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Report on
Preliminary Geotechnical Assessment

Section 75W Modification to Sandon Point Concept Plan
Lots 2 & 3 DP1176767 Geraghty Street, Bulli

Prepared for
Anglicare

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

	Signature	Date
Author	Alkis Castrissios	17.7.2018
Reviewer	For G W McIntosh	17.7.2018

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Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
1/1 Luso Drive
Unanderra NSW 2526
PO Box 486
Unanderra NSW 2526
Phone (02) 4271 1836
Fax (02) 4271 1897

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1. Introduction

This report presents the results of a preliminary geotechnical assessment undertaken for a proposed residential (Ocean View and Hill Top Precinct) and seniors living development (South Precinct) within Lots 2 and 3 in DP 1176767 Geraghty Street (previously known as Sturdee Avenue) at Bulli. The work was commissioned by Anglicare, the developer and undertaken in liaison with EPM Projects Pty Ltd, project managers and planners for the development.

This report has been written in support of a proposed Section 75W modification to the approved Sandon Point ARV Concept Plan (MP06_0094). The Sandon Point Concept Plan was approved by the Minister for Planning on 21st December 2006 for land at Sandon Point comprising a residential subdivision (for Stockland) and retirement development (for Anglicare). Stockland has modified the Concept Plan on four separate occasions and development on those lands is now substantially complete. To date no development has occurred on the Anglicare (ARV) lands.

The approved Concept Plan allows for the following development of the Anglicare lands:

- A residential aged care facility up to four storeys containing up to 120 beds;
- A mix of apartment buildings of up to 3 storeys containing up to 250 independent living units;
- Community facilities and services to support residents of the retirement village;
- Access and car parking;
- Landscaping including rehabilitation of riparian corridors and forest; and
- Stormwater management and utility services.

The proposed modification application retains the above land uses within the Central Precinct. It also proposes the introduction of standard medium density residential accommodation in the Hill Top and Ocean View Precincts. The proposal also seeks to modify the road layout approved on the site. No change is proposed to the land use zoning (developable area), height or floorspace ratio controls. The forest and riparian rehabilitation and protection measures also remain generally the same.

Geotechnical assessment was therefore undertaken to prepare a geotechnical report for submission with an application for a Section 75W modification of the Concept Plan Approval, and to provide preliminary information on likely subsurface conditions for conceptual planning of site preparation, retaining structures, foundations and pavements.

The assessment comprised a site inspection by a Principal Geotechnical Engineer followed by a review of existing geotechnical information, engineering analysis and reporting. Details of the previous field work undertaken by Douglas Partners Pty Ltd (DP) and the results obtained are given in the report together with comments relating to design and construction practice.

Concept layout drawings were provided by the client for the investigation. A site survey plan was sourced from the previous DP investigation.

2. Background

Several geotechnical and environmental investigations have been undertaken by DP and others since 2003 including:

- Stage II Environmental Site Assessment, Southern Portion of Lot 2 DP 224431 (now Lot 2 DP 1176767) Sturdee Avenue (now Geraghty Street), Bulli, NSW (Project Ref: S4037204_RPTDraft_29June06.doc) prepared by HLA-Envirosciences Pty Ltd. The assessment reported on previous investigations undertaken in 2005 and included excavation of test pits and drilling of boreholes.
- South Precinct: DP Geotechnical investigation including test pit excavations and cone penetration testing followed by laboratory testing of selected samples. The results of the field work and laboratory testing were forwarded in facsimile transmissions dated 10 & 21 July 2006. Following the completion of the field work and laboratory testing, the project was suspended and formal reporting was not undertaken.
- Ocean View precinct: Geotechnical investigation including test pit excavation and borehole drilling followed by laboratory testing of selected samples, engineering analysis and reporting. Details of the work undertaken and the results obtained were given in a report (Project 40618.01) dated 27 February 2008).

It is noted the DP has not undertaken any subsurface investigations in the proposed Hill Top Precinct. Notwithstanding this, conditions are expected to be similar to those encountered in the Ocean View Precinct.

The test pit and borehole logs from the above investigations are given in Appendix B. The approximate test locations are shown on Drawing 1 also in Appendix B.

3. Site Description and Regional Geology

The site, which is known as Lots 2 and 3 in DP 1176767 is a trapezoidal area of approximately 8.1 ha with maximum north-south and east-west dimensions of 290 m and 340 m respectively. It is bounded to the north by McCauleys Beach Estate, to the east and south by undeveloped land which includes the alignment of Tramway Creek, and to the west by the South Coast Rail line.

Surface levels typically fall at grades of 1 in 4 to 1 in 10 towards the west-to-east trending alignment of Cooksons Creek in about the centre of the site. The overall difference in level is about 20 m from the highest part of the site to the lowest. The southern section of the site (ie between Cooksons Creek and Tramway Creek) comprises a near-level terrace that has been formed by the placement of filling to estimated depths of 2 – 5 m.

At the time of the current inspection, the site was vacant. The northern section was heavily vegetated with the exception of a disused building in the north-western corner of the site. A disused quarry was located in the northern section of the site and included spoil stockpiles within the excavation. The southern section comprised the remains of a previous heavy industrial development.

Features observed during the recent inspection are shown on the colour photoplates in Appendix C.

Reference to the 1:50 000 Wollongong Geological Series Sheet (Ref 1) indicates that the site is underlain by interbedded quartz lithic sandstone, mudrock, carbonaceous mudrock, andesitic sandstone, coal and laminites belonging to the Illawarra Coal Measures of Permian age, with the lower slopes mantled by Quaternary alluvium (sand, silt, clay). The previous DP investigations confirmed the geological mapping with sandstone, siltstone and laminite encountered in those pits and boreholes that intersected rock.

4. Field Work Methods

4.1 Current

The 2018 assessment included a site inspection by a Principal Geotechnical Engineer on 26 June 2018 to view current site conditions and compare them to those reported in DP 2006 and 2008 investigations. Conditions observed during the inspection are shown on the colour photoplates given in Appendix C.

4.2 DP 2006 (South Precinct)

The field work for the DP 2006 investigation comprised the excavation of six test pits (Pits 401 – 406) to depths of 2.9 – 3.1 m and six cone penetration tests (CPT 407 – 412) to depths of 11.6 – 15.9 m.

The pits were excavated with a Cat 428C backhoe fitted with a 600 mm wide bucket and were logged on site by a geotechnical engineer. Disturbed and 'undisturbed' samples (in 50 mm diameter thin-walled tubes) were taken at regular depth intervals to assist in strata identification and for laboratory testing. Dynamic cone penetrometer tests (DCP, AS1289 6.3.2) were carried out adjacent to the test pits to assess the penetration resistance to the upper 0.4 – 1.2 m of the subsurface profile.

In the CPT, a 35 mm diameter cone tipped instrumented probe is pushed into the ground by hydraulic thrust from a ballasted truck mounted test rig. Strain gauges in the tip of the cone and the 130 mm long friction sleeve mounted behind the cone measure the resistance to penetration. These measurements are electronically recorded at 20 mm intervals. The results are interpreted to provide information on the subsurface conditions and properties. Notes describing the method of operation and interpretation of CPT results are included in Appendix A.

4.3 DP 2008 (Ocean View Precinct)

The field work for the DP 2008 investigation comprised field mapping by a senior geotechnical engineer, drilling of five boreholes (Bores 1 – 5) to depths of 6.0 – 14.3 m and excavation of ten test pits (Pits 6 – 16) to depths of 1.5 – 3.0 m.

The boreholes were drilled with a Bobcat-mounted soil sampling and drilling rig using continuous solid flight augers and rotary (washboring) techniques in the overburden soils to casing refusal at depths of 1.2 – 11.0 m. Bores 2, 3 and 5 were continued below casing refusal depths using NMLC (50 mm diameter) diamond core drilling equipment to the termination depths of 6.0 – 14.3 m. Bores 1 and 4 were terminated at either casing refusal or 'TC-bit' refusal at depths of 10.4 m and 6.0 m respectively.

Standard penetration tests (SPT) and "undisturbed" soil sampling (in 50 mm diameter thin-walled tubes) were undertaken at regular intervals in the overburden soils to obtain samples, to give an indication of the strength properties of the subsurface strata and for possible laboratory testing. Details of the test procedure are given in the notes in Appendix A, with the penetration 'N' values obtained shown on the borehole logs.

At the completion of the drilling, standpipe piezometers were installed in Bores 1 and 5 to facilitate long term monitoring of groundwater levels.

The test pits were excavated with a Yanmar Vi040 excavator fitted with a 450 mm wide bucket. The pits were logged by an engineering geologist who collected representative disturbed and "undisturbed" samples (in 50 mm diameter thin-walled tubes) to assist in strata identification and for laboratory testing. Dynamic cone penetrometer tests (AS 1289.6.3.2) were carried out adjacent to the test pit locations to assess the consistency of the overburden soils.

5. Field Work Results

5.1 Site Inspection

Inspection of the site by a Principal Geotechnical Engineer on 26 June 2018 indicated the following:

- Structures and pavements associated with the (now decommissioned) industrial plant in variable (but generally poor) condition (refer Photos 1 – 7, 9, 10, 12);
- The presence of filling to create a near-level terrace in the southern (ie developed) section of the site (refer Photos 8 and 11);
- Evidence of previous investigations such as damaged standpipe piezometers (refer Photo 9);
- The likelihood of filling placed to re-contour the central section (ie Cooksons Creek) between the Ocean View/Hill Top and South Precincts (refer Photos 13, 15 and 16);
- the presence of a former quarry some 1200 m^2 in plan area in the proposed Ocean View Precinct (refer Photo 17), with some spoil stockpiles within the base of the excavation (refer Photo 18). Bench heights are of the order of 2 m exposing residual clays and weathered sandstone;
- The northern section of the site is heavily vegetated (refer Photo 19);
- The presence of dilapidated structures in the north-western section of the site (refer Photos 20 and 21);
- Cut batters along Geraghty Street (ie adjacent to the proposed Hill Top Precinct) exposing residual soils and sandstone bedrock (refer Photos 23 and 24);
- Uncontrolled filling within the proposed Hill Top Precinct (refer Photos 25 and 26);
- With the exception of ongoing deterioration of existing structures and vegetation regrowth, surface conditions are virtually unchanged from those observed at the time of the DP 2006 and 2008 investigation.

5.2 DP 2006 (South Precinct)

Details of the subsurface conditions encountered in the DP 2006 investigation are given on the test pit logs and cone penetration test report sheets given in Appendix B. These should be read in conjunction with the notes defining classification methods and descriptive terms.

Relatively uniform conditions were encountered underlying the southern section of the site (consistent with the previous HLA 2006 investigation), with the succession of strata broadly summarised as follows:

FILLING:	of variable consistency and composition to depths of 0.5 – 4.5 m in Pits 401 – 403 and 406 and inferred from CPTs 407 – 412. Pits 404 and 405 were terminated within the filling at depths of 3.1 m and 3.0 m respectively. The filling comprised a variable matrix of slag, gravel, coalwash. Refuse (plastic, rubber, pipes, timber) were encountered in Pits 403 and 404. A strong hydrocarbon odour was also noted within Pit 403. The depth of filling increases in the easterly direction.
CLAY:	generally stiff to very stiff clay and silty clay to the termination depths of 2.9 – 3.0 m in Pits 401 – 403 and 406. Similar conditions were inferred underlying the filling in the CPTs to the termination depths of 13.0 – 15.9 m (within extremely weathered rock).

Slightly different conditions were inferred from CPTs 408 and 412 with a loose sand layer encountered at depths of 7.9 – 10.6 m and 6.7 – 9.5 m respectively. Furthermore, soft to firm clay was inferred from CPTs 409 and 410 at depths of 12.0 – 13.0 m and 11.1 – 11.8 m respectively.

Reference to the HLA 2006 report indicates the presence of soft clays underlying the filling in 11 of the 32 bores and 7 of the 17 test pits.

No free groundwater was observed in the test pits for the short time that they were left open. It is noted however, that the pits were immediately backfilled following excavation which precluded long term monitoring of groundwater levels. Free groundwater was encountered at depths of 2.9 – 4.6 m following removal of the cone rods. It is noted that due to the small diameter of the cone holes, groundwater data should be used with extreme caution. The existing standpipes installed by HLA were also dipped. The groundwater observations made during the field work are summarised in Table 1 and show a general dip in the easterly direction (consistent with the HLA report).

Table 1: Groundwater Observations

Location	Surface RL (m)	Groundwater Level (3/7/06)	
		Depth (m)	RL (m)
MW01	12.8	1.6	11.2
MW02	11.9	4.2	7.7
MW03	11.6	5.1	6.5
Bore 4	11.6	1.5	10.1
Bore 21	11.5	3.8	7.7
CPT 407	12.8	2.9	9.9
CPT 408	11.3	3.4	7.9
CPT 409	11.2	4.6	6.5
CPT 410	11.5	4.0	7.5
CPT 411	11.7	NE	-
CPT 412	12.1	4.6	7.5

NE = not encountered due to cone hole collapse.

5.3 DP 2008 (Ocean View Precinct)

Details of the conditions encountered in the DP 2008 investigation are given in the borehole and test pit logs in Appendix B. These should be read in conjunction with the notes defining classification methods and descriptive terms.

The field investigation encountered relatively uniform conditions underlying the north-eastern section of site, with the broad succession of strata broadly summarised as follows:

TOPSOIL:	to depths of 0.2 – 0.4 m (where encountered);
CLAY:	initially firm to stiff (but generally stiff) becoming stiff to very stiff below depths of 0.6 – 2.0 m in Bores 1 – 5 and to depths of 1.9 – 2.2 m in Pits 13, 14 and 16. Pits 6 – 12 were terminated within clay to depths of 2.5 – 3.0 m;
BEDROCK:	initially extremely low to very low strength becoming at least low strength at refusal of the 'TC-bit', bore casing and backhoe bucket at depths of 1.2 – 11.1 m in Bores 1 – 5 and Pits 13, 14 and 16. Core drilling in Bores 2, 3 and 5 recovered variably very low to high strength sandstone, siltstone and laminite to the termination depths of 6.0 – 14.3 m.

Table 2 summarises the depths/levels at which the various grades of rock were intersected.

Table 2: Rock Depths/Level

Pit/Bore	Surface level (m, AHD)	Top of ELS rock		Top of VL – LS rock		Top of M – HS rock	
		Depth (m)	RL (m)	Depth (m)	RL (m)	Depth (m)	RL (m)
1	9.1	NE	-	NE	-	NE	-
2	9.9	10.5	- 0.6	11.6	- 1.7	12.9	- 3.0
3	15.7	1.9	13.8	6.7	9.0	NE	-
4	18.4	1.9	16.5	6.0 (1)	12.4	NE	-
5	26.2	0.5	25.2	NE	-	1.2(1)	25.0
6	10.5	NE	-	NE	-	NE	-
7	8.7	NE	-	NE	-	NE	-
8	8.0	NE	-	NE	-	NE	-
9	9.7	NE	-	NE	-	NE	-
10	11.5	NE	-	NE	-	NE	-
11	11.2	2.2	9.0	NE	-	NE	-
12	16.2	NE	-	NE	-	NE	-
13	13.6	2.5	11.1	NE	-	NE	-
14	17.6	2.2	15.4	NE	-	NE	-
15	26.6	0.2	26.4	NE	-	1.4	25.2
16	27.8	1.9	25.9	NE	-	NE	-

Where: ELS = Extremely low strength VL – LS = Very low to low strength
M – H = Medium to high strength

Note: (1) Variably extremely low to medium strength below 2.5 m

Minor seepage was noted at the topsoil/clay interface (as a result of inclement weather preceding the investigation) in Pits 6, 7, 9 and 11. Seepage was also noted at depths of 2.0 – 3.0 m in Pits 6, 8 and 11.

No free groundwater was observed in the remaining pits during excavation or whilst auger drilling in the boreholes. It is noted however that the pits and boreholes were backfilled immediately at the completion of the field work, which precluded longer term monitoring of groundwater levels. The use of water whilst rotary drilling precluded groundwater observations.

Monitoring of the standpipe piezometer on 23 January 2008 indicated a standing water table in Bore 1 at 4.6 m depth (RL 4.5). The standpipe within Bore 5 was dry.

6. Laboratory Testing

Selected samples from the test pits and boreholes were tested in the DP laboratory for measurement of field moisture content, Atterberg limits, linear shrinkage, Shrink-swell Index, compaction properties and California bearing ratio. The detailed laboratory test report sheets are given in Appendix D, with the results summarised in Table 3.

Table 3: Results of Laboratory Testing (Mechanical)

Pit	Depth (m)	W_F (%)	W_P (%)	W_L (%)	PI (%)	LS (%)	Iss (%ΔpF)	CBR (%)	Material
7	0.5 – 0.9	39.8					5.6		Clay
9	1.0	36.5	32	82	50	11.5			Clay
13	1.5	27.1	24	75	51	15.5			Clay
14	0.5	28.5	22	83	61	11.0			Clay
16	0.5 – 0.85	21.8					1.2		Sandy Clay
402	0.7 – 0.8	15.5						6	Silty Clay
403	0.5 – 0.6	16.8	16	53	37	11.0			Silty Clay
405	1.2 – 1.3	12.2	19	32	13	5.0			Sandy Clay

Where: W_F = Field Moisture Content, W_P = Plastic limit, W_L = Liquid limit, PI = Plasticity Index, LS = Linear Shrinkage, I_{ss} = Shrink-swell Index

The results indicate that, the clays tested are of variable plasticity and as such, would be susceptible to shrinkage and swelling movements with changes in soil moisture content.

Selected samples were also despatched to a third party NATA-accredited laboratory for measurement of pH, chloride and sulfate concentrations. The details test report sheets are given in Appendix D, with the results summarised in Table 4 (following page).

Reference to AS 1259 – 2009 (Ref 2) indicates that the soils tested are “mildly to moderately” aggressive to concrete and “non-aggressive” to steel.

Table 4: Results of Laboratory Testing (Aggressivity)

Bore No	Depth (m)	pH	Cl^- (mg/kg)	SO_4^{2-} (mg/kg)	Material
1	4.5	4.4	<100	92	Clay
2	2.5	4.7	370	210	Clay
3	1.0	4.4	120	75	Clay
5	1.0	5.3	<100	<25	Weathered sandstone
401	1.0	4.4	<100	87	Silty Clay
405	1.2 – 1.3	8.1	<100	160	Filling

Where: EC = Electrical Conductivity
Cl^- = Chloride Concentration
SO_4^{2-} = Sulfate Concentration

Selected samples of the rock core were tested in the laboratory for measurement of point load strength index (Is[50]). The results are given on the borehole logs and indicate equivalent unconfined compressive strengths (UCS) in the range 2 – 64 MPa, reflecting very low up to high strength. The UCS values have been determined using a UCS:Is[50] correlation factor of 20.

7. Proposed Development

It is understood that an application for modification to the Concept Plan Approval is to be submitted for the following:

- creation of conventional residential allotments within the north-western and north-eastern sections of the site known as the Hill Top and Ocean View Precinct;
- construction of a seniors living development in the southern section of the site known as the South Precinct;
- construction of a traffic and pedestrian bridge across Tramway Creek to the south-west of the site.

The proposed layout is shown on Drawing 1 in Appendix B.

As the project is in the conceptual planning phase, detailed design information is not yet available. At this stage, it is understood that:

- excavation and filling to depths of up to 3 m will be required in the Ocean View and Hill Top Precincts to create a series of near-level terraces for the construction of townhouses;
- the seniors living development will likely comprise a number of three storey unit buildings over a common semi-basement car park. Excavation to depths of 0.5 – 2.0 m (with the depth increasing in the westerly direction) will be required to achieve a basement at RL 10.6.

8. Comments

8.1 General

The following comments are based on the results of previous investigations. An additional investigation will be required as the planning and development proceeds, in particular within the Hill Top Precinct where DP has not previously undertaken subsurface excavations. The following comments are provided as a guide and are preliminary only.

8.2 Site Classification

Due to the presence of deep filling (ie: excess of 0.4 m) in parts of the site, moderate slopes and the presence of a former quarry in the northern section of the site, the site would be classified as Class P in accordance with the requirements of AS 2870 – 2007 Residential Slabs and Footings (Ref 3).

It is noted however, that site classification is based on the undeveloped site and only serve to provide a classification with respect to reactivity. Furthermore, earthworks are proposed that will change the subsurface profiles and the standard footing details given in AS2870 (Ref 3) are not applicable to the proposed three and four storey structures. As such, structural design must be undertaken by a suitably qualified engineer using accepted engineering principles that take into account the site topography and subsurface conditions.

Notwithstanding the P classification and following site preparation in accordance with Section 8.4.1, the subsurface profiles underlying the Ocean View and Hill Top Precincts would likely be equivalent to Class M or Class H1 conditions, but subject to depth of filling, clay/fill plasticity and rock depth.

8.3 Seismic Considerations

Earthquake Hazard Maps published by the Australian Geological Survey Organisation are reproduced in AS 1170.4 – 2007 (Ref 4). The anticipated peak ground acceleration or acceleration coefficient for the Wollongong area is quoted as 0.9 m/sec^2 or 0.09 g. Furthermore, based on a comparison of the soil profile encountered during the field testing with those included in Reference 4, it is suggested that a Class C_e classification be adopted for design purposes.

8.4 Stability Assessment

The site has been assessed with reference to the Australian Geomechanics Society Landslide Taskforce *"Practice Note Guidelines for Landslide Risk Management"* (Ref 5). Based on the observations made during the inspection, assessment has been undertaken for two distinct zones:

- Area above RL 12 (Ocean View and Hill Top Precinct);
- Area below RL 12 (Ocean View and Hill Top Precinct) and South Precinct.

The results of this qualitative assessment for each of these areas are outlined in Tables 5 and 6, assuming consideration is taken of the comments provided within this report.

Table 5: Slope Stability Assessment (Area Above RL 12)

Hazard	Likelihood	Consequence to Proposed Development	Risk to Proposed Development
Creep of surface soils	Possible	Minor	Moderate
Active / deep-seated slide	Rare	Major	Low

Table 6: Slope Stability Assessment (Area Below RL 12 and South Precinct)

Hazard	Likelihood	Consequence to Proposed Development	Risk to Proposed Development
Creep of surface soils	Not credible	Minor	Very Low
Active / deep-seated slide	Not credible	Major	Very Low

In summary, it is considered that the northern (elevated) section of the site has a *low to moderate* risk of damage to property occurring as a result of slope instability due to the moderate ground slopes. The area of slight topographical relief is classified as *very low* risk. Notwithstanding the various risk categories nominated, development of the site is considered geotechnically feasible, with design and construction appropriate for hillside development required to maintain or reduce the risk classification in the steeper sections.

8.5 Excavation Conditions

Excavation of filling, topsoil, clay and extremely weathered rock will be readily achievable with conventional construction plant. Removal of very low or greater strength rock (which would be expected below depths of 2 – 3 m in the northern section of the Ocean View Precinct (in the vicinity of Bore 5 and Pits 15 and 16) and Hill Top Precinct will require light to moderate ripping, possibly with percussion assistance.

Previous DP investigation in the Ocean View Precinct has generally indicated groundwater levels below anticipated excavation levels. However, minor seepage was noted at the topsoil/clay interface (as a result of inclement weather preceding the investigation) in Pits 6, 7, 9 and 11. Seepage was also noted at depths of 2.0 – 3.0 m in Pits 6, 8 and 11.

The results of previous investigations have indicated the presence of a standing water table in the South Precinct at around RL 6.5 – 11.2 AHD (ie 4 m below to 0.6 m above the proposed basement level).

8.6 Site Preparation and Earthworks

8.6.1 Ocean View and Hill Top Precinct

Site preparation for the construction of residential structures should include the removal of topsoils and other deleterious materials from the proposed building areas. All work undertaken in the *low to moderate* risk zone must be undertaken in accordance with conventional practice for earthworks on hillside sites. Allowance will need to be made for the benching of all stripped areas to facilitate near-horizontal fill placement, temporary slopes to be formed no steeper than 1:1 (horizontal:vertical), with final slopes to be formed no steeper than 3:1 (H:V) and vegetated to reduce the effects of erosion. Batters steeper than 3:1 are to be retained by engineer-designed retaining walls founded in the underlying bedrock.

In areas that require filling, the stripped surfaces should be test rolled in the presence of a geotechnical engineer. Any areas exhibiting significant deflections under test rolling should be appropriately treated by over-excavation and replacement of unsuitable material with low plasticity filling placed in near-horizontal layers no thicker than 250 mm compacted thickness. Each layer should be compacted to a minimum dry density ratio of 98% relative to standard compaction, with placement moisture contents maintained within 2% of standard optimum.

Filling should not contain vegetation or other organic matter. Sufficient field inspections and in-situ testing of future earthworks should be undertaken in order to satisfy the requirements of a Level 1 inspection and testing service as defined in AS 3798 – 2007 (Ref 6).

Earthworks required for pavement construction will need to be based on batters formed no steeper than 3:1 (H:V) in the residual clays and 1.5:1 (H:V) in weathered rock. All batters should be suitably protected against erosion, with toe and spoon drains constructed as a means of controlling surface flows on the batters.

Site observations have indicated the presence of silty topsoils and clays that would be adversely affected by inclement weather. Whilst the soils are typically stiff when dry, they can lose strength rapidly during rainfall resulting in difficult trafficability. As such, surface drainage which directs runoff away from work areas should be installed prior to construction, possibly in conjunction with the designation of construction equipment haul routes to minimise trafficking of stripped areas.

Care should be taken to avoid drying out of natural clays or engineered filling during construction. A protective layer or membrane should be used in conjunction with regular site watering, if appropriate.

Conventional sediment and erosion control measures should be implemented during the construction phase with exposed surfaces to be topsoiled and vegetated as soon as practicable following the completion of earthworks.

8.6.2 South Precinct

The principal feature is the presence of deep uncontrolled filling (up to depths of 3 m, but possibly deeper in parts) overlying weak soils. As a deep footing system (ie piles) will be required to support multi-level structures, remedial earthworks could be limited to provide “an earth raft” for a working platform and subgrade support (ie form-fill).

Site preparation should include excavation to the underlying stiff clays or 1 m below subgrade level (whichever occurs first), followed by placement and compaction of filling to a minimum dry density ratio of 98% relative to standard compaction, with moisture contents maintained within 2% of standard optimum. The upper 0.5 in pavement areas is to be compacted to at least 100% dry density ratio relative to standard compaction. It is noted however, that due to the presence of wet zones within the filling, further excavation and replacement with granular material may be required in order to achieve ’bridging’ over the weak soils.

Site preparation works will need to be undertaken under Level 1 control (ie: full time geotechnical presence) as defined in AS3798 (Ref 6).

Based on the results of the investigation to date, care will need to be undertaken during excavation to selectively stockpile materials, as there will be the potential to re-use some of the existing filling. Highly organic, contaminated material (as determined by the environmental consultant) or other deleterious materials (such as refuse, timber etc) will not be suitable for re-use as structural filling.

