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REPORT
ON
GROUNDWATER ASSESSMENT

CONCEPT PLAN APPLICATION
CALDERWOOD URBAN DEVELOPMENT PROJECT

Prepared for:
DELFIN LEND LEASE LTD

PROJECT 48742.02
MARCH 2010

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ACEA
The Association of Consulting Engineers Australia

Executive Summary

A groundwater assessment has been undertaken for the Calderwood Urban Development Project, a 720 ha site near Albion Park, NSW. The investigation comprised drilling of boreholes and installation of monitoring wells in the resultant holes for ongoing monitoring of the water level and testing. The investigation was undertaken to address the Director General Requirements listed under the heading Stage 1 Project Application: Groundwater details.

The investigation area targeted the alluvial deposits found at the valley floors. The subsurface conditions encountered are typical of alluvial deposition associated with Macquarie Rivulet, namely interbedded firm to stiff clays/sandy clays and loose to medium dense sands overlying weathered rock belonging to either the Berry Formation or Budgong Sandstone.

Groundwater was typically encountered at depths of 2.5 – 5.5 m below the existing surface. Hydraulic conductivities measured in the alluvial deposits were within the range expected for the heterogeneous sand, clay, sandy clay and clayey sand materials. The values of hydraulic conductivity varied between 10^{-6} m/s and 10^{-8} m/s.

In general groundwater is not considered to be a significant constraint to development across the majority of the site above RL 20 (ie: outside of the alluvial deposit). Below RL 20, groundwater is considered to present a moderate constraint to development due to its proximity to the ground surface.

Planning for deep (> 2 m) cuts in these areas will require careful consideration and planning to mitigate the effects of groundwater. In addition, the location of detention basins may also require further investigation to assess the local conditions at the proposed sites.

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1. INTRODUCTION

1.1 General

This report presents the results of a groundwater assessment undertaken on a 720 ha parcel of land known as the Calderwood Urban Development 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).

This investigation has been prepared to satisfy the requirements of the Director General’s Requirements listed under the heading 'Stage 1 Application', specifically the third bullet point: "Groundwater Details".

The investigation comprised test bore drilling and sample collection followed by installation of groundwater monitoring wells, laboratory testing of selected samples, engineering analysis and reporting. Details of the work undertaken and the results obtained are given herein.

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. Specifically, this investigation has been prepared to satisfy the requirements of the Director General's Requirements listed under the heading 'Stage 1 Application', specifically the third bullet point: "Groundwater Details".

In accordance with the Director General's Requirements, this report has been prepared following consultation with the following agencies:

- Shellharbour City Council;
- Wollongong City Council;
- Department of Environment, Climate Change and Water.

2. SITE DESCRIPTION

The site is located in the Calderwood Valley, northwest of the township of Albion Park. It 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 718.4 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. 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 21 distinct lots 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, HYDROGEOLOGY AND SOIL LANDSCAPES

The Kiama and Robertson 1:50 000 Geological Series Sheets (Refs 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 underlies 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 Johnstons Spur.

The Soil Landscapes of the Kiama 1:100 000 Sheet (Ref 3) indicate 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.

A review of the Department's groundwater database showed that there were five registered bores on site, and approximately 40 within a 2 km radius of the site. The majority of these bores do not have bore installation data registered with their entries. The majority of the bores are found within the alluvial deposits of either Marshall Mount Creek or Macquarie Rivulet, as such it is expected that these are likely to be shallow bores accessing the unconfined aquifer within the alluvial sediments.

Based on the site geology, it is expected that unconfined aquifers will be found in the alluvial deposits surrounding Marshall Mount Creek and Macquarie Rivulet and to a lesser extent perched aquifers in the regolith on the hill sides of Johnstons Spur associated with the ephemeral creek lines. These regolith aquifers are not considered to contain a significant groundwater resource due to the expected low hydraulic conductivity of the residual soils.

Deeper confined aquifers are not expected to yield significant flows and are likely to be largely disconnected and contained within the limited fractures of the underlying sandstone and volcanics.

