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REPORT
ON
ACID SULPHATE SOIL ASSESSMENT

CONCEPT PLAN APPLICATION
CALDERWOOD URBAN DEVELOPMENT PROJECT

Prepared for:
DELFIN LEND LEASE LTD

PROJECT 48742.03
MARCH 2010

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ACEA
The Association of Consulting Engineers Australia

Executive Summary

An Acid Sulphate Soil (ASS) investigation has been undertaken for the Concept Plan Application of the Calderwood Urban Development Project, a 720 ha site near Albion Park, NSW. The investigation comprised test pit excavations and laboratory testing of soil samples including ASS screening tests and Chromium Suite Testing.

The investigation was undertaken to assess the constraints (if any) that ASS soils will have on the development of the site and to address the Director General Requirements of: '*any likely geotechnical impacts and mitigation measures.'*

The subsurface conditions encountered ranged from typical alluvial deposits associated with Macquarie Rivulet and Marshall Mount Creek, namely interbedded firm to stiff clays / sandy clays and loose to medium dense sands to residual clays overlying weathered rock belonging to either the Berry Formation or Budgong Sandstone. Groundwater was typically encountered at depths of 2.5 – 6 m below the existing surface in the lower elevations of the site. Site topography ranged from near-level adjacent to Macquarie Rivulet and Marshall Mount Creek through gentle undulating terrain to steeper areas around the Johnstons Spur.

The results of the limited testing undertaken indicate the presence of acid sulphate soils of heterogeneous lateral distribution within parts of the proposed development area, and generally below depths of 2 – 3 m. Generally ASS is distributed in the alluvial deposits surrounding the two predominant creeks, Marshall Mount and Macquarie Rivulet.

The act of disturbing or exposing these soils through construction activity shall necessitate the production of an acid sulphate soil management plan (ASSMP). The extent of ASS will require further investigation once final cut and fill levels have been determined for the areas of ASS risk prior to the creation of an ASSMP.

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1 INTRODUCTION

1.1 General

This report presents the results of an acid sulphate soil assessment undertaken on a 720 ha parcel of land known as the Calderwood Urban Developement Project, near Albion Park, henceforth "the site", refer Drawing 1. The work was commissioned by Cardno Forbes Rigby Pty Ltd (Cardno) on behalf of the potential developer of the site, Delfin Lend Lease Ltd (DLL).

Site investigation for acid sulphate soils (ASS) was undertaken to profile the subsurface conditions within the mapped area of concern and immediate surrounds in order to assess the acid sulphate potential of the underlying soils. It comprised test pit excavation and sample collection followed by laboratory testing of selected samples, engineering analysis and reporting. Details of the work undertaken and the results obtained are given herein together with comments relating to acid sulphate potential.

1.2 Background

This investigation has been prepared to accompany a Concept Plan Application under Part 3A of the Environmental Planning & Assessment Act, 1979 (EP&A Act) in relation to the Calderwood Urban Development Project. A Concept Plan Application under Part 3A of the

Environmental Planning & Assessment Act 1979 and a State significant site listing proposal under Schedule 3 of the State Environmental Planning Policy Major Development 2005 have been submitted to the Department of Planning.

The Calderwood Urban Development Project proposes a mix of residential, employment, retail, education, conservation and open space uses. The development proposes 4,800 dwellings and approximately 50 hectares of retail, education, community and mixed use / employment land. The overall development will accommodate about 12,400 people and will deliver $3 billion in development expenditure and create 7,600 full time equivalent jobs by 2026.

The Calderwood Urban Development Project site is located within the Calderwood Valley in the Illawarra Region. It is approximately 700 hectares in area with approximately 600 hectares of land in the Shellharbour LGA and the balance located within the Wollongong LGA.

The Calderwood Valley has long been recognised as a location for future urban development, firstly in the Illawarra Urban and Metropolitan Development Programmes and more recently in the Illawarra Regional Strategy (IRS).

The IRS nominates Calderwood as an alternate release area if demand for additional housing supply arises because of growth beyond projections of the Strategy, or if regional lot supply is lower than expected.

In 2008, the former Growth Centres Commission reviewed the proposed West Dapto Release Area (WDRA) draft planning documents . The GCC concluded that forecast housing land supply in the IRS cannot be delivered as expected due to implementation difficulties with the WDRA, and the significantly lower than anticipated supply of housing land to market in the Illawarra Region is now been recognised as a reality.

The GCC Review of the WDRA also recognised that there is merit in the early release of Calderwood in terms of creating a higher dwelling production rate and meeting State government policy to release as much land to the market as quickly as possible. Given the demonstrated shortfall in land supply in the Illawarra Region and the WDRA implementation difficulties highlighted in the GCC Report, the release of Calderwood for urban development now conforms to its strategic role under the IRS as a source of supply triggered by on-going delays in

regional lot supply. The Calderwood Urban Development Project can deliver about 12% of the IRS' new dwelling target.

Changes in outlook arising from global, national and regional factors influencing investment and delivery certainty, housing supply and affordability and employment and economic development also add to the case for immediate commencement of the Calderwood Project.

In April 2008 the Minister for Planning issued terms of reference for the preparation of a Justification Report to address the implications of initiating the rezoning of Calderwood for urban development including associated staging, timing and infrastructure considerations.

In February 2009 the Minister for Planning considered a Preliminary Assessment Report for the Calderwood Urban Development Project that provided justification for the planning, assessment and delivery of the project to occur under Part 3A of the EP&A Act, having regard to the demonstrated contribution that the project will have to achieving State and regional planning objectives.

Subsequently, on the 16 April 2009, pursuant to Clause 6 of SEPP Major Development, the Minister for Planning formed the opinion that the Calderwood Urban Development Project constitutes a Major Project to be assessed and determined under Part 3A of the EP&A Act, and also authorised the submission of a Concept Plan for the site. In doing so, the Minister also formed the opinion that a State significant site (SSS) study be undertaken to determine whether to list the site as a State Significant site in Schedule 3 of SEPP Major Development.

The Part 3A process under the EP&A Act allows for the Calderwood Urban Development Project to be planned, assessed and delivered in an holistic manner, with a uniform set of planning provisions and determination by a single consent authority. Given the scale of the proposal, the Concept Plan and SSS listing provide the opportunity to identify and resolve key issues such as land use and urban form, development staging, infrastructure delivery and environmental management in an integrated and timely manner.

This report has been prepared to fulfil the Environmental Assessment Requirements issued by the Director General for the inclusion of the Calderwood site as a State Significant Site under SEPP Major Development, and for a Concept Plan approval for the development.

2 SITE DESCRIPTION

The site is located in the Calderwood Valley, northwest of the township of Albion Park, and is bounded by the Illawarra Highway to the south and Marshall Mount Road in the north. North Macquarie Road bisects the site in a northeast – southwest direction. The site itself comprises an irregular shaped area of 703.6 ha, with maximum north-south and east-west dimensions of 3.70 km and 3.22 km respectively (refer Drawing 2, in Appendix A).

Macquarie Rivulet and Marshall Mount Creek run west to east across the site in the south and north respectively. The topography across the site is varied with essentially flat flood plains bordering the creeks, ranging to extremely steep ground on the flanks of Johnstons Spur, other areas of the site are gently undulating. Topographic relief is from 165 m at the top of Johnstons Spur to less than 10 m in the Marshall Mount Creek drainage.

The site is currently 20 distinct land packages in the local government areas of Wollongong and Shellharbour. The land is principally used as farm land, incorporating hobby farms, dairy farming, horse agistment and horse breeding. The site has been largely cleared though pockets of remnant vegetation remain, especially on the elevated portions of the site.

3 REGIONAL GEOLOGY AND SOIL LANDSCAPES

The Kiama and Robertson 1:50 000 Geological Series Sheets (Ref 1 and 2) indicate that the study area is underlain by a gently dipping (about 5° to the north - northwest), highly varied section of the stratigraphic sequence of the Permo - Triassic Sydney Basin. This sequence is locally to extensively overlain by alluvium, and locally by talus (slopewash and rockfall debris), of recent (Quaternary) age.

The distribution of the principal units of the bedrock stratigraphic is shown in Drawing 3. Typical lithologies of these units are summarised below in oldest to youngest order:

- **Berry Siltstone** - comprising mid grey to dark grey siltstone and fine-grained sandstone. This formation is found at the foot of hill slopes in the subject area, adjoining the Budgong Sandstone up-slope and the Alluvial deposits down-slope.
- **Budgong Sandstone** - comprising red brown to grey volcanic sandstone. This formation underlies foot to upper valley slopes in most of the study area.
- **Bumbo Latite Member** - a grey to blue grey aphanitic to porphyritic latite. This member within the Budgong Sandstone appears on the lower midslope of Johnstons Spur.
- **Cambewarra Latite Member –** similar to the Bumbo Latite Member, this unit is present at higher elevations, specifically at the highest point of Johnston's Spur.

The Soils Landscapes of the Kiama 1:100 000 Sheet (Ref 3) indicates that the properties included within the study area are located within six soil landscapes representing swamp, erosional and depositional geomorphological processes. The distribution of the soil landscapes are given on Drawing 4. Due to the nature of ASS formation, this investigation was particularly focused on the swamp and depositional soil landscapes, namely the Fairy meadow, Wotomolla Road and Albion Park Landscapes.

The Wollongong Acid Sulphate Soil Risk Map (Ref 4), published by NSW Department of land and Water Conservation (1997), maps the eastern extents of the site on Properties C and I (refer to Drawing 2 for property reference) as having a low probability of finding ASS below a depth of 3 m (refer to Drawing 5). Further, it states that this mapping level *'Generally [is] not expected to contain ASS materials, although highly localised occurrences may occur especially near boundaries with environments with a high probability of ASS occurrence.'* The nearest boundary with high probability is 230 m further east down Marshall Mount Creek. Based on this level of mapping the probability of finding ASS soils was deemed to be low.

4 FIELD WORK METHODS

The field work comprised 89 test pits (TP1 – TP89) excavated to depths of 1.5 – 3 m across the entire site for the combined purposes of the geotechnical and ASS investigation. Of these test

pits, 28 (TP9-11, 17-20, 41, 42, 48-50, 56, 60, 61, 67-69, 76-83, 85, 86) were used for ASS sample collection as they were from swamp or depositional environments.

The test pits were excavated by two teams both working with New Holland LB110B backhoes each fitted with a 450 mm wide bucket. The pits were logged on-site by an experienced geotechnical engineers who collected both disturbed and undisturbed samples to assist in strata identification and for laboratory testing. The soil samples collected were placed in plastic bags immediately upon collection and stored in an esky on ice for transportation to the Douglas Partners (DP) laboratory.

The locations of the field tests for ASS are shown on Drawing 6 in Appendix A. The levels shown on the pit logs sheets were determined by interpolation from the 2 m contour levels supplied by Cardno. This report only contains logs used for the ASS investigation, other logs from the assessment can be found in the Geotechnical Report.

5 FIELD WORK RESULTS

The test pits encountered relatively uniform subsurface conditions (refer test pit reports in Appendix B) with the principal variation being between the alluvial and residual soil landscapes. The site is essentially a residual environment split by two valleys in-filled with alluvium. These two alluvial deposits meet as Johnstons Spur descends to the alluvial plain around the Property I, (refer Drawing 2). The valleys contain Marshall Mount Creek in the North and Macquarie rivulet in the south.

This acid sulphate assessment will focus specifically on the alluvial deposits on the site. These deposits contain a mixture of strata including predominantly clay and to a lesser extent, sandy, clay, clayey sand, silty sand and sand. These strata show no real regularity across the site, as would be expected for an alluvial deposit over such a larger area. With this caveat, the strata in the alluvial deposits can broadly be summarised as:

TOPSOIL: generally silty sand with clay, gravel and rootlets to depths of 0.1 – 0.4 m;

CLAY/SANDY CLAY: ranging from soft to very stiff clays or sandy clays, occasionally gravelly in parts, damp to saturated in most locations;

SAND: loose to dense sand, silty sand or clayey sand found at depths of 0.5 – 3.0 m, typically wet to saturated. (This strata was only present in approximately 15% of test pits).

Groundwater seepage or wet conditions were observed at depths ranging between 1.8 m and 2.9 m in only Pits 11, 49 and 67. It is noted however, that the pits were backfilled immediately following excavation and sampling, thus precluding any longer-term monitoring of groundwater levels. Groundwater wells measured in the alluvial deposits of the site indicate that water levels are between 2.5 m and 4.5 m below ground level.

6 LABORATORY TESTING

Laboratory testing for acid sulphate soils was undertaken in two stages, with reference made to the ASSMAC *'Acid Sulphate Soil Manual'* (Ref. 5) and QASSIT (Ref. 6). Selected samples from the test pits (a total of 94 samples) were initially tested in the DP laboratory for measurement of pH in H_2O (pH_F) and pH after oxidation with H_2O_2 (pH_{FOX}) using a calibrated pH meter.

The detailed results of the screening tests (pH_F and pH_{FOX}) are included in Appendix C. Positive indicators of actual and potential acid sulphate soils (e.g. $pH_F < 4.0$, lowering of pH by at least one unit following peroxide oxidation, or $pH_{FOX} < 3.5$) were found in 23 samples and as such, confirmation of acid sulphate potential was required and assessed via the undertaking of Full Chromium Suite tests.

Thirteen soil samples were selected for Full Chromium Suite testing, which was carried out by EnviroLab Services. The method includes measurement of pH in potassium chloride (KCl), sulfidic – Titratable Actual Acidity (s-TAA) and Chromium Reducible Sulphur (S_{CR}) in order to determine Net Acidity (%S). The detailed laboratory test report sheets are included in Appendix D with the results summarised in Table 1.

The results indicate pH in potassium chloride values in the range of 3.9 – 4.4 with Net Acidity values in the range of 0.08 – 0.16%S for the soil samples tested. The results indicate that four of the Net Acidity values exceed the action criteria (0.03%S) for greater than 1000 tonnes of soil disturbed.

Table 1 – Results of Full Chromium Suite Testing

Pit No	Depth (m)	RL	pH KCl	s-TAA (%S)	S_{CR} (%S)	S_{NAS} (%S)	Net Acidity (%S)
11/2.8	2.8	5.2	4.4	0.03	<0.010	<0.005	0.03*
9/2.0	2	8	5.1	0.02	0.01	<0.005	0.03*
9/1.5	1.5	8.5	5.2	0.02	<0.010	<0.005	0.02
10/2.8	2.8	7.2	5.1	0.01	<0.010	<0.005	0.01
20/2.5	2.5	3.5	5.3	0.02	<0.010	<0.005	0.02
41/1.9	1.9	17.1	4.0	0.64	<0.010	<0.005	0.64
48/2.8	2.8	17.2	3.8	0.10	<0.010	0.01	0.11
50/1.0	1	9	5.1	0.04	<0.010	0.01	0.05*
56/1.4	1.4	10.6	5.3	0.03	<0.010	0.01	0.04*
60/1.0-1.2	1	13	5.0	0.02	<0.010	<0.005	0.02
61/2.4-2.5	2.4	11.6	5.2	0.02	<0.010	<0.005	0.02
77/1.0-1.1	1	13	5.5	0.01	<0.010	0.01	0.02
78/1.0-1.1	1	13	5.2	<0.01	<0.010	<0.005	0.01
Action Criteria[1] for >1000 tonnes of soil disturbed (Ref 5							**0.03**
Action Criteria[2] for 1 – 1000 tonnes of soil disturbed (Ref 5)							**0.06**

Where: s-TAA = sulphidic – Titratable Actual Acidity
S_{CR} = Chromium Reducible Sulphur
S_{NAS} = Net Acid Soluble Sulphur
Net Acidity = s-TAA + S_{CR} + S_{NAS}

0.14	Exceeds Action Criteria for >1000 tonnes of soil disturbed
0.08*	Exceeds Action Criteria for >1000 tonnes of soil disturbed but does not Exceed Action Criteria for 1 – 1000 tonnes of soil disturbed

7 PROPOSED DEVELOPMENT

The Calderwood Urban Development Project is a master planned community development by Delfin Lend Lease. The Project proposes a mix of residential, conservation and open space uses. The ASS soils found on site were uncovered at depths of between 2 m and 3 m. No detail on maximum cut depths is available at this time, but it is anticipated that cuts of between 3 m and 4 m are likely in some areas of the site.

8 COMMENTS

Based on the laboratory test results and the ASSMAC (Ref. 4) and QASSIT (Ref. 5) guidelines, the following interpretations are made with respect to acid sulphate potential.

Screening Tests

- The ASSMAC/QASSIT guidelines suggest that a soil is an actual ASS and that oxidation of pyrite has occurred in the past when pH_F is less than 4. The results of the initial screening tests for pH in H_2O (pH_F) were generally in the range of 7.3 – 5.2, indicating that the soils are neutral to mildly acidic;
- The Guidelines for screening tests indicate a Potential ASS when the result of $pH_{FOX}<3.5$. The results of the initial screening tests for pH following addition of H_2O_2 (pH_{FOX}) were generally in the range of 3.8 – 7.0;
- The final indicator for ASS in the screening test is the measured pH drops between pH_F and pH_{FOX} . The guideline indicates that a soil may be a PASS if a pH drop of greater than 1 is recorded. In the results, pH drops were typically in the range of 0.1 – 2.5 with 23 samples having drops of greater than 1 unit. Indicating that these samples may be PASS. Based on this determination some of the samples were submitted for Full Chromium Suite testing.