8.7 Disposal of Excavated Materials

It should be noted that the Protection of the Environment Operation Act (1997), requires all material taken to a landfill or fill site to meet designated environmental criteria for proposed land use. Accordingly, environmental testing will need to be carried out to classify the spoil, which was outside the scope of the current work. The type and extent of testing undertaken will depend on final use or destination of the spoil and requirements of the receiving site. It should be noted that some non-licensed fill sites, such as those operated by Councils or other bodies may have their own special environmental criteria to be met before receiving any materials.

8.8 Excavation Support – General

The filling, clays and extremely weathered rock that will be exposed in cut will not be able to stand vertically without support over both the short and long term.

As adequate space exists, it will be practicable to batter the sides of any excavation and in this regard, it is suggested to allow for temporary side slopes of 45⌠. Temporary batter slopes will probability need to be flatter than the uncontrolled filling, but subject to geotechnical inspection Permanent batters should be no steeper than 3:1 (horizontal:vertical) in stiff clays and 1.5:1 (H:V) in weathered rock. Where temporary battering is not feasible or vertical permanent slopes are proposed, engineered-designed retaining walls will be required for permanent support. Suitable methods of support of filling, clay and bedrock by retaining wall construction would include block work walls, reinforced earth walls, concrete crib walls or anchored soldier piles with close shuttering or spray concrete infilled panels.

8.9 Excavation Support – South Basement

In addition to the comments in Section 8.8, the results of previous investigation have indicated the presence of a standing water table in the South Precinct at around RL 6.5 – 11.2 AHD (ie 4 m below to 0.6 m above the proposed basement level). Based on the clayey subsurface profiles it is considered that inflows during bulk excavation should be controllable by pumping from suitably located collector sumps, but in the long term, the requirement for drainage behind perimeter walling and underfloor drainage (with discharge via a permanent pump system or gravity drainage) will be required as part of the final design.

If a permanent pump-out system (apart from that used on a periodic basis to drain overland flows which enter the basement from the driveway) is not preferred by the client or not allowed by the consent or regulatory authority, then the allowance will need to be made for watertight retaining walls in conjunction with a 'tanked' basement. Based on information available from previous investigations, preliminary design could be based on an uplift pressure of 10 kPa (ie 1 m head above RL10.6). Notwithstanding this, as groundwater levels are transient and can fluctuate over time, installation and monitoring of standpipe piezometers is recommended during the design phase.

As the basement will be below surrounding ground levels, allowance will need to be made for draining any overland flows which enter the basement from the driveway via a pump-out system.

8.10 Retaining Structures

It is suggested that earth pressures on cantilever retaining walls due to the retained soils be based on a triangular pressure distribution calculated as follows:

$\exists_z = \uparrow.Ka.z$

where $\exists_z$ = horizontal pressure at depth z

$\uparrow$ = unit weight of retained soil
= 20 kN/m^3

Ka = active lateral earth pressure coefficient
= 0.3 for stiff clays and horizontal compacted filling
= 0.15 for very low to medium strength rock

Design must also make allowance for the ground slope behind any retaining structure (as the earth pressure coefficients given above are for horizontal backfill only). "At rest" earth pressure coefficients (K_o) of 0.6 and 0.25 in clay and very low to low strength rock respectively, are appropriate where support must be provided to structures and where movement-intolerant services are present within the zone of influence of the retaining walls.

8.11 Foundations

8.11.1 Ocean View and Hill Top Precincts

All footing systems for residential structures should be designed and constructed in accordance with AS 2780 – 2011 (Ref 3) for the appropriate classification. Subject to the nature of the proposed structures and the design loads, stiff residual clays, controlled filling and weathered rock will most likely be available for foundation support. Suitable footing systems could comprise strip and pad footings, raft slabs and pier and beam/pier and slab systems, dimensioned to the requirements of AS 2870 – 2011.

Allowable bearing pressures appropriate for the range of material types available for foundation support would be as follows:

- Controlled filling (for footing loads up to 200 kN) 100 – 150 kPa
- Stiff clay (for footing loads up to 200 kN) 150 kPa
- Extremely weathered rock (extremely low strength) 450 kPa
- Highly to slightly weathered rock (low strength) 1200 kPa

Where cut and fill benches are proposed for individual structures, localised deepening of footings will be necessary to ensure uniform bearing is achieved. Inspection of footing excavations must be undertaken by a geotechnical consultant to confirm the appropriateness of all bearing stratums for the nominated design bearing pressures. The selection of bearing stratum will be dependent on the type of structures, the proposed loads and the resultant settlements.

Where partial rock is exposed during site preparation and footing excavation (which is likely in the elevated sections above RL 12 approx), it is recommended that all footings found in a uniform stratum of weathered rock. The principal advantages of a footings-to-rock foundation system is that settlements (both total and differential) would be negligible.

Notwithstanding the above, in the absence of subsurface information and the likelihood of filling associated with regrading of Cooksons Creek, allowance should be made for deep footing systems (eg steel screw piles) for the proposed townhouses that will front Geraghty Street in the Hill Top Precinct.

8.11.2 South Precinct and Bridge

Consideration has initially been given to the use of high level footings, but their use is not recommended. For the likely range of loadings proposed (multi storey buildings and bridge) and the subsurface conditions encountered, settlements (both total and differential) would be well beyond tolerable limits for the structure. As such, a piled foundation will be necessary, with the piles transferring load to a suitable bearing stratum, such as the weathered bedrock. With such a system, settlements (both total and differential) would be minimal. Similarly, retaining walls should also be founded in a deep footing system which transfers loads below the filling and soft soils to at least the level of stiff to very stiff clay.

Preliminary parameters for use in 'limit state' pile design calculations are included in Table 7.

Table 7: Preliminary Pile Design Parameters

Strata Description		Ultimate Shaft Adhesion (kPa)		Ultimate End Bearing Pressure (MPa)	Young's Modulus, E (MPa)
		Compression	Tension		
Clay	Soft to firm	15	-	-	-
	Stiff to very stiff	40	20		-
	Very Stiff	60	30	-	-
Sand	Loose	20	10	-	-
Rock	Extremely low – very low strength	150	75	3	100

Where a "limit state" design approach using ultimate stresses is adopted for foundation design in accordance with the guidelines contained within AS 2159 – 2009 (Ref 3), the design geotechnical strength (Rg) should be calculated as the ultimate geotechnical strength (Rug) multiplied by a geotechnical strength reduction factor (ϕ_g) value of 0.45 for sandstone. For serviceability limit state, a modulus reduction factor (ϕ_m) value of 0.75 is considered appropriate.

It is noted that whilst ultimate shaft adhesion values for soils are given in Table 7 as a guide, these should be neglected for piles founding on rock as pile deflections would be insufficient to generate adhesion in soil.

Pile capacity should be verified by direct site measurement for piles driven to a predetermined set using either dynamic testing or dynamic formulae, such as the Hiley Formula. The capacity of piles driven to refusal on rock would be limited by the structural capacity of the pile unit.

Higher bearing pressures could possibly be achievable in the underlying rock but would be subject to supplementary investigation which includes core drilling to assess the strength and fracture characteristics.

Suitable pile types could comprise driven timber or concrete, auger grouted or Atlas/Omega piles. Uncased bored piles are not recommended due to the variability of the subsurface profile, the presence of variable filling and sand lenses that would be subject to collapse and a groundwater table being above founding depths. A description of suitable piling systems is given below:

Auger Grouted Piles: Auger grouted piles, also known as grout injected piles, are considered to be an appropriate pile system, provided installation is undertaken by an experienced contractor. It is noted that in order to achieve sockets into greater than low strength rock (ie below CPT refusal depths of 11.5 – 16.0 m) it would be necessary to employ a high torque boring rig for pile construction. It is suggested that these drilling difficulties be assessed by individual piling tenderers based on inspection of the core samples following the completion of further subsurface investigations.

Steel Screw Piles: The use of a screw-in-foundation (SIF) is also considered a feasible foundation system for this site. SIFs are a system of steel screw piles which consist of a conventional circular hollow steel section which acts as the screw pile shaft. A helical plate is welded to the shaft near the

top to form the bearing element. Available information indicates that unit pile capacities up to 500 kN are possible.

The full structural capacity of the piles would only be obtained when installed to the weathered rock (ie: at depths of the order of 12 – 16 m). SIFs are a proprietary product and hence advice should be sought from specialist contractors in regard to pile capacities, length and the ability to penetrate the very stiff to hard clays.

Driven Timber and Concrete Piles: Working load capacities for both concrete and timber piles driven to refusal within the underlying rock are given in Table 8 with pile founding depths likely to be of the order of 12 – 16 m below present surface levels. Timber piles, suitably protected from fungal decay, would not be expected to be affected by the site soils.

Table 8: Maximum Safe Load Capacities of Driven Piles

Pile Type	Size (mm)	Safe Load Capacity (kN)
Pre-cast concrete	270 (square)	800
Treated Hardwood (strength grade S2)	180 (toe diam) 230 (toe diam)	500 1000

If a driven pile system is proposed, advice from specialist contractors should be sought with regard to noise and vibration.

8.12 Ground Slabs

Based on the field evaluation, the results of laboratory testing and subgrade preparation in accordance with Section 8.6, floor slab design could be undertaken on a design subgrade CBR of 3%. Corresponding moduli or subgrade reaction would be 20 – 25 kPa/mm for wheel loads, reducing to 1 – 2 kPa/mm for uniformly distributed loads up to 15 kPa but dependent on the area of the floor subject to loading.

The above criteria depend on the provision of surface and subsurface drainage to maintain the subgrade close to the optimum content. The slabs should incorporate articulation and joint details which take account of the reactive subgrade. The ground slabs must be cast independently of the footings, particularly where piled footings are adopted.

8.13 Site Maintenance and Drainage

The developed site should be maintained in accordance with the CSIRO publication *"Guide to Home Owners on Foundation Maintenance and Footing Performance"*, a copy of which is included in Appendix E. Whilst it must be accepted that minor cracking in most structures is inevitable, the guide describes suggested site maintenance practices aimed at minimising foundation movement to keep cracking within acceptable limits.

Surface drainage should be installed and maintained at the site to minimise overland flows. All collected stormwater, groundwater and roof runoff should be discharged into the stormwater disposal system. Similarly, effluent should be discharged in a controlled manner into the sewerage system.

8.14 Pavements

Based on the results of field investigation and previous experience in the Bulli area, a design CBR of 3% is considered appropriate for the clay soils with an alternative given for 5% should subgrade improvement be undertaken. Table 9 summarises the pavement thicknesses (Ref 7) for varying traffic loadings. The traffic loadings adopted are to be confirmed by the design engineer or Council (as appropriate) prior to the commencement of construction.

Table 9: Preliminary Pavement Thickness Design

Traffic Loading (ESA)	Total Pavement Thickness (mm)	
	CBR 3%	CBR 5%
1×10^4	320	250
5×10^4	370	280
1×10^5	385	300
5×10^5	480	365
1×10^6	520	395

The results of laboratory testing indicate that the clay soils are predominantly wet of standard optimum. Subject to test rolling, the incorporation of a 300 – 500 mm thick bridging layer of coarse granular material may be required to provide a working platform for construction. Whilst the need and extent for a bridging layer is best determined on site during construction, at this preliminary stage, allowance should be made for its inclusion along the road alignments.

The pavement gravels should be placed and compacted in layers no thicker than 150 mm with control exercised over placement moisture contents. If layer thicknesses greater than 150 mm are proposed, it may be necessary to test the top and bottom of the layer to ensure that the minimum level of compaction has been achieved through the full depth.

Suggested material quality and compaction requirements are given in Table 10. Whilst the use of lesser quality pavement materials than that detailed in Table 10 may be feasible, some compromise in either performance and/or pavement life must be anticipated and accepted.

Table 10: Pavement Material Quality and Compaction

Layer	Material Quality	Minimum Compaction
Wearing Course	To conform to Austroads	To conform to Austroads
Base Course	To conform to Austroads Soaked CBR ≥ 80%, PI ™6%	Minimum dry density ratio of 98% Modified (AS 1289 Test 5.2.1)
Sub-base Course	To conform to Austroads Soaked CBR ≥ 50%, PI ™12%	Minimum dry density ratio of 95% Modified (AS 1289 Test 5.2.1)
Subgrade Replacement	Soaked CBR ≥ 20%	Minimum dry density ratio of 100% Standard (AS 1289 Test 5.1.1)
Subgrade		Minimum dry density ratio of 100% Standard (AS 1289 Test 5.1.1)

Where: PI = Plasticity Index

Surface and subsurface drainage should be installed and maintained to protect the pavement and subgrade. The subsurface drains should be located at a minimum of 0.5 m depth below subgrade level. Guidelines on the arrangement of subsurface drainage are given on Page 20 of ARRB – SR41 (Ref 8). It should be noted that if the sub-base is of low permeability relative to the base layer, then the subsurface drain must intersect all pavement layers as shown in ARRB – SR41.

8.15 Summary

A preliminary geotechnical assessment has been undertaken to support an application for modification of the Concept Plan Approval for Lots 2 and 3 in DP 1176767 Geraghty Street, Bulli. Based on the results of previous DP investigations, the assessment has provided preliminary comments on:

- Subsurface conditions;
- Groundwater levels;
- Stability assessment;
- Site preparation and earthworks;
- Site classification;
- Excavation conditions;
- Footing options;
- Preliminary pavement thickness designs.

Further investigations will be required as the planning and design of the project progresses including areas not previously investigated by DP (such as the Hill Top Precinct and Tramway Creek bridge), and supplementary drilling to profile rock depth and strength in the South Precinct. Notwithstanding the need for further investigation, it is considered that the proposed development is feasible from the geotechnical perspective.

9. References

1. Geology of Wollongong 1:50 000 Geological Series Sheet No 9029 – 11, Dept of Mines, (1977).
2. Australian Standard AS 2159 – 2009 *Piling - Design and Installation*.
3. Australian Standard AS 2870 – 2007 *Residential Slabs and Footings.*
4. AS 1170.4 *Minimum Design Loads on Structures Part 4: Earthquake Actions in Australia* Australian Standards – 2007.
5. *Practice Note Guidelines for Landslide Risk Management*, Australian Geomechanics Society Landslide Taskforce (2007).
6. Australian Standard AS 3798 – 2007 Guidelines on Earthworks for Commercial and Residential Developments.
7. Austroads 2018 – Part 2 – Pavement Structural Design.
8. ARRB – SR41 – A Structural Design Guide for Flexible Residential Street Pavements, Australian Road Research Board, Special Report No. 41, 1989.

10. Limitations

Douglas Partners (DP) has prepared this report for this project at Lots 2 and 3 DP 1176767 Geraghty Street, Bulli in accordance with DP's proposal WOL180136 dated 13/6/18 and acceptance received from Ken Douglas-Hill of EPM Projects dated 19/6/18. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Anglicare for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

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Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud 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 the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

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Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

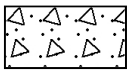
Symbols & Abbreviations

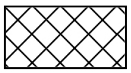
Graphic Symbols for Soil and Rock

General

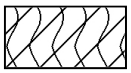

Asphalt

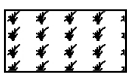

Road base

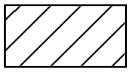

Concrete

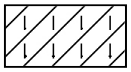

Filling

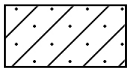
Soils


Topsoil

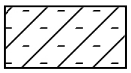

Peat

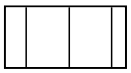

Clay

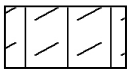

Silty clay

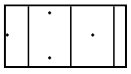

Sandy clay

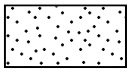

Gravelly clay

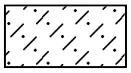

Shaly clay

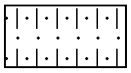

Silt


Clayey silt


Sandy silt


Sand

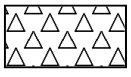

Clayey sand


Silty sand


Gravel

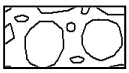

Sandy gravel


Cobbles, boulders

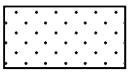

Talus

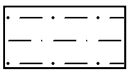
Sedimentary Rocks

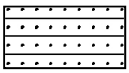

Boulder conglomerate

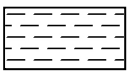

Conglomerate


Conglomeratic sandstone

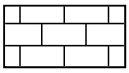

Sandstone


Siltstone

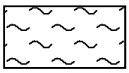

Laminite

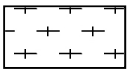

Mudstone, claystone, shale

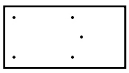

Coal


Limestone

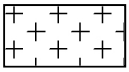
Metamorphic Rocks

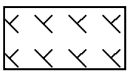

Slate, phyllite, schist

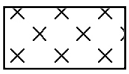

Gneiss

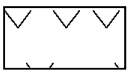

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Cone Penetration Tests

Douglas Partners

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

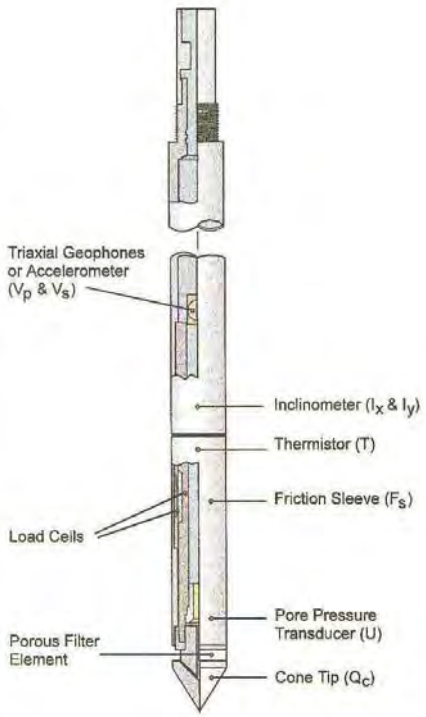


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

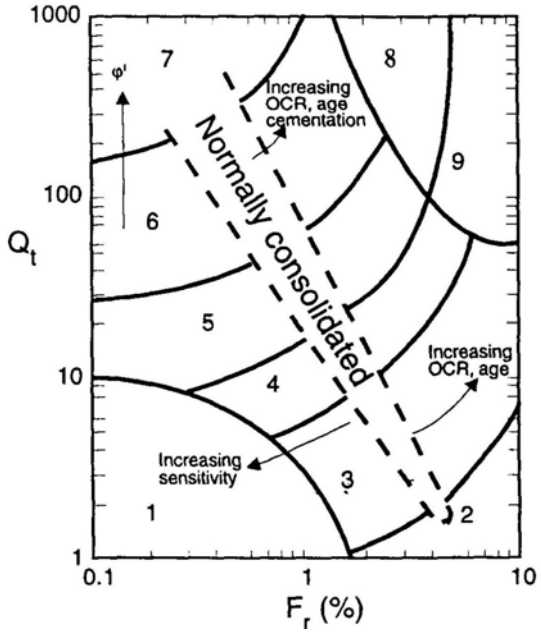


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

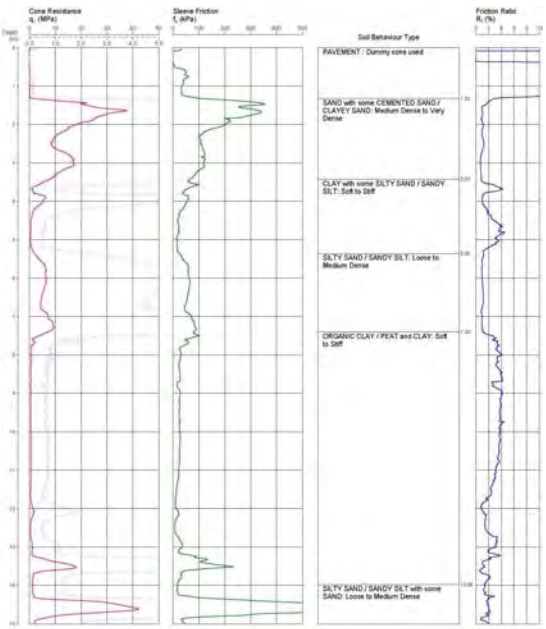
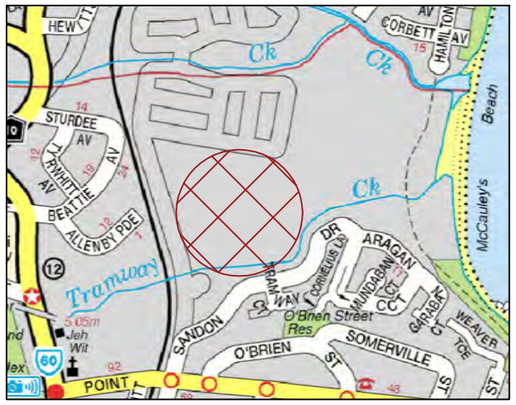


Figure 4: Sample Cone Plot

Appendix B

Drawing
Previous Borehole & Test Pit Logs and CPT Report Sheets



Locality Plan

LEGEND

- Previous test pit location (DP July 2006)
- Previous cone penetration test location (DP July 2006)
- Previous test pit location (HLA-Envirosciences Proj. S4037204 30 June 2006))
- Previous test bore location (HLA-Envirosciences Proj. S4037204 30 June 2006))
- Previous test bore location (DP February 2008)
- Previous test pit location (DP February 2008)
- 1 Photo number with direction of view

0 5 10 20 30 40 50 75 100 125m

1:1250 @ A3

STURDEE AVENUE

Illawarra

WILKIES STREET

3 DP 1176767

2 DP 1176767

DP 1048602

GERAGHTY STREET

Illawarra Railway Line

Railway

HILL TOP PRECINCT

OCEAN VIEW PRECINCT

VILLAGE CENTRE PRECINCT

Turpentine Forest

Turpintine forest area 1.187ha

Disused quarry

Aboriginal Archaeological site

R.C.

Cooksons Creek

6m Defendable Zone

4m Defendable Zone

TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP12 TP13 TP14 TP15 TP16 TP17

BH1 BH2 BH3 BH4 BH5 BH6 BH7 BH8 BH9 BH10 BH11 BH12 BH13 BH14 BH15 BH16 BH17 BH18 BH19 BH20 BH21/MW07 BH22 BH23 BH24 BH25/MW08 BH26 BH27 BH28 BH29 BH30 BH31 BH32 BH33

MW01 MW02 MW03

401 402 403 404 405 406 407 408 409 410 411 412

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Anglicare		TITLE: **Proposed Site Layout and Location of Tests** **Proposed Residential and Seniors Living Development** **Lots 2 & 3 DP 1176767 Geraghty Street, Bulli**
	OFFICE: Wollongong	DRAWN BY: DJM	MGA
	SCALE: 1:1250@A3 Approx.	DATE: 28.06.2018	PROJECT No: 40618.02 DRAWING No: 1 REVISION: 0

HLA-Envirosciences Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072
Telephone: 02 8484 8999
Fax: 02 8484 8989

MONITORING WELL LOG MW01

PROJECT NUMBER S4037202
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD Solid Auger
SAMPLING METHOD SPT
LOGGED BY I. Macfarlane
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 06/06/2005
SURFACE ELEVATION
WELL HEAD/TOC
BLANK 50mm Class 18 uPVC Casing
SCREEN 50mm Class 18 uPVC Factory Slotted Screen
GRAVEL PACK 2-3mm graded sand
SANITARY SEAL/BENTONITE Bentonite pellets

PID (ppm)	SAMPLE NUMBER	DEPTH (m BGL)	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
4.7	MW01_0.1-0.2	0	Bitumen	0.04
			Gravely silty SAND (FILL), medium dense, slightly moist, green/brown, minor ash	0.25
3.1	MW01_0.4-0.5		Gravely sandy SILT (FILL), soft, slightly moist, low plasticity, dark grey/grey. Gravel is ash	0.40
		0.5	CLAY (CL), medium stiff, moist, medium to high plasticity, orange/grey	0.60
4.6	MW01_0.8-1.0		Gravely CLAY (CL), medium stiff, moist, low plasticity, yellow/brown, minor sand	
		1.0		
			Grades to brown/orange	
		1.5		
5.8	MW01_1.8-2.0			1.85
		2.0	CLAY (CL), medium stiff, moist, low plasticity, grey/orange mottled, minor quartz gravel	
		2.5		
5.9	MW01_2.9-3.0	3.0		
		3.5		
			Grades to very moist	
		4.0		4.00
			CLAY (CL), medium stiff, moist to very moist, low plasticity, orange/brown	
		4.5	▽	
4.9	MW01_4.6-5.1			
			Grades to dark brown/brown, very moist to saturated	
		5.0		5.30
			Borehole terminated Total Depth: 5.30 m	

WELL DIAGRAM: Concrete; Backfill; Blank Casing; Bentonite; Gravel Pack; Screen; Cave-in

GENERAL LOG S4037202_BORELOGS_19JUL05.GPJ HLA_SYD.GDT 29/06/06

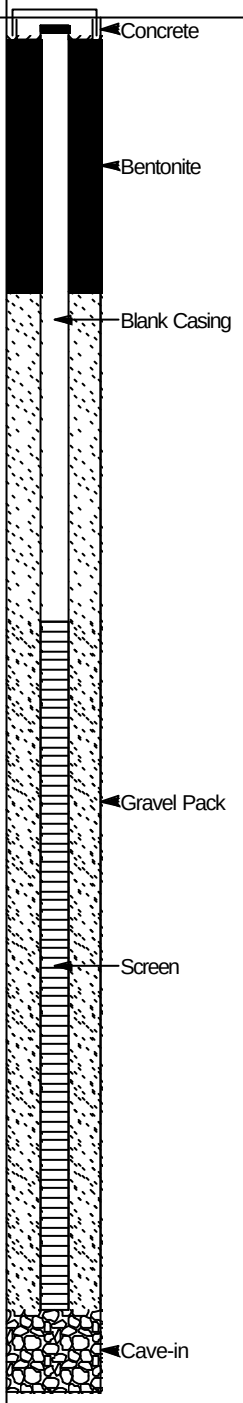
HLA-Envirosciences Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072
Telephone: 02 8484 8999
Fax: 02 8484 8989

MONITORING WELL LOG MW02

PROJECT NUMBER S4037202
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD Solid Auger
SAMPLING METHOD SPT
LOGGED BY I. Macfarlane
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 06/06/2005
SURFACE ELEVATION
WELL HEAD/TOC
BLANK 50mm Class 18 uPVC Casing
SCREEN 50mm Class 18 uPVC Factory Slotted Screen
GRAVEL PACK 2-3mm graded sand
SANITARY SEAL/BENTONITE Bentonite pellets