4. FIELD WORK METHODS

The field work comprised the drilling of 12 bores (BH 101 – BH 112) drilled to depths of 3 – 8 m across the site (refer to the bore logs attached in Appendix B). At the completion of drilling, monitoring wells were installed in BH 102, BH 103, BH 105 – BH 110 and BH 112 to facilitate long term monitoring of groundwater levels and to allow testing for hydraulic conductivity. Wells were not installed in BH 101 and BH 111 due to the presence of collapsing gravel bands which precluded the lowering of the standpipe or in BH 104 which encountered rock at 0.7 m and dry conditions. The boreholes were drilled with a Gemco 210B trailer mounted drill rig using 140 mm solid flight augers and were logged on-site by an experienced geotechnical engineers who collected disturbed samples to assist in strata identification and for geotechnical laboratory testing.

Monitoring wells were installed using a 3 m screened section below the water table joined to PVC casing to the surface. Generally casing was left protruding 1 m above the ground surface level to allow the monitoring wells to be located in the open paddocks.

The results of test pitting undertaken for the geotechnical investigation for the Concept Plan Application have also been referenced for the groundwater assessment.

The locations of the boreholes are shown on Drawing 5 in Appendix A. The levels shown on the borehole logs were determined by interpolation from the 2 m contour levels supplied by Cardno and as such, are approximate only.

5. FIELD WORK RESULTS

5.1 Boreholes

The groundwater assessment focused largely on the alluvial deposits found between RL 10 m and RL 20 m AHD, which corresponds to a crescent shaped area running from the southwest of the site across the northeast to the central eastern portion of the site, then back northwest to the northwestern corner of the site (refer Drawing 3).

The site is essentially a residual landform with two incised valleys that are in-filled with alluvium. These two alluvial deposits meet as Johnstons Spur descends to the alluvial plain around Property I. The valleys contain Marshall Mount Creek in the north and Macquarie Rivulet in the south (refer Drawing 2).

These deposits contain a variable profile that includes clay and to a lesser extent sandy clay, clayey sand, silty sand and sand. These strata show no uniformity across the site and are typical of alluvial deposits. As such, the strata in the alluvial deposits can broadly be summarised as:

TOPSOIL: generally clayey or sandy silt and rootlets to depths of 0.1 – 0.4 m;

CLAYS/SANDY CLAYS: ranging from firm to very stiff clays or sandy clays, gravelly in parts, damp to saturated in most locations from depths of 0.1 – 8.4 m;

SANDS/SILTY SANDS: loose to dense sand, silty sand or clayey sand found at depths of 1.1 – 6.0 m, typically wet to saturated. (This strata was not present in all test bores and was sometimes underlain by the clay formation mentioned above);

ROCK: extremely low to very low strength, extremely to highly weathered sandstone or siltstone intercepted generally at depths of 4.9 – 8.4 m. BH 104 encountered siltstone at 0.7 m and BH 107 and BH 112 did not reach rock within the depth of the investigation.

These results were consistent with the expected geology of alluvial deposits overlying residual landscapes.

5.2 Water Levels

All installed monitoring wells were dipped to obtain the depth to water below the ground surface. In order to present the data as reduced levels, further survey will be required to determine exact surface levels at the borehole locations. The surface levels shown on the borehole logs were determined by interpolation from a 2 m contour plot and as such have not been used.

Table 1 presents water levels measured in the monitoring wells.

Table 1 – Groundwater Depths

Monitoring Well ID	Depth below ground level (m) 11 December 09	Depth below ground level (m) 7 January 10
102	4.5	5.8
103	3.3	3.6
105	3.4	3.5
106	2.8	3.0
107	3.1	3.3
108	2.6	2.5
109	2.7	2.5
110	3.0	2.8
112	4.5	4.4

5.3 Hydraulic Conductivity Testing

Testing was undertaken to determine the hydraulic conductivity of the shallow aquifers found on the site. The wells were tested using standard drawdown tests (slug tests) whereby a volume of water (the slug) is removed from the bore and the recovery of the water table up the well is measured. In this case, the slug was removed using a 12 volt "tornado" pump. The final amounts of water were removed using a stainless steel bailer to minimise sediment clogging of the pump. Recovery was measured using a Geotechnical Systems Australia downhole data logger. The water level was measured at 4 second intervals in time periods, with the test period ranging from 12 minutes to 2.5 hours, depending on the recovery rate of the bore.

At one location, BH 110, water was extracted from the well at a rate of 20 L/min (0.33 L/sec) for a duration of 15 minutes, with no appreciable drawdown noted. Recovery of the well occurred before the data logger could be lowered to allow measurement and as a result, no measurable value was recorded. A falling head test will need to be carried out as part of further investigations.