Full Chromium Suite Tests

- The results of the full chromium suite testing indicate Net Acidity values in the range of 0.01 – 0.11%S for the soil samples tested with 6 of the 13 samples tested exceeding the guideline value.
- The samples generally returned elevated results of s-TAA and non-detectable values of Scr, indicating that the soils are actual acid sulphate soils which have already undergone pyrite oxidation.

In summary, the results of the limited testing undertaken to date indicate the presence of acid sulphate soils of heterogeneous lateral distribution within parts of the proposed development area, and generally below depths of 2 – 3 m. The act of disturbing or exposing these soils through construction activity shall necessitate the production of an acid sulphate soil management plan (ASSMP). The extent of ASS will require further investigation once final cut and fill levels have been determined for the areas of ASS risk prior to the creation of a ASSMP.

Specifically the following will be required:

- Maximum excavation depths at Property A, B, C, G, I, N, O, P, and Q (refer Drawing 2).
- Further ASS investigation to the proposed excavation depths in these properties .
- Preparation of an ASSMP based on the findings of this report supplemented by the findings of the additional investigations.

9 LIMITATIONS

Douglas Partners (DP) has prepared this report for this Calderwood Urban Development Project at Calderwood in accordance with DP's proposal dated 8 October 2009 and acceptance received from Mr Bill Mitchell dated 8 October 2009. The work was carried out under DP Conditions of Engagement. This report is provided for the exclusive use of the DLL for the specific project and purpose 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.

This report must be read in conjunction with the attached "Notes Relating to This Report" and any other attached explanatory notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions from review by others of this report or test data, which are not otherwise supported by an expressed statement, interpretation, outcome or conclusion stated in this report. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

DOUGLAS PARTNERS PTY LTD

Christopher C Kline
Associate

Reviewed by:

G W McIntosh
Principal

References:

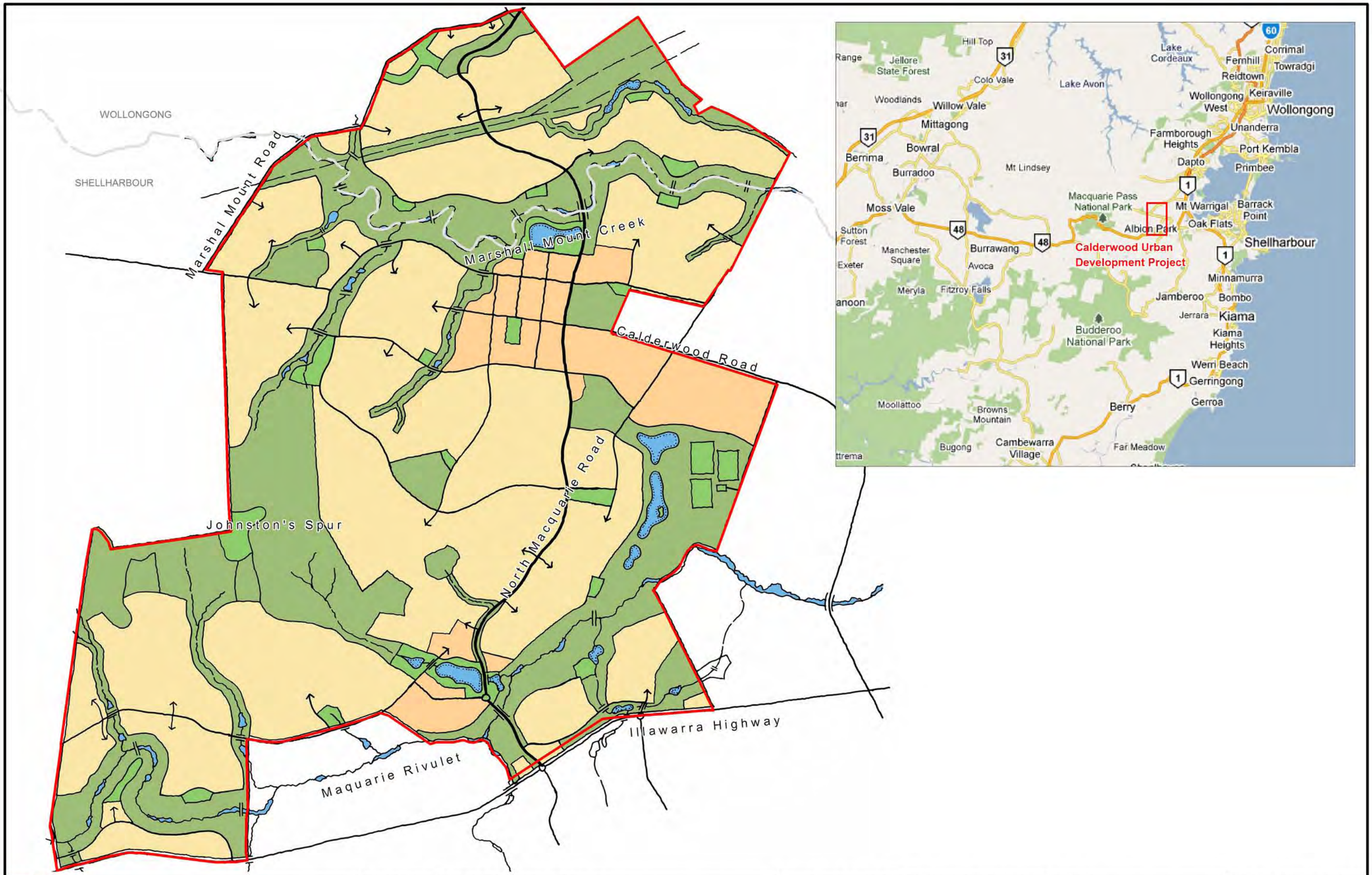
1. Department of Mines, "Geology of the Kiama 1:50 000 Series Sheet No. 9028-1", 1977.
2. Department of Mines, "Geology of the Robertson 1:50 000 Series Sheet No. 9028-4", 1977.
3. Department of Conservation and Soil Management, "Soil Landscapes of Kiama 1:100 000 Series Sheet 09028" 1993.

References:

1. Department of Mines, *"Geology of the Kiama 1:50 000 Series Sheet No. 9028-1"*, 1977.
2. Department of Mines, “Geology of the Robertson 1:50 000 Series Sheet No. 9028-4”, 1997.
3. Department of Conservation and Soil Management, “Soil Landscapes of Kiama 1:100 000 Series Sheet 09028” 1993
4. Wollongong 1:25 000 Acid Sulphate Risk Map. NSW Department of Land and Water Conservation (1997).
5. ASSMAC (1998), "Acid Sulfate Soil Manual, New South Wales Acid Sulphate Soil Management Advisory Committee.
6. Dear S E, Moore N G, et al "Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines" Dept of Natural Resources and Mines, (2002).

APPENDIX A

Drawings 1 – 5



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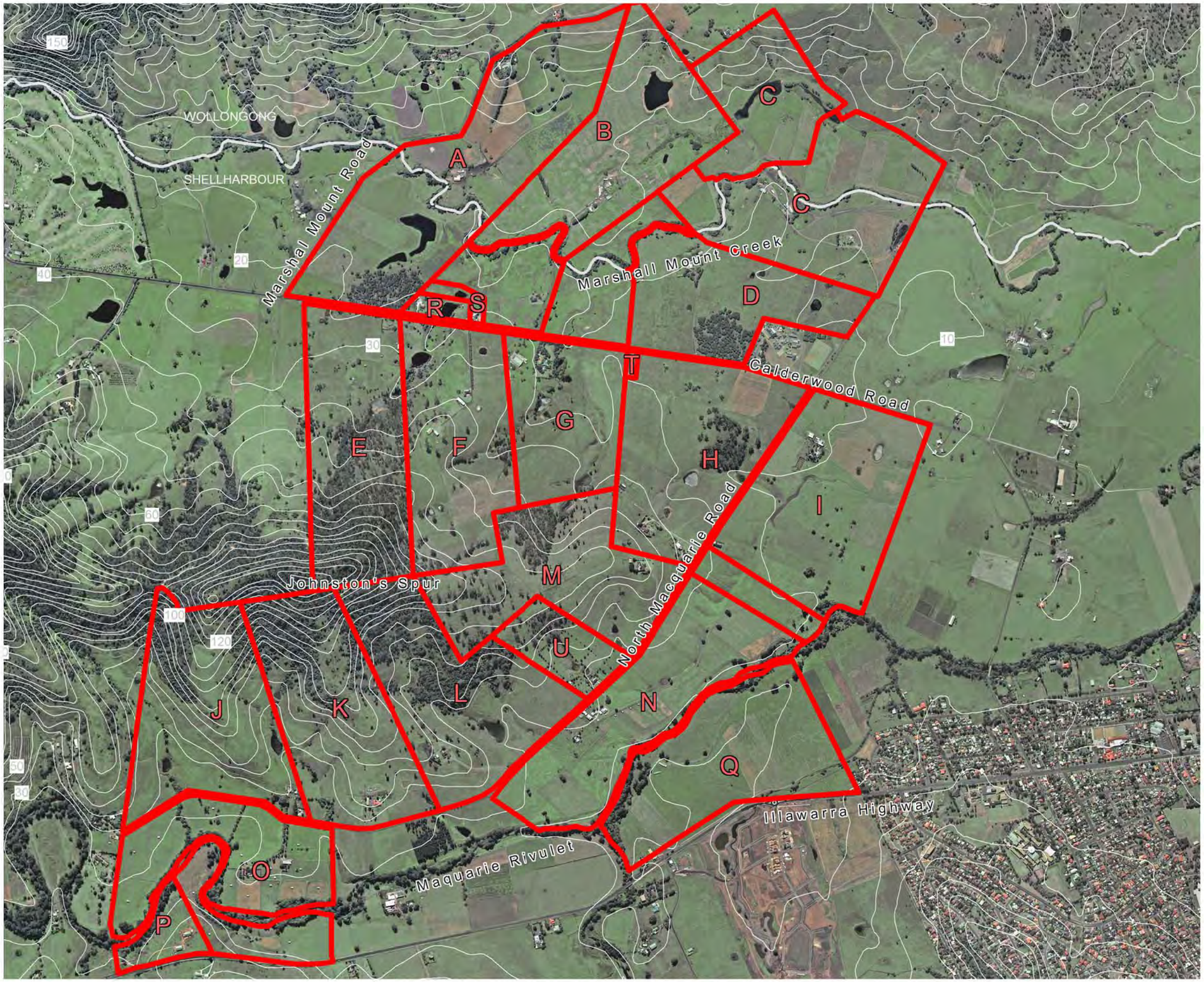
			REVISION: 1



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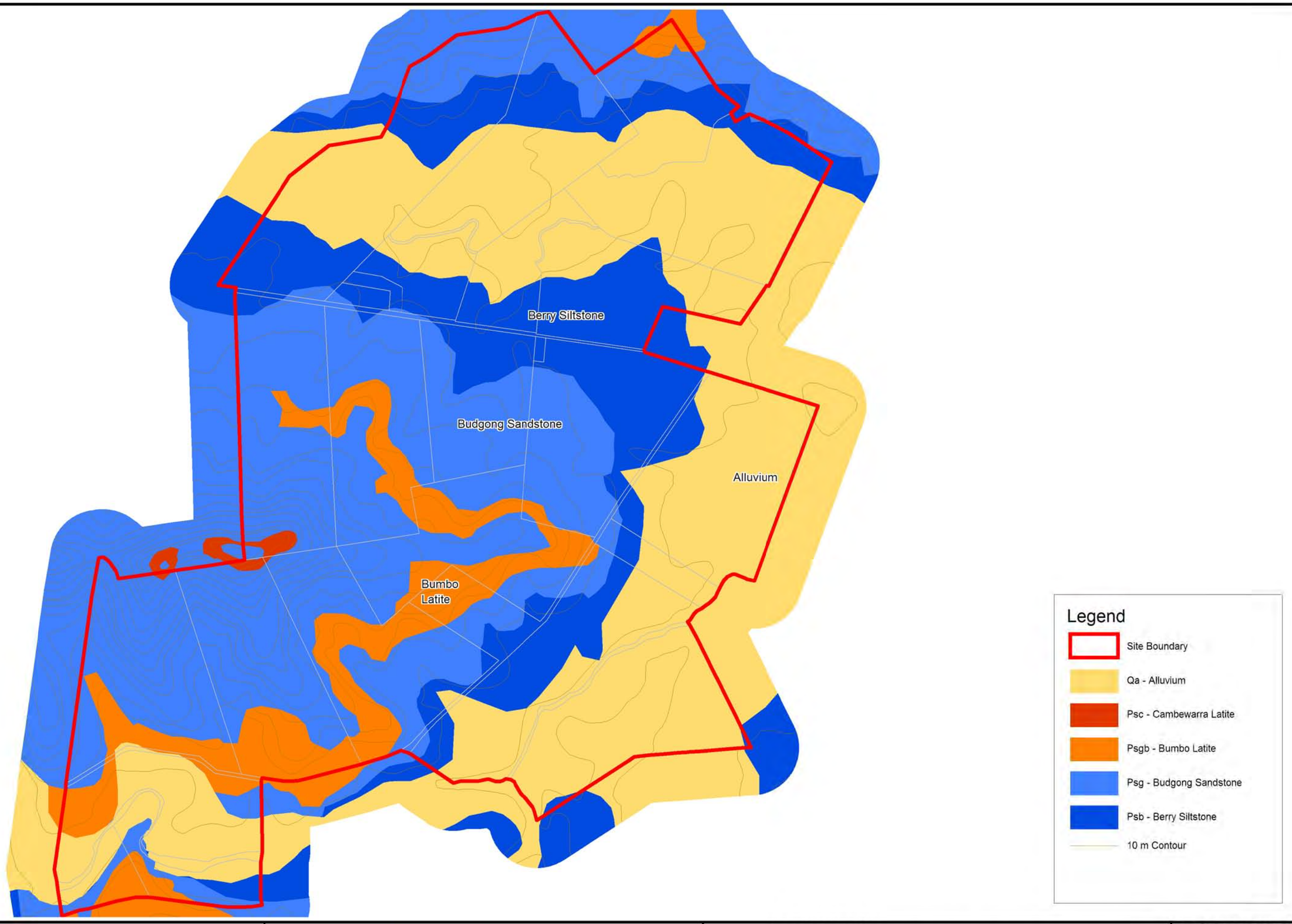
	DRAWN BY: CCK / SCALE: 1:15000 @A3 / OFFICE: W'GONG		
	APPROVED BY: CCK	DATE: 18 FEB 10	

PROJECT: 48742.02
DRAWING: 2
REVISION: 1



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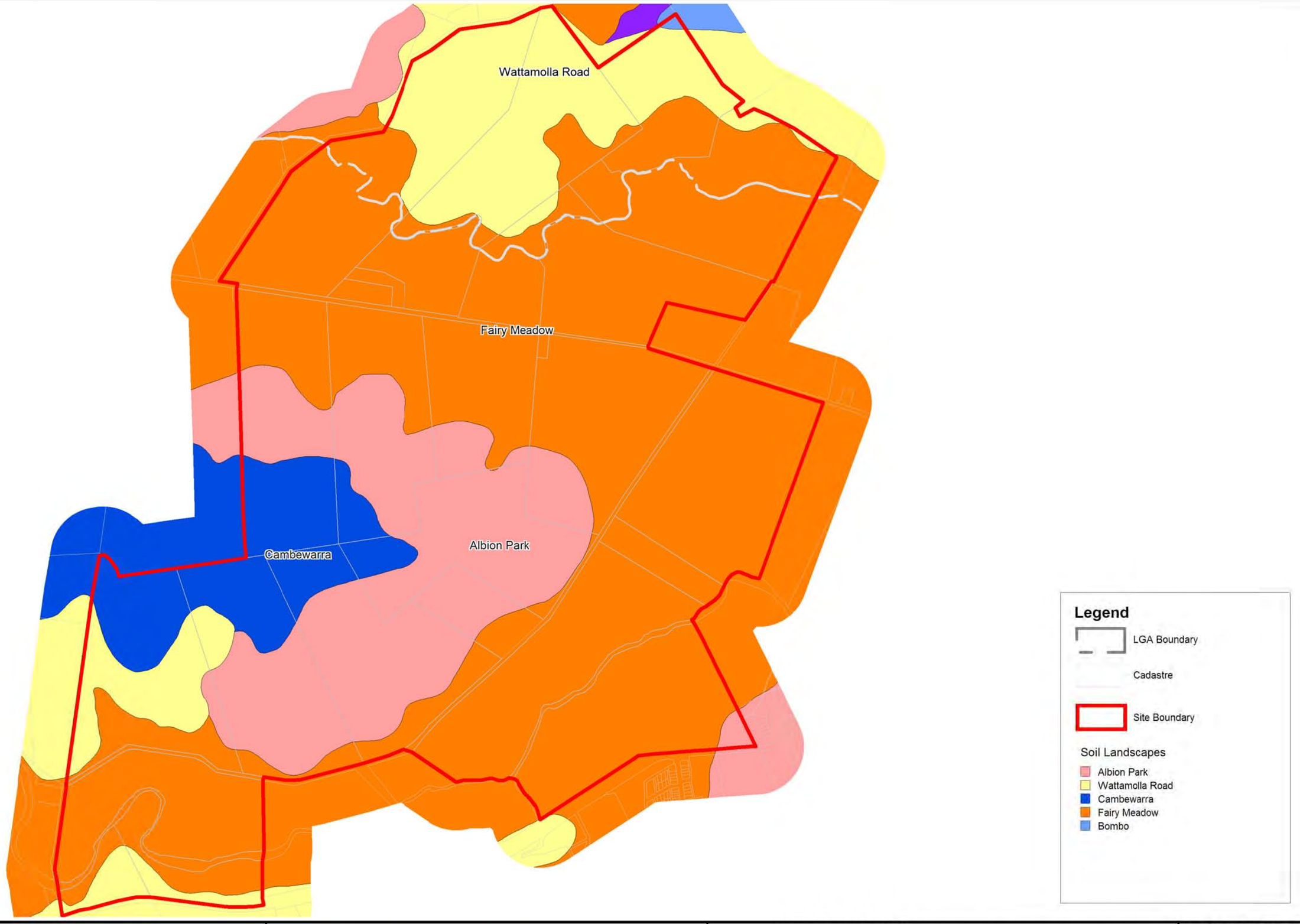
	DRAWN BY: CCK / SCALE: 1:15000 @A3	OFFICE: W'GONG	PROJECT: 48742.02
	APPROVED BY: CCK	DATE: 18 FEB 10	DRAWING: 3 REVISION: 1