PID (ppm)	SAMPLE NUMBER	DEPTH (m BGL)	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
5.8	MW02_0.0-0.2 DUP01	0	Silty SAND (FILL), loose to medium dense, slightly moist, red/brown, minor quartz, coal and ash gravel	0.25
4.2	MW02_0.4-0.5	0.5	Silty SAND (FILL), medium dense, slightly moist, dark brown with minor yellow, minor clay, coal	0.80
3.8	MW02_0.9-1.0	1.0	Sandy SILT (FILL), soft, slightly moist, low plasticity, light brown/brown	1.30
		1.5	Sandy CLAY (CLS) medium stiff to stiff, moist, low plasticity, orange/brown with some grey	
5.7	MW02_1.9-2.0	2.0		
		2.5	Grades to very stiff	
		3.0		
		3.5	Silty CLAY (CL-ML), stiff to very stiff, moist to very moist, low plasticity, brown with some grey	3.50
		4.0	Silty sandy CLAY (CL-ML), medium stiff, very moist to saturated, low plasticity, brown	4.00
5.3	MW02_4.2-4.5	4.5		
		5.0		
		5.5		
4.7	MW02_5.9-6.0	6.0	Silty CLAY (CL-ML), stiff, moist to very moist, low plasticity, brown/orange	5.90 6.00
			Borehole terminated Total Depth: 6.00 m	



GENERAL LOG S4037202_BORELOGS_19JUL05.GPJ HLA_SYD.GDT 29/06/06

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Telephone: 02 8484 8999
Fax: 02 8484 8989

MONITORING WELL LOG MW03

PROJECT NUMBER S4037202
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD Solid Auger
SAMPLING METHOD SPT
LOGGED BY I. Macfarlane
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 06/06/2005
SURFACE ELEVATION
WELL HEAD/TOC 0.56
BLANK 50mm Class 18 uPVC Casing
SCREEN 50mm Class 18 uPVC Factory Slotted Screen
GRAVEL PACK 2-3mm graded sand
SANITARY SEAL/BENTONITE Bentonite pellets

PID (ppm)	SAMPLE NUMBER	DEPTH (m BGL)	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
4.5	MW03_0.0-0.2	0	Silty sandy CLAY (FILL), medium stiff, moist, low plasticity, dark brown/grey/black, minor brick, ash and coal	0.20
6.6	MW03_0.4-0.5	0.5	Gravely SILT (FILL), soft, moist, low plasticity, minor coal and ash	0.40
3.7	MW03_0.9-1.0	1.0	Gravely sandy SILT (FILL), soft, moist, low plasticity, grey/black, minor plastic, ash, coal and slag, hydrocarbon odour	1.20
		1.5	Gravely silty CLAY (FILL), soft to medium stiff, moist to vey moist, grey, minor coal, ash and purple rock	1.70
3.4	MW03_1.9-2.0	2.0	Gravely silty CLAY (FILL), stiff, moist, black, minor coal, ash and purple rock	2.50
		2.5	Silty GRAVEL (FILL), dense to very dense, moist, dark grey/black,gravel is coal and ash	2.80
4.2	MW03_2.8-3.0	3.0	Sandy CLAY (CLS), stiff, moist, low plasticity, brown/orange, minor charcoal	
		3.5		
		4.0		
		4.5		
3.8	MW03_5.0-5.3	5.0	Sandy CLAY (CLS), medium stiff, very moist to saturated, low plasticity, light brown	5.00
		5.5		
		6.0		
		6.5		
3.9	MW03_6.6-6.7		Borehole terminated Total Depth: 6.80 m	6.80

WELL DIAGRAM: Bentonite; Blank Casing; Gravel Pack; Screen

GENERAL LOG S4037202_BORELOGS_19JUL05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH1

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen	0.05
							Weathered concrete	0.20
16.9			BH1_ 0.2-0.35	✳			Gravely SAND (FILL), very loose sand, very moist to saturated, dark grey, no odour, minor coal and ironstone	0.35
24.8			BH1_ 0.35-0.5	✳	0.5		Sandy Clayey SILT/ Sandy Silty CLAY (FILL), stiff to medium stiff, moist, low plasticity, dark grey/ brown, minor rootlets and charcoal, no odour,	0.60
20.1			BH1_ 0.65-0.75				Sandy CLAY (CLS), medium stiff to stiff clay, slightly moist, low plasticity, orange/brown, minor charcoal	0.80
					1.0		Sandy CLAY (CLS), medium stiff to stiff, slightly moist, low plasticity, cream and orange/red mottled, minor charcoal	1.30
16.4			BH1_ 1.0-1.1				Borehole terminated - refusal Total Depth: 1.30 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH2

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen	0.10
21.6			BH2_ 0.1-0.3				Road base slab/ packed ash (FILL)	0.30
21.7			BH2_ 0.3-0.38	✳			Gravely Sandy SILT (FILL), medium stiff, slightly moist to moist, medium plasticity, dark grey, minor charcoal/coal wash, blue metal, no odour	0.38
15.7			BH2_ 0.4-0.5		0.5		CLAY (CL), stiff to medium stiff, slightly moist to moist, medium plasticity, orange/grey/brown, minor charcoal and sand	0.65
21.9			BH2_ 0.8-0.9		1.0		Sandy CLAY (CLS), medium stiff, slightly moist, low plasticity, red/brown with orange and grey mottles, minor charcoal	
17.1			BH2_ 1.3-1.4					1.40
							Borehole terminated, refusal on sandstone Total Depth: 1.40 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH3

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen	0.15
							Gravel (FILL), dense to very dense, slightly moist	
8.9			BH3_ 0.35-0.5 DUP01	✳ ✳	0.5			
9.3			BH3_ 0.58-0.68	✳				
								0.95
					1.0		Silty CLAY (FILL), soft, moist, low plasticity, dark grey/brown, minor coal wash, no odour	1.06
19.8			BH3_ 1.06-1.13				Coal wash (FILL), saturated, water lens	1.13
14.4			BH3_ 1.14-1.2				Silty CLAY (FILL), soft, moist, low plasticity, dark grey/brown, minor coal wash, no odour	1.25
							Coal wash (FILL), saturated	1.33
							Silty CLAY (FILL), soft, moist, low plasticity, dark grey/brown, minor coal wash, no odour	
19.7			BH3_ 1.5-1.7		1.5			
								1.78
16.9			BH3_ 1.8-1.9				Sandy CLAY/Sandy SILT (FILL), stiff, saturated, low plasticity, light grey and ochre, minor sandstone nodules, very slight odour	1.91
					2.0		Silty CLAY (CL-ML), stiff to medium stiff, moist to very moist, low plasticity, dark grey/ brown, minor rootlets	
16.8			BH3_ 2.1-2.2	✳				2.30
							Borehole terminated, refusal Total Depth: 2.30 m	

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BOREHOLE LOG BH4

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Grass	0.02
7			BH4_ 0.02-0.18				Sandy CLAY/Sandy SILT (FILL), soft, very moist, low plasticity, dark grey, no odour, minor gravel and roots	0.18
							GRAVEL (FILL), very moist to saturated, black, no odour	0.25
							GRAVEL (FILL), very dense grey rock	0.27
14.9			BH4_ 0.27-0.35	✳			GRAVEL (FILL), very moist to saturated, black, no odour	0.35
20.6			BH4_ 0.35-0.44				Sandy SILT/Sandy CLAY (FILL), medium stiff, moist, low plasticity, dark grey/brown, no odour	0.44
							Sandy CLAY (CLS), medium stiff, slightly moist, low plasticity, grey and orange/brown mottled, minor charcoal in upper section, no odour	
8.4			BH4_ 0.5-0.6		0.5			
					1.0			
7.3			BH4_ 1.1-1.2					1.20
							Total Depth: 1.20 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH5

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen	
								0.15
13.4			BH5_ 0.15-0.3 DUP02 TRIP01	✳ ✳ ✳			GRAVEL (FILL), dense, crumbly, slightly moist to moist, black, slight odour	
					0.5			
								0.66
							GRAVEL (FILL), very dense, grey, dry	0.68
							GRAVEL (FILL), dense, crumbly, slightly moist to moist, black, slight odour	
								0.90
							GRAVEL (FILL), very dense, grey, dry	
					1.0		Saturated lens of coal wash (FILL)	
10.7			BH5_ 1.3-1.4	✳				1.37
							SAND (FILL), loose to dense, saturated, cream/yellow, no odour, large sandstone fragments	1.44
11.4			BH5_ 1.44-1.54		1.5		CLAY (FILL), soft, moist, low to medium plasticity, grey/brown, minor charcoal	
								1.58
							Sandy CLAY (CLS), soft to medium stiff, moist, low plasticity, grey and orange/brown mottled, very minor charcoal	
7.1			BH5_ 1.8-1.9					1.87
							Sandy CLAY (CLS), soft to medium stiff, moist to very moist, low plasticity, grey and orange brown/mottled, very minor charcoal	
					2.0			
11.4			BH5_ 2.1-2.2	✳				2.20
							Borehole terminated Total Depth: 2.20 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH6

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen	
								0.20
							GRAVEL (FILL), dense, crumbly, slightly moist to moist, black, slight odour	
11			BH6_ 0.4-0.5	✳	0.5			
								0.90
11.1			BH6_ 0.9-1.0				Coal wash (FILL), with layers of grey, dry rock	1.00
					1.0		GRAVEL (FILL), dense, crumbly, slightly moist to moist, black, slight odour	
								1.40
10.5			BH6_ 1.4-1.5				Coal wash (FILL), with layers of grey, dry rock	1.50
					1.5		GRAVEL (FILL), dense, crumbly, slightly moist to moist, black, slight odour	
								1.70
12.7							CLAY (FILL), soft, moist, low to medium plasticity, orange/brown, no odour	1.80
			BH6_ 1.7-2.0	✳			Silty CLAY (CL-ML), very soft to soft, very moist to saturated, low plasticity, dark grey/brown, minor charcoal, slight odour	
					2.0			2.00
							Sandy CLAY (CLS), soft to medium soft, moist to very moist, low plasticity, grey and orange/brown mottled, no odour	
					2.5			
12.8			BH6_ 2.8-3.0					
					3.0			3.00
							Borehole terminated Total Depth: 3.00 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH7

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen	0.15
							GRAVEL (FILL), dense to very dense, dry to slightly moist	0.40
6.4			BH7_ 0.4-0.5	✳	0.5		Coal wash (FILL), dense to very dense, dry to slightly moist, black with no odour	0.50
							GRAVEL (FILL), dense to very dense, dry to slightly moist	
8.1			BH7_ 0.9-1.0 DUP03	✳	1.0			
					1.5			
10.5			BH7_ 1.8-2.0	✳			Silty CLAY (CL-ML), very soft to soft, moist, low plasticity, dark grey/brown, slight organic odour	1.80
					2.0		Sandy CLAY (CLS), soft, moist to very moist, low plasticity, grey and orange/brown mottled, no odour	2.00
					2.5			
11.9			BH7_ 2.9-3.0		3.0		Borehole terminated Total Depth: 3.00 m	3.00

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH8

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen	
								0.15
							GRAVEL (FILL), coal wash fill, very dense, crumbly, slightly moist to moist, black, no odour	
8.3			BH8_ 0.4-0.5	*	0.5			
								0.80
12.2			BH8_ 0.8-1.0	*	1.0		CLAY (FILL), soft to medium stiff, slightly moist to moist, low plasticity, brown/red/black/grey mottled with minor ironstone, charcoal, sandstone nodules and rootlets, no odour	
11.8			BH8_ 1.1-1.3					1.20
							SANDSTONE (FILL)	1.22
							CLAY (FILL), soft to medium stiff, slightly moist to moist, low plasticity, brown/red/black/grey mottled, with minor ironstone, charcoal, sandstone nodules and rootlets no odour	
								1.40
11.7			BH8_ 1.4-1.5		1.5		Sandy SILT (MLS), soft to medium stiff, moist to very moist, low plasticity, dark grey/ brown, minor rootlets, no odour	
								1.58
7.7			BH8_ 1.65-1.85				Sandy CLAY/ Sandy SILT (CLS), very moist to saturated, low plasticity, grey/ brown, no odour, high sand content, sand is well graded, fine to medium grained	
								1.85
							Borehole terminated Total Depth: 1.85 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH9

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen	
								0.20
							Clayey GRAVEL (FILL), very dense, slightly moist to moist, black, no odour, coal wash fill with some clay mixed in	
12.6								
10.9			BH9_ 0.3-0.5 DUP04 TRIP02 BH9_ 0.4-0.5	✳ ✳ ✳	0.5			
								0.65
14.1			BH9_ 0.65-0.74	✳			Blue metal/clay (FILL), saturated	
								0.74
12.5			BH9_ 0.75-0.9				Sandy CLAY (FILL), reworked clay fill, soft, moist to very moist, low plasticity, grey/orange/brown, minor black, no odour, minor charcoal and rootlets, minor fine sands	
					1.0			1.00
							Sandy CLAY (CLS), stiff, moist, low plasticity, red/brown and grey mottled, minor charcoal, no odour	
					1.5			
								1.60
							Borehole terminated Total Depth: 1.60 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH10

PROJECT NUMBER S4037203 **DATE** 21/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Asphalt	
10.3			BH10_ 0.2-0.28	✳			GRAVEL (FILL), coal wash fill, very dense, crumbly, dry, low plasticity, black, no odour	0.20
							CLAY (FILL), medium stiff, moist, low to medium plasticity, ochre, possibly reworked	0.28
11.1			BH10_ 0.3-0.4 DUP05					
					0.5		Sandy CLAY (CLS), stiff, moist, low plasticity, red/brown and grey mottled, minor charcoal, no odour, minor rootlets	0.50
10.7			BH10_ 0.8-1.0	✳				
					1.0			
							Borehole terminated Total Depth: 1.10 m	1.10

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH11

PROJECT NUMBER S4037203 **DATE** 22/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Asphalt	
								0.20
4.9			BH11_ 0.2-0.3	✳			GRAVEL (FILL), coal wash fill, grey shale-like rock inclusions, very dense, dry to slightly moist, grey/black, no odour,	
								0.33
5			BH11_ 0.4-0.5		0.5		Gravely Clayey SILT (FILL), gravel is coal and blue metal, dense, crumbly, slightly moist to moist, low plasticity, grey/brown, no odour	
								0.56
5.7			BH11_ 0.6-0.8 DUP06 TRIP03		1.0		CLAY (CL), with minor fine sands, stiff, slightly moist to moist, low plasticity, orange/brown and grey mottled, no odour, minor ironstone, charcoal and very minor rootlets	
					1.5			
								1.60
							Borehole terminated Total Depth: 1.60 m	

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BOREHOLE LOG BH12

PROJECT NUMBER S4037203
PROJECT NAME ARV Bulli
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 22/11/2005
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.12
							GRAVEL (FILL), coal wash fill with minor pockets of hardened silt, dense but crumbly, slightly moist to dry, low plasticity, black, no odour	
7.7			BH12_ 0.4-0.58	✳	0.5			0.47
							GRAVEL (FILL), very moist to saturated lense	0.58
5.4			BH12_ 0.6-0.8	✳			Sandy SILT (MLS), medium stiff, moist to very moist, low plasticity, dark grey/brown, minor rootlets, charcoal, sandstone nodules, no odour	0.93
5.8			BH12_ 1.0-1.2		1.0		Silty Sandy CLAY (CLS), sand is well graded, fine to medium grained, medium stiff, moist to very moist, low plasticity, orange/grey/brown, no odour, minor charcoal and ironstone	
					1.5			1.53
							GRAVEL (GP), ironstone gravel	1.55
							CLAY (CL), stiff to very stiff, moist, medium plasticity, orange/brown and grey mottled, no odour	
6.8			BH12_ 2.4-2.5		2.0			
					2.5			2.50
							Borehole terminated Total Depth: 2.50 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH13

PROJECT NUMBER S4037203 **DATE** 22/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.12
7			BH13_ 0.2-0.4	✳			GRAVEL (FILL), coal wash fill, dense and crumbly, slightly moist, black and grey, no odour	0.40
							GRAVEL (FILL), very dense, grey rock, dry	0.45
					0.5		GRAVEL (FILL), coal wash fill, dense, crumbly, slightly moist, black and grey, no odour	0.58
							GRAVEL (FILL), very dense, grey rock, dry	0.65
							GRAVEL (FILL), coal wash fill, dense, crumbly, slightly moist, black and grey, no odour	0.79
5.2			BH13_ 0.79-0.88	✳			SAND (FILL), very loose, saturated, medium grey, slight odour	0.88
3.2			BH13_ 0.9-1.0		1.0		Sandy SILT (MLS), medium stiff, moist to very moist, low plasticity, dark grey/ brown, minor rootlets and charcoal, no odour	1.10
2.2			BH13_ 1.2-1.3	✳			Silty Sandy CLAY (CLS), medium stiff, moist to very moist, low plasticity, orange/grey/ brown, minor rootlets, very minor charcoal, no odour	1.40
							Borehole terminated Total Depth: 1.40 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Level 5, 828 Pacific Highway
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Telephone: 02 8484 8999
Fax: 02 8484 8989

BOREHOLE LOG BH14

PROJECT NUMBER S4037203
PROJECT NAME ARV Bulli
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 22/11/2005
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.12
6.9			BH14_ 0.12-0.25				Silty SAND (FILL), very soft, grey/brown, no odour	0.13
							GRAVEL (FILL), coal wash fill, dense and crumbly, slightly moist to moist, black, no odour	
6.4			BH14_ 0.3-0.4					0.35
							SAND (FILL), saturated, orange and brown	0.37
							GRAVEL (FILL), coal wash fill, dense and crumbly, slightly moist to moist, black, no odour	
					0.5			
								0.70
5.1			BH14_ 0.7-0.78	✳			Sandy GRAVEL (FILL), white and grey slag, very loose, moist to very moist, light grey and white, no odour	0.78
3.1			BH14_ 0.8-0.95				CLAY (FILL), reworked clay, mottled black, red/orange and brown/grey, minor ironstone, rootlets, charcoal, large sandstone fragments, slag and brick	
					1.0			
								1.40
							CLAY (CL), soft to medium stiff, moist, low to medium plasticity, grey/brown with minor black, minor charcoal and ironstone	
6.3			BH14_ 1.5-1.55		1.5			
6.9			BH14_ 1.7-1.8					1.80
							Borehole terminated Total Depth: 1.80 m	

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Fax: 02 8484 8989

BOREHOLE LOG BH15

PROJECT NUMBER S4037203 **DATE** 22/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.14
3.9			BH15_ 0.14-0.4 DUP07				SAND (FILL), very loose, grey/cream, no odour GRAVEL (FILL), coal wash fill, black, no odour	0.15
4.8			BH15_ 0.4-0.6	✳	0.5		SAND (FILL), very loose, very moist to slightly moist, layered brown/grey over cream over brown over yellow/cream Charcoal Inclusions	0.40
4.4			BH15_ 0.6-0.7				CLAY (FILL), reworked clay fill, medium stiff to stiff, moist, low plasticity, grey/brown with some orange and black, minor charcoal, no odour	0.60
4.3			BH15_ 0.7-0.8				Clayey SILT (CL), medium stiff, slightly moist to moist, low plasticity, dark grey/brown, minor rootlets, charcoal, no odour	0.68
					1.0		CLAY (CL), stiff to very stiff, slightly moist to moist, low plasticity, medium grey/brown, minor charcoal and very minor rootlets, no odour Grades to orange/red and grey mottled	0.85
5.5			BH15_ 1.3-1.5		1.5		Borehole terminated Total Depth: 1.50 m	1.50

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH16

PROJECT NUMBER S4037203 **DATE** 22/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
6.6			BH16_ 0.02-0.2 DUP08 TRIP04		0.5 1.0 1.5		Grass and topsoil SILT (FILL), very soft, dry, low plasticity, light grey, no odour GRAVEL (FILL), coal wash fill with medium to large chunks of very dense rock like share or basalt, dense and crumbly, dry to slightly moist, black and grey, no odour Decrease in gravel content, more well-graded particulate texture	0.02 0.10 2.00
7.2			BH16_ 2.0-2.4		2.0 2.5 3.0 3.5		GRAVEL (FILL), slightly moist, loose to medium dense, black with few charcoal chunks Increase in gravel content	3.55
6.6			BH16_ 3.55-3.65				GRAVEL (FILL), dense and crumbly, saturated, black and grey, no odour	3.65
6.8			BH16_ 3.7-3.9		4.0		Silty SAND/Sandy SILT (SM) possibly original top soil, loamy, very soft to soft, saturated, low plasticity, grey/brown, minor rootlets, 'rusty' odour	4.18
7.9			BH16_ 4.2-4.4		4.5		Sandy CLAY (CLS), soft to medium soft, moist, low to medium plasticity, red/brown and grey mottled, no odour, minor ironstone, charcoal and rootlets	
7			BH16_ 4.9-5.1		5.0		Borehole terminated Total Depth: 5.10 m	5.10

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH17

PROJECT NUMBER S4037203 **DATE** 22/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
10.2			BH17_ 0.02-0.22	✳			Grass and topsoil	0.02
							Sandy GRAVEL (FILL), road base/ blue metal crushed gravel, poorly graded, very dense, dry, grey, no odour	0.22
							GRAVEL (FILL), coal wash fill with crushed sand, loose, dry to slightly moist, black, no odour	0.50
8.5			BH17_ 0.5-0.6	✳	0.5		Sandy GRAVEL (FILL), ash and slag gravel, medium dense, slightly moist, grey and black, no odour	0.52
8.7			BH17_ 0.63-0.72				Silty GRAVEL (FILL), road base or slag/coal gravel in a silty matrix, poorly graded, slightly moist to moist, brown and grey, no odour	0.63
9.8			BH17_ 0.75-0.85	✳			CLAY (FILL), soft to medium stiff, slightly moist to moist, medium plasticity, mottled orange and cream and red and grey, minor sandstone and brick	0.72
							Gravely SILT (FILL), coal wash/charcoal gravel, medium stiff to stiff, moist to very moist, low plasticity, black and purple brown, no odour	0.96
9.4			BH17_ 1.0-1.2		1.0		GRAVEL (FILL), coal wash fill, very dense, crumbly, moist, black, no odour	
					1.5			1.63
9.9			BH17_ 1.65-1.75				Clayey Sandy SILT (MLS), medium stiff, very moist, low plasticity, brown, minor charcoal, no odour	1.90
					2.0		Silty CLAY (CL-ML), medium stiff, moist to very moist, low to medium plasticity, orange/brown, no odour	
9.1			BH17_ 2.1-2.3	✳			Grades to sandy clay, stiff, slightly moist to moist, low plasticity, orange/brown, no odour	
					2.5		Borehole terminated Total Depth: 2.50 m	2.50

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Fax: 02 8484 8989

BOREHOLE LOG BH18

PROJECT NUMBER S4037203 **DATE** 22/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
9.9			BH18_ 0.05-0.13				Grass and topsoil	0.05
10.9			BH18_ 0.13-0.32				GRAVEL (FILL), coal wash fill, very dense, crumbly, moist, black, no odour	0.13
8.6			BH18_ 0.32-0.45	*			CLAY (FILL), medium stiff, slightly moist to moist, medium plasticity, orange/brown and grey, no odour, minor charcoal	0.32
10.5			BH18_ 0.45-0.65	*	0.5		Clayey SAND (FILL), coarse, compacted, medium dense to dense, moist, red/orange/grey, minor shells, no odour	0.45
							Silty GRAVEL (FILL), coal wash gravel, loose to medium dense, moist to very moist, dark brown/grey, no odour, minor ironstone and charcoal	0.75
					1.0		GRAVEL (FILL), coal wash gravel, large fragments of grey rock, dense, crumbly, moist, black, no odour	
					1.5			
					2.0			
10.1			BH18_ 2.1-2.3				Grades to crushed gravel/sand	
					2.5			
9.4			BH18_ 3.0-3.1		3.0		SAND (FILL), very loose, very moist, grey, no odour	3.00
4.1			BH18_ 3.34-3.50				Sandy SILT (FILL), soft, very moist, low plasticity, dark grey, minor rootlets and charcoal	3.34
					3.5		Grades to light grey/brown	3.50
							CLAY (FILL), medium stiff, moist, low to medium plasticity, grey/brown and black with minor charcoal	3.75
11.7			BH18_ 3.8-4.0				Gravely CLAY (FILL), dense to very dense, moist, low plasticity, orange/brown with cream and black and red, minor charcoal, ironstone and siltstone	
					4.0			4.02
11.9			BH18_ 4.02-4.2 DUP09	* *			Sandy GRAVEL (FILL), charcoal and coal wash reasonably well graded, loose, saturated, black, no odour	4.20
8.2			BH18_ 4.3-4.5				SAND (SW), loose, very moist to saturated, orange/brown	
					4.5		Grades to saturated, increased clay content, stiffens with depth	
								4.70
							Borehole terminated Total Depth: 4.70 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Fax: 02 8484 8989

BOREHOLE LOG BH19

PROJECT NUMBER S4037203
PROJECT NAME ARV Bulli
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 23/11/2005
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
10.1			BH19_ 0.05-0.3				Grass and topsoil	0.05
							Gravely SILT/Gravely CLAY (FILL), very soft gravely silt, very stiff gravely clay, moist, low plasticity, grey/brown, no odour, minor charcoal/coke, plastic, rootlets and sandstone	
					0.5		Large sandstone fragments	0.50
18.9			BH19_ 0.6-0.8	*			Sandy GRAVEL (FILL), coal wash/ash fill, loose, fine, dry to slightly moist, light grey, no odour, large fragments of coal	
					1.0			1.20
							Sandy GRAVEL (FILL), coal wash/ash fill, loose, moderate grading, dry to slightly moist, medium dark grey, no odour, chunks of coal	
15.1			BH19_ 1.4-1.5		1.5			1.55
							Sandy GRAVEL (FILL), coal wash/ash fill, moderate grading, fine to medium size, very loose, dry to slightly moist, dark grey, no odour, large fragments of coal	
19			BH19_ 1.8-2.0	*			Sandy GRAVEL (FILL), coal wash/ash fill, fine ash, loose, very light grey	1.77
					2.0			2.09
19.5			BH19_ 2.1-2.3				Sandy GRAVEL (FILL), coal wash/ash fill, moderate grading, medium dense, dark grey/black	
					2.5		Sandy GRAVEL (FILL), Layer of red 'brick-like' rock	2.50
								2.70
10.7			BH19_ 2.7-2.9				Sandy GRAVEL (FILL), coal wash/ash very fine, slightly moist to moist, black	2.90
							Sandy GRAVEL (FILL), coal wash/ash very fine, slightly moist to moist, light grey	2.92
14.2			BH19_ 2.95-3.1		3.0		Sandy CLAY (FILL), medium stiff to stiff, moist, low plasticity, red/brown, minor charcoal and ironstone, no odour	3.10
							Sandy CLAY (CLS), stiff, moist, low plasticity, mottled red/brown and grey and cream, minor charcoal and ironstone	
					3.5			
8.1			BH19_ 3.8-4.0					
					4.0		Borehole terminated Total Depth: 4.00 m	4.00

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Gordon NSW 2072
Telephone: 02 8484 8999
Fax: 02 8484 8989