Analysis of the test results was undertaken using both the Hvorslev and Bouwer-Rice Methods. The results calculated were generally consistent and all results were within the same order of magnitude.

The results of the tests are included in the report sheets given in Appendix C. The results of the hydraulic conductivity results are summarised in Table 2.

Table 2 – Hydraulic Conductivity Results

Monitoring Well ID	Hydraulic Conductivity (m/sec)
BH 102	4×10^{-8}
BH 105	5×10^{-7}
BH 106	9×10^{-8}
BH 107	3×10^{-6}
BH 110	High
BH 112	4×10^{-7}

6. LABORATORY TESTING AND DISCUSSION

Particle size analysis was undertaken on four samples from the subject site. The detailed laboratory report sheets are included in Appendix C.

For granular soils, an estimate of hydraulic conductivity can be made using Hazen's method based on the D_{10} value (ie: the size at which 10% of the sample is finer) from the grading curve. The majority of the samples collected were too silty/clayey for hydraulic conductivity determination using Hazen's method, however four sandy soils were collected which were within the appropriate limits.

Table 3 lists the results of the grading and the corresponding hydraulic conductivity calculated using Hazen's Formula and Shepherd's method.

Table 3 – Hydraulic Conductivity Results

Borehole/ Test pit ID	D_{10} (mm)	D_{50} (mm)	Hydraulic Conductivity Hazen (m/sec)
BH 108	0.07	0.28	1.96×10^{-7}
TP 78	0.075	0.3	2.25×10^{-7}
TP 81	0.06	0.28	1.44×10^{-7}
TP 59	0.16	0.29	1.02×10^{-6}

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 and will incorporate water detention structures, as well as channel widening on the floodplain of Macquarie Rivulet.

8. COMMENTS

Based on our groundwater investigation, the following comments are offered:

- Groundwater bores were predominantly drilled within the 10 – 20 m AHD band of the site. Rock was intercepted during drilling at varying depths but generally between 4 m and 8.5 m below ground surface level (refer to borehole logs BH 101 – BH 112). Two bores (BH 106 & BH 107) did not encounter rock and BH 104 encountered rock at 0.7 m;
- Groundwater levels during the investigation were found to be in the range of 2.5 – 4.5 m below ground surface level (refer Drawing 5). Due to the proximity of the water table to the ground surface, further investigation is required to ascertain the seasonal high groundwater level in future stages of the development;
- The shallow aquifers generally were contained in the alluvial deposits of Marshall Mount Creek and Macquarie Rivulet and were limited by the underlying bedrock. The shallow groundwater was essentially perched on this impermeable unit. The aquifers comprised predominantly clayey sands, clays and sandy clays with some gravel;
- Hydraulic conductivities (K) varied across the site and were in general, within the range expected for the clayey and silty alluvial soils encountered. The values ranged across two orders of magnitude from 10^{-6} m/s to 10^{-8} m/s (refer Drawing 5). BH 110 located in the southeastern corner of the site recorded high values of K (flow rates of 20 L per min were obtained, with only minimal drawdown noted over a 15 min period.) The variability in K across the site could not be linked specifically to observed surface landforms but is more likely the result of heterogeneous alluvial deposits;
- In general groundwater will not be a significant constraint to development across the majority of the site above RL 20. Below RL 20 or in localised low lying areas adjacent to creek-lines, groundwater may present itself as a moderate constraint due to its proximity to the ground surface. This will require further assessment in the subsequent development stages.

Based on these observations, it is recommended that where future developments are located in areas below RL 20 and where cuts greater than 2 m are proposed, further groundwater assessment must be undertaken to establish the groundwater level at the site. Locations of detention basins will also require investigation to assess the local groundwater conditions. Future assessment will utilise the existing network of groundwater bores on site.

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.

The results provided in the report are considered to be indicative of the subsurface conditions on the site only to the depths investigated at the specific sampling and/or testing locations, and only at the time the work was carried out. DP's advice is based on observations, measurements, tests or derived interpretations. The accuracy of the advice provided by DP in this report is limited by unobserved features and variations in ground conditions across the site in areas between test locations and beyond the site boundaries or by variations with time. The advice may be limited by restrictions in the sampling and testing which was able to be carried out, as well as by the amount of data that could be collected given the project and site constraints. Actual ground conditions and materials behaviour observed or inferred at the test locations may differ from those which may be encountered elsewhere on the site. Should variations in subsurface conditions be encountered, then additional advice should be sought from DP and, if required, amendments made.