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	APPROVED BY: CCK		DATE: 18 FEB 10

PROJECT: 48742.02
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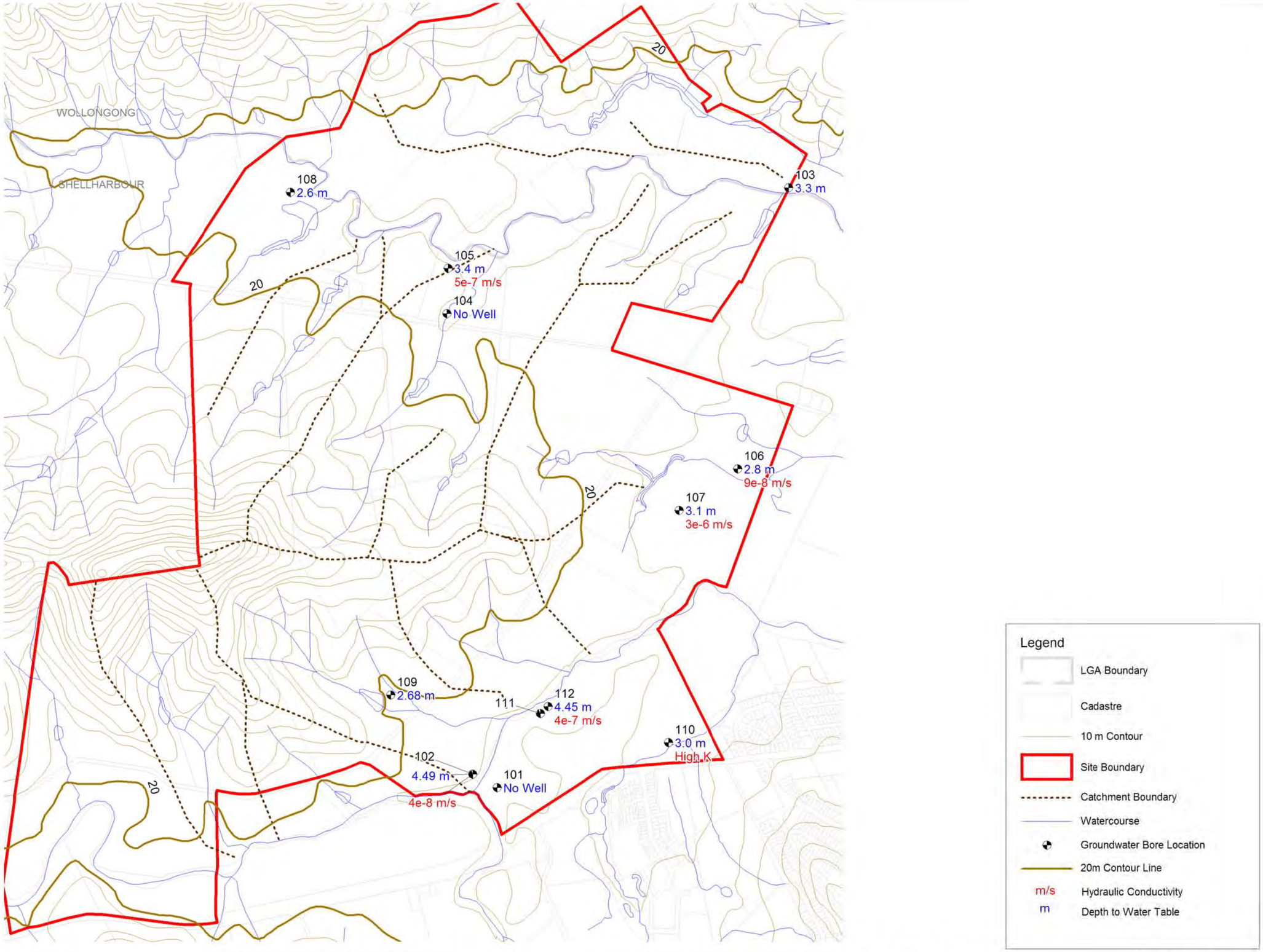
REVISION: 1



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	DRAWN BY: CCK / SCALE: 1:15000 @A3	OFFICE: W'GONG		DRAWING: 5
	APPROVED BY: CCK	DATE: 18 FEB 10		REVISION: 1

APPENDIX B

Notes Relating to this Report
Test Bore Report Sheets

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NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring 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.

Description and Classification Methods

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

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling 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 with 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.

Details of the type and method of sampling are given in the report.

Drilling Methods.

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of 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 sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole 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 in sands above the water

table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength 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 short of full penetration, 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 tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

q_c (MPa) = (0.4 to 0.6) N (blows per 300 mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

q_c = (12 to 18) c_u

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. 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 relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Bore Logs

The bore logs presented herein 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. 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 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, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it 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.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations 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.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company 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 condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

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

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, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation 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

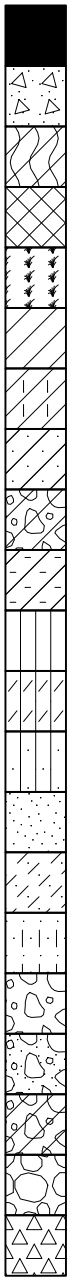
is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical 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.

GRAPHIC SYMBOLS FOR SOIL & ROCK

SOIL



BITUMINOUS CONCRETE

CONCRETE

TOPSOIL

FILLING

PEAT

CLAY

SILTY CLAY

SANDY CLAY

GRAVELLY CLAY

SHALY CLAY

SILT

CLAYEY SILT

SANDY SILT

SAND

CLAYEY SAND

SILTY SAND

GRAVEL

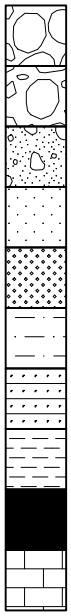
SANDY GRAVEL

CLAYEY GRAVEL

COBBLES/BOULDERS

TALUS

SEDIMENTARY ROCK



BOULDER CONGLOMERATE

CONGLOMERATE

CONGLOMERATIC SANDSTONE

SANDSTONE FINE GRAINED

SANDSTONE COARSE GRAINED

SILTSTONE

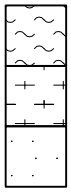
LAMINITE

MUDSTONE, CLAYSTONE, SHALE

COAL

LIMESTONE

METAMORPHIC ROCK

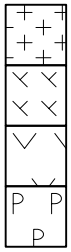


SLATE, PHYLITTE, SCHIST

GNEISS

QUARTZITE

IGNEOUS ROCK



GRANITE

DOLERITE, BASALT

TUFF

PORPHYRY

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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 16
EASTING: 293421
NORTHING: 6172019
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 48742
DATE: 02 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
16	0.15	TOPSOIL - dark brown clay with some roots and rootlets, humid							
		CLAY - firm, dark brown clay with some sand and silt with trace rootlets, humid to damp							
15	1			S	1.0		2,2,3 N = 5		1
					1.45				
14	2	- becoming soft to firm below 2.0m		S	2.0		2,2,2 N = 4		2
					2.45				
13	3	- becoming firm, grey mottled orange brown slightly sandy clay below 3.0m (ALLUVIUM)		S	3.0		2,3,4 N = 7		3
	3.5	SANDY CLAY - firm, grey mottled orange brown sandy clay, humid to damp (ALLUVIUM)			3.45				
12	4								4
					4.5		3,3,2 N = 5		
	4.7	SAND - very loose, orange brown fine to medium grained sand with some silt, humid (ALLUVIUM)		S					
11	5				4.95				5
10	6								6
	6.0	SANDY CLAY - very stiff, slightly gravelly (medium to coarse sandstone) sandy clay, wet (RESIDUAL SOIL)		S	6.0		7,9/110mm,- refusal		
		- becoming firm to stiff below 6.42m			6.24				
	6.72	TUFFACEOUS SANDSTONE - extremely low to very low strength, extremely to highly weathered, orange brown tuffaceous sandstone							
9	7	- becoming very low to low strength below 7.24m							7
8	8								8
	8.57	Bore discontinued at 8.57m (refusal on low to medium strength sandstone)							
7	9								9

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** RJH **CASING:** -

TYPE OF BORING: SFA (v-bit) to 7.24m, SFA (TC-bit) to 8.57m

WATER OBSERVATIONS: Free groundwater observed at 6.0m, at 6.2m after 30 minutes

REMARKS: No well installed

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 16
EASTING: 293324
NORTHING: 6172066
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 48742
DATE: 02 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
16	0.2	TOPSOIL - brown clay with some roots and rootlets, humid							backfill
		CLAY - firm, dark orange brown grey clay with trace sand and rootlets, humid to damp (ALLUVIUM)		S	1.0		2,2,3 N = 5		bentonite
15	1				1.45				
14	2			S	2.0		2,1,1 N = 2		
	2.1	SAND - very loose, orange brown fine to medium sand with some silt, humid (ALLUVIUM)			2.45				case
13	3	- becoming very loose to loose, fine to coarse grained sand with some silt and trace medium to coarse gravel (quartz) below 3.0m		S	3.0		2,2,3 N = 5		
					3.45				
12	4								
		- becoming loose below 4.5m		S	4.5		3,3,3 N = 6	▼	sand
11	5				4.95				
		- becoming medium dense below 5.15m							
10	6								
	6.0				6.0		3,16,- refusal		
	6.15	CLAYEY SAND - medium dense, orange brown to grey slightly gravelly (medium to coarse sandstone) clayey fine to coarse grained sand, damp (RESIDUAL SOIL)		S	6.3				
9	7	TUFFACEOUS SANDSTONE - extremely low to very low strength, extremely to highly weathered, orange brown tuffaceous sandstone							screen
8	8								
	8.27	- becoming very low to low strength below 8.20m							
		Bore discontinued at 8.27m (refusal on low to medium strength sandstone)							
7	9								

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** RJH **CASING:** -

TYPE OF BORING: SFA (v-bit) to 8.20m, SFA (TC-bit) to 8.27m

WATER OBSERVATIONS: Free groundwater observed at 6.0m

REMARKS: Water level dipped 4/12/09

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 16
EASTING: 294590
NORTHING: 6174429
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 48742
DATE: 25 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
16	0	SILTY SAND - brown silty fine grained sand, humid							bentonite
15	1								
	1.6	CLAY - stiff to very stiff, dark grey clay with some silt, humid							case
14	2								
13	3	- becoming damp to moist						▼	sand
12	4	4.0 SILTY CLAY - stiff, light grey silty clay, moist to wet							
		- saturated							
11	5								screen
10	6								
	6.4								
	6.48	SILTSTONE							
		Bore discontinued at 6.48m (TC-bit refusal)							
9	7								
8	8								
7	9								

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: Free groundwater observed at 4.5m

REMARKS: Water level dipped 4/12/09

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 16
EASTING: 293216
NORTHING: 6173922
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 48742
DATE: 25 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
16	0.1	TOPSOIL - brown silt topsoil							
		CLAY - firm, brown clay with some roots and trace gravel							
	0.7	SILTSTONE - extremely low strength, moderately weathered, light grey siltstone							
15	1								1
14	2	- becoming dark grey							2
		- becoming light grey							
13	3	3.0 Bore discontinued at 3.0m (slow progress in shale)							3
12	4								4
11	5								5
10	6								6
9	7								7
8	8								8
7	9								9

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: No free groundwater observed

REMARKS: No well installed due to dry conditions and shallow rock.

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 14
EASTING: 293220
NORTHING: 6174104
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 48742
DATE: 25 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
14	0	TOPSOIL - brown clayey silt with some rootlets							case
	0.3	SILTY CLAY - dark brown silty clay, humid							backfill
		- with some gravel							
13	1								bentonite
	1.1	SILTY SAND - light brown/yellow silty sand with some sandstone gravel, humid							
12	2								
	2.0	SILTY SANDY CLAY - light brown silty sandy clay with some sandstone gravel, damp							
	2.6	CLAY - light grey clay with trace silt, damp to moist							
11	3							▼	sand
		- becoming yellow with a trace of fine sand, damp							screen
10	4								
	4.0	CLAY - yellow brown clay with some sand and quartz gravel, wet							
9	5								
	5.0	SILTSTONE - low strength, extremely weathered siltstone							
	5.48	Bore discontinued at 5.48m (slow progress in siltstone)							
8	6								
7	7								
6	8								
5	9								

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Water level dipped 4/12/09

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 10
EASTING: 294387
NORTHING: 6173297
DIP/AZIMUTH: 90°/--

BORE No: 106
PROJECT No: 48742
DATE: 25 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
10	0	TOPSOIL - brown clay and silt with some rootlets							
	0.4	CLAY - very stiff, dark grey clay, humid							
9	1								1
	1.1	CLAY - very stiff, brown clay, damp							
8	2								2 backfill
		- becoming moist						▼	case
7	3								3
	3.4	SILTY CLAY - firm, yellow brown silty clay, moist							
6	4								4
									bentonite
5	5	- saturated							5
4	6	- with some fine grained sand							6 sand
3	7	- with some gravel							7 screen
2	8								8
	8.2	Bore discontinued at 8.2m (refusal on rock/gravel)							
1	9								9

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Water level dipped 4/12/09

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 10
EASTING: 294150
NORTHING: 6173129
DIP/AZIMUTH: 90°/--

BORE No: 107
PROJECT No: 48742
DATE: 25 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
10		TOPSOIL - brown silty clay topsoil with some rootlets							
	0.7	CLAY - stiff, brown clay, humid							backfill
9	1								
	1.6	CLAY - stiff, yellow brown clay, damp							bentonite
8	2	- with some silt and trace fine grained sand							
		- becoming moist						▼	case
7	3								
		- becoming saturated							
6	4								
									sand
5	5								
									screen
4	6								
3	7								
	7.7	Bore discontinued at 7.7m (target depth reached)							
2	8								
1	9								

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Water level dipped 4/12/09

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 19
EASTING: 292585
NORTHING: 6174410
DIP/AZIMUTH: 90°/--

BORE No: 108
PROJECT No: 48742
DATE: 26 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
19	0	TOPSOIL - brown clayey silt							backfill
	0.2	CLAYEY SILT - light grey clayey silt, humid							bentonite
	0.5	CLAY - firm, grey mottled yellow clay, damp							
18	1								case
17	2								
	2.3	CLAY - firm, brown clay, damp to moist						▼	
	2.7	CLAY - yellow brown clay with trace sand and gravel, moist							
16	3								sand
15	4	- sand content increasing, becoming saturated							screen
14	5	- gravel content increasing							
	5.5	SANDSTONE - low strength, extremely weathered sandstone							
	5.65	Bore discontinued at 5.65m (target depth reached)							
13	6								
12	7								
11	8								
10	9								

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: Free groundwater observed at 2.0m after installing piezometer

REMARKS: Water level dipped 4/12/09

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 21
EASTING: 292990
NORTHING: 6172385
DIP/AZIMUTH: 90°/--

BORE No: 109
PROJECT No: 48742
DATE: 26 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
21	0.25	TOPSOIL - brown silty sandy clay topsoil							backfill
		CLAYEY GRAVEL - medium dense, 10mm sandstone gravel in a clay matrix, humid							case bentonite
20	1								
	1.8	GRAVELLY CLAY - brown sandstone gravelly clay with some sand, humid (weathered rock)							
19	2								sand
18	3							▼	screen
	3.9								
17	4	SANDSTONE							
	4.0	Bore discontinued at 4.0m (slow progress in weathered rock)							
16	5								
15	6								
14	7								
13	8								
12	9								

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Water level dipped 4/12/09

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 10
EASTING: 294108
NORTHING: 6172194
DIP/AZIMUTH: 90°/--