BOREHOLE LOG BH20

PROJECT NUMBER S4037203 **DATE** 23/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Grass and topsoil	0.05
24.2			BH20_ 0.1-0.4		0.5		Gravely SILT (FILL), crushed red and cream brick in a silty/sand matrix, dense, moist, low plasticity, red and cream and brown	0.60
5.2			BH20_ 0.6-1.0 DUP10 TRIP05	* * *	1.0		Sandy GRAVEL (FILL), coal wash/ash fill, loose, moist, low plasticity, grey with some white and yellow, minor siltstone, slag	1.00
27.6			BH20_ 1.1-1.2		1.5		Gravely SILT (FILL), coal and slag gravel, very soft, slightly moist, low plasticity, brown, minor rootlets, no odour	1.57
20.6			BH20_ 1.6-1.7				Sandy Silty CLAY (FILL), stiff to very stiff, slightly moist to moist, low plasticity, orange and brown and black and red, minor charcoal, rootlets and ironstone	1.82
17.3			BH20_ 1.9-2.1	*	2.0		Sandy GRAVEL (FILL), coal wash fill, dense, crumbly, dry to slightly moist, low plasticity, black/grey	2.50
21.8			BH20_ 2.5-2.7	*	2.5		Very dense grey, dry, rock inclusions	2.90
22.4			BH20_ 3.0-3.2		3.0		Sandy CLAY (CLS), stiff, moist, low plasticity, grey/brown, minor charcoal, no odour.	
30.4			BH20_ 3.8-4.0		3.5			
					4.0		Borehole terminated Total Depth: 4.00 m	4.00

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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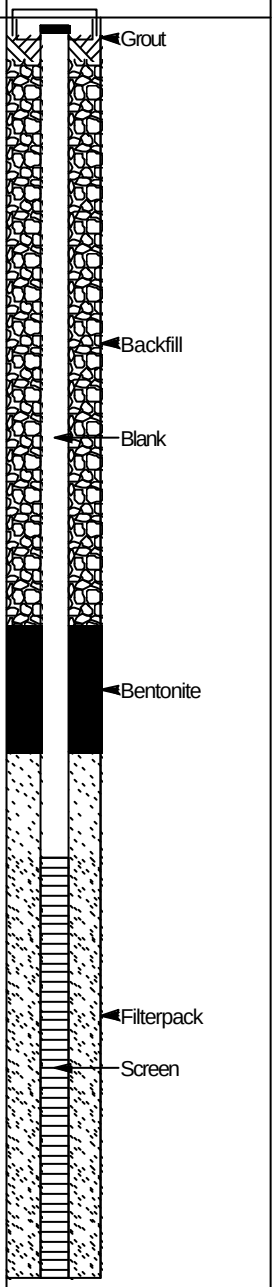
Telephone: 02 8484 8999
Fax: 02 8484 8989

MONITORING WELL LOG BH21/MW07

PROJECT NUMBER S4037203
PROJECT NAME ARV Bulli
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 23/11/2005
SURFACE ELEVATION
WELL HEAD/TOC
BLANK 50mm diameter UPVC blank
SCREEN 50mm diameter UPVC factory slotted
GRAVEL PACK 2-3mm graded sand
SANITARY SEAL/BENTONITE Bentonite chips/Grout

PID (ppm)	SAMPLE NUMBER	DEPTH (m BGL)	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
		0	Concrete	0.24
		0.5	Sandy GRAVEL (FILL), coal wash fill, dense, crumbly, moist, black, no odour	0.50
26.1	BH21MW07_ 0.8-1.0	1.0	Clayey GRAVEL/ Gravely CLAY (FILL), coal wash fill in a clay matrix, soft loose, very moist, low to medium plasticity, dark grey/brown/black, no odour	
30.5	BH21MW07_ 1.3-1.5	1.5		1.60
			CLAY (FILL)	1.70
		2.0	Clayey GRAVEL/ Gravely CLAY (FILL), coal wash fill in a clay matrix, soft loose, very moist, low to medium plasticity, dark grey/brown/black, moderate odour	2.30
24.9	BH21MW07_ 2.3-2.5	2.5	Clayey GRAVEL/ Gravely CLAY (FILL), coal wash fill in a clay matrix, soft loose, very moist, low to medium plasticity, dark grey/brown/black, strong hydrocarbon odour	2.70
29.5	BH21MW07_ 2.7-2.8		Tree root, large piece of old wood, strong HC odour	2.85
27.4	BH21MW07_ 2.85-2.95	3.0	Sandstone (FILL), hard, very moist, cream and red, burnt phosphorus odour	
	BH21MW07_ 3.0-3.2			3.20
	BH21MW07_ 3.2-3.4	3.5	CLAY (FILL), soft to medium stiff, very moist, medium plasticity, grey/brown, no odour, minor charcoal and ironstone	3.80
31.3	BH21MW07_ 4.2-4.4	4.0	CLAY (CL), medium stiff, moist, low to medium plasticity, orange/brown and grey mottled, no odour	
		4.5		
		5.0		
30.7	BH21MW07_ 5.3-5.5	5.5		
		6.0	Borehole terminated Total Depth: 6.00 m	6.00



GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Gordon NSW 2072
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Fax: 02 8484 8989

BOREHOLE LOG BH22

PROJECT NUMBER S4037203 **DATE** 23/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Auger and Push Tube
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
21							Grass, gravel, topsoil	0.02
							Silty GRAVEL (FILL), loose, dry, low plasticity, grey and brown, minor refractory product, siltstone, coal/slag, blue metal, no odour	0.20
21.9			BH22_ 0.02-0.2	✳			Gravely CLAY (FILL), stiff to very stiff, moist, low plasticity, orange/brown and black, minor crushed brick, coal, no odour	
			BH22_ 0.2-0.4 DUP11	✳				0.45
18.9			BH22_ 0.5-0.6	✳	0.5		Silty GRAVEL (FILL), coal wash fill in a silty matrix, very stiff, moist, low plasticity, black and dark grey, no odour	0.71
9.5			BH22_ 0.76-0.85				Gravely CLAY (FILL), stiff to very stiff, moist, low plasticity, orange/brown and black, minor crushed brick, coal, no odour	0.76
			BH22_ 0.9-1.0	✳	1.0		Gravely SAND/ Sandy (GRAVEL), very loose, slightly moist to moist, orange/brown, no odour	0.85
							Silty GRAVEL (FILL), slag gravel in a silt matrix, very dense, slight odour	
					1.5		Silty GRAVEL/Gravely SILT (FILL), coal wash fill in a silt matrix	1.50
							Gravely CLAY (FILL), stiff to very stiff, moist, low plasticity, orange/brown and black, minor crushed brick, coal, no odour	1.75
							Sandy GRAVEL (FILL), coal wash fill	1.87
38.8			BH22_ 1.95-2.05		2.0		Sandy SILT (FILL), soft, moist, low plasticity, dark grey/brown, minor rootlets, clear plastic, no odour	1.95 1.98
							CLAY (FILL), soft, moist to very moist, low to medium plasticity, grey and black and brown, no odour	2.10
46.1			BH22_ 2.2-2.4	✳			SILT (ML), medium stiff, moist to very moist, low plasticity, dark brown, no odour	
					2.5			2.60
							Sandy CLAY (CLS), saturated to moist, low plasticity, grey/orange, no odour, minor siltstone, charcoal, ironstone and rootlets	
31.9			BH22_ 2.7-2.9				Grades to saturated	
					3.0		Grades to red/brown	
37.9			BH22_ 3.3-3.5					
					3.5		Borehole terminated Total Depth: 3.50 m	3.50

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Level 5, 828 Pacific Highway
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Telephone: 02 8484 8999
Fax: 02 8484 8989

BOREHOLE LOG BH23

PROJECT NUMBER S4037203 **DATE** 23/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
46.2			BH23_ 0.02-0.2	*			Grass and topsoil	0.02
							CLAY (FILL), soft to medium stiff, moist, low to medium plasticity, orange/brown, minor roots and coal, no odour	0.28
							Sandy GRAVEL (FILL), coal wash fill, dense, moist, low plasticity, dark brown, minor rootlets, no odour	0.40
44.9			BH23_ 0.5-0.7	*	0.5		GRAVEL (FILL), fine ash and slag fill, loose, slightly moist to moist, low plasticity, pink/cream, minor charcoal, no odour	
							Grades to grey	0.72
							SAND (FILL), weathered sandstone, dense, slightly moist, orange/cream, no odour	0.90
					1.0		Silty GRAVEL (FILL), coal wash fill/charcoal, very dense, moist, dark grey/black, no odour, piece of lead metal sheeting at 1.4 m	1.40
					1.5		Silty SAND (FILL), slag, slightly moist, very dense, white/light grey, slight odour	1.70
45.7			BH23_ 1.8-2.0				Silty SAND (FILL), slag, saturated, soft, white/light grey, slight odour	2.00
38.9			BH23_ 2.0-2.2	*	2.0		GRAVEL (FILL), slag, saturated, decaying 'trade-waste' odour	2.10
							CLAY (FILL), contains fine sand, very moist, low to medium plasticity, red/brown some black, minor charcoal, ironstone, moderate odour	2.25
			BH23_ 2.3-2.4				Sandy GRAVEL (FILL), coal wash fill with layers of very dense rock	2.57
					2.5		Sandy CLAY (CLS), soft to medium stiff, very moist, low plasticity, grey/brown, minor charcoal, ironstone, no odour	
							Grades to red/brown	
44.1			BH23_ 2.9-3.0	*	3.0		Borehole terminated	3.00
					3.5			
					4.0		Total Depth: 4.00 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Level 5, 828 Pacific Highway
Gordon NSW 2072
Telephone: 02 8484 8999
Fax: 02 8484 8989

BOREHOLE LOG BH24

PROJECT NUMBER S4037203 **DATE** 23/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.18
60.9			BH24_ 0.2-0.4	✳			GRAVEL (FILL), road base and slag	0.20
							Silty GRAVEL (FILL), coal wash fill, very dense, moist, low plasticity, black, no odour	
					0.5			0.55
							Sandy CLAY (FILL), stiff, moist, low plasticity, red/brown and grey mottled, no odour	0.70
58.6			BH24_ 0.8-1.0				Gravely Sandy CLAY (FILL), gravel is coke/coal/charcoal, stiff, very moist, low plasticity, red/brown and grey mottled, minor charcoal and slag, no odour	
					1.0			
					1.5			1.55
41.4			BH24_ 1.6-1.9 DUP12 TRIP06				Silty GRAVEL (FILL), coal wash fill, dense, crumbly, moist, low plasticity, black, no odour	
					2.0			2.24
48			BH24_ 2.3-2.5	✳			Sandy SILT (MLS), soft, very moist, low plasticity, dark brown/grey, organic odour	2.40
					2.5		Sandy CLAY (CLS), soft, very moist to saturated. Low plasticity, orange/grey/brown, minor rootlets, charcoal, no odour	
							Grades to stiff and moist	
32			BH24_ 2.8-3.0				Grades to red/brown and grey mottled	
					3.0			
					3.5			
					4.0			4.00
							Borehole terminated Total Depth: 4.00 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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MONITORING WELL LOG BH25/MW08

PROJECT NUMBER S4037203
PROJECT NAME ARV Bulli
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 23/11/2005
SURFACE ELEVATION
WELL HEAD/TOC
BLANK 50mm diameter UPVC blank
SCREEN 50mm diameter UPVC factory slotted
GRAVEL PACK 2-3mm graded sand
SANITARY SEAL/BENTONITE Bentonite chips/Grout

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.18
28.4			BH25MW08_ 0.18-0.3				GRAVEL (FILL), slag gravel vesicular and light weight, very dense, saturated from coring, grey slight odour	0.32
36.1			BH25MW08_ 0.5-0.7	*	0.5		Silty GRAVEL (FILL), coal wash fill with pockets of grey/orange/brown clay, very dense and crumbly, slightly moist to moist, black, slight odour, also contains layers of very dense rock	
					1.0			1.20
							CLAY (FILL), soft, moist, medium plasticity, cream and grey and red mottled, minor charcoal, ironstone, no odour	
20.4			BH25MW08_ 1.4-1.6 DUP13		1.5			1.65
							Silty GRAVEL (FILL), coal wash fill with pockets of grey/orange/brown clay, very dense, crumbly, slightly moist to moist, black, with layers of very dense rock, slight odour	
37.6			BH25MW08_ 2.1-2.3	*	2.0		light grey ash pocket	2.40
23.7			BH25MW08_ 2.4-2.6		2.5		Sandy SILT (MLS), original topsoil, stiff to medium stiff, very moist, low plasticity, dark brown/grey, minor rootlets, charcoal	2.50
							Sandy CLAY (CLS), soft to medium stiff, moist to very moist, low plasticity, orange/brown, minor rootlets, ironstone charcoal, no odour	
					3.0		Grades to orange/brown/red and grey mottled, moist and medium stiff	
							becomes stiff and slightly moist to moist	
27.5			BH25MW08_ 3.4-3.6		3.5			
					4.0			
21.3			BH25MW08_ 4.4-4.6		4.5			
					5.0		Increasing ironstone gravel intrusions	
18.2			BH25MW08_ 5.4-5.5		5.5		Increasing grey clay	5.50
							Borehole terminated Total Depth: 5.50 m	

WELL DIAGRAM: Grout; Bentonite; Blank; Filterpack; Screen

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Fax: 02 8484 8989

BOREHOLE LOG BH26

PROJECT NUMBER S4037203 **DATE** 24/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.16
11.8			BH26_ 0.155-0.21				SAND (FILL), well graded beach sand, very loose, grey/cream/yellow, slight odour	0.21
							GRAVEL (FILL), coal wash fill, very dense and crumbly, dry, low plasticity, black, layers of very dense coal, no odour	
					0.5			0.50
							layer of red brick-like rock, pink/orange	0.65
							GRAVEL (FILL), coal wash fill, very dense and crumbly, dry, low plasticity, black, layers of very dense coal, no odour	
					1.0		Grades to slightly moist to moist	1.25
24			BH26_ 1.25-1.33				SAND (FILL), well graded beach sand, very loose, saturated, grey, no odour	1.33
18.2			BH26_ 1.4-1.7 DUP14 TRIP07				GRAVEL (FILL), coal wash fill, very dense and crumbly, dry, low plasticity, black, layers of very dense coal, no odour	
					1.5			
					2.0			2.08
23.7			BH26_ 2.1-2.17				Gravely Sandy CLAY (FILL), medium stiff, moist, low to medium plasticity, orange/brown and black, minor crushed brick, sandstone, slag, charcoal and ironstone	2.17
27.4			BH26_ 2.2-2.3				SILT (ML), medium stiff, moist, low plasticity, dark brown, minor rootlets and charcoal, no odour	2.33
					2.5		CLAY (CL), stiff to medium stiff, moist, low to medium plasticity, grey/brown/orange, very minor charcoal, no odour	
27.8			BH26_ 2.6-2.8				Grades to soft to medium stiff, moist to very moist	
							Grades to orange/brown and grey mottled	
							Grades to stiff to moist	
					3.0			
							Grades to very stiff, slightly moist to moist	
					3.5		Borehole terminated Total Depth: 3.50 m	3.50

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH27

PROJECT NUMBER S4037203 **DATE** 24/11/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube & SPT
SAMPLING METHOD SS
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.15
19.3			BH27_ 0.2-0.4	✳			Silty GRAVEL/Gravely SILT (FILL), gravel is coke/coal/charcoal, dense and crumbly, dry to slightly moist, low plasticity, black and white, no odour	0.42
					0.5		Silty GRAVEL (FILL), coal wash fill, dense and crumbly, slightly moist to moist, black, contains layers of dense dry grey/brown rock, no odour	
18.8			BH27_ 0.8-1.2	✳	1.0		ASH (FILL), pocket of light grey ash	1.10
								1.28
							SANDSTONE (FILL), yellow/red/cream sandstone	1.36
17.5			BH27_ 1.5-1.7 DUP15	✳	1.5		Gravely Silty CLAY (FILL), soft to medium stiff, moist, low plasticity, white/red/brown/orange mottled, minor charcoal, ironstone, no odour	1.80
26			BH27_ 1.9-2.0	✳	2.0		SILT (ML), original topsoil, medium stiff, moist to very moist, low plasticity, brown, minor rootlets, charcoal, no odour	2.10
							Sandy CLAY (CL), medium stiff to stiff, moist, low plasticity, orange/brown, very minor charcoal, ironstone, no odour	
					2.5			
22.7			BH27_ 2.8-3.0					
					3.0		Borehole terminated Total Depth: 3.00 m	3.00

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Fax: 02 8484 8989

BOREHOLE LOG BH28

PROJECT NUMBER S4037203 **DATE** 06/12/2005
PROJECT NAME ARV Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Auger
SAMPLING METHOD Auger
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Vines, leaf litter, topsoil	0.02
			BH28_ 0.02-0.2	✳			Clayey SILT/ Silty CLAY (FILL), stiff to medium stiff, moist, low plasticity, brown, minor rootlets, ironstone, coal chunks, no odour, clay is medium stiff, red and grey mottled	
								0.30
			BH28_ 0.4-0.5 DUP16		0.5		Gravely SILT/ GRAVEL (FILL), coal ash, medium stiff, medium dense, moist low plasticity, dark grey and white, minor ironstone, no odour	
			BH28_ 0.7-0.8				Large fragments of dense coal	
					1.0		Increase in moisture	
			BH28_ 1.5-1.6	✳	1.5			
							Packing tape, plastic bag, ironstone gravel inclusions	1.85
							Borehole terminated, refusal on ironstone and sandstone gravel Total Depth: 1.85 m	

GENERAL LOG S4037203_22DEC05.GPJ HLA_SYD.GDT 29/06/06

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Level 5, 828 Pacific Highway
Gordon NSW 2072
Telephone: 02 8484 8999
Fax: 02 8484 8989

BOREHOLE LOG BH29

PROJECT NUMBER S4037204 **DATE** 13/03/2006
PROJECT NAME Stage II ESA, Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube
SAMPLING METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen	0.20
							Sandy GRAVEL (FILL), loose, slightly moist, black, no odour, coal wash fill - dense coal gravel is loose, ground up coal matrix	
					0.5			
1.8			BH29_0.6-0.8 DUP01	* *				
					1.0			
8			BH29_1.0-1.2					
								1.25
29.6			BH29_1.25-1.35	*			Sandy SILT/ Sandy CLAY (CL), very moist, low plasticity, brown, original topsoil (or reworked natural clay), strong hydrocarbon odour	1.35
23.8			BH29_1.4-1.5		1.5		Sandy SILT/ Sandy CLAY (CL), moist, low plasticity, brown, original topsoil (or reworked natural clay), no obvious contaminants	1.50
							Silty CLAY (CL), stiff, slightly moist, low plasticity, ochre, no obvious contaminants, minor ironstone gravel	
19.2			BH29_1.8-2.0	*				
					2.0		Becomes orange and minor grey mottled	
								2.40
21.4			BH29_2.5-3.0 DUP02		2.5		CLAY (CL), very stiff, slightly moist, low plasticity, orange/brown and grey mottled, no obvious contaminants	
					3.0			3.00
							Borehole terminated Total Depth: 3.00 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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Gordon NSW 2072
Telephone: 02 8484 8999
Fax: 02 8484 8989

BOREHOLE LOG BH30

PROJECT NUMBER S4037204 **DATE** 13/03/2006
PROJECT NAME Stage II ESA, Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube
SAMPLING METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.14
18.2			BH30_ 0.1-0.2				SAND (FILL), very loose, very moist from coring, orange brown, no odour, medium coarse grained sand	0.20
							Sandy GRAVEL (FILL), loose, moist, black, coal wash fill, slight odour at 0.8 mbgs	
7.3			BH30_ 0.4-0.8 DUP03	*	0.5			
					1.0		Becomes finer grained	
					1.5			1.60
14.1			BH30_ 1.6-1.8				Band of very dense, light grey/white slag gravel	1.68
							Sandy GRAVEL (FILL), loose, moist, black, coal wash fill	2.00
10.2			BH30_ 2.0-2.2	*	2.0		CLAY (FILL), soft, very moist, low plasticity, mottled brown/yellow and white and red, slight odour, minor ironstone	2.20
6.4			BH30_ 2.2-2.4				SILT/ Sandy SILT (ML), soft, very moist, low plasticity, dark brown, very minor charcoal, very slight odour, possibly original top soil	2.40
					2.5		Sandy CLAY (CL), stiff, moist, low plasticity, orange/brown and minor red/dark brown, minor ironstone, no odour, rootlets, sand is fine grained	
15.1			BH30_ 2.7-3.0					
					3.0		Borehole terminated Total Depth: 3.00 m	3.00

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH31

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD Push Tube
SAMPLING METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 13/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Concrete	0.16
14.8			BH31_ 0.2-0.6 DUP04		0.5		SAND (FILL), loose to very loose, saturated from coring, orange brown, no odour, coarse to medium grained	0.20
							Sandy GRAVEL (FILL), loose, moist, black, no odour, coal wash fill, coal chunks (dense) in crushed coal matrix (loose)	0.60
9.8			BH31_ 0.6-0.8				Gravelly CLAY (FILL), very stiff, moist, low plasticity, mottled white and grey and yellow and red and black, no odour, gravel is coal, ironstone and blue metal	0.80
							Sandy GRAVEL (FILL), loose, moist, black, no odour, coal wash fill	
9			BH31_ 1.0-1.2		1.0			
								1.40
11.2			BH31_ 1.40-1.65	✳	1.5		GRAVEL (FILL), very dense, dry to slightly moist, very strong hydrocarbon/chemical odour, band of very light grey/white, very dense gravel, weathered concrete	1.60
							Sandy GRAVEL (FILL), loose, moist to very moist, low plasticity, black, no odour, coal wash fill, odour in top 0.1 m of coal wash	
					2.0		Large grey chunks of very dense gravel	
9.8			BH31_ 2.5-3.0 DUP05 DUP06	✳ ✳ ✳	2.5		Contains pockets of mixed in clay fill, slight odour	
5.8			BH31_ 3.0-3.2		3.0		Sandy CLAY (CL), stiff, moist, low plasticity, orange/brown with minor red and white, no odour, minor ironstone	3.00
							Increase in ironstone gravel	3.40
					3.5			3.70
5.7			BH31_ 3.8-4.0	✳			Sandy CLAY (CL), stiff, moist, low plasticity, orange/brown with minor red and white, no odour, minor ironstone	
					4.0		Borehole terminated Total Depth: 4.00 m	4.00

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH32

PROJECT NUMBER S4037204 **DATE** 13/03/2006
PROJECT NAME Stage II ESA, Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube
SAMPLING METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen, into road base gravel	0.35
6.2			BH32_ 0.5-1.0 DUP07 DUP08		0.5		Gravelly CLAY/ Clayey GRAVEL (FILL), very dense gravel in loose matrix, clay is very stiff, moist, low to medium plasticity, some small saturated pockets, no odour, gravel is crushed brick, coal wash, chunks of sandstone at 1 mbgs, ironstone	
					1.0			
					1.5			
8.6			BH32_ 1.8-2.0		2.0		Becomes mainly coal wash fill	
								2.35
8.5			BH32_ 2.4-2.5	*	2.5		Sandy SILT/ SILT (ML), medium stiff, very moist, low plasticity, dark brown, no obvious contaminants, possibly original topsoil	2.50
							Becomes saturated at 2.45 mbgs, slight odour	
7.5			BH32_ 2.6-2.9	*			Clayey SAND/ Sandy CLAY (CL), soft to medium stiff, saturated, low plasticity, yellow brown, no obvious contaminants	
							Becomes less sandy, stiff, reddish brown, moist, low plasticity	
					3.0			3.00
							Borehole terminated Total Depth: 3.00 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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BOREHOLE LOG BH33

PROJECT NUMBER S4037204 **DATE** 13/03/2006
PROJECT NAME Stage II ESA, Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD Push Tube
SAMPLING METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Bitumen, into road base gravel	0.35
5			BH33_ 0.5-0.8	✳	0.5		Gravelly CLAY/ Clayey GRAVEL (FILL), medium stiff, dense, moist to very moist, low plasticity, black and grey brown, no odour, coal wash fill mixed with pockets of clay fill, layers of very dense light grey gravel, no odour	
					1.0			
7			BH33_ 1.4-1.5					1.45
					1.5		Gravelly CLAY/ Clayey GRAVEL (FILL), medium stiff, dense, moist to very moist, low plasticity, black and grey brown, no odour, coal wash fill mixed with pockets of clay fill	
					2.0		Becomes predominantly coal wash fill	
								2.45
8.1			BH33_ 2.5-2.7	✳	2.5		SILT/Sandy SILT (ML), soft to medium stiff, very moist, low plasticity, dark brown, slight phosphorus odour, very minor fine sand, possibly original top soil	2.75
6.6			BH33_ 2.8-3.0				Sandy CLAY (CL), medium stiff to stiff, very moist, low plasticity, yellow/brown, no odour, minor fine sand content	3.00
					3.0		Borehole terminated Total Depth: 3.00 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP01

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 14/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
11.3			TP01_ 0.1-0.2	✳			Sandy Gravelly SILT (FILL), stiff, slightly moist to moist, low plasticity, brown and black, minor rootlets, no odour, gravel is coal wash, some clay pockets, some ironstone and packing tape	0.35
9.6			TP01_ 0.4-0.5		0.5		Sandy CLAY (FILL), stiff to very stiff, moist, low plasticity, orange and red and cream, no odour, contains sandstone chunks	0.55
11.6			TP01_ 0.6-0.7				Sandy GRAVEL (FILL), very dense coal in medium stiff matrix, moist, black, no odour, coal wash fill	
					1.0			1.05
11.6			TP01_ 1.05-1.10				Seam of light grey ash in fill, not continuous western wall of test pit	1.13
10.8			TP01_ 1.2-1.3 DUP09	✳			Sandy GRAVEL (FILL), very dense coal in medium stiff matrix, moist, black, no odour, coal wash fill	1.40
					1.5		Sandy SILT (ML), soft, moist to very moist, low plasticity brown, no odour, possibly original topsoil	1.60
10.8			TP01_ 1.8-2.0				CLAY/ Silty CLAY (CL), soft to medium stiff, moist, low plasticity, orange brown, no odour	
					2.0		Test pit terminated Total Depth: 2.00 m	2.00

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP02

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 14/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
12.1			TP02_ 0.1-0.2				Gravelly SILT (FILL), loose, dry to slightly moist, low plasticity, brown, no odour, rootlets, like topsoil, gravel is ironstone, blue metal and coal	0.30
13.2			TP02_ 0.6-0.8	*	0.5 1.0 1.5		Sandy CLAY (FILL), very stiff, slightly moist to moist, low plasticity, orange and some red and white, no odour, reworked natural clay, sandstone chunks, ironstone, some big blocks of sandstone	1.70
11.1			TP02_ 1.7-1.9	*			Gravelly Sandy SILT/ Gravelly Sandy CLAY (FILL), very soft, very moist to saturated, low plasticity, very dark brown. Black, no odour, rootlets, possibly original topsoil with some coal wash mixed in, coal wash has stained soil black	1.90
					2.0		CLAY (CL), stiff to very stiff, moist, low plasticity, orange/ brown, minor grey, rootlets, no odour	
15.4			TP02_ 2.2-2.3					2.30
							Test pit terminated Total Depth: 2.30 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP03