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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.

10 CONCLUSIONS

Despite the presence of acid sulphate soils on the subject site, it is considered that ASS will only be a moderate constraint to development. ASS will be able to be managed with good engineering practice which will include the preparation of an ASS Management Plan and lime dosing of affected soils disturbed by earthworks.

DOUGLAS PARTNERS PTY LTD

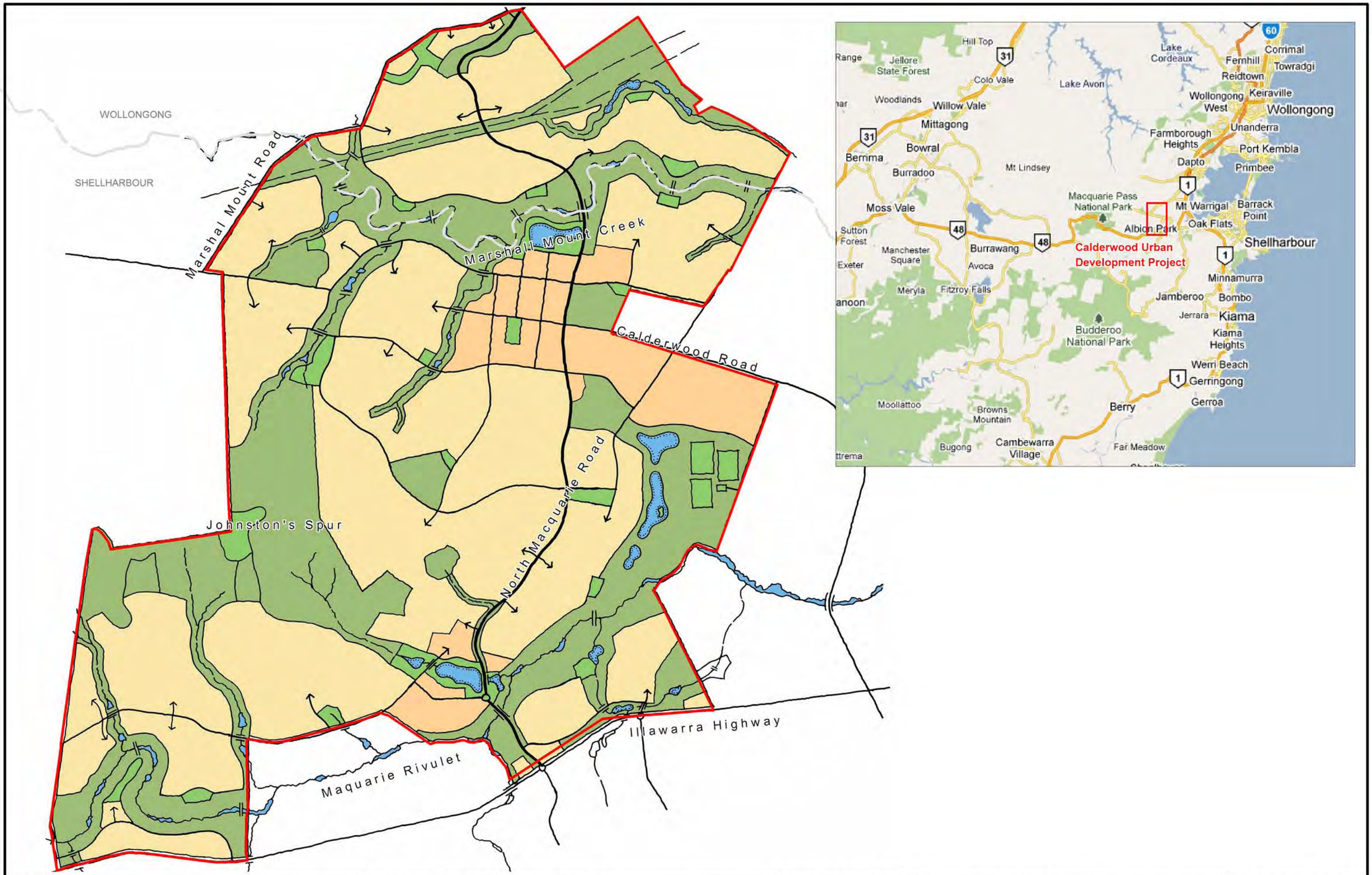
Christopher C Kline
Associate

Reviewed by:

