				**Silty CLAY:** As above but high plasticity, and no root matter, red brown mottled orange brown with some grey, some boulders							
			2.0									1.5	PP	>600kPa
			2			CH	**Silty CLAY:** As above but very stiff		M	VSt				
			3.0											
												3.5	PP	350kPa
			3.7			CH	**Silty CLAY:** As above but red brown mottled blue grey and orange brown, soft to firm, moist to wet		M-W	S-F				
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH6

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551454.00
Northing: 6877469.00
RL:
Total Depth: 7.50
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger	SWL		0.0			CH	**Silty CLAY**: As above but red brown mottled blue grey and orange brown, soft to firm, moist to wet		M-W	S-F		4	PP	40-60kPa
			4.8			CH	**Silty CLAY**: As above but wet		W	S-F				
			5.0											
			6.0											
			6.2			CH	**Silty CLAY**: As above but firm, and blue grey		W	F				
			6.6			CH	**Silty CLAY**: Hard, high plasticity, orange brown mottled light grey, moist		M	H				
			7.0									7.3 –	PP	500kPa
			7.5				**7.50m: BOREHOLE TERMINATED**							
			8.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH7

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551183.00
Northing: 6877459.00
RL:
Total Depth: 7.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			1.0			CH	**Silty CLAY:** Hard, high plasticity, red brown, moist		M	H		1 –	PP	>600kPa
			1.3			CH	**Silty CLAY:** As above but with a trace of extremely weathered grey deco basalt layering		M	H				
			2.0											
			3.0											
			3.4			CH	**Silty CLAY:** As above but with basalt boulders		M	H				
			3.7			CH	**Silty CLAY:** As above but no basalt boulders, and very stiff		M	VSt				
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH7

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551183.00
Northing: 6877459.00
RL:
Total Depth: 7.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			5.0			CH	**Silty CLAY:** As above but no basalt boulders, and very stiff		M	VSt				
			6.0											
			6.5			CH	**Silty CLAY:** As above but with basalt boulders		M	VSt				
			7.0 7											
							7.00m: BOREHOLE TERMINATED AT MAX. TC BIT REFUSAL ON BASALT BOULDER							
			8.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH8

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551489.00
Northing: 6877546.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.7	Colluvium		CH	**Silty CLAY:** Very stiff to hard, red brown, high plasticity, trace of fine to medium grained sand, some fine to medium gravel, moist		M	VSt-H		0.3 –	PP	400kPa
			1.0			CH	**Silty CLAY:** As above but hard, red brown mottled orange brown		M	H				
			1.3	Inter-face		CH	**Silty CLAY:** As above but red brown mottled blue grey and orange brown		M	H				
			1.6	Residual Neranleigh Fernvale		CH	**Silty CLAY:** Very stiff, high plasticity, light grey streaked orange brown, moist		M	VSt		1.8 –	PP	310kPa
			2.0									2.2 –	PP	340kPa
			3.0 3				**3.00m: BOREHOLE TERMINATED**							
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH9

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551399.00
Northing: 6877534.00
RL:
Total Depth: 3.50
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger	SWL		0.0			CH	**Silty CLAY:** Stiff, high plasticity, grey mottled red brown and orange brown, moist		M	St		0.4	PP	150kPa
												0.5	D	
			0.6			CH	**Sandy CLAY:** Stiff, high plasticity, grey, fine to medium with some coarse grained sand, trace of fine gravel, moist		M	St				
			1.0											
												1.2	D	
			1.3			CH	**Silty CLAY:** Stiff, high plasticity, grey, trace of fine grained sand, moist		M	St				
			2.0											
			2.1			CH	**Silty CLAY:** As above but soft to firm, wet, and brown mottled grey, some fine grained sand, some fine gravel		M	S-F				
												2.3	D	
												2.5	PP	50kPa
			2.7			CH	**Silty CLAY:** As above but firm, and moist to wet		M-W	F				
			3.0									2.9	PP	75kPa
			3.4				**Silty CLAY:** As above but with basalt boulders							
			3.5			CH			M-W	F				
							3.50m: BOREHOLE TERMINATED AT MAX. TC BIT REFUSAL ON BASALT BOULDER							
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH10

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551317.00
Northing: 6877600.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.25			CH	**Silty CLAY:** Very stiff, high plasticity, red brown with some orange brown mottling, moist		M	VSt				
			1.0 (1)			CH	**Silty CLAY:** As above but grey mottled red brown		M	VSt		0.4 – 0.5	D, PP	300kPa
			2.0			CH	**Sandy CLAY:** Soft, high plasticity, grey mottled orange brown, fine to medium grained sand, fine to medium gravel, wet		W	S		1.2 1.5	D PP	40kPa
			2.4			CH	**Silty CLAY:** Firm to stiff, high plasticity, dark grey, moist to wet		M-W	F-St		2.5 2.8	D PP	80-100kPa
			3.0 (3)				**3.00m: BOREHOLE TERMINATED**							
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH11