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 14/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
3.8			TP03_ 0.0-0.2	*			Sandy Gravelly SILT (FILL), stiff, slightly moist to moist, low plasticity, brown and black, minor rootlets, no odour, gravel is coal wash, some clay pockets, some ironstone	
								0.22
2.5			TP03_ 0.22-0.50	*			Sandy GRAVEL (FILL), very dense, slightly moist, light grey and minor green, no odour, grey and minor green slag gravel	
					0.5			0.50
4.1			TP03_ 0.6-0.7				Sandy CLAY (FILL), stiff to very stiff, moist, low plasticity, orange and red and cream, no odour, contains sandstone chunks	
								0.73
							Sandy GRAVEL (FILL), very dense coal in medium stiff matrix, moist, dark brown/ black, no odour, coal wash fill	
					1.0			
5.9			TP03_ 1.0-1.2 DUP10 DUP11	* * *			Becomes black and very moist	
								1.45
8.6			TP03_ 1.5-1.6		1.5		Sandy SILT (FILL), soft, moist to very moist, low plasticity, brown, no odour, plastic liner/ bag	1.50
							Sandy SILT (ML), soft, moist to very moist, low plasticity, brown, no odour, possibly original topsoil	
								1.84
							CLAY (CL), soft to medium stiff, moist, low plasticity, orange brown with minor grey, no odour	
					2.0			
8.5			TP03_ 2.1-2.3					
								2.30
							Test pit terminated Total Depth: 2.30 m	

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TEST PIT LOG TP04

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 14/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
					0.5		Gravelly Sandy SILT (FILL), medium stiff, dry to slightly moist, low plasticity, dark brown/ grey, rootlets, no odour, contains lots of crushed bricks and sandstone, dried clay lumps, ironstone, pieces of metal, concrete	
12.4			TP04_ 0.5-0.7		1.0			
								1.20
7.1			TP04_ 1.3-1.4 DUP12	✳	1.5		Sandy GRAVEL (FILL), medium dense, dry to slightly moist, light grey and white, no odour, ash, plastic bags/ sheets	
					2.0			2.10
9.7			TP04_ 2.2-2.4	✳	2.5		Clayey Sandy GRAVEL (FILL), dense to very dense, dry to slightly moist, low plasticity, black, no odour, coal wash fill with lots of clay fill mixed in	
								2.75
12.6			TP04_ 2.9-3.0		3.0		Clayey SAND/ Sandy CLAY (SP), medium stiff, moist, low plasticity, orange/ brown, ironstone	3.00
							Test pit terminated Total Depth: 3.00 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP05

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 14/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
					0.5		Gravelly Sandy SILT (FILL), medium stiff, dry to slightly moist, low plasticity, dark brown/ grey, large roots, no odour, contains lots of crushed bricks and sandstone, dried clay lumps, ironstone, pieces of metal, concrete	
					1.0			1.20
11							Sandy GRAVEL (FILL), medium dense, dry to slightly moist, light grey and white, no odour, ash, plastic bags/ sheets, very thin layer of ash fill, light grey	1.22
			TP05_ 1.2-1.7		1.5		Clayey Sandy GRAVEL (FILL), dense to very dense, dry to slightly moist, low plasticity, black, no odour, coal wash fill with lots of clay fill mixed in	
								1.70
							Test pit terminated Total Depth: 1.70 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP06

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 14/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Gravelly Clayey SILT (FILL), stiff, slightly moist, low plasticity, dark brown/ grey, no odour, lots of crushed terracotta bricks, brown clay pockets (soft medium plasticity, moist)	
12.6			TP06_0.4-0.6		0.5			
11.5			TP06_0.7-0.7				Vitreous SLAG (FILL), hard, very dense, dry, very light grey and white, slag odour	0.70
							Test pit terminated, excavator refusal Total Depth: 0.72 m	0.72

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP07

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 14/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
11.8			TP07_ 0.1-0.5 DUP13	✳	0.5		Gravelly Clayey SILT (FILL), stiff, moist, low plasticity, brown and grey and red and white, slight odour, contains pockets of clay and pockets of white vitreous slag	0.90
14.4			TP07_ 1.0-1.1	✳	1.0		Sandy GRAVEL (FILL), medium dense, moist, low plasticity, medium grey, no odour, looks like a mix of ash fill and coal wash and ironstone	1.01
							Vitreous SLAG (FILL), hard, very dense, dry, grey, slag odour	1.10
							Test pit terminated, excavator refusal Total Depth: 1.10 m	

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TEST PIT LOG TP08

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 14/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
					0		Coal wash /ash (FILL), medium stiff, medium dense, dry, low plasticity, medium grey and light grey, no odour, roots, mix of ashy coal wash fill, also buried bricks, plastic, sandstone, woven plastic and packing tape, cables, terracotta, rubbish	
4.7			TP08_ 0.5-0.8 DUP14	✳	0.5			
					1.0		Buried drum, empty but caked with very odours, saturated fill, very strong degrading hydrocarbon odour, sample collected from saturated/ stained dark grey soil around drum	
20.5			TP08_ 1.3-1.4	✳				
13.7			TP08_ 1.4-1.5		1.5		SLAG (FILL), hard, dense, dry, low plasticity, white, slag odour	1.40
							SLAG (FILL), hard, dense, dry, low plasticity, white, slag odour	1.65
					2.0			
							Sandy GRAVEL (FILL), medium stiff, medium dense, moist, black, no odour, coal wash fill	2.40
9.2			TP08_ 2.5-2.7		2.5			
9.8			TP08_ 2.7-2.9	✳			CLAY (CL), soft to medium stiff, moist, low plasticity, orange/ brown, no odour, rootlets	2.70
					3.0		Test pit terminated Total Depth: 3.00 m	3.00

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP09

PROJECT NUMBER S4037204 **DATE** 14/03/2006
PROJECT NAME Stage II ESA, Bulli **SURFACE ELEVATION**
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
					0.0		Gravelly SILT (FILL), medium stiff, slightly moist, low plasticity, brown, roots, no odour, contains blue metal, coal, wood, plastic bags and liners/ sheeting	
23.9			TP09_ 0.5-0.7		0.5			
					1.0		Increase in amount of coal wash, becomes black pockets	
								1.20
8.1			TP09_ 1.2-1.4	✳			Sandy GRAVEL (FILL), soft and crumbly, dry to slightly moist, very light grey and white, no odour, slag/ white coke ash	
					1.5			
								1.60
11.2			TP09_ 1.7-1.8				Sandy CLAY (CL), medium stiff, moist low plasticity, orange/ brown and red, no odour	
					2.0			2.00
							Test pit terminated Total Depth: 2.00 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP10

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 15/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
8.3			TP10_ 0.00-0.18				GRAVEL (FILL), loose, moist, black, mo odour, leaves and roots, coal wash fill	
								0.18
16.5			TP10_ 0.2-0.4				Gravelly Silty CLAY (FILL), stiff to medium stiff, slightly moist to moist, low plasticity, black and brown, no odour, mix of clay chunks, coal wash, general rubbish, plastic sheeting, coated blocks of refractory waste, milk crate, wood, timber, metal, roots, packing tape, chunks of white dense slag, clumps of black stick, very moist fill with a very strong hydrocarbon odour and green crystals formed around the lumps	
					0.5			
10.5			TP10_ 0.8-1.0 DUP15 DUP16					
					1.0			
19.6			TP10_ 1.2-1.3				Drum, contents include very moist, silvery black, sticky fill, extremely strong hydrocarbon odour	
25.4			TP10_ 1.3-1.4 DUP17					
					1.5			
					2.0			
11.4			TP10_ 2.4-2.7		2.5			
								2.70
13.7			TP10_ 2.7-2.9				Silty CLAY (CL), medium stiff, moist, low plasticity, orange/ brown, no odour	
					3.0			3.00
							Test pit terminated Total Depth: 3.00 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP11

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 15/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
14.8			TP11_ 0.5-0.8	✳	0.5		Gravelly Sandy SILT (FILL), soft, loose, dry to slightly moist, low plasticity, grey, no odour, mix of silt and ashy grey fill (refractory product), contains timber, plastic, a mug, bricks, roots	
					1.0			1.20
14.1			TP11_ 1.6-1.9		1.5		Clayey SILT (FILL), medium stiff, dry to slightly moist, low plasticity, brown, no odour, possibly reworked natural	
					2.0		Plastic liner/ rubbish and wire	2.40
16.4			TP11_ 2.5-2.7	✳	2.5		CLAY/Sandy CLAY (CL), soft to medium stiff, moist, low plasticity, orange brown, no odour	2.70
							Test pit terminated Total Depth: 2.70 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP12

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 15/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
9.1			TP12_0.3-0.5		0.5		Gravelly Sandy SILT (FILL), soft, dry to slightly moist, low plasticity, dark grey and brown, no odour, roots, ash, timber, coal wash, bricks	0.80
8.1			TP12_1.0-1.2		1.0		Clayey SILT (FILL), medium stiff to stiff, slightly moist, low plasticity, brown, no odour, possibly reworked natural	1.60
8.6			TP12_1.6-1.9		1.5		CLAY/ Sandy CLAY (CL), soft to medium stiff, moist, low plasticity, orange/ brown, no odour	1.90
							Test pit terminated Total Depth: 1.90 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP13

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 15/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
7			TP13_ 0.2-0.5		0.5		Gravelly Sandy SILT (FILL), soft, slightly moist to moist, low plasticity, dark grey and black, no odour, contains mix of coal wash and ash (refractory product), wood and timber, bricks, terracotta	0.30
							Gravelly Sandy SILT (FILL), medium stiff, slightly moist, low plasticity, medium to light grey, no odour, contains mix of coal wash and ash (refractory product)	0.50
							Test pit terminated, excavator refusal on hard rock/ slag Total Depth: 0.50 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP14

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 15/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
6.6			TP14_ 0.0-0.3		0.5		Gravelly Sandy SILT (FILL), soft, slightly moist to moist, low plasticity, dark grey and black, no odour, bricks, metal, plastic, refractory product, clay pockets, roots	0.50
9.9			TP14_ 0.6-0.7				Clayey SAND (FILL), soft, slightly moist, low plasticity, light grey, no odour, seam of light grey ash/ slag (refractory product)	0.80
6.4			TP14_ 1.2-1.5	*	1.0 1.5		Sandy GRAVEL (FILL), dense to medium dense, moist, black with brown clay pockets, no odour, coal wash fill Plastic bag/ liner/ sheet Old rusted crushed empty drum Big metal rod/ pipe	
3.5			TP14_ 2.0-2.2 DUP18		2.0 2.5		Metal wire rope	2.80
2.2			TP14_ 2.9-3.1	*	3.0		Sandy CLAY (CL), medium stiff to stiff, moist low plasticity, orange/ brown, no odour, no obvious contaminants	3.20
							Test pit terminated Total Depth: 3.20 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

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TEST PIT LOG TP15

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 15/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Silty GRAVEL (FILL), medium dense, slightly moist, low plasticity, black, roots, no odour, coal wash fill with some silty, grey ashy fill (refractory product), bricks, plastic, timber	
9.4			TP15_ 0.5-0.7	*	0.5			
					1.0			
					1.5			
								1.60
							Gravelly Silty CLAY (FILL), loose soil with stiff clay, dense, slightly moist, low plasticity, black, clay is brown, no odour, coal wash and clay mix with rubbish, timber, carpet, packing tape, plastic, concrete, metal, bricks, coal	
5.7			TP15_ 1.8-2.0		2.0			
								2.20
17.8			TP15_ 2.2-2.4	*			Drum, soil surrounding drum are thick, black, sticky, silvery, extremely odorous	
								2.40
							Gravelly Silty CLAY (FILL), loose soil with stiff clay, dense, slightly moist, low plasticity, black, clay is brown, no odour, coal wash and clay mix with rubbish, timber, carpet, packing tape, plastic, concrete, metal, bricks, coal	2.50
					2.5			
10.9			TP15_ 2.6-2.8	*			Sandy CLAY/ Clayey SAND (CL), soft, moist to very moist, low plasticity, orange brown, no odour, ironstone	
								2.80
							Test pit terminated Total Depth: 2.80 m	

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TEST PIT LOG TP16

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 15/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							GRAVEL (FILL), coal wash fill, dense, slightly moist, low plasticity, black and brown, no odour	0.05
							Silty GRAVEL (FILL), medium dense, slightly moist to dry, low plasticity, brown and grey, no odour, coal wash and clay fill with some silty, grey ashy fill (refractory product), bricks, plastic, timber	
					0.5			
9.1								
			TP16_ 0.7-1.2		1.0		Band of white refractory product, no odour	
								1.50
					1.5		Gravelly Clayey SILT (FILL), stiff, dry, low plasticity, brown, roots, no odour, reworked natural with coal wash, rubbish mixed in plastic, timber, coal	
6.8			TP16_ 1.7-1.9					
					2.0			
								2.40
9.1			TP16_ 2.4-2.6		2.5		Silty CLAY (CL), soft, slightly moist to moist, low plasticity, brown, no odour, lots of rootlets, possibly original top soil	2.60
							Test pit terminated, test pit cave in Total Depth: 2.60 m	

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TEST PIT LOG TP17

PROJECT NUMBER S4037204
PROJECT NAME Stage II ESA, Bulli
LOCATION Bulli
DRILLING METHOD 6 tonne excavator
EXCAVATION METHOD Grab
LOGGED BY A. Syriatowicz
STABILISED WATER LEVEL
GROUND WATER ELEVATION
COMMENTS

DATE 15/03/2006
SURFACE ELEVATION

PID (ppm)	BLOW COUNTS	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGL)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							Gravelly Sandy SILT (FILL), soft, slightly moist low plasticity, dark brown, no odour, with pockets of brown clay, coal, roots	
9.4			TP17_ 0.2-0.5		0.5			
					1.0			1.00
							Sandy GRAVEL (FILL), very dense, loose but chunks, very moist, black, no odour, coal wash fill	
8.8			TP17_ 1.2-1.5 DUP19 DUP20	✳ ✳ ✳	1.5			
					2.0			
					2.5			
7.3			TP17_ 2.8-3.0 DUP21		3.0			
9.7			TP17_ 3.1-3.4	✳				3.20
							CLAY/ Silty CLAY (CL), medium stiff, moist to very moist, low plasticity, orange brown, very slight odour	3.40
							Test pit terminated, test pit cave in Total Depth: 3.40 m	

GENERAL LOG S4037204_BORELOGS_16MAY06.GPJ HLA_SYD.GDT 29/06/06

TEST PIT LOG

CLIENT: Event Project Management
PROJECT: Proposed Retirement Village
LOCATION: Lots 1 & 2 DP 224431 Sturdee Avenue Bulli

SURFACE LEVEL: 13.1 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 401
PROJECT No: 40618
DATE: 03 Jul 06
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
13	0.1	FILLING - brown silty clay							
		FILLING - dark grey silty gravel (coalwash) with some light grey sandy silty clay							
	0.35	FILLING - brown and orange brown sandy silty clay							
				B	0.5				
					0.6				
	0.9	SILTY CLAY - very stiff to hard, grey mottled red brown silty clay with trace gravel		D	1.0		pp > 400kPa		
12	1								1
		- some sand							
					1.7				
				B	1.8		pp = 300kPa		
11	2								2
	2.2	CLAY - very stiff to hard, grey, dark grey and orange brown slightly silty clay with trace gravel							
				D	2.7		pp > 350kPa		
	3								3
10	3.0	Pit discontinued at 3.0m (limit of investigation)							

RIG: Cat 428C backhoe - 600mm bucket

LOGGED: Lackenby

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED
Initials:
Date:

Douglas Partners
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TEST PIT LOG

CLIENT: Event Project Management
PROJECT: Proposed Retirement Village
LOCATION: Lots 1 & 2 DP 224431 Sturdee Avenue Bulli

SURFACE LEVEL: 10.6 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 402
PROJECT No: 40618
DATE: 03 Jul 06
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.15	FILLING - brown silty clay with dark grey silty gravel (coalwash)							
		FILLING - orange brown, light grey and red silty clay with sandstone cobbles and boulders up to 1.0m in length and some sand. Boulders with minimum dimensions of 0.4 m noted							
				B	0.7				
					0.75				
				U	0.8				
					1.0				
				D	1.5				
	1.9	SILTY CLAY - stiff, brown and orange brown silty clay, crumbly							
				D	2.1				
	2.3	SILTY CLAY - stiff to very stiff, orange brown, brown and red brown silty clay		D	2.4		pp = 200kPa		
		- orange brown and grey							
				B	3.0				
	3.1	Pit discontinued at 3.1m (limit of investigation)			3.1		pp = 250kPa		

RIG: Cat 428C backhoe - 600mm bucket

LOGGED: Lackenby

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

Douglas Partners
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TEST PIT LOG

CLIENT: Event Project Management
PROJECT: Proposed Retirement Village
LOCATION: Lots 1 & 2 DP 224431 Sturdee Avenue Bulli

SURFACE LEVEL: 11.6 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 403
PROJECT No: 40618
DATE: 03 Jul 06
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILLING - dark grey silty gravel (coalwash) with brown sandy silty clay							
	0.3	FILLING - stiff to very stiff, orange brown, red brown and light grey gravelly sandy silty clay with trace cobbles			0.5				
11				B	0.6		pp = 150-270kPa		
	1								1
	1.1	FILLING - generally comprising brown and grey silty clay with bricks, steel, glass, plastic bag, fence, sleeper, terracota pipe, coalwash and rubber hose. Strong hydrocarbon odour noted			1.3				
				B	1.4				
10									
	2			D	2.0				2
9									
	2.7	SILTY CLAY - stiff to very stiff, brown mottled orange brown silty clay			2.7				
				B	2.8		pp = 160-260kPa		
	2.9	Pit discontinued at 2.9m (collapsing pit)							
	3								3
8									

RIG: Cat 428C backhoe - 600mm bucket

LOGGED: Lackenby

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Event Project Management
PROJECT: Proposed Retirement Village
LOCATION: Lots 1 & 2 DP 224431 Sturdee Avenue Bulli

SURFACE LEVEL: 11.0 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 404
PROJECT No: 40618
DATE: 03 Jul 06
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
11	0.1	FILLING - brown silty clay with gravel							
	0.3	FILLING - grey silty clay with slag gravel and metal sheeting							
	0.4	FILLING - dark grey silty gravel (coalwash)							
	0.7	FILLING - brown silty clay (eastern pit end only)							
10	1	FILLING - dark grey silty gravel with cobbles (coalwash) with some ash							1
	1.4	FILLING - orange brown, light grey and red brown clay with some silt and gravel		B	1.4				
					1.5		pp = 130-150kPa		
9	2			D	2.0				2
	2.2	FILLING - dark grey silty gravel (coalwash) with timber and plastic bags							
				B	2.8				
8	3				2.9				3
	3.1	Pit discontinued at 3.1m (limit of investigation)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Cat 428C backhoe - 600mm bucket

LOGGED: Lackenby

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: Event Project Management
PROJECT: Proposed Retirement Village
LOCATION: Lots 1 & 2 DP 224431 Sturdee Avenue Bulli

SURFACE LEVEL: 11.6 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 405
PROJECT No: 40618
DATE: 03 Jul 06
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	FILLING - orange brown silty clay with some dark grey silty gravel (coalwash) and tree roots							
	0.4	FILLING - dark grey silty gravel (coalwash) with trace brick fragments		D	0.5				
	0.6	FILLING - orange brown sandy silty clay with grey silt and gravel							
				B	1.2				
		- concrete slab in southern pit wall			1.3				
				D	1.6				
				B	2.4				
					2.5				
				D	2.9				
	3.0	Pit discontinued at 3.0m (limit of investigation)							

RIG: Cat 428C backhoe - 600mm bucket

LOGGED: Lackenby

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: Event Project Management
PROJECT: Proposed Retirement Village
LOCATION: Lots 1 & 2 DP 224431 Sturdee Avenue Bulli

SURFACE LEVEL: 12.3 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 406
PROJECT No: 40618
DATE: 03 Jul 06
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.08	FILLING - asphalt							
		FILLING - dark grey silty gravel (coalwash)							
12	0.5	CLAY - stiff to very stiff, orange brown and grey clay			0.5				
				U					
					0.8		pp = 200kPa		
					0.9				
	1			B	0.9				1
				U	1.0				
		- silty clay, very stiff to hard							
					1.2		pp = 300kPa		
11				D	1.5		pp > 400kPa		
	2								2
10									
				D	2.6		pp > 400kPa		
					2.9				
	3			B					3
	3.0	Pit discontinued at 3.0m (limit of investigation)			3.0				
9									

RIG: Cat 428C backhoe - 600mm bucket

LOGGED: Lackenby

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED
Initials:
Date:

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CONE PENETRATION TEST

CLIENT: ANGLICAN RETIREMENT VILLAGES

PROJECT: PROPOSED RETIREMENT VILLAGE

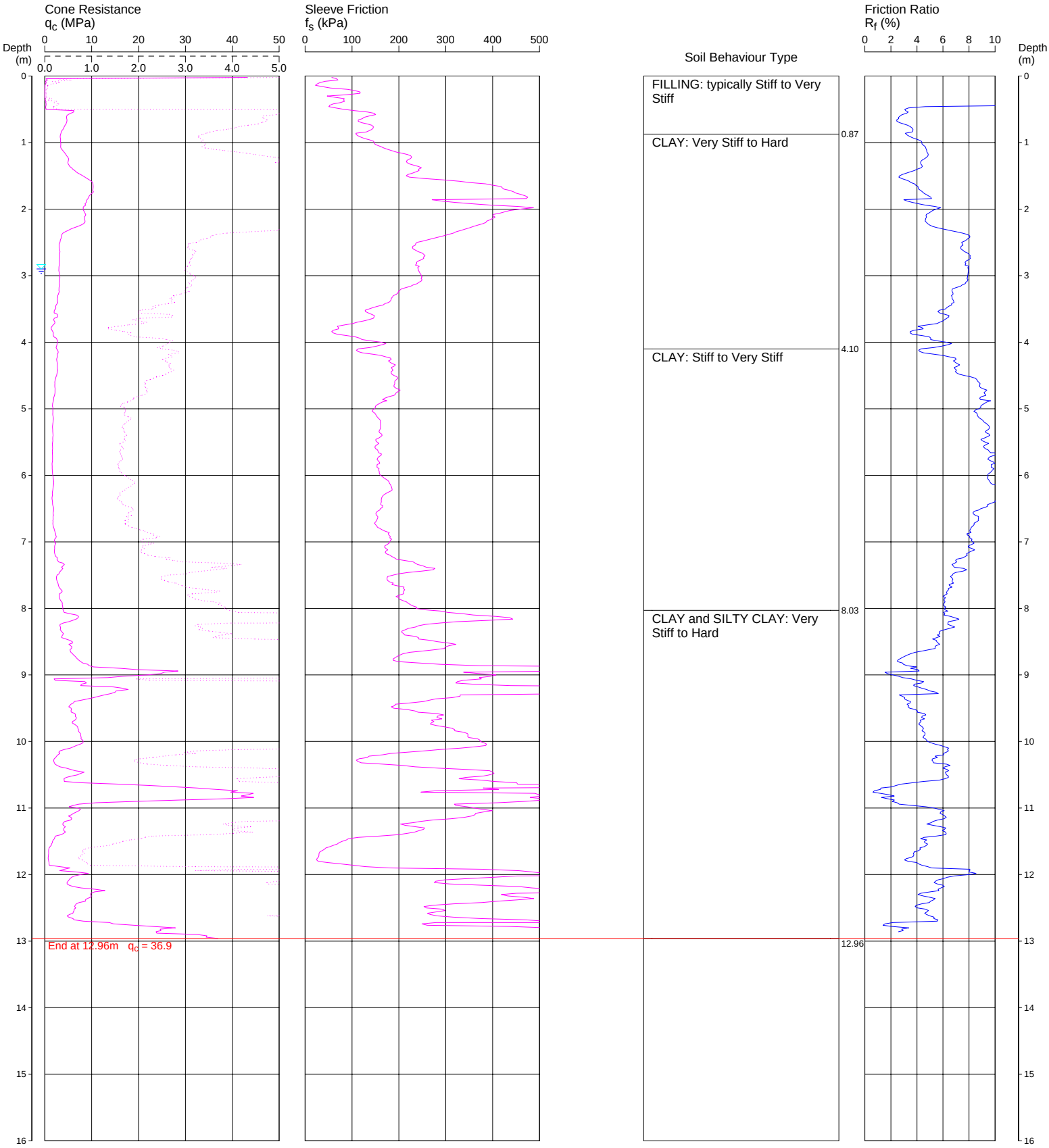
LOCATION: LOTS 1 & 2 DP 22431 STURDEE AVENUE, BULLI NSW

PROJECT No: 40618

CPT 407

DATE 3/07/2006

SURFACE RL: 12.8 AHD



REMARKS: GROUNDWATER AT 2.9 m AT COMPLETION OF TEST
DUMMY CONE TO 0.5m. TWO ATTEMPTS TO PENETRATE FILL AT THIS LOCATION

Date
Plotted
Checked

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Cone ID: CONE-H5 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: ANGLICAN RETIREMENT VILLAGES