BORE No: 110
PROJECT No: 48742
DATE: 26 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
10		TOPSOIL - brown silty clay topsoil, humid							backfill
9	0.9 1	CLAY - stiff, dark grey clay, humid to damp							bentonite
	1.6	CLAY - stiff to very stiff, yellow brown mottled grey clay with some silt and trace sand, damp							case
8	2 2.2	SANDY CLAY - stiff, yellow brown sandy clay, damp to moist - gravel band							
7	3							▼	
6	4								
	4.6	CLAY - stiff, dark brown clay with some sand and silt, damp							
5	5	- becoming wet							sand
4	6	- gravel bands							screen
3	7								
2	8								
	8.4 8.5	SANDSTONE - extremely weathered, extremely low strength, sandstone							
1	9	Bore discontinued at 8.5m (slow progress in sandstone)							

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: Free groundwater observed at 1.4m after piezometer installation

REMARKS: Water level dipped 4/12/09

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 13
EASTING: 293593
NORTHING: 6172311
DIP/AZIMUTH: 90°/--

BORE No: 111
PROJECT No: 48742
DATE: 25 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
13		SILT - loose, brown silt with trace sand, humid							
		- gravel bands (quartz)							
		- with some sand							
12	1	1.0 SAND - loose to medium dense, brown medium grained sand with some silt							
11	2								
10	3	3.3 SAND AND CLAY - fine grained sand and brown clay with trace fine gravel, moist to wet							
9	4	- becoming saturated							
8	5	- gravel bands							
		5.4							
		5.5 SANDSTONE - extremely weathered, extremely low strength sandstone							
		Bore discontinued at 5.5m							
7	6	(slow progress in sandstone)							
6	7								
5	8								
4	9								

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: No free groundwater observed

REMARKS: No well installed, gravel collapse at 1.5m and 3.0m

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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BOREHOLE LOG

CLIENT: Delfin Lend Lease
PROJECT: Master Planning Geotechnical Study
LOCATION: Calderwood

SURFACE LEVEL: 12
EASTING: 293623
NORTHING: 6172339
DIP/AZIMUTH: 90°/--

BORE No: 112
PROJECT No: 48742
DATE: 26 Nov 09
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
12	0.0	TOPSOIL - loose, brown silt with trace sand, humid							backfill
	0.3	SAND - loose, brown medium grained sand with some silt							case
11	1								bentonite
10	2	- gravel bands							
9	3	- becoming wet							sand
8	4	- becoming saturated						▼	screen
7	5								
	5.5	Bore discontinued at 5.5m (target depth reached)							
6	6								
5	7								
4	8								
3	9								

RIG: Gemco 210B **DRILLER:** Paul Boers **LOGGED:** CCK **CASING:** -

TYPE OF BORING: 140mm SFA

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Water level dipped 4/12/09

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

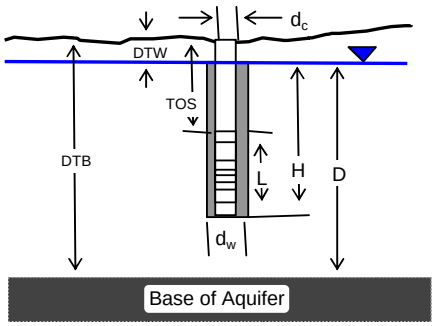
Laboratory Test Report Sheets

WELL ID: BH2

Local ID: S-1292
Date: 14/08/1997
Time: 0:00

INPUT

Construction:		
Casing dia. (d_c)	5	cm
Annulus dia. (d_w)	14	cm
Screen Length (L)	3	Meter
Depths to:		
water level (DTW)	4.49	Meter
top of screen (TOS)	5.2	Meter
Base of Aquifer (DTB)	8.2	Meter
Annular Fill:		
across screen --	Coarse Sand	
above screen --	Bentonite	
Aquifer Material --	Fine-Grained Sandsto	



COMPUTED

L_{wetted}	3	Meter
D =	3.71	Meter
H =	3.71	Meter
L/r_w =	5.14	
$y_{0\text{-DISPLACEMENT}}$ =	4.16	Meter
$y_{0\text{-SLUG}}$ =	3.05	Meter

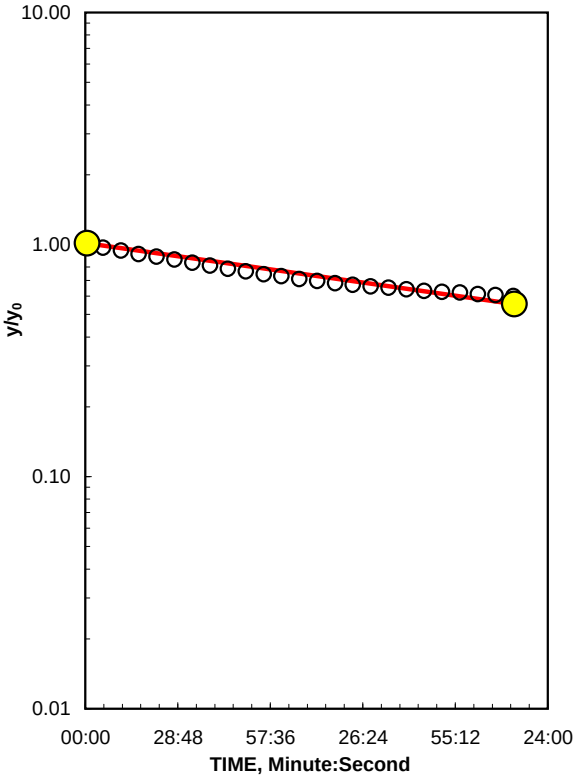
From look-up table using L/r_w

Fully penetrate C =	0.863	
ln(Re/rw) =	1.775	
Re =	1.36	Meter
Slope =	3.28E-05	$\log_{10}$/sec
$t_{90\%}$ recovery =	30471	sec

Input is consistent.

K = 5.00E-08 Meter/Secor

Adjust slope of line to estimate K



REMARKS: Bouwer and Rice analysis of slug test, WRR 1976

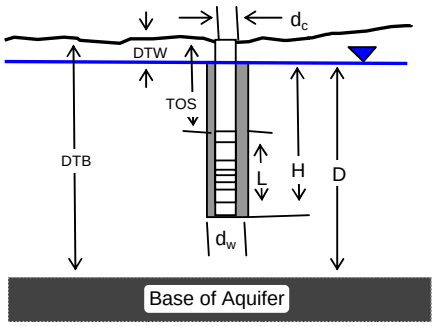
Initial test

WELL ID: BH5

Local ID: S-1292
Date: 14/08/1997
Time: 12:22

INPUT

Construction:		
Casing dia. (d_c)	5	cm
Annulus dia. (d_w)	14	cm
Screen Length (L)	3	Meter
Depths to:		
water level (DTW)	3.4	Meter
top of screen (TOS)	3	Meter
Base of Aquifer (DTB)	6	Meter
Annular Fill:		
across screen --	Coarse Sand	
above screen --	Bentonite	
Aquifer Material --	Fine Sand	



COMPUTED

L_{wetted}	2.6	Meter
D =	2.6	Meter
H =	2.6	Meter
L/r_w =	4.46	
$y_{0\text{-DISPLACEMENT}}$ =	1.64	Meter
$y_{0\text{-SLUG}}$ =	3.05	Meter

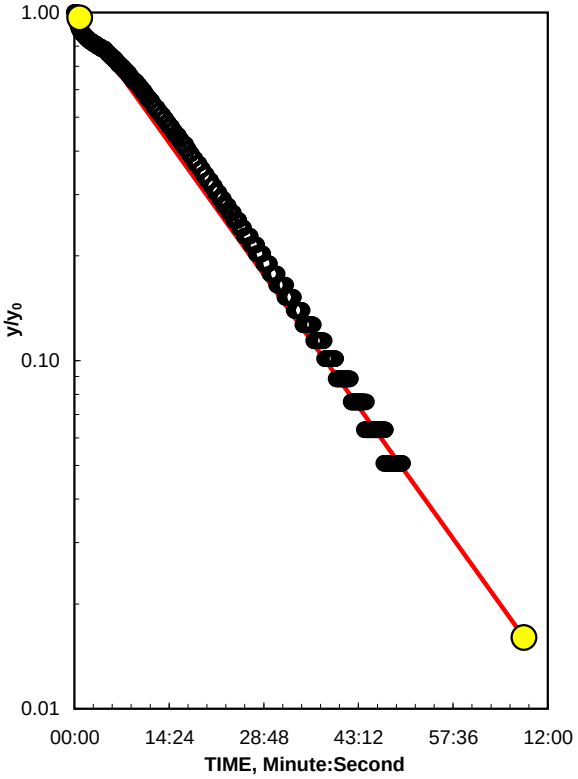
From look-up table using L/r_w

Fully penetrate C =	0.835	
ln(Re/rw) =	1.561	
Re =	1.09	Meter
Slope =	0.000439	$\log_{10}$/sec
$t_{90\%}$ recovery =	2277	sec

Input is consistent.

K = 6.00E-07 Meter/Secor

Adjust slope of line to estimate K



K= 0.0000006 is less than likely minimum of 0.000011 for Fine Sand

REMARKS: Bouwer and Rice analysis of slug test, WRR 1976

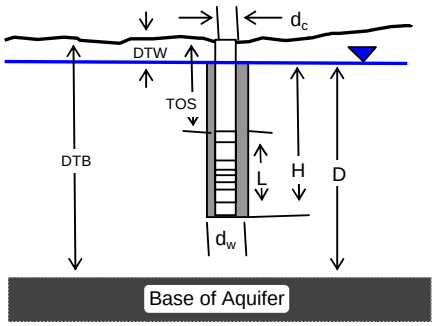
Initial test

WELL ID: BH6

Local ID: S-1292
Date: 14/08/1997
Time: 14:12

INPUT

Construction:		
Casing dia. (d_c)	5	cm
Annulus dia. (d_w)	14	cm
Screen Length (L)	3	Meter
Depths to:		
water level (DTW)	2.8	Meter
top of screen (TOS)	5.2	Meter
Base of Aquifer (DTB)	8.2	Meter
Annular Fill:		
across screen --	Coarse Sand	
above screen --	Bentonite	
Aquifer Material --	Clay soils (surface)	



COMPUTED

L_{wetted}	3	Meter
D =	5.4	Meter
H =	5.4	Meter
L/r_w =	5.14	
$y_{0\text{-DISPLACEMENT}}$ =	5.00	Meter
$y_{0\text{-SLUG}}$ =	3.05	Meter

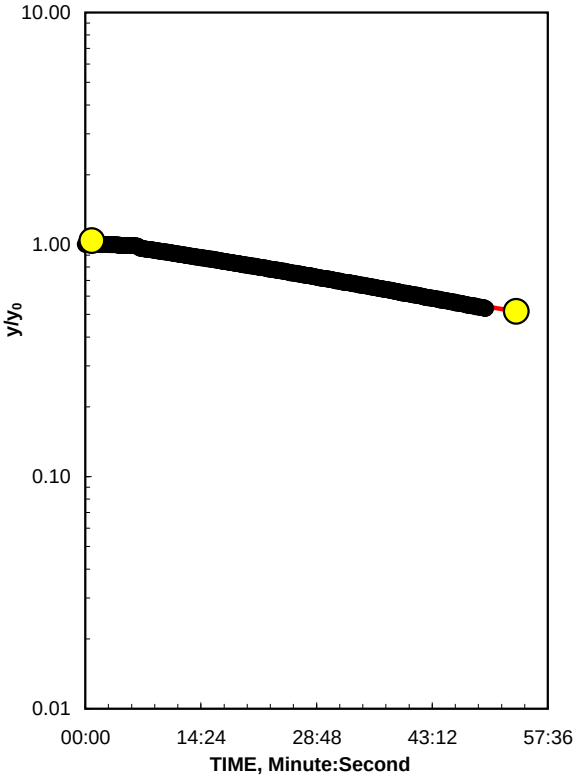
From look-up table using L/r_w

Fully penetrate C =	0.863	
ln(Re/rw) =	1.937	
Re =	1.59	Meter
Slope =	9.58E-05	$\log_{10}$/sec
$t_{90\%}$ recovery =	10433	sec

Input is consistent.

K = 1.00E-07 Meter/Secor

Adjust slope of line to estimate K



REMARKS: Bouwer and Rice analysis of slug test, WRR 1976

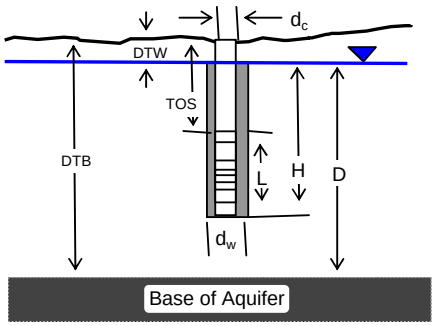
Initial test

WELL ID: BH7

Local ID: S-1292
Date: 14/08/1997
Time: 13:45

INPUT

Construction:		
Casing dia. (d_c)	5	cm
Annulus dia. (d_w)	14	cm
Screen Length (L)	3	Meter
Depths to:		
water level (DTW)	3.1	Meter
top of screen (TOS)	4.8	Meter
Base of Aquifer (DTB)	8	Meter
Annular Fill:		
across screen --	Coarse Sand	
above screen --	Bentonite	
Aquifer Material --	Fine Sand	



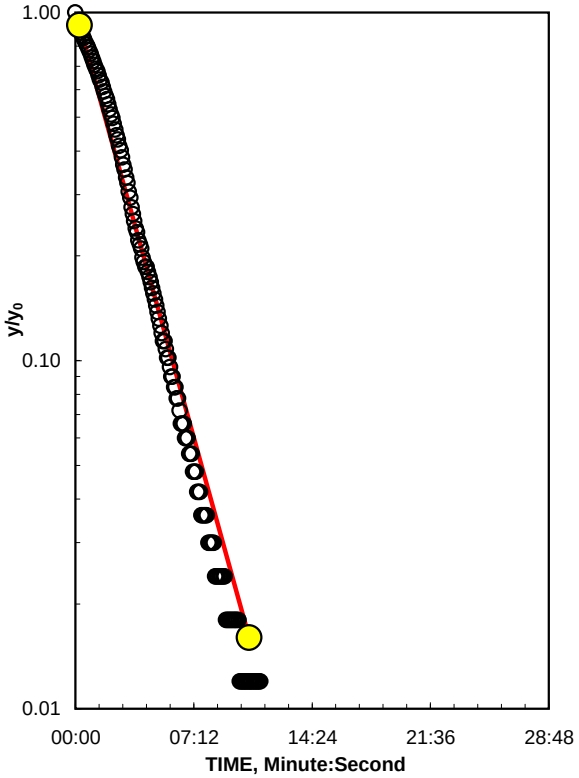
COMPUTED

L_{wetted}	3	Meter
D =	4.9	Meter
H =	4.7	Meter
L/r_w =	5.14	
$y_{0\text{-DISPLACEMENT}}$ =	3.47	Meter
$y_{0\text{-SLUG}}$ =	3.05	Meter
From look-up table using L/r_w		
Partial penetrate A =	1.745	
B =	0.233	
ln(Re/rw) =	1.434	
Re =	0.96	Meter
Slope =	0.002839	$\log_{10}$/sec
$t_{90\%}$ recovery =	352	sec

Input is consistent.

K = 3.00E-06 Meter/Secor

Adjust slope of line to estimate K



K= 0.000003 is less than likely minimum of 0.000011 for Fine Sand

REMARKS: Bouwer and Rice analysis of slug test, WRR 1976

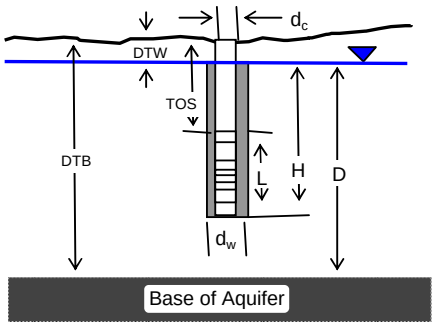
Initial test

WELL ID: BH12

Local ID: S-1292
Date: 14/08/1997
Time: 8:40

INPUT

Construction:		
Casing dia. (d_c)	5	cm
Annulus dia. (d_w)	14	cm
Screen Length (L)	3	Meter
Depths to:		
water level (DTW)	4.45	Meter
top of screen (TOS)	4.45	Meter
Base of Aquifer (DTB)	7.45	Meter
Annular Fill:		
across screen --	Coarse Sand	
above screen --	Bentonite	
Aquifer Material --	Medium-Grained Sand	



COMPUTED

L_{wetted}	3	Meter
D =	3	Meter
H =	3	Meter
L/r_w =	5.14	
$y_{0\text{-DISPLACEMENT}}$ =	0.62	Meter
$y_{0\text{-SLUG}}$ =	1.52	Meter

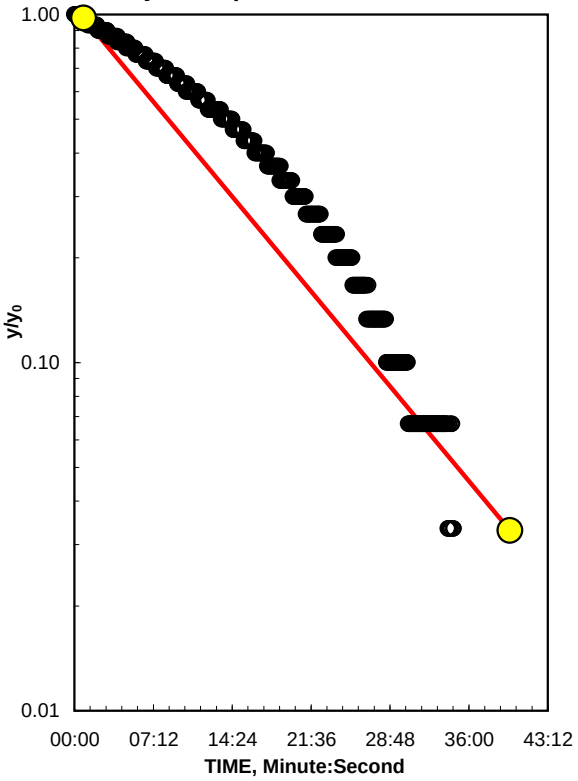
From look-up table using L/r_w

Fully penetrate C =	0.863	
ln(Re/rw) =	1.678	
Re =	1.23	Meter
Slope =	0.000631	$\log_{10}$/sec
$t_{90\%}$ recovery =	1585	sec

Input is consistent.