Page: 1 of 1

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551270.00
Northing: 6887546.00
RL:
Total Depth: 4.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1	Topsoil		CI	**Silty CLAY:** Hard, medium plasticity, red brown, some root matter, moist		M	H				
						CH	**Silty CLAY:** As above but high plasticity, no root matter, red brown with some orange brown lensing, trace of fine gravel		M	H		0.4	PP	>600kPa
			1.0	Slopewash										
			1.3			CH	**Silty CLAY:** As above but red brown mottled orange brown		M	H		1.5	PP	>600kPa
			2.0											
			2.3			CH	**Silty CLAY:** As above but with some basalt boulders		M	H				
			2.7	Deco Basalt		CH	**Silty CLAY:** As above but orange brown mottled red brown and grey		M	H				
			3.0											
			3	Neranleigh Fernvale		CH	**Silty CLAY:** Hard, high plasticity, light grey mottled orange brown, moist		M	H				
			3.4	Bedrock		ARG	**ARGILLITE:** Extremely weathered, very low strength, light grey mottled orange brown	XW		VLS				
			4.0				**4.00m: BOREHOLE TERMINATED**							

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH12

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551104.00
Northing: 6877603.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 11/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1	Topsoil		CI	**Silty CLAY:** Hard, medium to high plasticity, red brown with some grey, some root matter, moist		M	H				
						CH			M	H				
				Residual			**Silty CLAY:** As above but high plasticity, red brown and no root matter					0.3	PP	>600kPa
			0.6			CH	**Silty CLAY:** As above but red brown mottled orange brown		M	H				
			1.0									1	PP	>600kPa
			1.1	Neranleigh Fernvale		CH	**Silty CLAY:** As above but orange brown mottled grey, with some fine grained sand		M	H				
			1.3			CH	**Silty CLAY:** As above but grey, no sand, and slickensided		M	H		1.4	PP	500kPa
			1.8			CH	**Silty CLAY:** As above but orange brown mottled grey		M	H				
			2.0											
			2.2			CH	**Silty CLAY:** As above but light grey mottled orange brown		M	H				
			2.9				**Silty CLAY:** As above but with some extremely weathered argillite layering							
			3.0			CH			M	H				
			3				**3.00m: BOREHOLE TERMINATED**							
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH13

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551063.00
Northing: 6877731.00
RL:
Total Depth: 2.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 11/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1			SC	**Clayey SAND:** Medium dense, fine to medium grained sand, brown, low plasticity fines, moist		M	MD				
						SC	**Clayey SAND:** As above but orange brown mottled brown		M	MD				
			0.4			SC	**Clayey SAND:** As above but light orange brown mottled light grey		M	MD				
			0.7	Bedrock		SST	**SANDSTONE:** Extremely weathered, very low strength, light orange brown mottled, light grey	XW		VLS				
			1.0											
			1.2			ARG	**ARGILLITE:** Extremely weathered, very low strength, light orange brown mottled, light grey	XW		VLS				
			2.0 2				**2.00m: BOREHOLE TERMINATED**							
			3.0											
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH14

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551103.00
Northing: 6877372.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 11/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1			CI	**Silty CLAY:** Hard, medium plasticity, red brown mottled brown, some root matter, moist		M	H				
						CH	**Silty CLAY:** As above but high plasticity, red brown and no root matter		M	H		0.4 –	PP	>600kPa
			0.7			CH	**Silty CLAY:** As above but red brown with some grey mottling		M	H				
			1.0 1			CH	**Silty CLAY:** As above but red brown and no grey mottling		M	H				
			1.4			CH	**Silty CLAY:** As above but red brown with some orange brown mottling		M	H		1.5 –	PP	>600kPa
			2.0											
			2.2			CH	**Silty CLAY:** As above but red brown with some orange brown and grey mottling		M	H				
			3.0 3				**3.00m: BOREHOLE TERMINATED**							
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH15

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551414.00
Northing: 6877336.00
RL:
Total Depth: 6.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.75			CH	**Silty CLAY:** Hard, high plasticity, red brown, trace of fine to medium gravel, moist		M	H		0.3 –	PP	>600kPa
			1.0			CH	**Silty CLAY:** As above but lenses of light grey deco basalt lensing		M	H				
			2.0											
			2.6	Deco Basalt		CH	**Silty CLAY:** As above but firm, moist to wet, and lenses of blue grey sandy clay		M	F				
			3.0											
			4.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH15

Job Number: GE10/001
Client: Metricon Pty Ltd
Project: Broadscale Geotechnical Investigation
Location: Altitude 1, Fraser Drive, Tweed Heads