PROJECT: PROPOSED RETIREMENT VILLAGE

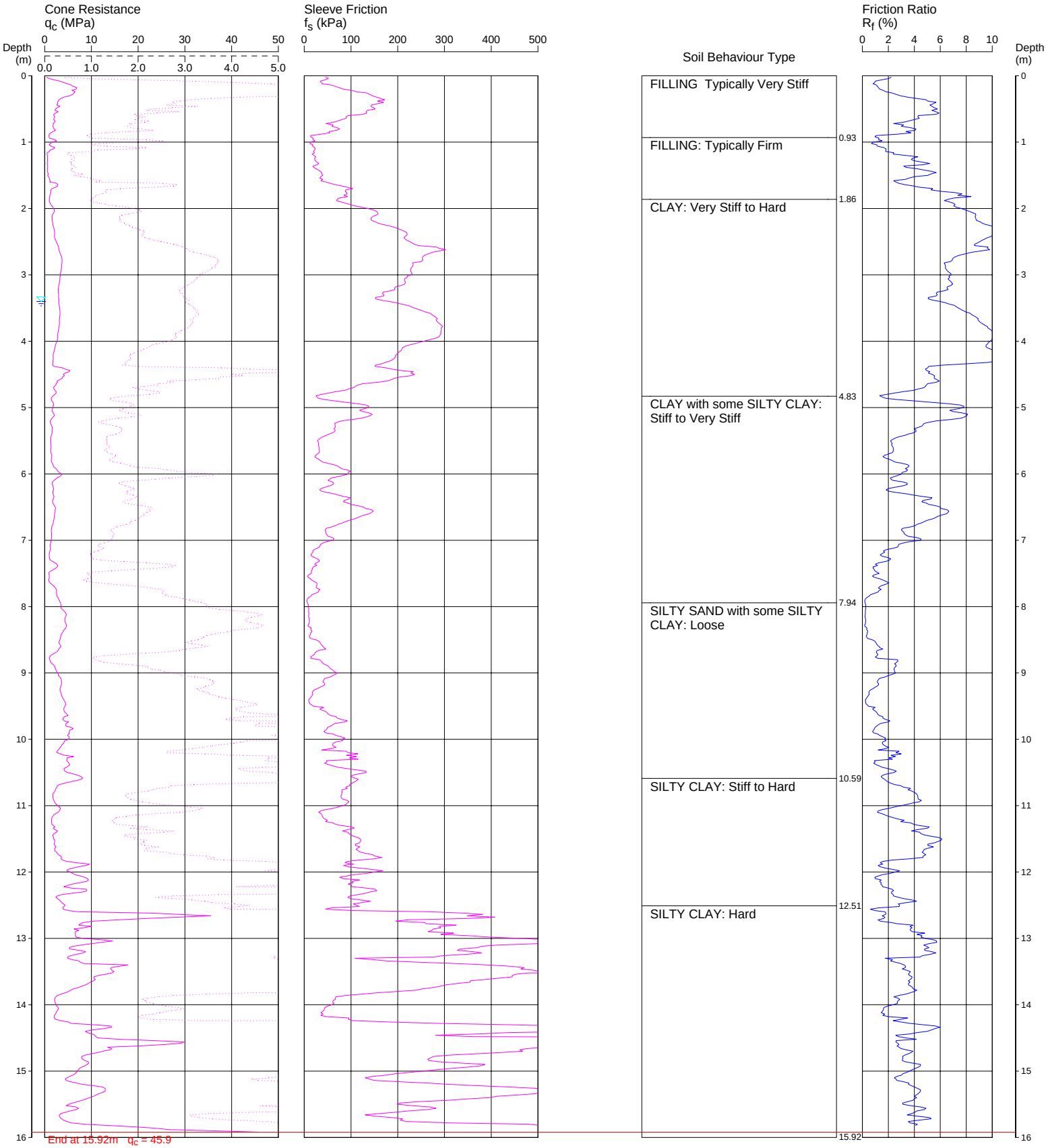
LOCATION: LOTS 1 & 2 DP 22431 STURDEE AVENUE, BULLI NSW

PROJECT No: 40618

CPT 408

DATE 3/07/2006

SURFACE RL: 11.3 AHD



REMARKS: GROUNDWATER AT 3.4 m AT COMPLETION OF TEST
THREE ATTEMPTS TO PENETRATE FILL AT THIS LOCATION

Date
Plotted
Checked

File: N:\GEOTECHNICAL PROJECTS\406\40618\Cone-GINT Files\40618408.CP5
Cone ID: CONE-H5 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: ANGLICAN RETIREMENT VILLAGES

PROJECT: PROPOSED RETIREMENT VILLAGE

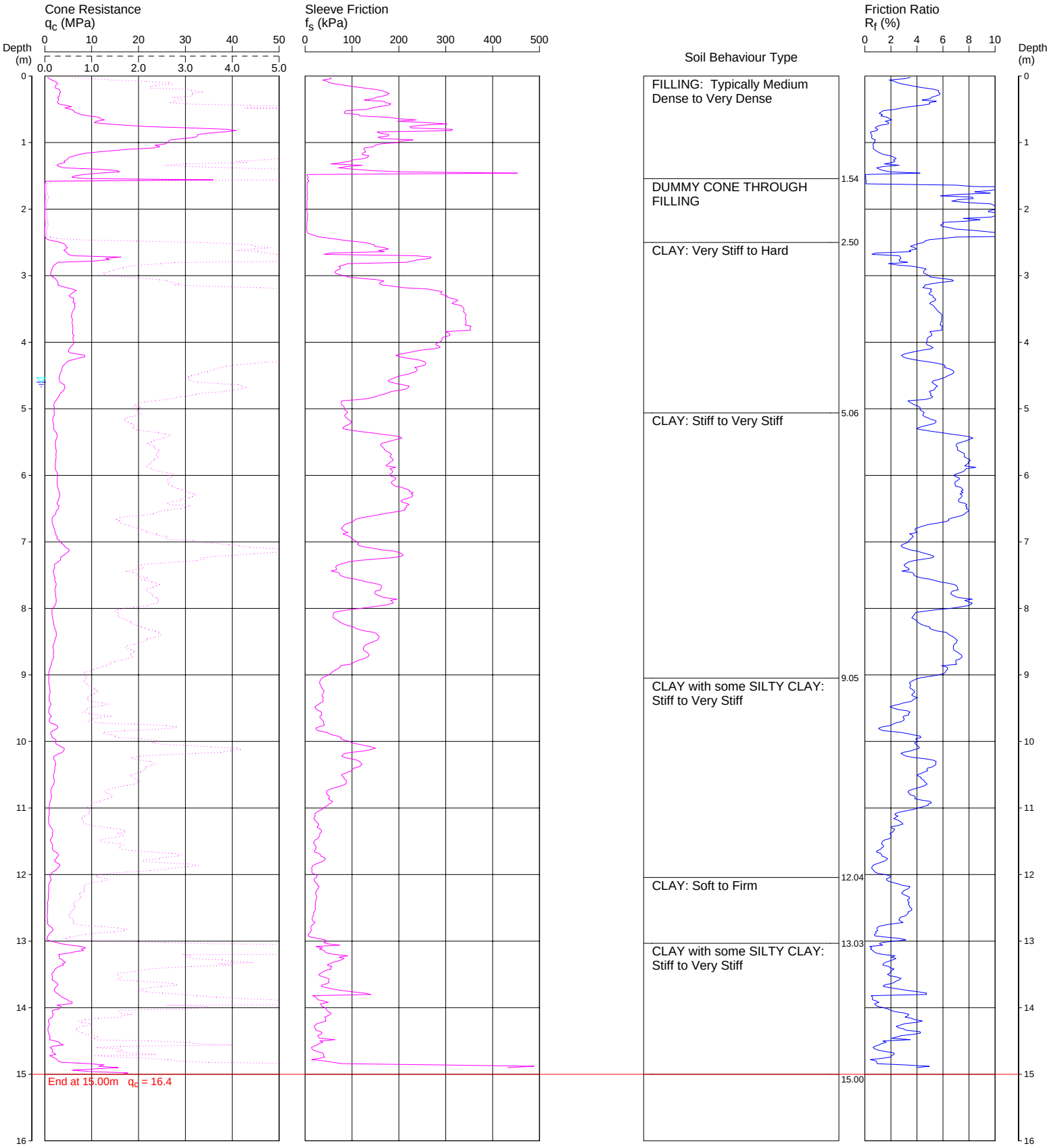
LOCATION: LOTS 1 & 2 DP 22431 STURDEE AVENUE, BULLI NSW

PROJECT No: 40618

CPT 409

DATE 3/07/2006

SURFACE RL: 11.2 AHD



REMARKS: GROUNDWATER AT 4.6 m AT COMPLETION OF TEST
DUMMY CONE TO 2.5 m

Date	
Plotted	
Checked	

File: N:\GEOTECHNICAL PROJECTS\406\40618\Cone-GINT Files\40618409.CP5
Cone ID: CONE-H5 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: ANGLICAN RETIREMENT VILLAGES

PROJECT: PROPOSED RETIREMENT VILLAGE

LOCATION: LOTS 1 & 2 DP 22431 STURDEE AVENUE, BULLI NSW

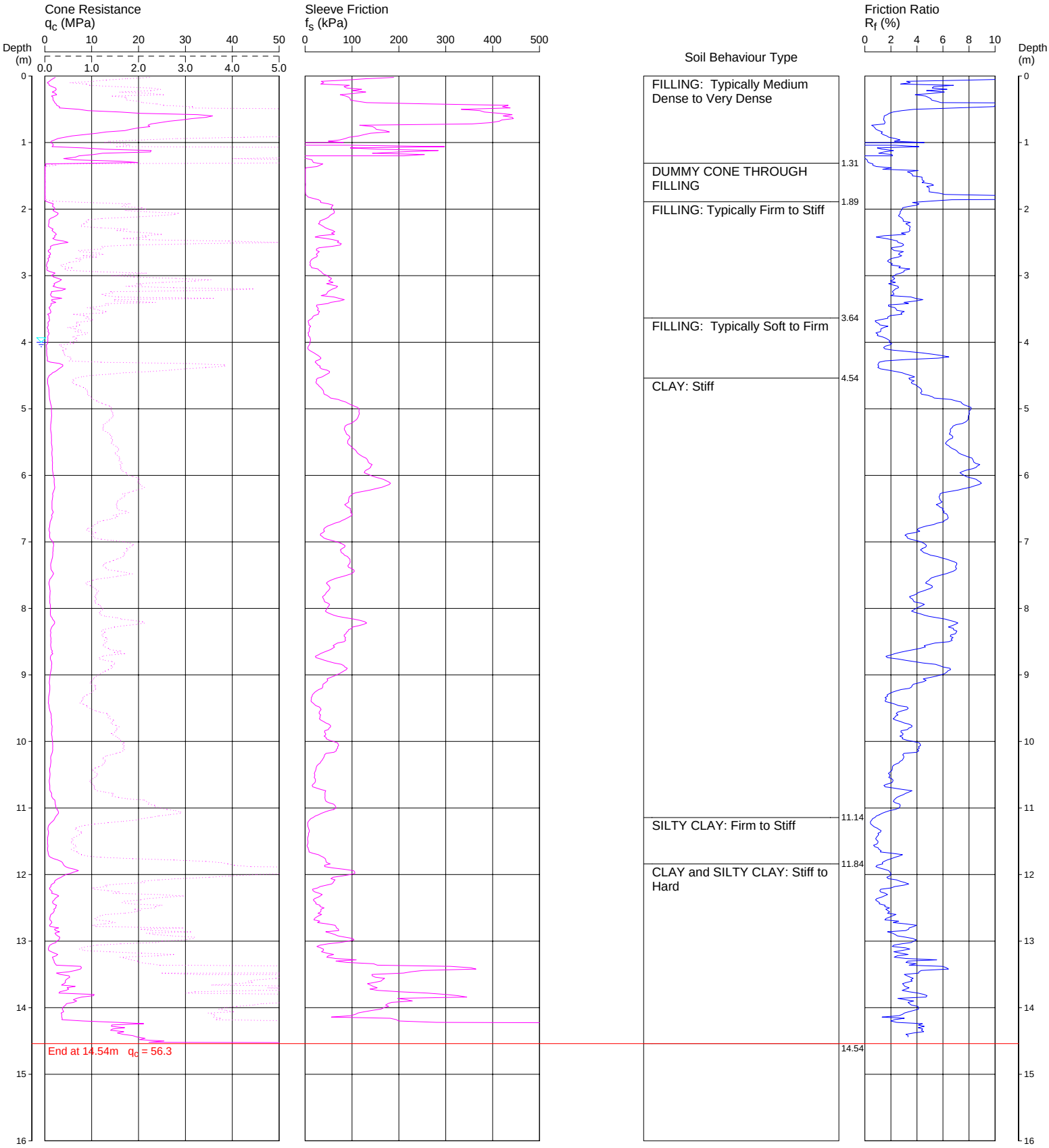
PROJECT No: 40618

CPT 410

Page 1 of 1

DATE 3/07/2006

SURFACE RL: 11.5 AHD



REMARKS: GROUNDWATER AT 4.0 m AT COMPLETION OF TEST
DUMMY CONE 1.3 - 2.0 m

Date
Plotted
Checked

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Cone ID: CONE-H5 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: ANGLICAN RETIREMENT VILLAGES

PROJECT: PROPOSED RETIREMENT VILLAGE

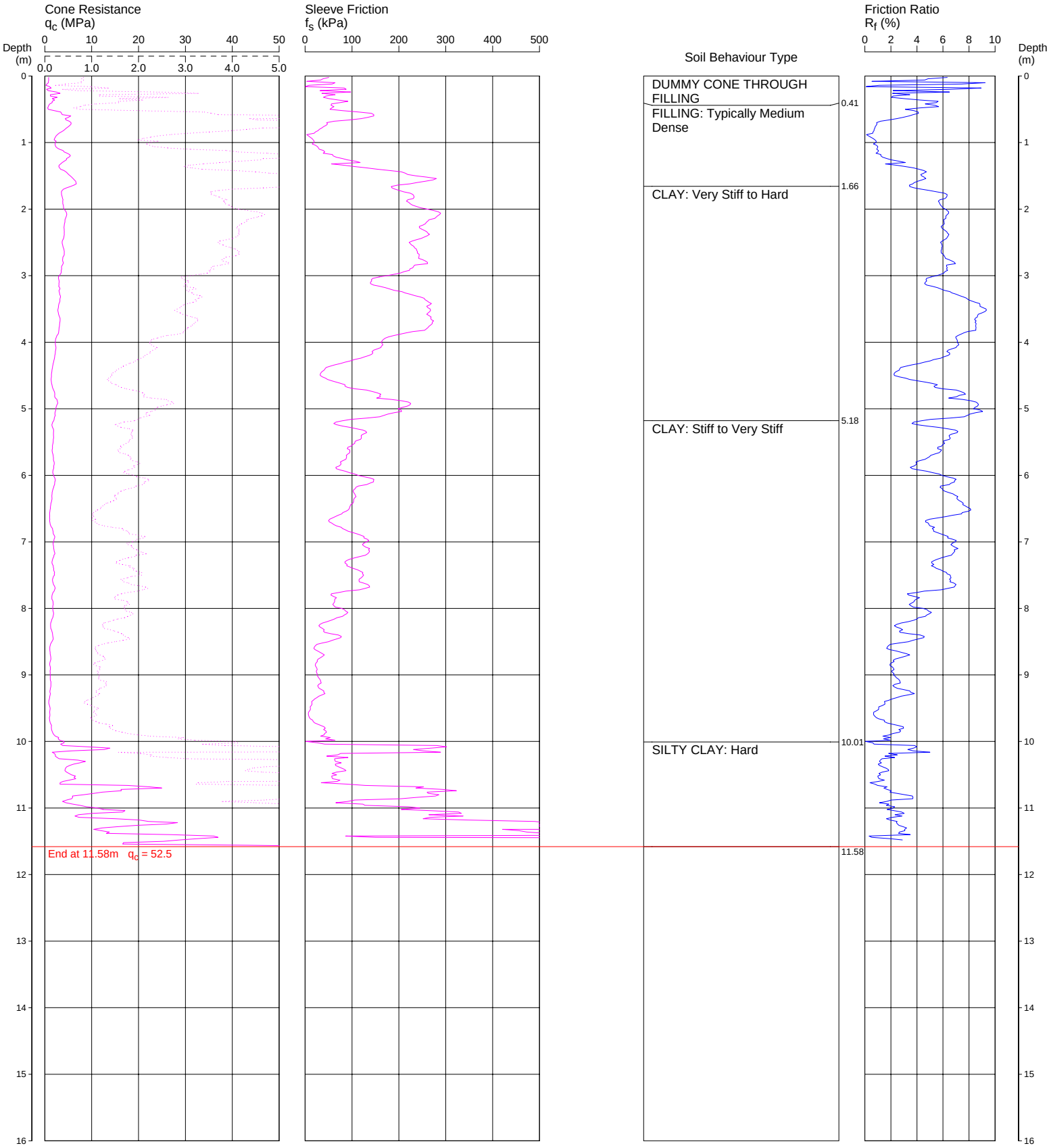
LOCATION: LOTS 1 & 2 DP 22431 STURDEE AVENUE, BULLI NSW

PROJECT No: 40618

CPT 411

DATE 3/07/2006

SURFACE RL: 11.7 AHD



REMARKS: HOLE COLLAPSED AT COMPLETION OF TEST
DUMMY CONE TO 0.6 m

Date	
Plotted	
Checked	

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Cone ID: CONE-H5 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: ANGLICAN RETIREMENT VILLAGES

PROJECT: PROPOSED RETIREMENT VILLAGE

LOCATION: LOTS 1 & 2 DP 22431 STURDEE AVENUE, BULLI NSW

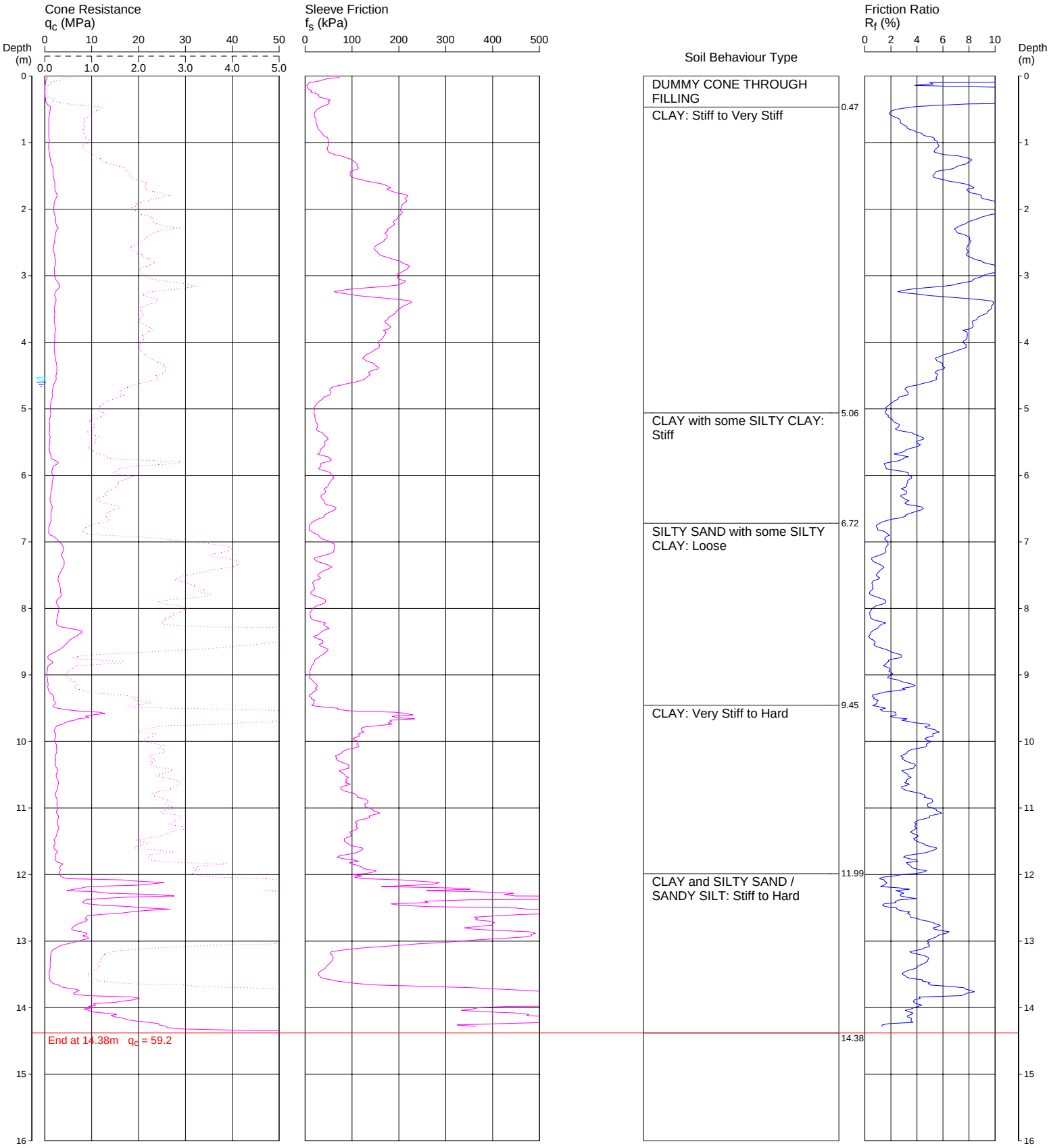
PROJECT No: 40618

CPT 412

Page 1 of 1

DATE 3/07/2006

SURFACE RL: 12.1 AHD



REMARKS: GROUNDWATER AT 4.6 m AT COMPLETION OF TEST
DUMMY CONE TO 0.5 m

Date
Plotted
Checked

File: N:\GEOTECHNICAL PROJECTS\406\40618\Cone-GINT Files\40618412.CP5
Cone ID: CONE-H5 **Type:** 2 Standard

ConePlot Version 5.8.1

Douglas Partners
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BOREHOLE LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 9.1 AHD
EASTING: 308563.1
NORTHING: 6199754.9
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
9	0.35	TOPSOIL - dark brown clayey silt topsoil with some roots and rootlets, damp										
		CLAY - stiff, light grey mottled light red brown slightly silty clay with trace sand, damp [RESIDUAL SOIL]										
8	1								S			4,5,8 N = 13
7	2	- very stiff, grey mottled red brown below 2.0m							S			5,8,8 N = 16
6	3											
5	4								S			8,16,15 N = 31
4	5											
3	6								S			7,12,16 N = 28
2	7	- hard, grey white mottled orange red brown below 7.0m							S			11,17,25/120mm refusal

RIG: E Grima **DRILLER:** Groundtest **LOGGED:** R Haselden **CASING:** HW to 2.5m
TYPE OF BORING: SFA (TC-bit) to 2.5m, rotary (water) to 10.41m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: AC
Date: 2/08

Douglas Partners
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BOREHOLE LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 9.1 AHD
EASTING: 308563.1
NORTHING: 6199754.9
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
0	9	CLAY - stiff, light grey mottled light red brown slightly silty clay with trace sand, damp [RESIDUAL SOIL] *(continued)*							S			11,18,23 N = 41
-1	10	- friable below 10.0m							S			15,25,25/110mm refusal
	10.41	Bore discontinued at 10.41m										
-2	11											
-3	12											
-4	13											
-5	14											
-6	15											

RIG: E Grima **DRILLER:** Groundtest **LOGGED:** R Haselden **CASING:** HW to 2.5m
TYPE OF BORING: SFA (TC-bit) to 2.5m, rotary (water) to 10.41m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: AL
Date: 2/08

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BOREHOLE LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 9.90 AHD
EASTING: 308596
NORTHING: 6199803.2
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 40618.01
DATE: 17-18/12/07
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.25	TOPSOIL - dark brown clayey silt topsoil with some roots and rootlets										
	0.65	SILTY CLAY - dark orange brown silty clay with trace roots and rootlets, damp										
1		CLAY - firm, grey mottled red brown clay with some sand and trace roots, damp [RESIDUAL SOIL]							S			3,3,4 N = 7
2		- grey white mottled orange red brown below 1.8m - stiff below 2.0m							S			2,4,5 N = 9
3												
4		- stiff to very stiff below 4.1m							S			4,7,10 N = 17
5												
6									S			4,5,7 N = 12
7		- friable with some gravel (siltstone) below 7.0m						Note: Unless otherwise stated, rock is fractured along smooth, planar, FeS and FeV joints and bedding planes	S			6,6,8 N = 14

RIG: Bobcat **DRILLER:** E Grima **LOGGED:** R Haselden **CASING:** HW to 2.8m
TYPE OF BORING: SFA (TC-bit) to 2.8m, rotary (water) to 11.10m, coring (NMLC) to 14.33m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▽ Water level

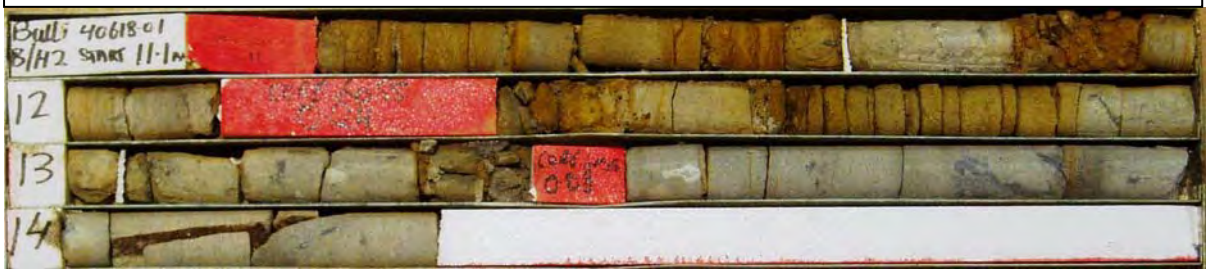
CHECKED
Initials: AL
Date: 4/08

Douglas Partners
Geotechnics · Environment · Groundwater

DOUGLAS PARTNERS PTY LTD

PROPOSED RETIREMENT VILLAGES – STURDEE AVENUE, BULLI

BORE: 2 DEPTH: 11.10m – 14.35m PROJECT: 40618.01 DEC 2007



BOREHOLE LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 9.90 AHD
EASTING: 308596
NORTHING: 6199803.2
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 40618.01
DATE: 17-18/12/07
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW Fs FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
1		CLAY - firm, grey mottled red brown clay with some sand and trace roots, damp										
		[RESIDUAL SOIL] *(continued)*										
		= light grey mottled orange brown below 8.5m							S			4,5,7 N = 12
9												
0	10	- very stiff below 10.0m							S			8,10,15 N = 25
	10.5	SANDSTONE - extremely low to very low strength, extremely to highly weathered, light yellow grey to light grey sandstone										
-1	11											
	11.1							11.1m: CORE LOSS: 120mm				
	11.22	SANDSTONE - extremely low to low strength, extremely to highly weathered, highly fractured, grey to yellow grey and yellow brown sandstone with some medium strength, fresh to moderately weathered bands							C	80	46	PL(A) = 0.2MPa
-2	12								C	95	68	
	12.14							12.14m: CORE LOSS: 240mm				
									C	73	40	
-3	12.93											PL(A) = 0.3MPa
	13	SANDSTONE - high becoming very high strength, slightly weathered to fresh, fractured, light grey sandstone							C	80	46	
	13.41							13.41m: CORE LOSS: 80mm				
-4	14								C	96	50	PL(A) = 3.4MPa
	14.33	Bore discontinued at 14.33m										
-5	15											
-6												

RIG: Bobcat **DRILLER:** E Grima **LOGGED:** R Haselden **CASING:** HW to 2.8m

TYPE OF BORING: SFA (TC-bit) to 2.8m, rotary (water) to 11.10m, coring (NMLC) to 14.33m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 4/08