K = 8.00E-07 Meter/Secor

Adjust slope of line to estimate K



K= 0.0000008 is less than likely minimum of 0.0000035 for Medium-Grained Sandstone

REMARKS: Bouwer and Rice analysis of slug test, WRR 1976

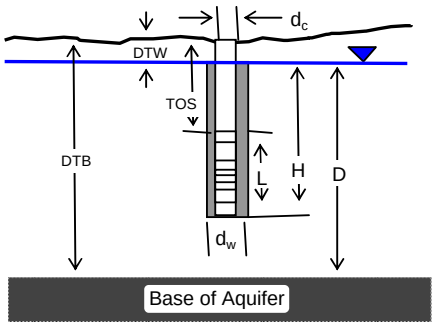
Initial test

WELL ID: BH12 - Falling

Local ID: S-1292
Date: 14/08/1997
Time: 9:15

INPUT

Construction:		
Casing dia. (d_c)	5	cm
Annulus dia. (d_w)	14	cm
Screen Length (L)	3	Meter
Depths to:		
water level (DTW)	4.45	Meter
top of screen (TOS)	4.45	Meter
Base of Aquifer (DTB)	10	Meter
Annular Fill:		
across screen --	Coarse Sand	
above screen --	Bentonite	
Aquifer Material --	Clay soils (surface)	



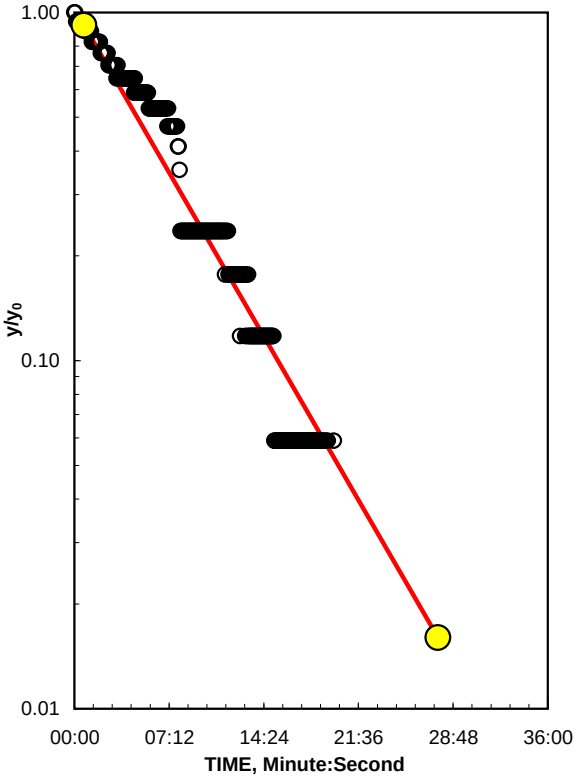
COMPUTED

L_{wetted}	3	Meter
D =	5.55	Meter
H =	3	Meter
L/r_w =	5.14	
$y_{0\text{-DISPLACEMENT}}$ =	0.35	Meter
$y_{0\text{-SLUG}}$ =	0.51	Meter
From look-up table using L/r_w		
Partial penetrate A =	1.745	
B =	0.233	
ln(Re/rw) =	1.141	
Re =	0.72	Meter
Slope =	0.001089	$\log_{10}$/sec
$t_{90\%}$ recovery =	919	sec

Input is consistent.

K =	1.00E-06	Meter/Secor

Adjust slope of line to estimate K



REMARKS: Bouwer and Rice analysis of slug test, WRR 1976

Initial test

Douglas Partners
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1 Luso Drive
Unanderra NSW 2526

Phone: (02) 4271 1836
Fax: (02) 4271 1897

HYDRAULIC CONDUCTIVITY TEST REPORT (Hvorslev Analysis)

Client:	Delfin Lend Lease Ltd	*Project No:*	48742
Project:	Urban Development	*Date:*	4-Dec-09
Location:	Calderwood	*Tested by:*	CCK

Test Location

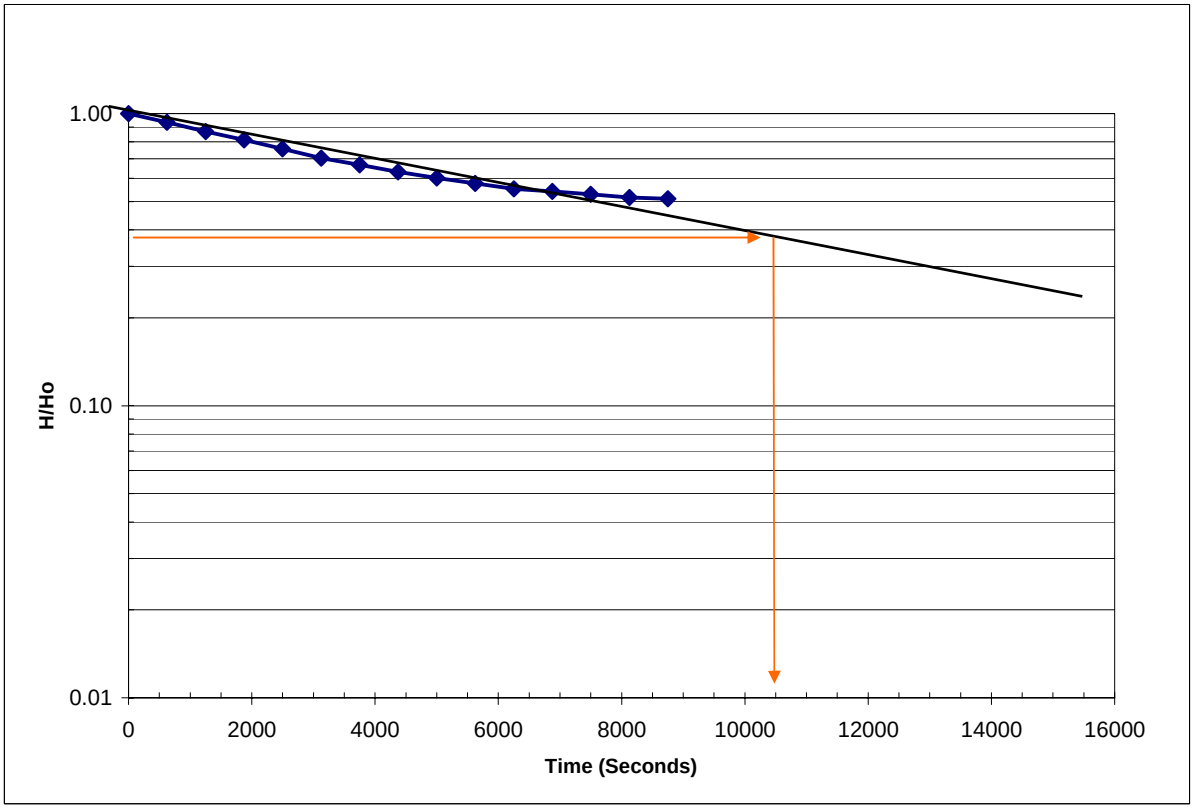
Description:	Borjeson Property	**Bore No.**	**BH2**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Rising Head, pumped and bailed dry	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

Details of Installation

Bore

Depth of bore hole	8.25 *m*	Length of Screen	3 *m*
Water Table (bgl)	4.49 *m*	Length of Logger	0.32 *m*
Casing Radius	25 *mm*	Bore Radius	70 *mm*

Test Results



T_0 = 11000 *seconds*

Hydraulic Conductivity

K = 3.56E-08 m/sec

= 3.56E-06 cm/sec

= 0.0031 m/day

$$K = \frac{r^2 \ln\left(L_e/R\right)}{2L_e T_0}$$

r = well radius
L_e = Screen Length
R = bore radius

T_0 = time for the water level to rise or fall to 37 %

Checked by:	

Douglas Partners
Geotechnics · Environment · Groundwater

1 Luso Drive
Unanderra NSW 2526

Phone: (02) 4271 1836
Fax: (02) 4271 1897

HYDRAULIC CONDUCTIVITY TEST REPORT (Hvorslev Analysis)

Client:	Delfin Lend Lease Ltd	*Project No:*	48742
Project:	Urban Development	*Date:*	4-Dec-09
Location:	Calderwood	*Tested by:*	CCK

Test Location

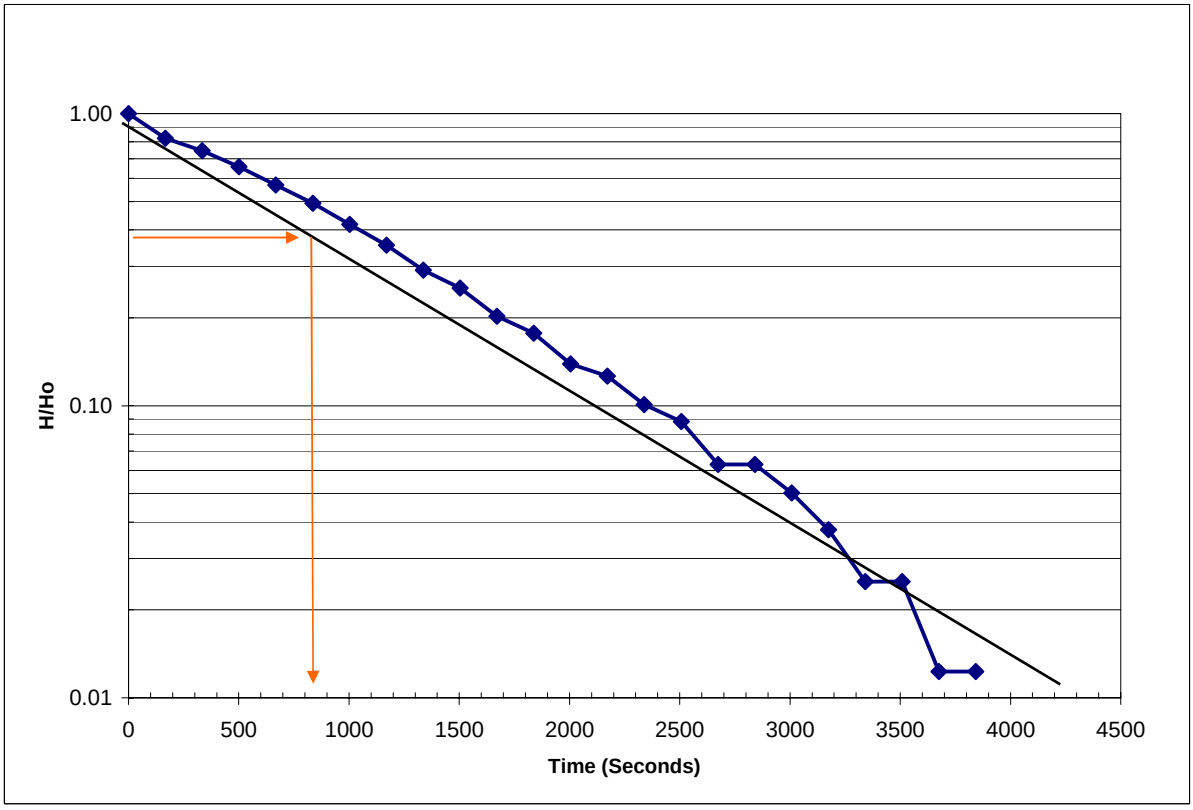
Description:	Novero Property	**Bore No.**	**BH5**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Rising Head, pumped and bailed dry	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

Details of Installation

Bore

Depth of bore hole	5.4 *m*	Length of Screen	3 *m*
Water Table (bgl)	3.4 *m*	Length of Logger	0.32 *m*
Casing Radius	25 *mm*	Bore Radius	70 *mm*

Test Results



T_0 = 800 *seconds*

Hydraulic Conductivity

K = 4.89E-07 m/sec

= 4.89E-05 cm/sec

= 0.0423 m/day

$$K = \frac{r^2 \ln\left(L_e/R\right)}{2L_e T_0}$$

r = well radius
L_e = Screen Length
R = bore radius

T_0 = time for the water level to rise or fall to 37 %

Checked by:	

Douglas Partners
Geotechnics · Environment · Groundwater

1 Luso Drive
Unanderra NSW 2526

Phone: (02) 4271 1836
Fax: (02) 4271 1897

HYDRAULIC CONDUCTIVITY TEST REPORT (Hvorslev Analysis)

Client:	Delfin Lend Lease Ltd	*Project No:*	48742
Project:	Urban Development	*Date:*	4-Dec-09
Location:	Calderwood	*Tested by:*	CCK

Test Location

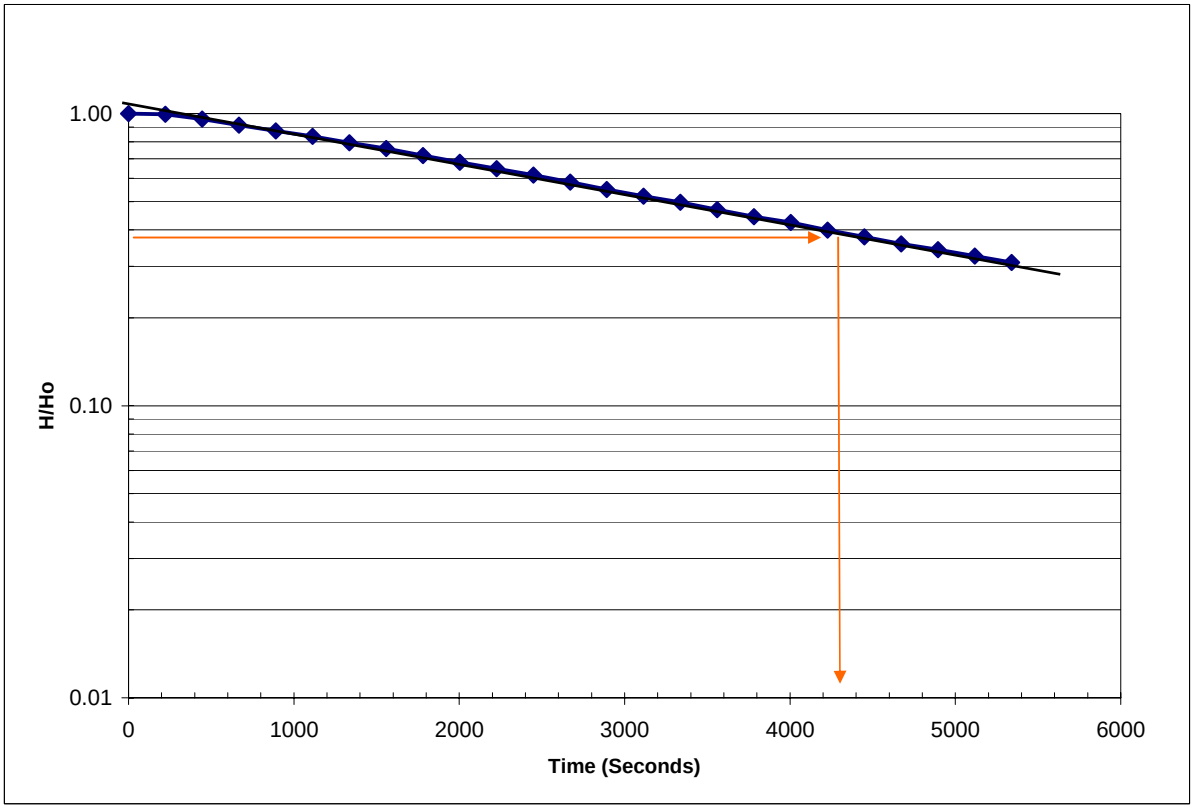
Description:	Swan Property	**Bore No.**	**BH6**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Rising Head, pumped and bailed dry	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

Details of Installation

Bore

Depth of bore hole	8.2 *m*	Length of Screen	3 *m*
Water Table (bgl)	2.8 *m*	Length of Logger	0.32 *m*
Casing Radius	25 *mm*	Bore Radius	70 *mm*

Test Results



T_0 = 4300 *seconds*

Hydraulic Conductivity

K = 9.10E-08 m/sec

= 9.10E-06 cm/sec

= 0.0079 m/day

$$K = \frac{r^2 \ln\left(L_e/R\right)}{2L_e T_0}$$

r = well radius
L_e = Screen Length
R = bore radius

T_0 = time for the water level to rise or fall to 37 %

Checked by:	