Easting: 551414.00
Northing: 6877336.00
RL:
Total Depth: 6.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: L. Bexley
Date: 15/01/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			5.0 5	Deco Basalt		CH	**Silty CLAY:** As above but firm, moist to wet, and lenses of blue grey sandy clay		M	F				
			6.0 6			CH	**Silty CLAY:** As above but with extremely weathered deco basalt boulders throughout		M	F				
			7.0				**6.00m: BOREHOLE TERMINATED**							
			8.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

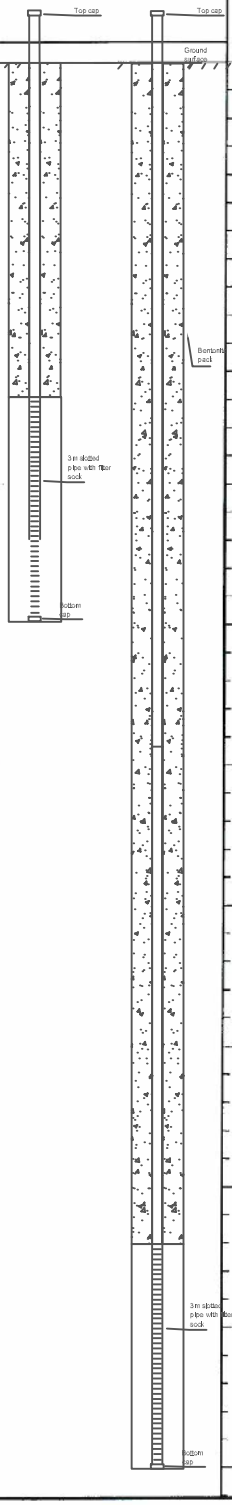
8) Appendix 2 – Gilbert & Sutherland borehole logs

Borehole: MB1
Project: GJ0901
Client: Metricon Developments
Northing: 3877251
Easting: 551308
RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 25.00
Logged by: JT
Drilled by: Altitude 1
Start date:
Completion date:

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)
				HEAVY CLAY , Very stiff, high plasticity, orange/brown, trace of fine to coarse sand, moist
				HEAVY CLAY, Very stiff, high plasticity, orange/brown mottled grey/brown, fine to coarse sand, fine to medium cobbles, moist
				HEAVY CLAY , Hard, high plasticity, brown/orange, trace of fine to coarse sand, moist
				HEAVY CLAY , Hard, high plasticity, grey mottled orange/brown, moist , Start of washbore
				HEAVY CLAY , Hard, high plasticity, grey mottled orange/brown, moist
				HEAVY CLAY , Hard, high plasticity, pink/grey mottled grey
5				SANDY CLAY , Hard, high plasticity, grey mottled orange/brown, fine to coarse sand
				SANDY CLAY , Hard, high to medium plasticity, grey mottled orange/brown, fine to coarse sand (loosing water)
10				EXTREMELY WEATHERED BASALT , Extremely weathered, very weak, light grey mottled orange/brown. Add rock-roller. , Add 2x3m casing = 9.0m
15				DISTINCTLY WEATHERED BASALT , Distinctly weathered, very weak, light grey mottled orange/brown.
20				
25				, Bore terminated.



Borehole: MB2

Project: GJ0901

Client: Metricon Developments

Northing: _____

Easting: _____

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 25.00

Logged by: JT

Drilled by: Altitude 1

Start date:

Completion date:

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)
				HEAVY CLAY , Stiff, high plasticity, organge/brown mottles, grey/brown, trace of fine to coarse sand, moist
				SANDY CLAY , Soft, high plasticity, grey, fine to coarse sand, wet
				GRAVEL , wet
				HEAVY CLAY , Stiff, high plasticity, orange/brown mottled grey/brown with fine to coarse sand, moist
				HEAVY CLAY , Very stiff, high plasticity, orange/brown mottled grey/brown with fine to coarse sand, moist
				, Start of wash bore (casing)
				HEAVY CLAY , Very stiff, high plasticity, orange/brown mottled grey/brown with fine to coarse sand, moist
5				HEAVY CLAY , Hard, high plasticity, orange/brown mottled grey/brown with fine to coarse sand, moist
				HEAVY CLAY , Clay/sandstone, Firm, high plasticity, light grey, trace of fine to medium sand, moist
				SAND , Medium/dense, fine to coarse sand, light grey, trace of high plasticity clay lumps, wet
				SANDY CLAY , Firm, high plasticity, orange/grey mottled light grey, rock roller from 9.0m
10				
15				
				DISTINCTLY WEATHERED BASALT , Distinctly weathered, weak, light grey mottled orange, trace of quartz
20				
25				, Bore terminated