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PROPOSED RETIREMENT VILLAGES – STURDEE AVENUE, BULLI

BORE: 3 DEPTH: 3.5m – 7.1m PROJECT: 40618.01 DEC 2007

BOREHOLE LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 15.7 AHD
EASTING: 308499.2
NORTHING: 6199780.2
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 40618.01
DATE: 19 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
15	0.3	TOPSOIL - dark brown silty topsoil with some clay, roots and rootlets, humid										
1		CLAY - stiff, light grey mottled light red brown clay, damp [RESIDUAL SOIL]							S			3,5,10 N = 15
14	1.9							Note: Unless otherwise stated, rock is fractured along smooth, planar, FeS joints				
2		SANDSTONE - extremely low strength, extremely weathered, grey mottled orange brown sandstone							S			11,17,28 N = 45
13												
3	3.5											
12		SANDSTONE - extremely low to very low strength, extremely to highly weathered, fractured, grey to yellow grey and orange brown sandstone							C	99	0	pp = 310-320kPa
4									C	95	0	pp > 600kPa pp = 190kPa pp > 600kPa
11								4.29m: Cl Co 60mm				
5								4.73-4.80m: fragmented	C	95	0	
10								5.25m: Cl Co 200mm				pp = 90-110kPa
6												pp = 280-450kPa pp = 350kPa
9								6.22m: Fe Co 2mm 6.40-6.62m: Cl Co 225mm	C	99	0	pp = 120-150kPa
7												pp > 600kPa
8	7.13	Bore discontinued at 7.13m										

RIG: Bobcat **DRILLER:** E Grima **LOGGED:** R Haselden **CASING:** HW to 2.5m

TYPE OF BORING: SFA (TC-bit) to 2.5m, rotary (water) to 3.5m, coring (NMLC) to 7.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 4/1/08

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BOREHOLE LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 18.4 AHD
EASTING: 308537
NORTHING: 6199821.8
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 40618.01
DATE: 18 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
18	0.2	TOPSOIL - dark brown slightly clayey silt topsoil with some roots and rootlets, humid to damp										
		CLAY - grey mottled light red brown clay, damp (RESIDUAL SOIL)										
17	1	= stiff, grey white mottled orange red brown below 0.6m							S			3,4,6 N = 10
	1.9	SANDSTONE - extremely low strength, extremely weathered, grey mottled orange brown sandstone										
16	2								S			9,17,19 N = 36
15	3											
14	4								S			11,21,25/100mm refusal
13	5											
									S			10,18,30 N = 48
12	5.95	Bore discontinued at 5.95m										
11	6											
	7											

RIG: E Grima **DRILLER:** Groundtest **LOGGED:** R Haselden **CASING:** -
TYPE OF BORING: SFA (TC-bit) to 5.5m
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▽ Water level

CHECKED
Initials: Av
Date: 2/08

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DOUGLAS PARTNERS PTY LTD

PROPOSED RETIREMENT VILLAGES – STURDEE AVENUE, BULLI

BORE: 5 DEPTH: 1.2m – 6.0m PROJECT: 40618.01 DEC 2007

BOREHOLE LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 26.2 AHD
EASTING: 308460.1
NORTHING: 6199826.4
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 40618.01
DATE: 20 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low / Very Low / Low / Medium / High / Very High / Ex High		0.01 / 0.05 / 0.10 / 0.50 / 1.00	B - Bedding J - Joint S - Shear D - Drill Break				
26	0.3	TOPSOIL - dark brown slightly clayey silt topsoil with some roots and rootlets, humid to damp						Note: Unless otherwise stated, rock is fractured along smooth, planar, FeS, subhorizontal and subvertical joints and bedding planes				
	0.5	CLAY - orange brown and brown clay with trace rootlets, damp										
	1	SANDSTONE - extremely low to very low strength, extremely to highly weathered, grey mottled orange brown sandstone							S			25/150mm,-,- refusal
25	1.2	SANDSTONE - high strength, slightly weathered, slightly fractured, yellow grey to grey sandstone							C	98	10	PL(A) = 1.7MPa
24	2											PL(A) = 0.2MPa
	2.0	SANDSTONE - low to medium strength, moderately to highly weathered, fractured to fragmented, grey to red brown sandstone										
	2.5	LAMINITE - extremely low to low strength, extremely to moderately weathered, highly fractured to fragmented, light to dark grey and orange brown laminite						2.5m: CORE LOSS: 140mm 2.64-2.70m: fragmented 2.82-3.00m: fragmented	C	64	0	PL(A) = 0.3MPa
23	3							3.16-3.19m: fragmented 3.27-3.31m: fragmented 3.38-3.41m: fragmented	C	78	0	
	3.81							3.61m: Cl Co 130-140mm 3.81m: CORE LOSS: 140mm				
22	4							3.95-4.30m: fragmented				
	4.36	SILTSTONE - very low to medum strength, moderately to highly weathered, highly fractured to fragmented, dark grey and orange brown siltstone						4.40-4.60m: fragmented 4.68-4.80m: fragmented 4.85-4.90m: fragmented 5.10-5.35m: fragmented	C	88	0	PL(A) = 0.1MPa
21	5											
	5.31	SILTSTONE - low to medium strength, slightly to moderately weathered, fractured, dark grey and orange brown siltstone							C	98	29	PL(A) = 0.6MPa
	6											
20	6.0	Bore discontinued at 6.0m										
	7											
19												

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** R Haselden **CASING:** HW to 1.2m

TYPE OF BORING: SFA (TC-bit) to 1.20m, coring (NMLC) to 6.00m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 2/08

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TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 10.5 AHD
EASTING: 308524.7
NORTHING: 6199744.9
DIP/AZIMUTH: 90°/--

PIT No: 6
PROJECT No: 40618.01
DATE: 12 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL - soft to firm, dark brown silty clay topsoil with some roots and rootlets, damp to wet		pp	0.2		pp = 140kPa		
	0.25	CLAY - stiff, red brown clay with trace coarse gravel (siltstone), damp - trace rootlets between 0.25 - 2.0m		D	0.5		pp = 210-290kPa		
10		- light grey mottled red brown below 0.8m		D	1.0		pp = 230-310kPa		1
9				D	1.5		pp = 210-320kPa		
8	2	- white mottled red brown below 2.0m		D	2.0		pp = 180-270kPa		2
7	3 3.0	Pit discontinued at 3.0m		D	3.0		pp = 220-230kPa		3

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: Minor seepage at 3.0m and seepage out of topsoil at boundary

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 4/08

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TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 8.7 AHD
EASTING: 308581.1
NORTHING: 6199764.2
DIP/AZIMUTH: 90°/--

PIT No: 7
PROJECT No: 40618.01
DATE: 12 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
8	0.3	TOPSOIL - soft to firm, dark brown silty clay topsoil with some roots and rootlets, damp							
		SANDY CLAY - stiff, red brown sandy clay, damp. Trace rootlets between 0.3 - 1.0m							
		- very stiff below 0.6m		U	0.5				
					0.9		pp = 350-360kPa		
1				D	1.0		pp = 230-340kPa		1
				D	1.5		pp = 260-340kPa		
7	1.9	CLAY - very stiff, mid to dark grey mottled red brown clay, damp							
2	2.5	Pit discontinued at 2.5m (very slow progress)		D	2.5		pp = 310-420kPa		2
6									3
3									
5									

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: Minor seepage from topsoil at boundary

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 4/08

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TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 8.0 AHD
EASTING: 308627.2
NORTHING: 6199784
DIP/AZIMUTH: 90°/--

PIT No: 8
PROJECT No: 40618.01
DATE: 12 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
8		TOPSOIL - soft to firm, dark brown silty clay topsoil with some roots and rootlets, damp							5 10 15 20
	0.3	CLAY - stiff to very stiff, brown grey mottled red brown clay with trace rootlets, damp		B	0.5 0.6		pp = 170-250kPa		
7	1	- becoming light grey mottled red brown below 1.0m		D	1.0		pp = 340-350kPa		1
	1.2	SANDY CLAY - very stiff, light grey mottled red brown sandy clay with some gravel sized pockets of sand, damp		D	1.6		pp = 280-310kPa		
6	2								2
	2.0	CLAY - very stiff to hard, grey mottled dark red brown clay, damp		D	2.1		pp = 350-410kPa		
	2.6	Pit discontinued at 2.6m (very slow progress)		D	2.6		pp = 250-410kPa		
5	3								3

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: Very slight seepage at 2.6m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 9.7 AHD
EASTING: 308599.6
NORTHING: 6199804.3
DIP/AZIMUTH: 90°/--

PIT No: 9
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL - soft to firm, dark brown clayey silt topsoil with some roots and rootlets, damp		pp	0.2		pp = 60kPa		
	0.4	CLAY - stiff, red brown clay, damp - trace rootlets between 0.4 - 0.6m			0.6				
				U					
		- grey mottled red brown below 0.8m		pp	0.8		pp = 220-240kPa		
	1	- very stiff below 1.0m		D	1.0		pp = 250-370kPa		1
				D	1.5		pp = 280-340kPa		
		- light grey mottled red brown below 1.7m							
	2			D	2.1		pp = 150-210kPa		2
	3	3.0 Pit discontinued at 3.0m		D	3.0		pp = 150-190kPa		3

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: Minor water inflow from the topsoil at the boundary

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 4/08

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TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 11.5 AHD
EASTING: 308572.5
NORTHING: 6199798
DIP/AZIMUTH: 90°/--

PIT No: 10
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL - soft to firm, dark brown clayey silt topsoil with some roots and rootlets, damp							
	0.4	CLAY - stiff, dark red brown clay, damp - trace roots and rootlets between 0.4 - 0.6m		D	0.5		pp = 260-460kPa		
11		- light brown grey mottled light red brown below 0.6m							
	1			D	1.0		pp = 260-300kPa	1	
		- light grey mottled red brown with trace root remains below 1.2m (RESIDUAL)							
10				D	1.5		pp = 250-350kPa		
	2			D	2.0		pp = 270-350kPa	2	
9		- trace medium gravel below 2.5m							
	2.8	Pit discontinued at 2.8m (slow progress)		D	2.8		pp = 250-380kPa		
	3							3	
8									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 11.2 AHD
EASTING: 3085582.5
NORTHING: 6199779
DIP/AZIMUTH: 90°/--

PIT No: 11
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
11		TOPSOIL - soft to firm, dark brown clayey silt topsoil with some roots and rootlets, damp							
	0.35	CLAY - stiff, dark red brown and grey clay, damp - trace roots between 0.35 - 0.5m		D	0.6 0.65		pp = 190-250kPa		
		- light grey mottled light red brown below 0.8m		U					
10	1			pp	1.05		pp = 270-280kPa		1
				D	1.5		pp = 220-250kPa		
		- white mottled red brown below 1.9m							
9	2								2
		- some medium to coarse gravel (extremely low strength sandstone) below 2.2m							
	2.5	Pit discontinued at 2.5m (slow progress)		D	2.5		pp = 270-280kPa		
8	3								3

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: Water seepage from topsoil at boundary. Water inflow at 2.0m, stopped 30 seconds later.

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: tv
Date: 2/08

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TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 16.2 AHD
EASTING: 308531.6
NORTHING: 6199803.3
DIP/AZIMUTH: 90°/--

PIT No: 12
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
16	0.25	TOPSOIL - soft to firm, grey brown clayey silt topsoil with some roots and rootlets, moist to damp							
		CLAY - stiff, red brown clay, damp - trace roots between 0.25 - 0.4m		D	0.5		pp = 370-380kPa		
		- light grey mottled light red brown below 0.7m							
15	1	- very stiff below 0.9m		D	1.0		pp = 360-400kPa		1
		- friable below 1.4m (RESIDUAL SOIL)		D	1.5				
14	2			D	2.0				2
		- very low strength sandstone bands below 2.4m		D	2.5				
	2.6	Pit discontinued at 2.6m (slow progress)							
13	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 2/5

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TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 13.6 AHD
EASTING: 308504.3
NORTHING: 6199767.4
DIP/AZIMUTH: 90°/--

PIT No: 13
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL - soft to firm, mid to dark brown clayey silt topsoil with some roots and rootlets, moist		D	0.2				
	0.4	CLAY - stiff, red brown clay, damp							
					0.6				
		- light grey mottled red brown below 0.7m		U					
				pp	0.85		pp = 240-290kPa		
		- white mottled red brown below 1.4m		D	1.5		pp = 260-360kPa		
		- some sandstone, gravel and cobbles below 1.8m							
				D	2.0		pp = 260-300kPa		
	2.45	SANDSTONE - extremely low to very low strength, highly to extremely weathered, white and light red brown sandstone		D	2.5				
	2.55	Pit discontinued at 2.55m (slow progress)							

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 2/08

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 17.6 AHD
EASTING: 308471.6
NORTHING: 6199788.9
DIP/AZIMUTH: 90°/--

PIT No: 14
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
17	0.2	CLAY - firm, grey brown clay with roots and rootlets, moist to damp							
		CLAY - stiff, white mottled red brown clay, damp							
		- very stiff below 0.3m		D	0.5		pp = 270-280kPa		
	1	- hard, below 0.9m		D	1.1		pp > 600kPa		
		- friable with bands of sandstone/siltstone below 1.4m		D	1.5				
16	2			D	2.0				
	2.2	SILTSTONE - very low to low strength, moderately weathered, grey siltstone with bands of clay							
	2.3	Pit discontinued at 2.3m (very slow progress)							
15	3								
14									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U$_x$	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 2/08

Douglas Partners
Geotechnics · Environment · Groundwater

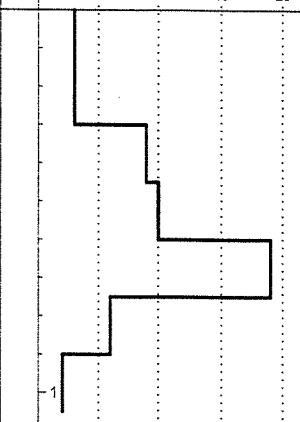
TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 26.6 AHD
EASTING: 308484.1
NORTHING: 6199831
DIP/AZIMUTH: 90°/--

PIT No: 15
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL - soft to firm, brown silt topsoil with some clay, moist							
	0.2	SANDSTONE - extremely low to very low strength, highly to extremely weathered, grey to red brown sandstone. Recovered as slightly cobbly sand with some clay and boulders (POSSIBLE FILL)		D	0.5				
				D	1.1				
	1.4								
	1.45	SANDSTONE - medium strength, slightly weathered, light grey sandstone							
		Pit discontinued at 1.45m (refusal)							



RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 4/08

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TEST PIT LOG

CLIENT: Anglican Retirement Village
PROJECT: Proposed Retirement Village
LOCATION: Lot 2 DP224431 Sturdee Avenue, Bulli

SURFACE LEVEL: 27.8 AHD
EASTING: 308464.1
NORTHING: 6199842.3
DIP/AZIMUTH: 90°/--

PIT No: 16
PROJECT No: 40618.01
DATE: 17 Dec 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
27	0.3	TOPSOIL - soft to firm, dark brown silt topsoil with some clay, roots and rootlets, moist							
		CLAY - firm, light red brown clay, damp							
		- very soft between 0.45 - 0.75m			0.5				
		- light red grey mottled light brown below 0.6m		U					
		- stiff below 0.75m			0.85				
1				D	1.2				1
		- light grey and friable below 1.5m		D	1.5				
26	1.9	SILTSTONE - low to medium strength, slightly weathered, light grey siltstone							
2	2.0	Pit discontinued at 2.0m (very slow progress)							2
25									
3									3
24									

Dynamic Penetrometer Test (blows per 150mm): 5 10 15 20

RIG: Yanmar ViO 40

LOGGED: R Haselden

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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Appendix C

Colour Photoplates

Photo 1 – View north along proposed alignment of Geraghty Street.

Photo 2 – View south along proposed alignment of Geraghty Street towards Tramway Creek.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 3 – General view of existing structures.

Photo 4 – General view of existing structures.

Douglas Partners Geotechnics | Environment | Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 5 – View along southern section of the site. Batter to Tramway Creek to the right of the stand of trees.

Photo 6 – General view of existing structures.

Douglas Partners Geotechnics | Environment | Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 7 – General view of existing structures.

Photo 8 – Batter in filling leading to Tramway Creek.

Douglas Partners Geotechnics | Environment | Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 9 – View of MW03 (damaged).

Photo 10 – General view of existing structures.

Douglas Partners Geotechnics | Environment | Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 11 – Batter in filling leading to lower central area between the Ocean View and Village Centre Precincts.

Photo 12 – General view of existing structures.

Photo 13 – View of near-level area between the Hilltop and Village Centre Precincts.

Photo 14 – View east in central section of the site.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 15 – View south-east from the proposed Geraghty Road alignment along drainage depression.

Photo 16 – View of the southern section of the proposed Hilltop Precinct.

Douglas Partners Geotechnics | Environment | Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 17 – View of the former quarry in the north-western section of the proposed Ocean View Precinct.

Photo 18 – Fill mound of likely quarry spoil in the southern section of the proposed Ocean View Precinct.

Photo 19 – View of proposed Ocean View Precinct from the northern boundary.

Photo 20 – View west along the northern boundary.

Douglas Partners Geotechnics | Environment | Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 21 – View of existing structures in the north-western section of the site (Hilltop Precinct).

Photo 22 – View south along Geraghty Street.

Douglas Partners Geotechnics | Environment | Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 23 – 1.5 – 2m high cut batter exposing residual soils.

Photo 24 – 3 m high cut batter exposing residual soils overlying medium strength sandstone.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Photo 25 – Concrete pieces on the surface.

Photo 26 – Concrete pieces surface of batter probably formed with uncontrolled filling.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	40618.02
	Proposed Seniors Living Development	PLATE No:	
	Lots 2 & 3 DP1176767 Geraghty St, Bulli	REV:	
	CLIENT: Anglicare	DATE:	26.6.2018

Appendix D

Laboratory Test Report Sheets

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

Unit 1, 1 Luso Drive
Unanderra NSW 2526
Australia

PO Box 486
Unanderra NSW 2526

Phone (02) 4271 1836
Fax: (02) 4271 1897
wollongong@douglaspartners.com.au

RESULTS OF MOISTURE CONTENT, PLASTICITY AND LINEAR SHRINKAGE TESTS

Client: ANGLICAN RETIREMENT VILLAGES C/- EVENT PROJECT MANAGEMENT
Project: PROPOSED RETIREMENT VILLAGE
Location: LOTS 1 & 2 DP 224431 STURDEE AVENUE, BULLI

Project No: 40618
Report No: UL06-083A
Report Date: 12/7/06
Date Sampled: 3/7/06
Date of Test: 5/7/06
Page: 1 of 1

TEST LOCATION	DEPTH (m)	DESCRIPTION	CODE	W_F %	W_L %	W_P %	PI %	*LS %
405	1.2-1.3	Black brown silty sandy clay (CL)	2,3,5	12.2	32	19	13	5.0
403	0.5-0.6	Brown gravelly silty clay (CH)	2,3,5	16.8	53	16	37	11.0

Legend:
W_F Field Moisture Content
W_L Liquid limit
W_P Plastic limit
PI Plasticity index
LS Linear shrinkage from liquid limit condition (Mould length 125mm)

Test Methods:
Moisture Content: AS 1289 2.1.1 - 2005
Liquid Limit: AS 1289 3.1.2 - 1995, ~~3.1.1 - 1995~~
Plastic Limit: AS 1289 3.2.1 - 1995
Plasticity Index: AS 1289 3.3.1 - 1995
Linear Shrinkage: AS 1289 3.4.1 - 1995
Cone Liquid Limit: ~~AS 1289 3.9.1 - 2002~~ ~~AS 1289.1.3.1 - 1999~~

Code
Sample history for plasticity tests
1. Air dried
2. Low temperature (<50°C) oven dried
3. Oven (105°C) dried
4. Unknown

Method of preparation for plasticity tests
5. Dry sieved
6. Wet sieved
7. Natural

*Specify if sample crumbled CR or curled CU

Sampling Method(s): AS 1289.1.2.1 (6.5.4) - 1998, AS 1289.1.1-2001

Remarks:

Approved Signatory:

Tested: JR, RD
Checked: DE

David Evans
Laboratory Manager

NATA Accredited Laboratory Number: 828
NATA endorsed test report. This document shall not be reproduced, except in full.

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Douglas Partners Pty Ltd
ABN 75 053 980 117
PO Box 486
Unanderra NSW 2526
Australia

Unit 1 /1 Luso Drive
Unanderra NSW 2526
Phone (02) 4271 1836
Fax: (02) 4271 1897
wollongong@douglaspartners.com.au

RESULT OF SHRINK-SWELL INDEX DETERMINATION

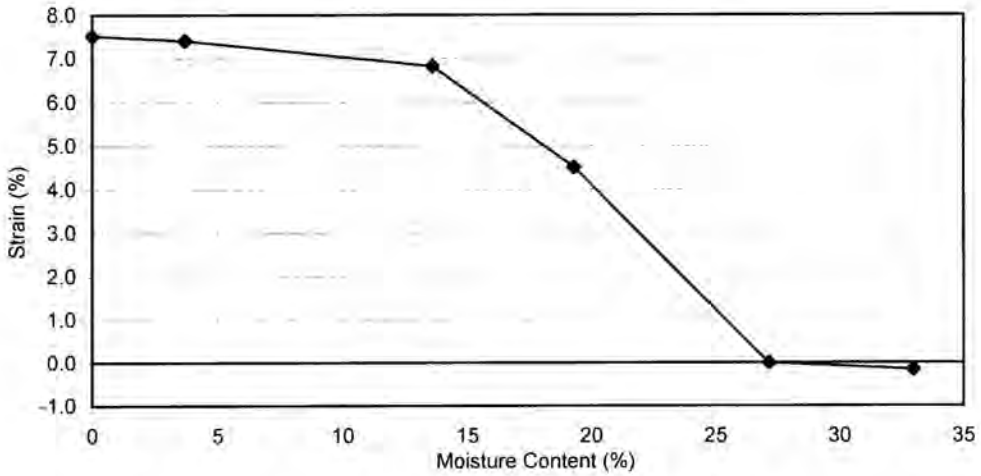
Client :	ANGLICAN RETIREMENT VILLAGES C/- EVENT PROJECT MANAGEMENT	**Project No. :**	40618
		Report No. :	UL06-083B
Project :	Proposed Retirement Village	**Report Date :**	12/07/2006
		Date Sampled :	3/07/2006
Location :	Lots 1 & 2 DP 224431 Sturdee Avenue, Bulli	**Date of Test:**	6/07/2006
Test Location :	406		
Depth / Layer :	0.9-1.2m	**Page:**	1 of 1

CORE SHRINKAGE TEST

Shrinkage - air dried	7.4 %
Shrinkage - oven dried	7.5 %
Significant inert inclusions	0.0 %
Extent of cracking	UC
Extent of soil crumbling	0.0 %
Moisture content of core	27.1 %

SWELL TEST

Pocket penetrometer reading at initial moisture content	100 kPa
Pocket penetrometer reading at final moisture content	590 kPa
Initial Moisture Content	33.0 %
Final Moisture Content	33.0 %
Swell under 25kPa	0.2 %



SHRINK-SWELL INDEX Iss 4.2% per Δ pF

Description: Brown silty clay

Test Method(s): AS 1289.7.1.1 - 2003, AS 1289.2.1.1 - 2005

Sampling Method(s): AS 1289.1.3.1-1999

Extent of Cracking:
UC - Uncracked
SC - Slightly cracked
MC - Moderately cracked
HC - Highly cracked
FR - Fractured

Remarks:

Tested:	DE, RD
Checked:	DE

David Evans
Laboratory Manager

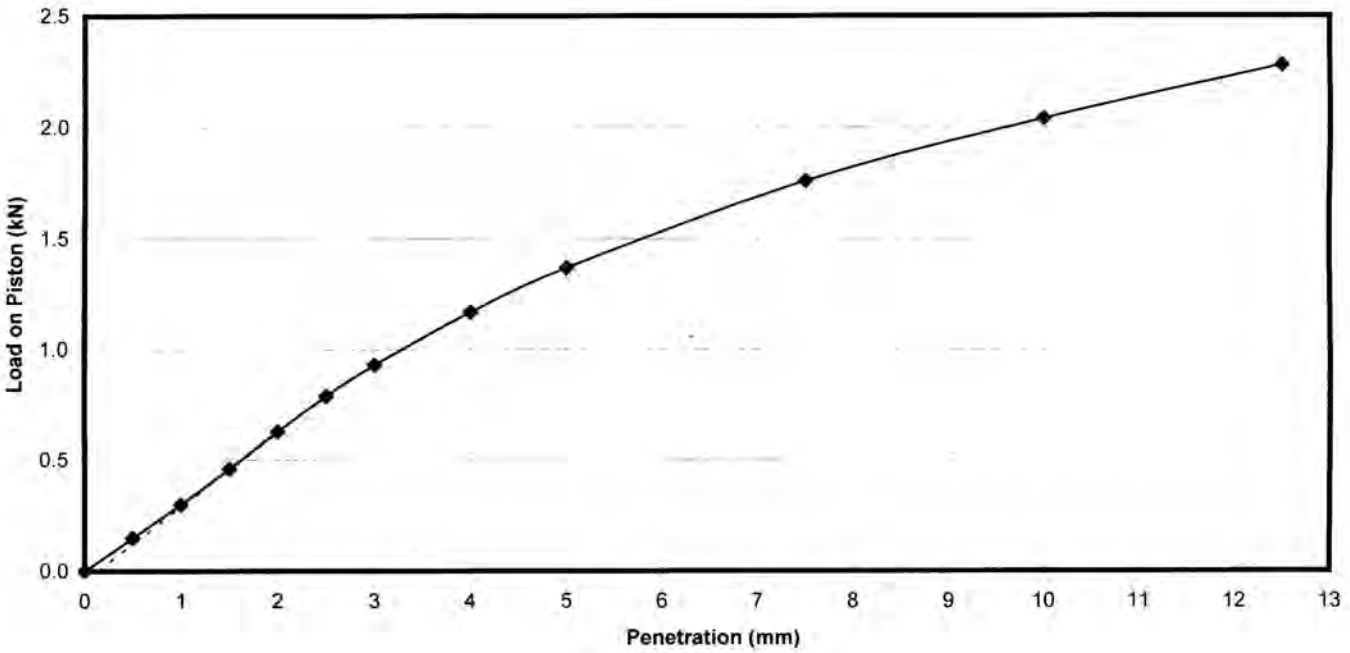
Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
PO Box 486
Unanderra NSW 2526
Australia

Unit 1/1 Luso Drive
Unanderra NSW 2526
Phone (02) 4271 1836
Fax: (02) 4271 1897
wollongong@douglaspartners.com.au

RESULT OF CALIFORNIA BEARING RATIO TEST

Client :	ANGLICAN RETIREMENT VILLAGES C/- EVENT PROJECT MANAGEMENT	**Project No. :**	40618
		Report No. :	UL06-083C
Project :	Proposed Retirement Village	**Report Date :**	12/07/2006
		Date Sampled :	3/07/2006
Location :	Lots 1 & 2 DP 224431 Sturdee Avenue, Bullli	**Date of Test:**	6/07/2006
Test Location :	402		
Depth / Layer :	0.7-0.8m	**Page:**	1 of 1



Description: Brown silty clay

Test Method(s): AS 1289.6.1.1-1998, AS 1289.2.1.1-2005

Sampling Method(s): AS 1289.1.2.1 (6.5.4) - 1998, AS 1289.1.1-2001 **Percentage > 19mm:** 0.0%

LEVEL OF COMPACTION: 100% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 0.9%
MOISTURE RATIO: 101% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		14.1	1.89
After soaking		15.8	1.88
After test	Top 30mm of sample	18.0	-
	Remainder of sample	14.8	-
Field values		15.5	-
Standard Compaction		14.0	1.90

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**6**
	5.0 mm	**7**

NATA Accredited Laboratory Number 828

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Approved Signatory:

Tested:	AT, DE
Checked:	DE

David Evans
Laboratory Manager

Envirolab Services Pty Ltd
ABN 37 112 535 645
54 Frenchs Rd Willoughby NSW 2068
ph 02 9958 5801 fax 02 9958 5803
email: tnotaras@envirolabservices.com.au

CERTIFICATE OF ANALYSIS 6099

Client:
Douglas Partners Unanderra
Unit 1, 1 Luso Drive
Unanderra
NSW 2526

Attention: Joanne Lackenby

Sample log in details:

Your Reference:	**40618, Proposed Retirement Village**
No. of samples:	2 Soils
Date samples received:	05/07/06
Date completed instructions received:	05/07/06

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by:	12/07/06
Date of Preliminary Report:	Not Issued
Issue Date:	11/07/06

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Accredited for compliance with ISO/IEC 17025.
Tests not covered by NATA are denoted with *.