Douglas Partners
Geotechnics · Environment · Groundwater

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Unanderra NSW 2526

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HYDRAULIC CONDUCTIVITY TEST REPORT (Hvorslev Analysis)

Client:	Delfin Lend Lease Ltd	*Project No:*	48742
Project:	Urban Development	*Date:*	4-Dec-09
Location:	Calderwood	*Tested by:*	CCK

Test Location

Description:	Swan Property	*Easting:*	293421 *m*
Material type:	Clayey Sand	*Northing*	6172019 *m*
Type of Test:	Rising Head, pumped and bailed dry	*Surface Level:*	- *m AHD*

Bore No. BH7

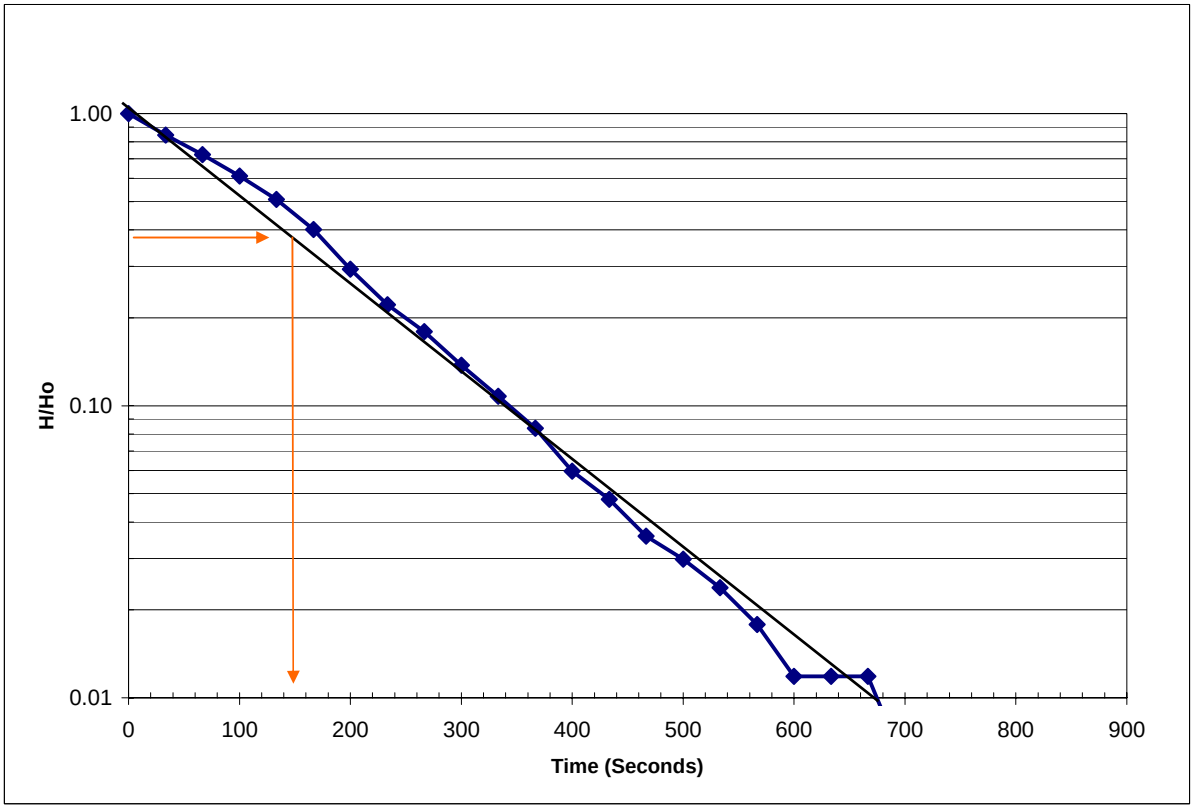
Precipitation Comments: nil

Details of Installation

Bore

Depth of bore hole	7.7 *m*	Length of Screen	3 *m*
Water Table (bgl)	3.1 *m*	Length of Logger	0.32 *m*
Casing Radius	25 *mm*	Bore Radius	70 *mm*

Test Results



T_0 = 140 *seconds*

Hydraulic Conductivity

K =	**2.80E-06**	**m/sec**
=	**2.80E-04**	**cm/sec**
=	**0.2416**	**m/day**

$$K = \frac{r^2 \ln\left(L_e/R\right)}{2L_e T_0}$$

r = well radius
L_e = Screen Length
R = bore radius

T_0 = time for the water level to rise or fall to 37 %

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HYDRAULIC CONDUCTIVITY TEST REPORT (Hvorslev Analysis)

Client:	Delfin Lend Lease Ltd	*Project No:*	48742
Project:	Urban Development	*Date:*	4-Dec-09
Location:	Calderwood	*Tested by:*	CCK

Test Location

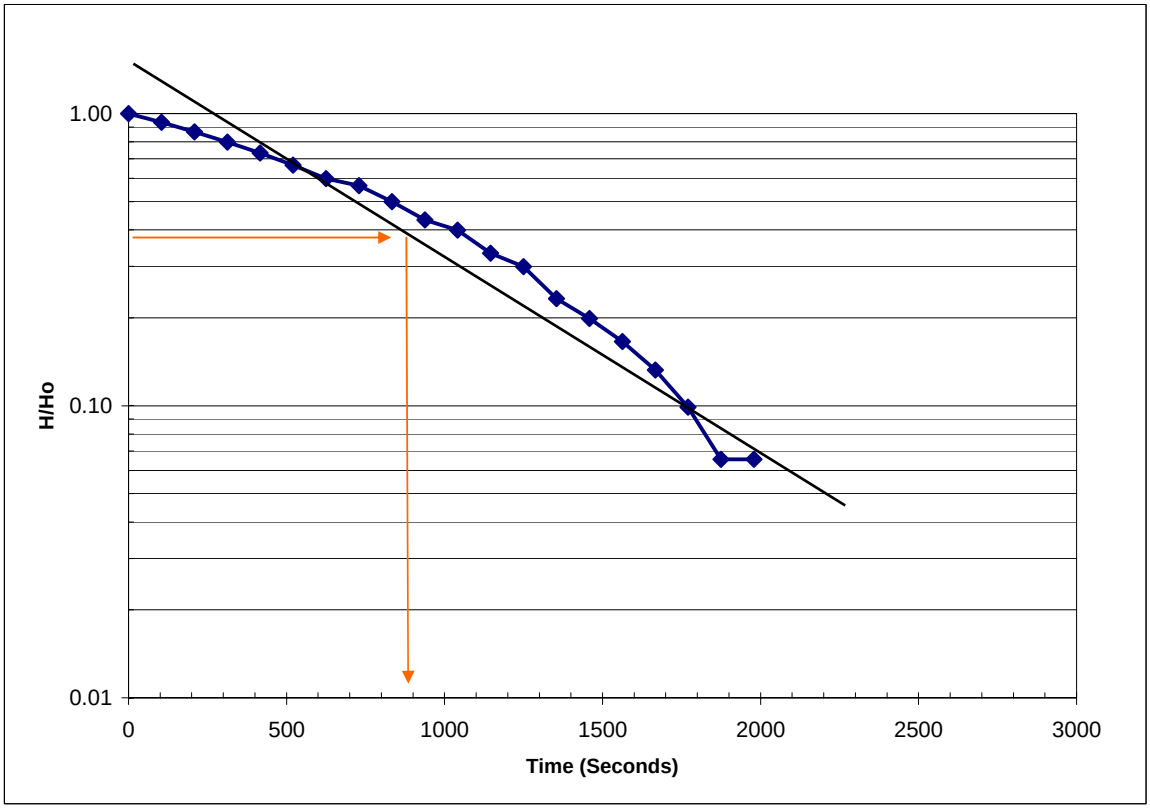
Description:	Keys Property	**Bore No.**	**BH12**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Rising Head, pumped and bailed dry	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

Details of Installation

Bore

Depth of bore hole	5.5 *m*	Length of Screen	4 *m*
Water Table (bgl)	4.49 *m*	Length of Logger	0 *m*
Casing Radius	25 *mm*	Bore Radius	70 *mm*

Test Results



T_0 = 850 *seconds*

Hydraulic Conductivity

K = 3.72E-07 m/sec

= 3.72E-05 cm/sec

= 0.0321 m/day

$$K = \frac{r^2 \ln\left(L_e/R\right)}{2L_e T_0}$$

r = well radius
L_e = Screen Length
R = bore radius

T_0 = time for the water level to rise or fall to 37 %

Checked by:	

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HYDRAULIC CONDUCTIVITY TEST REPORT (Hvorslev Analysis)

Client:	Delfin Lend Lease Ltd	*Project No:*	48742
Project:	Urban Development	*Date:*	4-Dec-09
Location:	Calderwood	*Tested by:*	CCK

Test Location

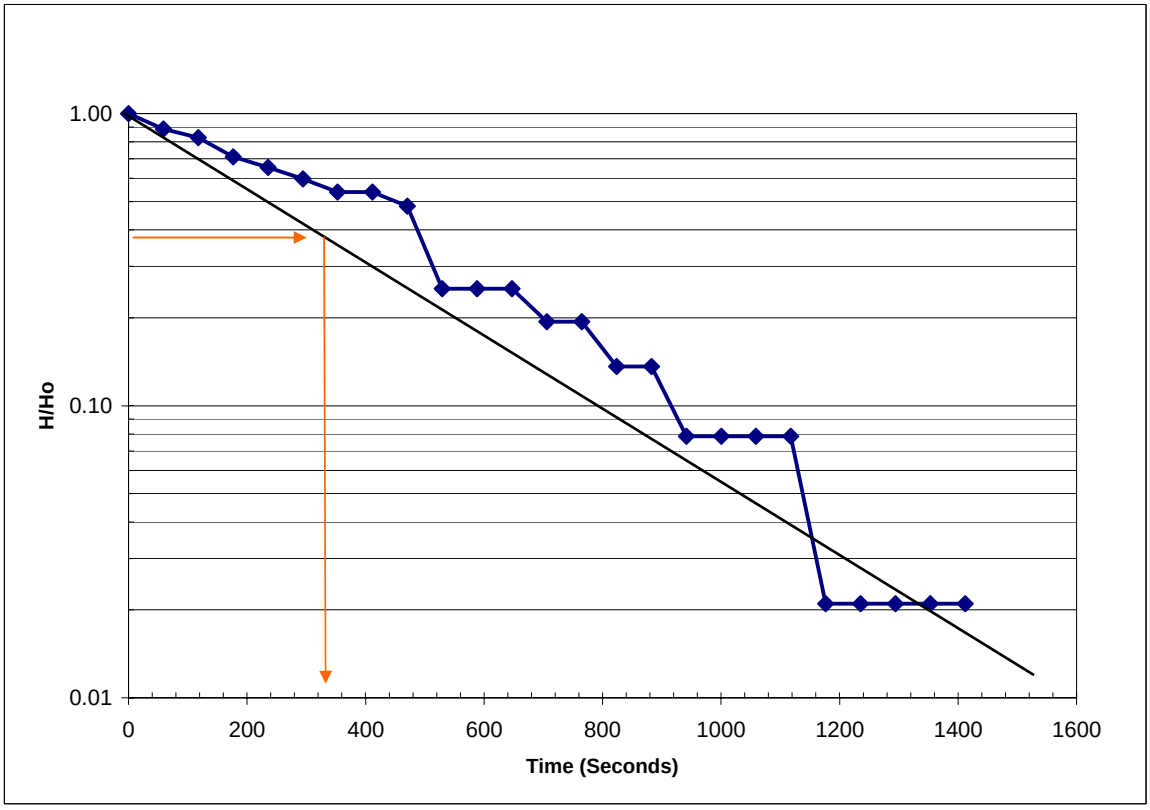
Description:	Keys Property	**Bore No.**	**BH12**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Falling Head, water added	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

Details of Installation

Bore

Depth of bore hole	5.5 *m*	Length of Screen	4 *m*
Water Table (bgl)	4.49 *m*	Length of Logger	0.32 *m*
Casing Radius	25 *mm*	Bore Radius	70 *mm*

Test Results



T_0 = 260 *seconds*

Hydraulic Conductivity

K = 1.22E-06 m/sec

= 1.22E-04 cm/sec

= 0.1050 m/day

$$K = \frac{r^2 \ln\left(L_e/R\right)}{2L_e T_0}$$

r = well radius
L_e = Screen Length
R = bore radius

T_0 = time for the water level to rise or fall to 37 %

Checked by:	

APPENDIX D

Hydraulic Conductivity Test Report Sheets

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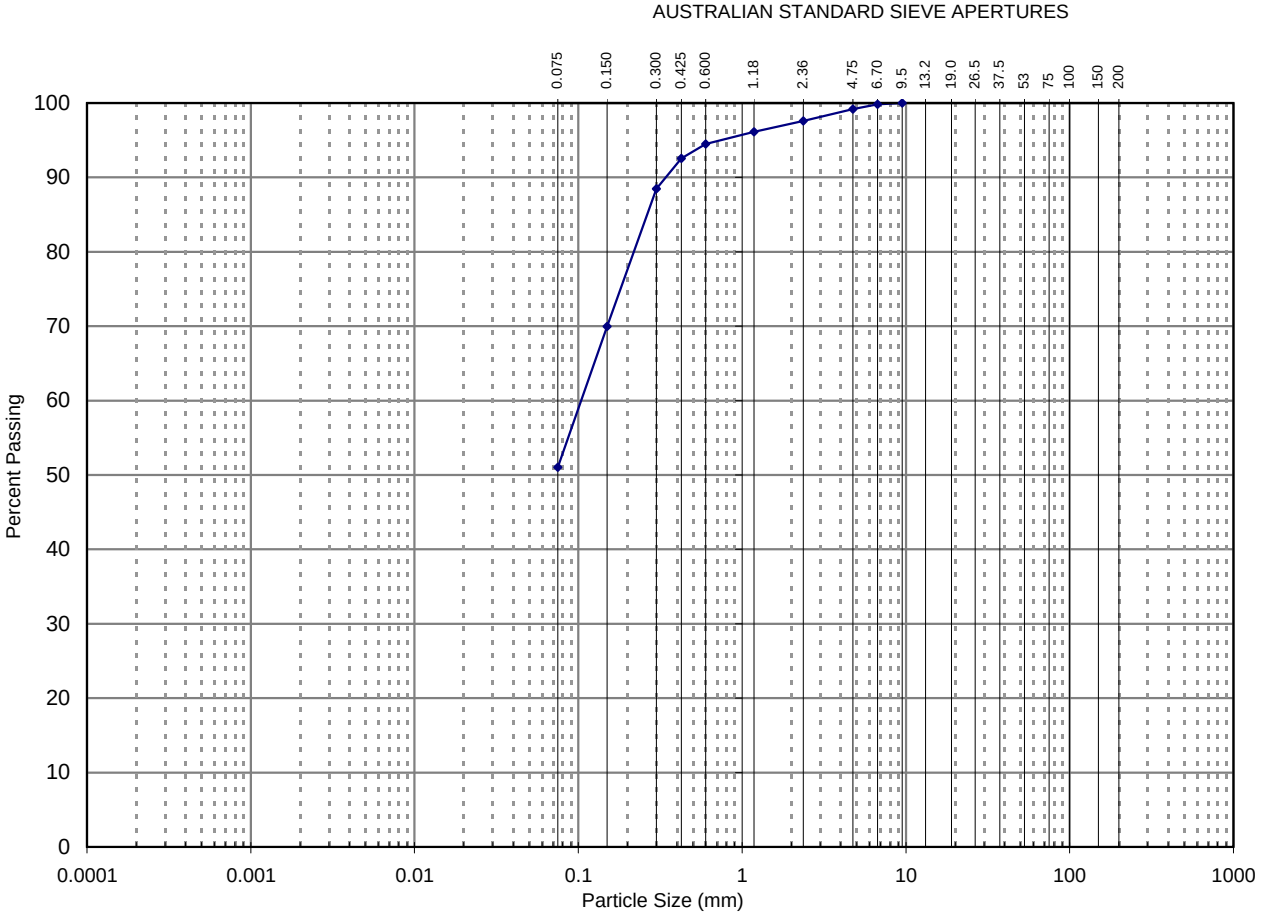
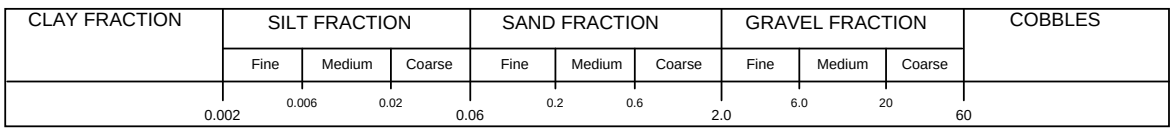
wollongong@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	DELFIN LEND LEASE			**Project No. :**	48742
				Report No. :	UL09-218B
Project :	Master Geotech Study			**Report Date :**	03-Nov-09
				Date Sampled:	9-13-Nov-09
Location :	Calderwood			**Date of Test:**	23-Nov-09
Road No:	-	**Sample / Pit No:**	8	**Depth / Layer:**	1.0 - 1.1m
Chainage:	-	**Section / Lot No:**	-	**Test Request No:**	-
				Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	~
9.5	**100%**
6.7	**100%**
4.75	**99%**
2.36	**98%**
1.18	**96%**
0.600	**95%**
0.425	**93%**
0.300	**88%**
0.150	**70%**
0.075	**51%**



Description: Brown silty sandy clay

Test Method(s): AS 1289.3.6.1

Sampling Method(s): Sampled by Wollongong Engineering Department

Remarks: -

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Approved Signatory:

Tested:	JR
Checked:	DE

David Evans
Laboratory Manager

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Geotechnics · Environment · Groundwater

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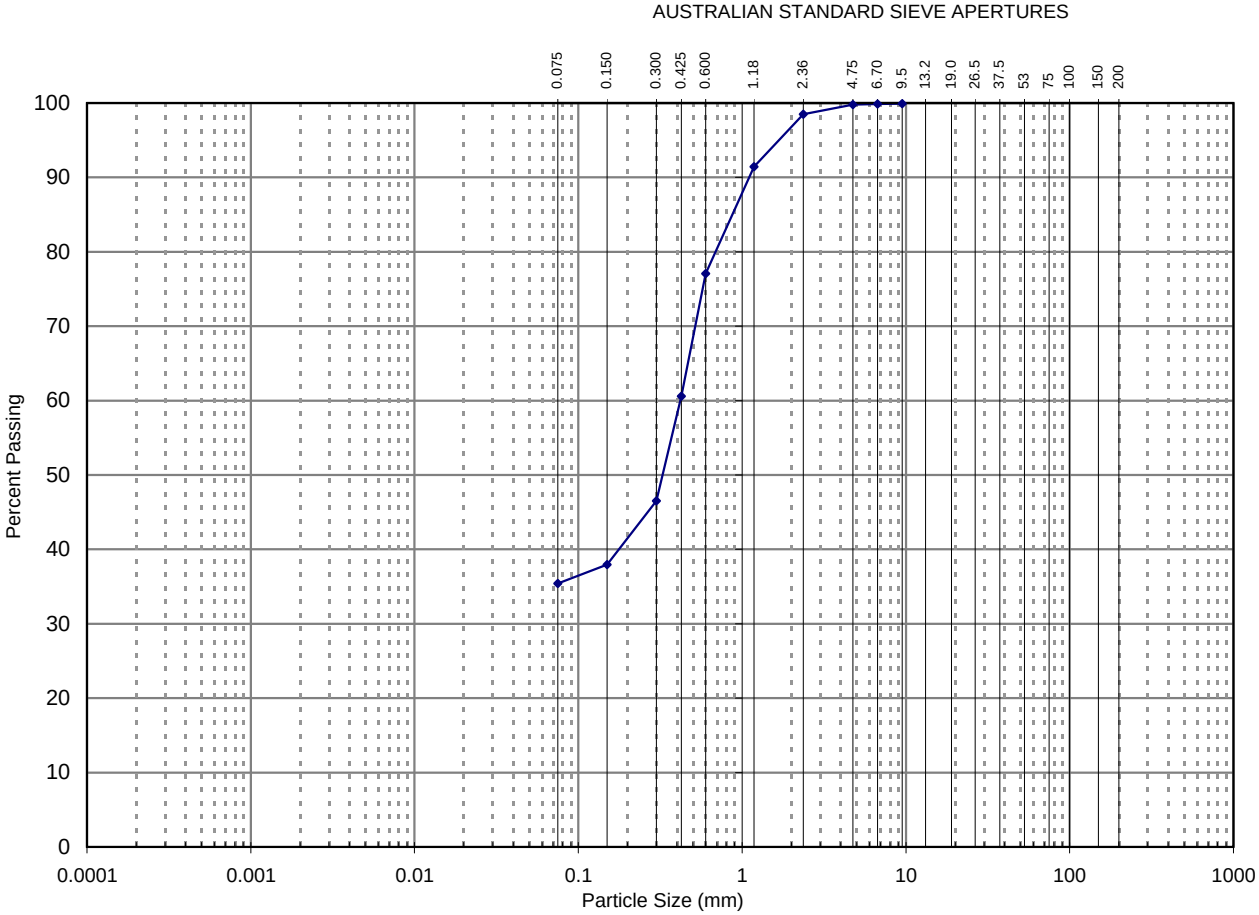
RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	DELFIN LEND LEASE			**Project No. :**	48742
				Report No. :	UL09-218C
Project :	Master Geotech Study			**Report Date :**	03-Nov-09
				Date Sampled:	9-13-Nov-09
Location :	Calderwood			**Date of Test:**	23-Nov-09
Road No:	-	**Sample / Pit No:**	42	**Depth / Layer:**	1.0 - 1.1m
Chainage:	-	**Section / Lot No:**	-	**Test Request No:**	-
				Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	~
9.5	**100%**
6.7	**100%**
4.75	**100%**
2.36	**98%**
1.18	**91%**
0.600	**77%**
0.425	**61%**
0.300	**47%**
0.150	**38%**
0.075	**35%**

Description: Orange brown silty clayey sand

Test Method(s): AS 1289.3.6.1

Sampling Method(s): Sampled by Wollongong Engineering Department

Remarks: -

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Approved Signatory:

Tested:	JR
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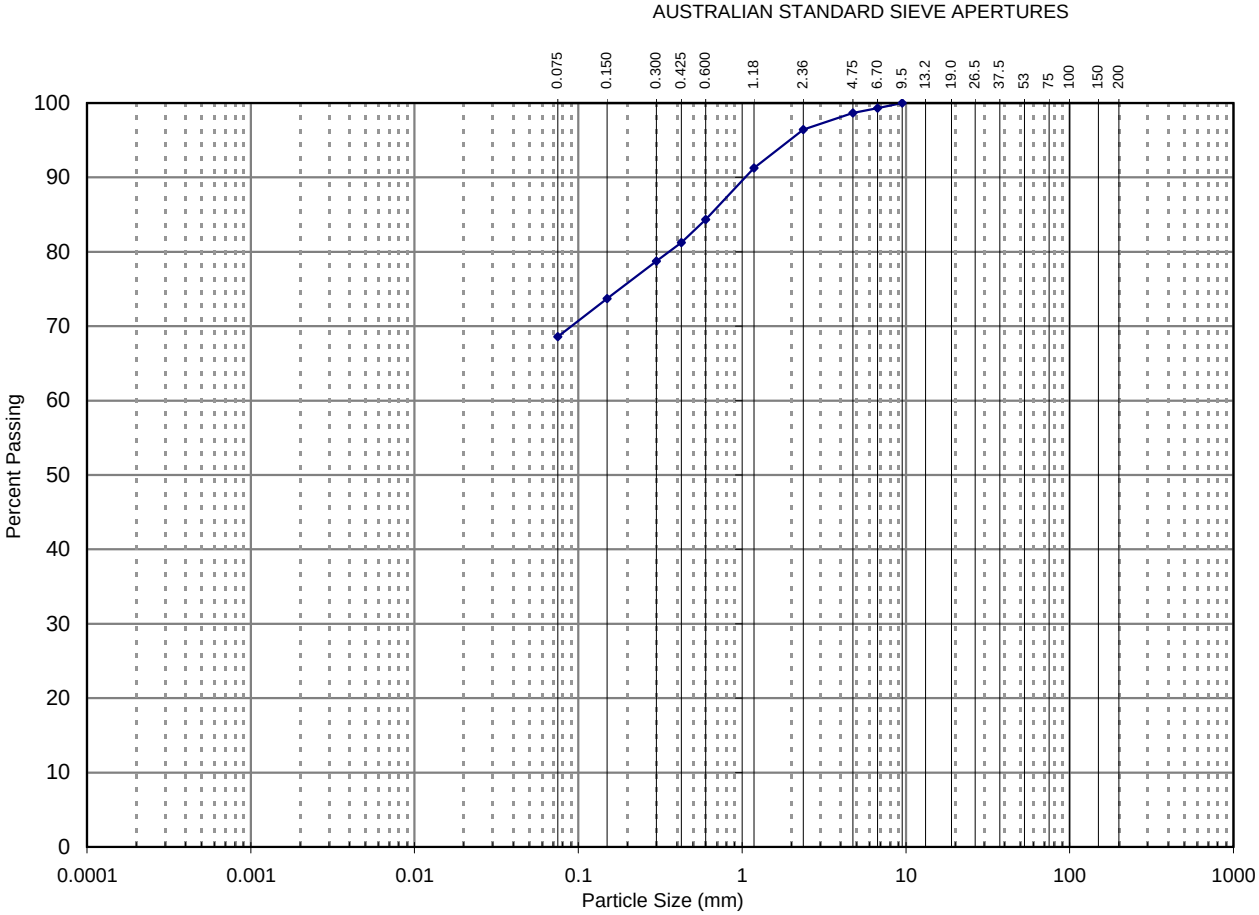
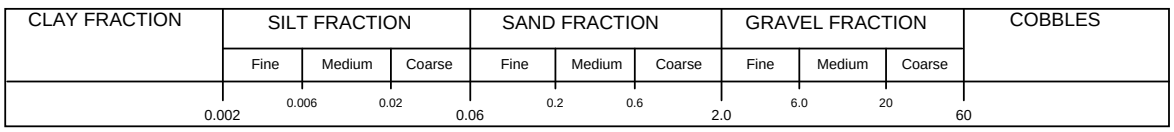
RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	DELFIN LEND LEASE			**Project No. :**	48742
				Report No. :	UL09-218D
Project :	Master Geotech Study			**Report Date :**	03-Nov-09
				Date Sampled:	9-13-Nov-09
Location :	Calderwood			**Date of Test:**	23-Nov-09
Road No:	-	**Sample / Pit No:**	56	**Depth / Layer:**	0.5 - 0.7m
Chainage:	-	**Section / Lot No:**	-	**Test Request No:**	-
				Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	~
9.5	**100%**
6.7	**99%**
4.75	**99%**
2.36	**96%**
1.18	**91%**
0.600	**84%**
0.425	**81%**
0.300	**79%**
0.150	**74%**
0.075	**69%**



Description: Brown sandy silty clay

Test Method(s): AS 1289.3.6.1

Sampling Method(s): Sampled by Wollongong Engineering Department

Remarks: -

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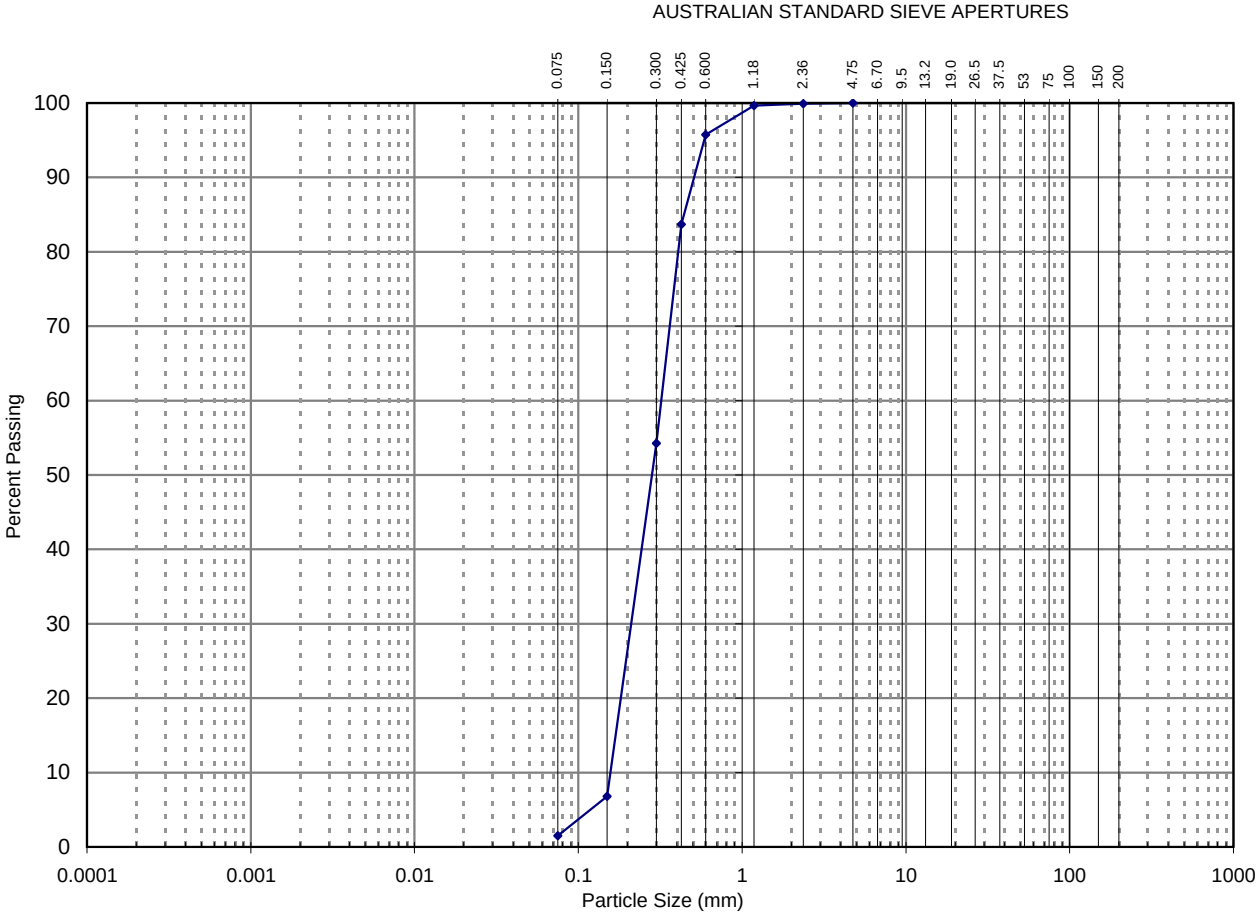
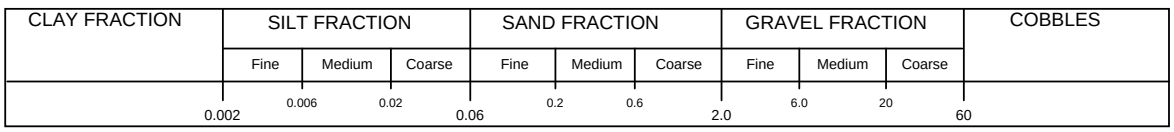
RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	DELFIN LEND LEASE			**Project No. :**	48742
				Report No. :	UL09-218E
Project :	Master Geotech Study			**Report Date :**	03-Nov-09
				Date Sampled:	9-13-Nov-09
Location :	Calderwood			**Date of Test:**	23-Nov-09
Road No:	-	**Sample / Pit No:**	59	**Depth / Layer:**	0.5 - 0.7m
Chainage:	-	**Section / Lot No:**	-	**Test Request No:**	-
				Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	~
9.5	~
6.7	~
4.75	**100%**
2.36	**100%**
1.18	**100%**
0.600	**96%**
0.425	**84%**
0.300	**54%**
0.150	**7%**
0.075	**2%**