Results Approved By:

Jacinta Hurst
Operations Manager

Miscellaneous Inorg - soil			
Our Reference:	UNITS	6099-1	6099-2
Your Reference	----------	401/1.0	405/1.2-1.3
Type of sample	----------	Soil	Soil
pH 1:5 soil:water	pH Units	4.4	8.1
Sulphate, SO4 1:5 soil:water	mg/kg	87	160
Chloride 1:5 soil:water	mg/kg	<100	<100

Method ID	Methodology Summary
LAB.1	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
LAB.9	Sulphate determined turbidimetrically.
LAB.11	Chloride determined by argentometric titration.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
pH 1:5 soil:water	pH Units		LAB.1	[NT]	6099-1	4.4 || 4.3 || RPD: 2	[NR]	[NR]
Sulphate, SO4 1:5 soil:water	mg/kg	25	LAB.9	<25	6099-1	87 || 110 || RPD: 23	6099-2	75%
Chloride 1:5 soil:water	mg/kg	100	LAB.11	<100	6099-1	<100 || <100	[NR]	[NR]

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
pH 1:5 soil:water	pH Units	[NT]	[NT]	LCS	100%
Sulphate, SO4 1:5 soil:water	mg/kg	[NT]	[NT]	LCS	97%
Chloride 1:5 soil:water	mg/kg	[NT]	[NT]	LCS	105%

Report Comments:

INS: Insufficient sample for this test	NT: Not tested	PQL: Practical Quanitation Limit
RPD: Relative Percent Difference	NA: Test not required	LCS: Laboratory Control Sample
NR: Not requested	<: Less than	>: Greater than

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample): This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria:

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 20-140% for SVOC and speciated phenols is acceptable. Surrogates: Generally 60-140% is acceptable.

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Douglas Partners Pty Ltd
ABN 75 053 980 117
Unit 1, 1 Luso Drive
Unanderra NSW 2526
Australia

PO Box 486
Unanderra NSW 2526
Phone (02) 4271 1836
Fax: (02) 4271 1897
wollongong@douglaspartners.com.au

RESULTS OF MOISTURE CONTENT, PLASTICITY AND LINEAR SHRINKAGE TESTS

Client:	**ANGLICAN RETIREMENT VILLAGES C/- EVENT PROJECT MANAGEMENT PTY LTD**	**Project No:**	40618.01
		Report No:	UL08-006A
Project:	PROPOSED RETIREMENT VILLAGE	**Report Date:**	9/1/08
		Date Sampled:	17/12/07
Location:	LOT 2 DP224431 STURDEE AVENUE, BULLI	**Date of Test:**	20/12/07
		Page:	1 of 1

TEST LOCATION	DEPTH (m)	DESCRIPTION	CODE	W_F %	W_L %	W_P %	PI %	*LS %
Pit 9	1.0	Brown clay (CH)	2,3,5	36.5	82	32	50	11.5
Pit 13	1.5	Brown clay (CH)	2,3,5	27.1	75	24	51	15.5
Pit 14	0.5	Brown clay (CH)	2,3,5	28.5	83	22	61	11.0

Legend:
W_F Field Moisture Content
W_L Liquid limit
W_P Plastic limit
PI Plasticity index
LS Linear shrinkage from liquid limit condition (Mould length 125mm)

Test Methods:
Moisture Content: AS 1289 2.1.1 - 2005
Liquid Limit: AS 1289 3.1.2 - 1995, ~~3.1.1 - 1995~~
Plastic Limit: AS 1289 3.2.1 - 1995
Plasticity Index: AS 1289 3.3.1 - 1995
Linear Shrinkage: AS 1289 3.4.1 - 1995
Cone Liquid Limit: ~~AS 1289 3.9.1 - 2002~~ ~~AS 1289.1.3.1 - 1999~~

Code
Sample history for plasticity tests
1. Air dried
2. Low temperature (<50°C) oven dried
3. Oven (105°C) dried
4. Unknown

Method of preparation for plasticity tests
5. Dry sieved
6. Wet sieved
7. Natural

*Specify if sample crumbled CR or curled CU

Sampling Method(s): Sampled by Wollongong Engineering Department

Remarks:

Approved Signatory:

Tested: JM, RD
Checked: TZ

David Evans
Laboratory Manager

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025
ACCREDITED FOR TECHNICAL COMPETENCE

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
Po Box 486 Unanderra
NSW 2526
Australia

Unit 1/1 Luso Drive
Unanderra NSW 2526
Phone (02) 4271 1836
Fax: (02) 4271 1897
wollongong@douglaspartners.com.au

RESULT OF SHRINK-SWELL INDEX DETERMINATION

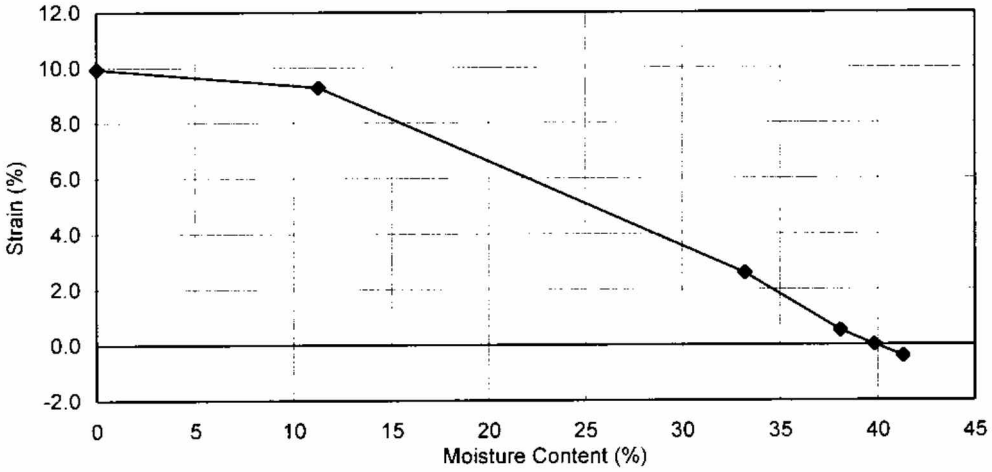
Client :	Anglican Retirement Villages C/- Event Project Management Pty Ltd	**Project No. :**	40618.01
		Report No. :	UL08-006B
Project :	Proposed Retirement Village	**Report Date :**	9/01/2008
		Date Sampled :	17/12/2007
Location :	Lot 2 DP224431 Sturdee Avenue, Bulli	**Date of Test:**	2/01/2008
Test Location :	Pit 7		
Depth / Layer :	0.5 - 0.9m	**Page:**	1 of 1

CORE SHRINKAGE TEST

Shrinkage - air dried	9.3 %
Shrinkage - oven dried	9.9 %
Significant inert inclusions	1.0 %
Extent of cracking	UC
Extent of soil crumbling	0.0 %
Moisture content of core	39.8 %

SWELL TEST

Pocket penetrometer reading at initial moisture content	300 kPa
Pocket penetrometer reading at final moisture content	110 kPa
Initial Moisture Content	39.8 %
Final Moisture Content	41.3 %
Swell under 25kPa	0.4 %



SHRINK-SWELL INDEX Iss 5.6% per Δ pF

Description: Orange brown sandy clay

Test Method(s): AS 1289.7.1.1 - 2003, AS 1289.2.1.1 - 2005

Sampling Method(s): Sampled by Wollongong Engineering Department

Extent of Cracking:
UC - Uncracked
SC - Slightly cracked
MC - Moderately cracked
HC - Highly cracked
FR - Fractured

Remarks:
Note that NATA accreditation does not cover the performance of pocket penetrometer readings

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	JM
Checked:	TZ

Dave Evans
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
Po Box 486 Unanderra
NSW 2526
Australia

Unit 1/1 Luso Drive
Unanderra NSW 2526
Phone (02) 4271 1836
Fax: (02) 4271 1897
wollongong@douglaspartners.com.au

RESULT OF SHRINK-SWELL INDEX DETERMINATION

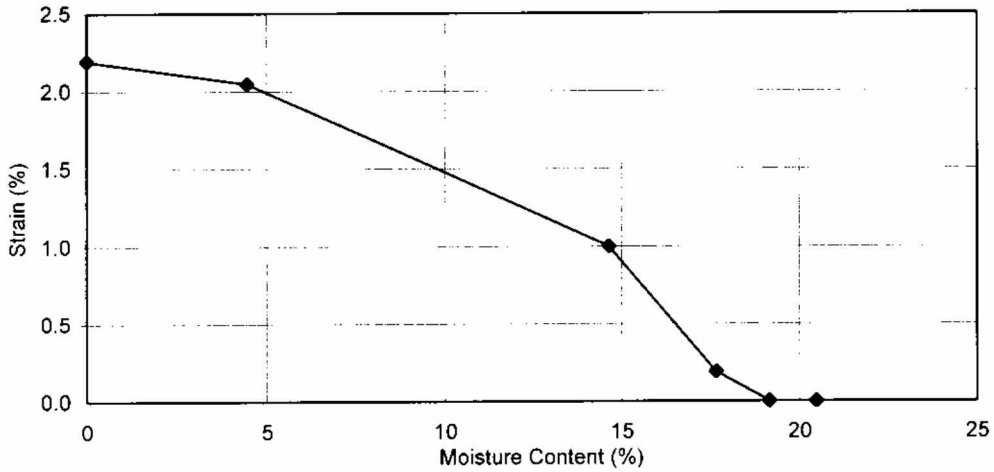
Client :	Anglican Retirement Villages C/- Event Project Management Pty Ltd	**Project No. :**	40618.01
		Report No. :	UL08-006C
Project :	Proposed Retirement Village	**Report Date :**	9/01/2008
		Date Sampled :	17/12/2007
Location :	Lot 2 DP224431 Sturdee Avenue, Bulli	**Date of Test:**	2/01/2008
Test Location :	Pit 16		
Depth / Layer :	0.50 - 0.85m	**Page:**	1 of 1

CORE SHRINKAGE TEST

Shrinkage - air dried	2.0 %
Shrinkage - oven dried	2.2 %
Significant inert inclusions	3.0 %
Extent of cracking	SC
Extent of soil crumbling	2.0 %
Moisture content of core	19.2 %

SWELL TEST

Pocket penetrometer reading at initial moisture content	240 kPa
Pocket penetrometer reading at final moisture content	100 kPa
Initial Moisture Content	21.8 %
Final Moisture Content	20.5 %
Swell under 25kPa	0.0 %



SHRINK-SWELL INDEX Iss 1.2% per Δ pF

Description: Brown sandy clay

Test Method(s): AS 1289.7.1.1 - 2003, AS 1289.2.1.1 - 2005

Sampling Method(s): Sampled by Wollongong Engineering Department

Extent of Cracking:
UC - Uncracked
SC - Slightly cracked
MC - Moderately cracked
HC - Highly cracked
FR - Fractured

Remarks:

Note that NATA accreditation does not cover the performance of pocket penetrometer readings

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number: 828
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Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	JM, JR
Checked:	TZ

Dave Evans
Laboratory Manager

Envirolab Services Pty Ltd
ABN 37 112 535 645
54 Frenchs Rd Willoughby NSW 2068
ph 02 9958 5801 fax 02 9958 5803
email: tnotaras@envirolabservices.com.au

CERTIFICATE OF ANALYSIS 16175

Client:
Douglas Partners Unanderra
Unit 1, 1 Luso Drive
Unanderra
NSW 2526

Attention: Arthur Castrissios

Sample log in details:

Your Reference:	**40618.01, Proposed Retirement Village**
No. of samples:	4 Soils
Date samples received:	09/01/08
Date completed instructions received:	09/01/08

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by:	16/01/08
Date of Preliminary Report:	Not Issued
Issue Date:	15/01/08

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Accredited for compliance with ISO/IEC 17025.
Tests not covered by NATA are denoted with *.

Results Approved By:

David Springer
Business Development & Quality Manager

Miscellaneous Inorg - soil Our Reference: Your Reference Type of sample	UNITS ---------- ----------	16175-1 Bore 1/5.5m Soil	16175-2 Bore 2/2.5m Soil	16175-3 Bore 3/1.0m Soil	16175-4 Bore 5/1.0m Soil
pH 1:5 soil:water	pH Units	4.4	4.7	4.4	5.3
Chloride 1:5 soil:water	mg/kg	<100	370	120	<100
Sulphate, SO4 1:5 soil:water	mg/kg	92	210	75	<25

Method ID	Methodology Summary
LAB.1	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
LAB.11	Chloride determined by argentometric titration.
LAB.9	Sulphate determined turbidimetrically.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
pH 1:5 soil:water	pH Units		LAB.1	[NT]	[NT]	[NT]	LCS	100%
Chloride 1:5 soil:water	mg/kg	100	LAB.11	<100	[NT]	[NT]	LCS	101%
Sulphate, SO4 1:5 soil:water	mg/kg	25	LAB.9	<25	[NT]	[NT]	LCS	100%

Report Comments:

Asbestos was analysed by Approved Identifier: Not applicable for this job

INS: Insufficient sample for this test	NT: Not tested	PQL: Practical Quantitation Limit
RPD: Relative Percent Difference	NA: Test not required	LCS: Laboratory Control Sample
NR: Not requested	<: Less than	>: Greater than

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample): This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria:

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable. Surrogates: Generally 60-140% is acceptable.

Appendix E

CSIRO Publication
AGS Extract

Foundation Maintenance and Footing Performance:
A Homeowner's Guide

CSIRO

BTF 18
replaces
Information
Sheet 10/91

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

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

Soil Types

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

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

Causes of Movement

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

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

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

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

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

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

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

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

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

GENERAL DEFINITIONS OF SITE CLASSES

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

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

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

Unevenness of Movement

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

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

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

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

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

Effects of Uneven Soil Movement on Structures

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

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

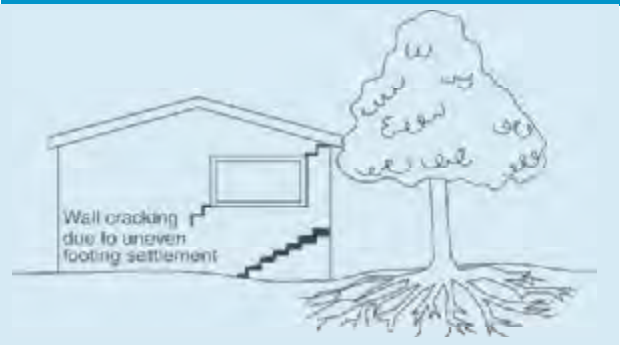
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

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

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

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

Trees can cause shrinkage and damage



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

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

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

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

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

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

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

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

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

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

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

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

Water Service and Drainage

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

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

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

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

Prevention/Cure

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

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

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

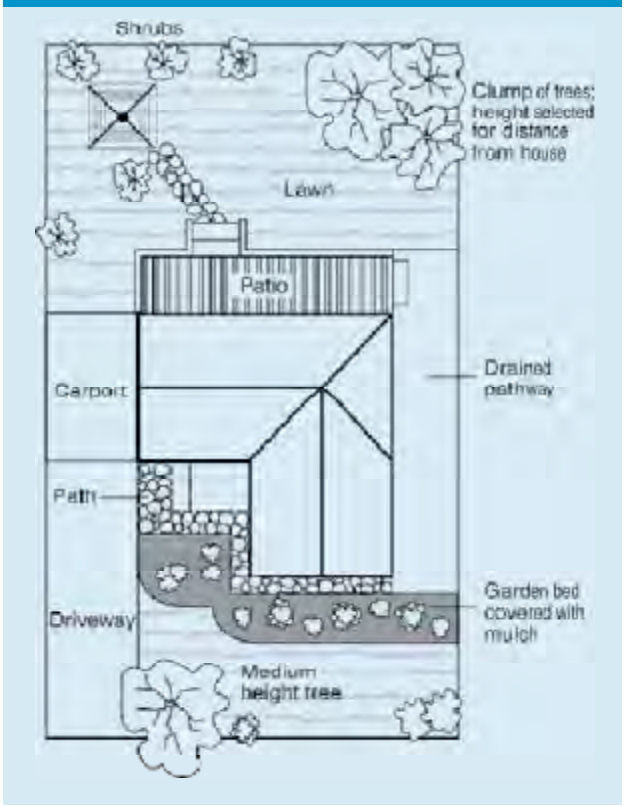
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

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

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

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

Gardens for a reactive site



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

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

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

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

Condensation

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

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

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

The garden

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

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

Existing trees

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

Information on trees, plants and shrubs

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

Excavation

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

Remediation

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

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

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

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Email: publishing.sales@csiro.au

APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	**1: CATASTROPHIC 200%**	**2: MAJOR 60%**	**3: MEDIUM 20%**	**4: MINOR 5%**	**5: INSIGNIFICANT 0.5%**
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or **L** (5)
B - LIKELY	10^{-2}	VH	VH	H	M	**L**
C - POSSIBLE	10^{-3}	VH	H	M	M	**VL**
D - UNLIKELY	10^{-4}	H	M	**L**	**L**	**VL**
E - RARE	10^{-5}	M	**L**	**L**	**VL**	**VL**
F - BARELY CREDIBLE	10^{-6}	**L**	**VL**	**VL**	**VL**	**VL**

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

Risk Level		**Example Implications** (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10^{-1}	$5x10^{-2}$	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	$5x10^{-3}$	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	$5x10^{-4}$	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	$5x10^{-5}$	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	$5x10^{-6}$	100,000 years	200,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

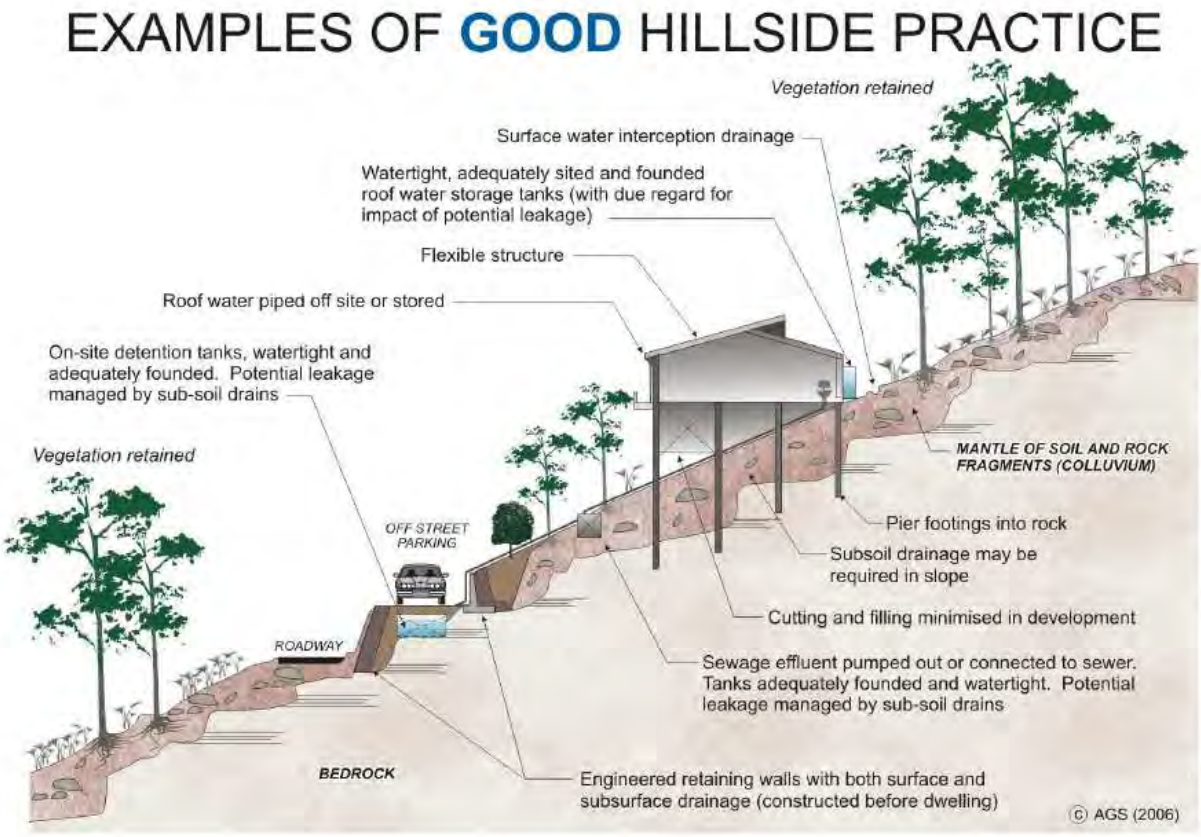
Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	


EXAMPLES OF GOOD HILLSIDE PRACTICE
Vegetation retained
Surface water interception drainage
Watertight, adequately sited and founded roof water storage tanks (with due regard for impact of potential leakage)
Flexible structure
Roof water piped off site or stored
On-site detention tanks, watertight and adequately founded. Potential leakage managed by sub-soil drains
Vegetation retained
MANTLE OF SOIL AND ROCK FRAGMENTS (COLLUVIUM)
OFF STREET PARKING
Pier footings into rock
Subsoil drainage may be required in slope
Cutting and filling minimised in development
ROADWAY
Sewage effluent pumped out or connected to sewer. Tanks adequately founded and watertight. Potential leakage managed by sub-soil drains
BEDROCK
Engineered retaining walls with both surface and subsurface drainage (constructed before dwelling)
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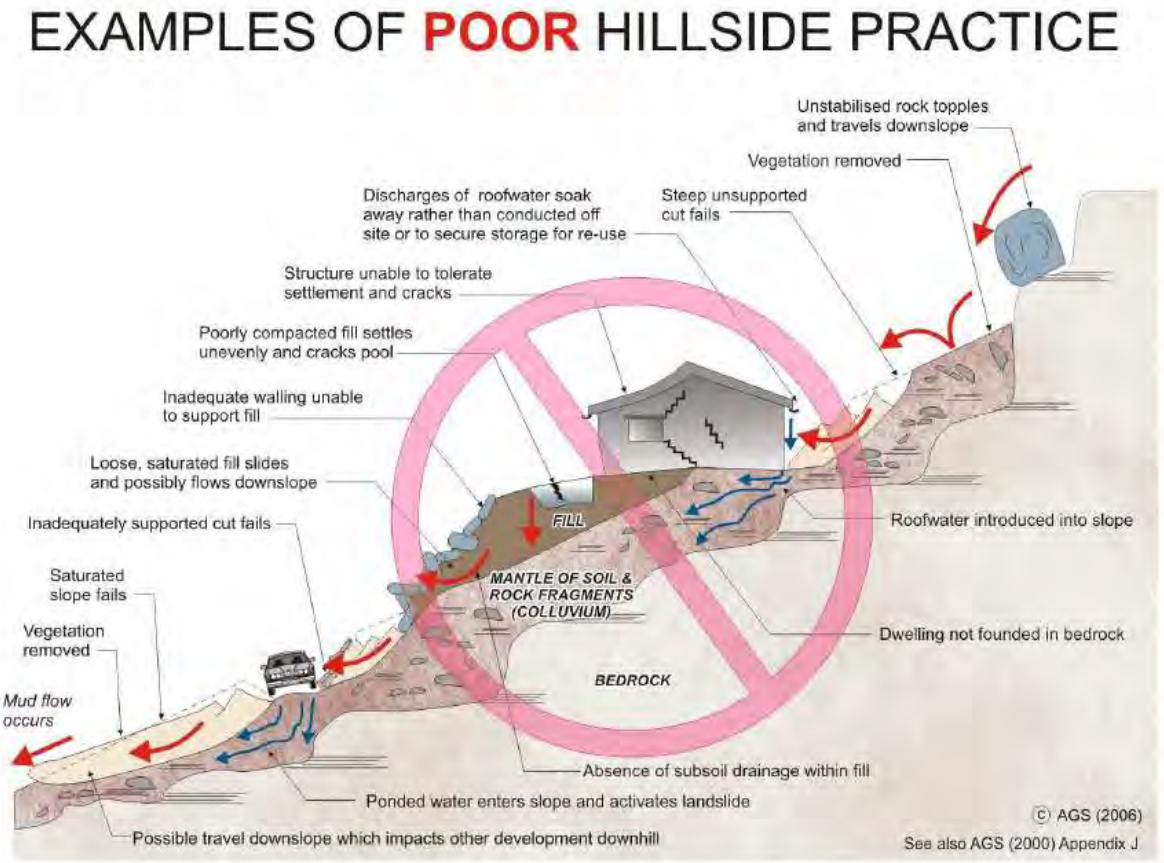
EXAMPLES OF POOR HILLSIDE PRACTICE
Unstabilised rock topples and travels downslope
Vegetation removed
Discharges of roofwater soak away rather than conducted off site or to secure storage for re-use
Steep unsupported cut fails
Structure unable to tolerate settlement and cracks
Poorly compacted fill settles unevenly and cracks pool
Inadequate walling unable to support fill
Loose, saturated fill slides and possibly flows downslope
Inadequately supported cut fails
FILL
Roofwater introduced into slope
Saturated slope fails
MANTLE OF SOIL & ROCK FRAGMENTS (COLLUVIUM)
Vegetation removed
Dwelling not founded in bedrock
BEDROCK
Mud flow occurs
Absence of subsoil drainage within fill
Ponded water enters slope and activates landslide
Possible travel downslope which impacts other development downhill
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See also AGS (2000) Appendix J