Description: Brown sand

Test Method(s): AS 1289.3.6.1

Sampling Method(s): Sampled by Wollongong Engineering Department

Remarks: -

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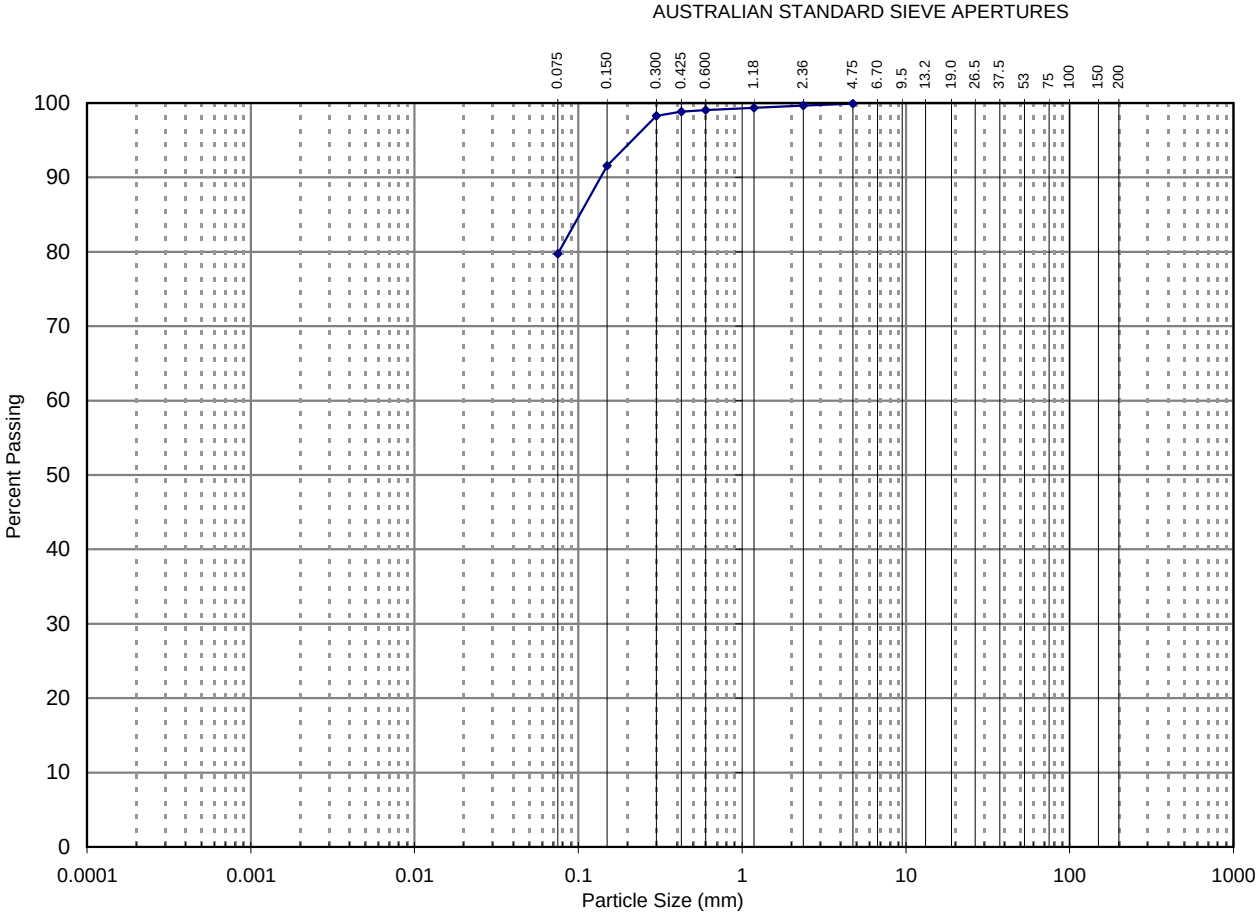
RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	DELFIN LEND LEASE			**Project No. :**	48742
				Report No. :	UL09-218F
Project :	Master Geotech Study			**Report Date :**	03-Nov-09
				Date Sampled:	9-13-Nov-09
Location :	Calderwood			**Date of Test:**	23-Nov-09
Road No:	-	**Sample / Pit No:**	7	**Depth / Layer:**	0.9 - 1.0m
Chainage:	-	**Section / Lot No:**	-	**Test Request No:**	-
				Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	~
9.5	~
6.7	~
4.75	**100%**
2.36	**100%**
1.18	**99%**
0.600	**99%**
0.425	**99%**
0.300	**98%**
0.150	**92%**
0.075	**80%**

Description: Orange brown sandy silty clay

Test Method(s): AS 1289.3.6.1

Sampling Method(s): Sampled by Wollongong Engineering Department

Remarks: -

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Tested:	JR
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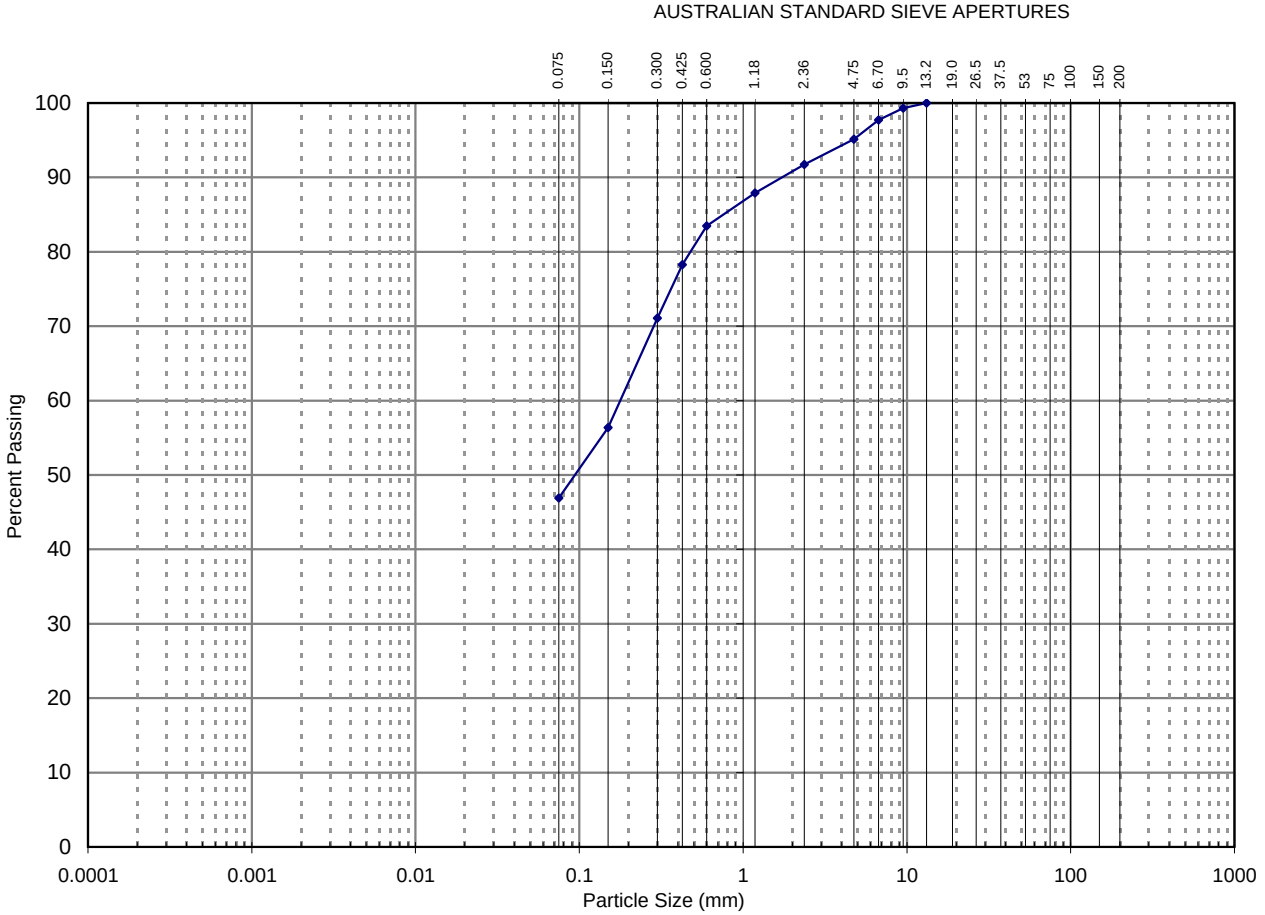
RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	DELFIN LEND LEASE			**Project No. :**	48742
				Report No. :	UL09-218G
Project :	Master Geotech Study			**Report Date :**	03-Nov-09
				Date Sampled:	9-13-Nov-09
Location :	Calderwood			**Date of Test:**	23-Nov-09
Road No:	-	**Sample / Pit No:**	15	**Depth / Layer:**	1.0 - 1.1m
Chainage:	-	**Section / Lot No:**	-	**Test Request No:**	-
				Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	**100%**
9.5	**99%**
6.7	**98%**
4.75	**95%**
2.36	**92%**
1.18	**88%**
0.600	**83%**
0.425	**78%**
0.300	**71%**
0.150	**56%**
0.075	**47%**

Description: Brown gravelly silty clayey sand

Test Method(s): AS 1289.3.6.1

Sampling Method(s): Sampled by Wollongong Engineering Department

Remarks: -

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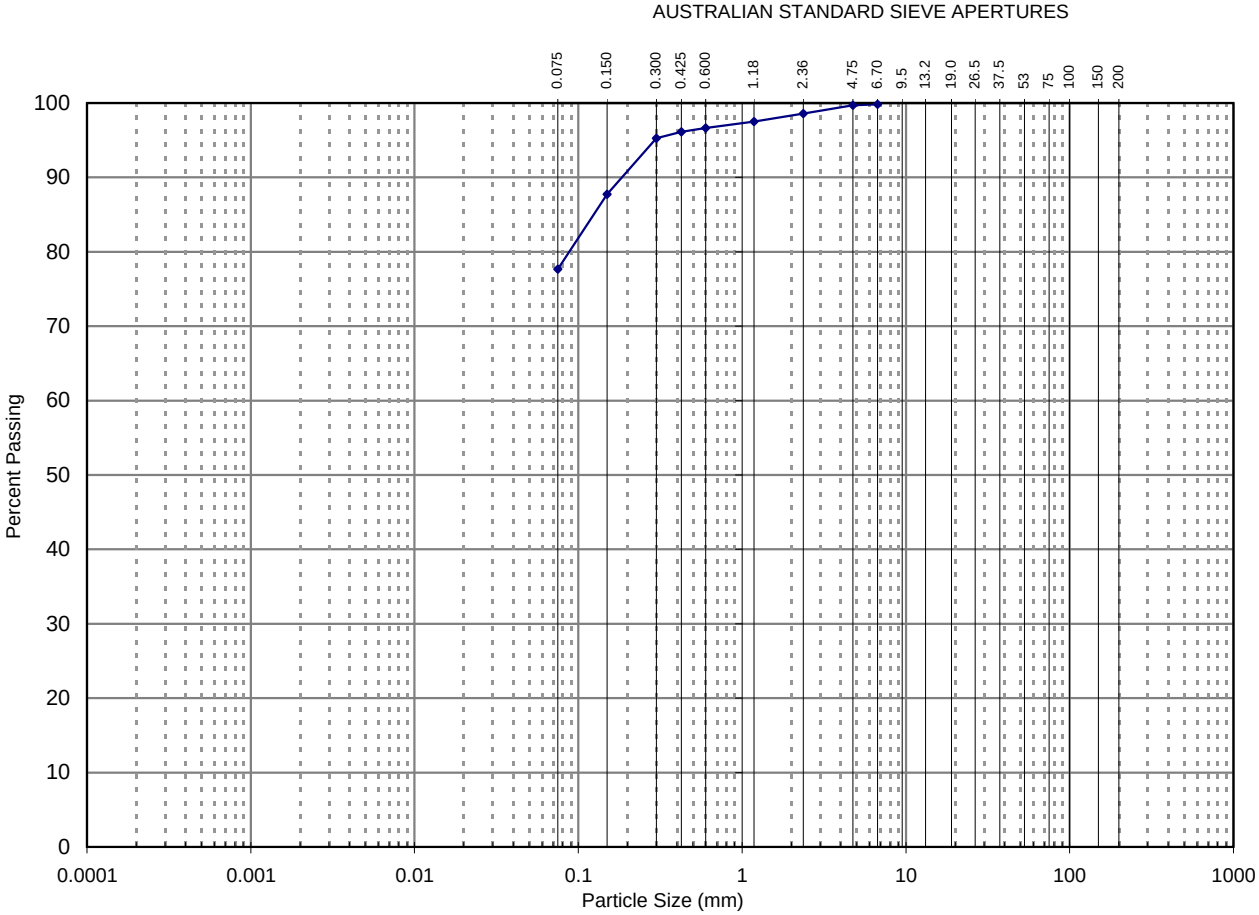
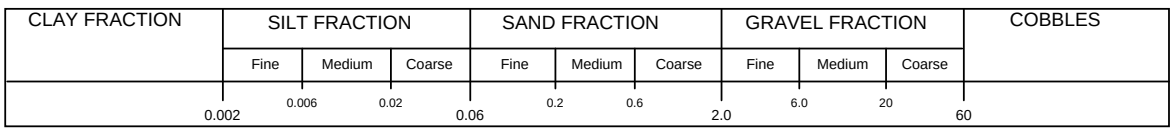
RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	DELFIN LEND LEASE			**Project No. :**	48742
				Report No. :	UL09-218H
Project :	Master Geotech Study			**Report Date :**	03-Nov-09
				Date Sampled:	9-13-Nov-09
Location :	Calderwood			**Date of Test:**	23-Nov-09
Road No:	-	**Sample / Pit No:**	31	**Depth / Layer:**	0.5 - 0.7m
Chainage:	-	**Section / Lot No:**	-	**Test Request No:**	-
				Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	~
9.5	~
6.7	**100%**
4.75	**100%**
2.36	**99%**
1.18	**98%**
0.600	**97%**
0.425	**96%**
0.300	**95%**
0.150	**88%**
0.075	**78%**



Description: Brown sandy silty clay

Test Method(s): AS 1289.3.6.1

Sampling Method(s): Sampled by Wollongong Engineering Department

Remarks: -

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Approved Signatory:

Tested:	JR
Checked:	DE

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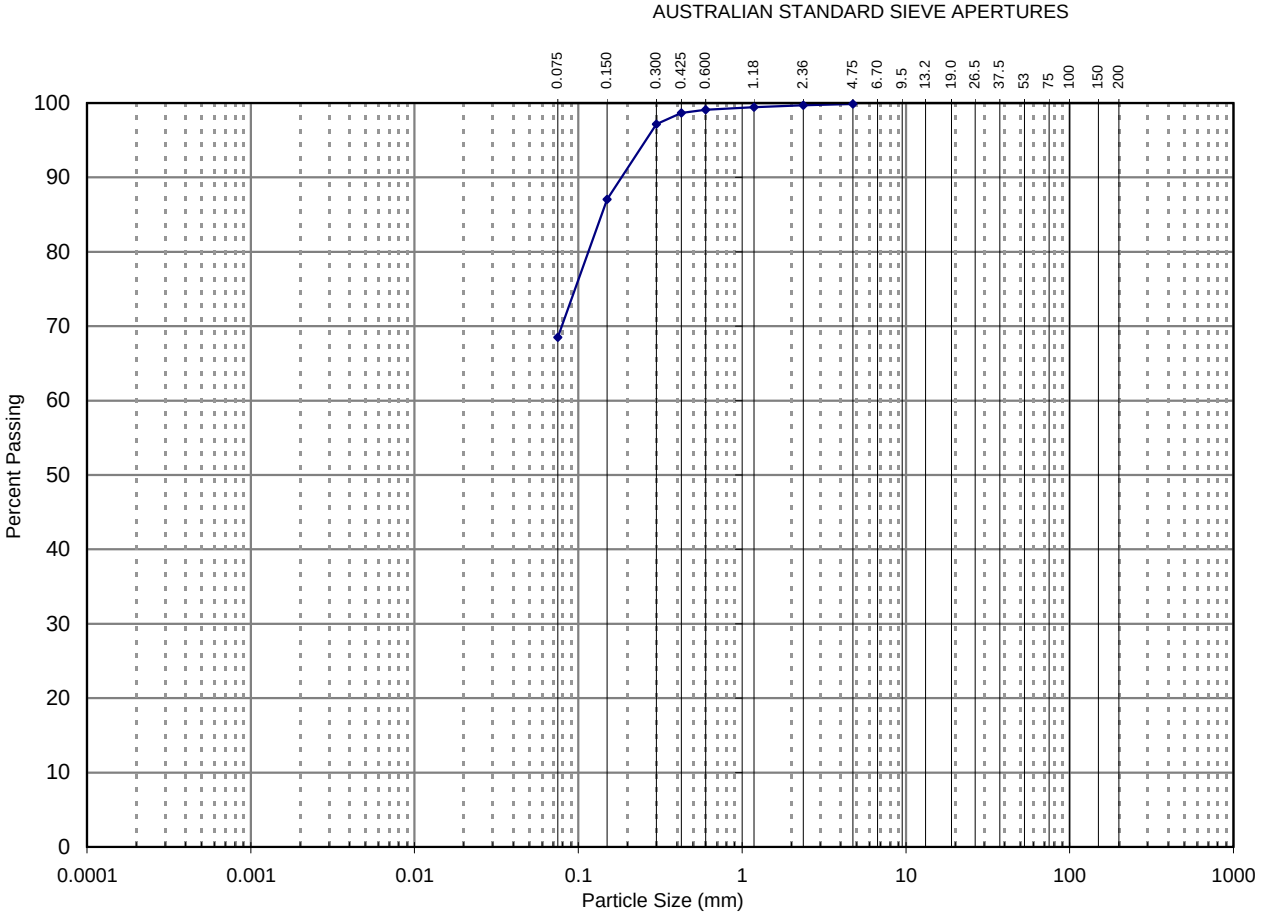
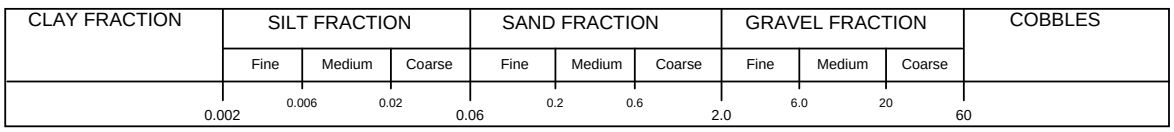
RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	DELFIN LEND LEASE			**Project No. :**	48742
				Report No. :	UL09-218J
Project :	Master Geotech Study			**Report Date :**	03-Nov-09
				Date Sampled:	9-13-Nov-09
Location :	Calderwood			**Date of Test:**	23-Nov-09
Road No:	-	**Sample / Pit No:**	88	**Depth / Layer:**	0.5 - 0.7m
Chainage:	-	**Section / Lot No:**	-	**Test Request No:**	-
				Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	~
9.5	~
6.7	~
4.75	**100%**
2.36	**100%**
1.18	**99%**
0.600	**99%**
0.425	**99%**
0.300	**97%**
0.150	**87%**
0.075	**69%**



Description: Brown sandy clayey silt

Test Method(s): AS 1289.3.6.1

Sampling Method(s): Sampled by Wollongong Engineering Department

Remarks: -

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