Grahame Wilson
Principal

APPENDIX A

Drawings 1 – 5



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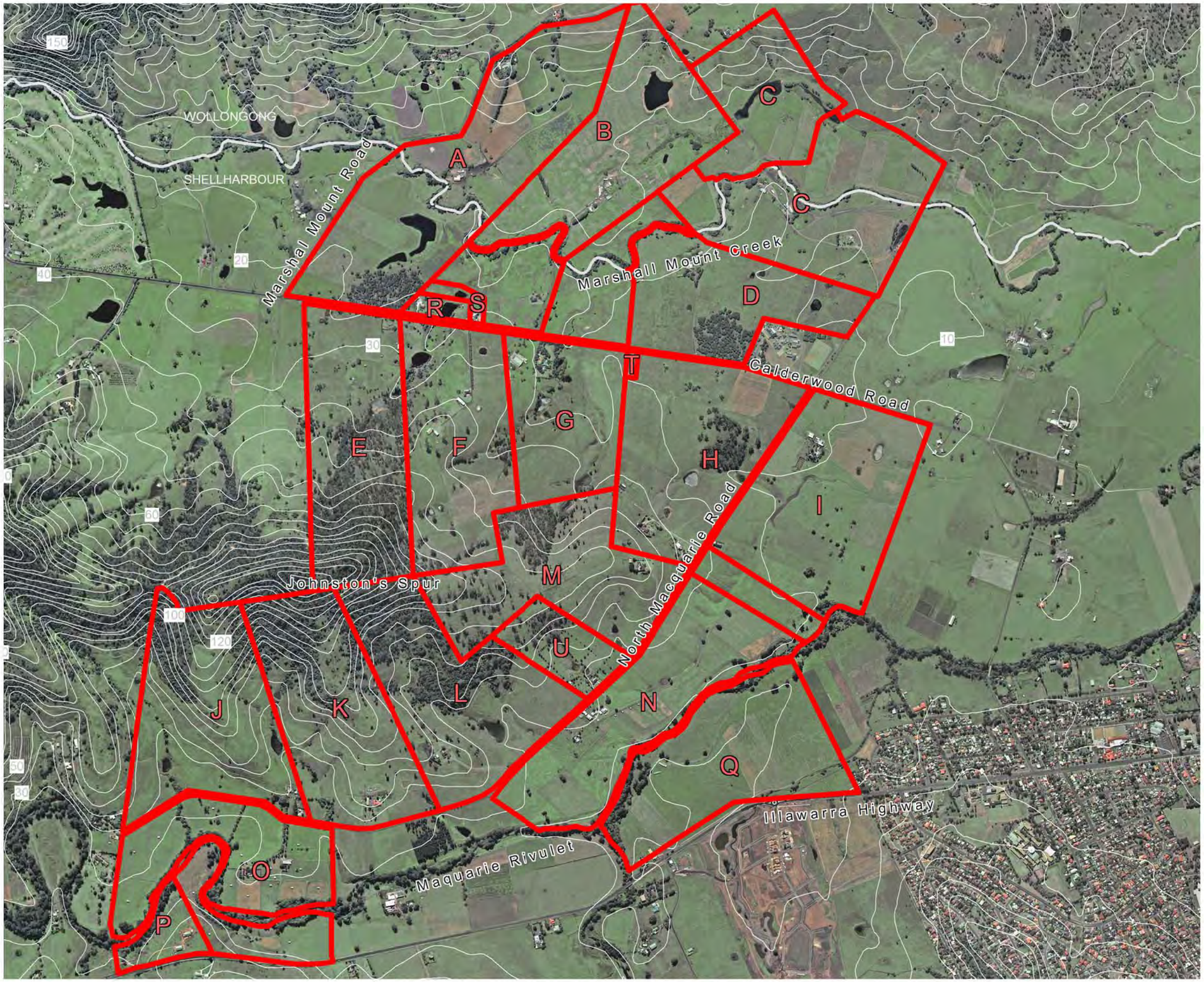

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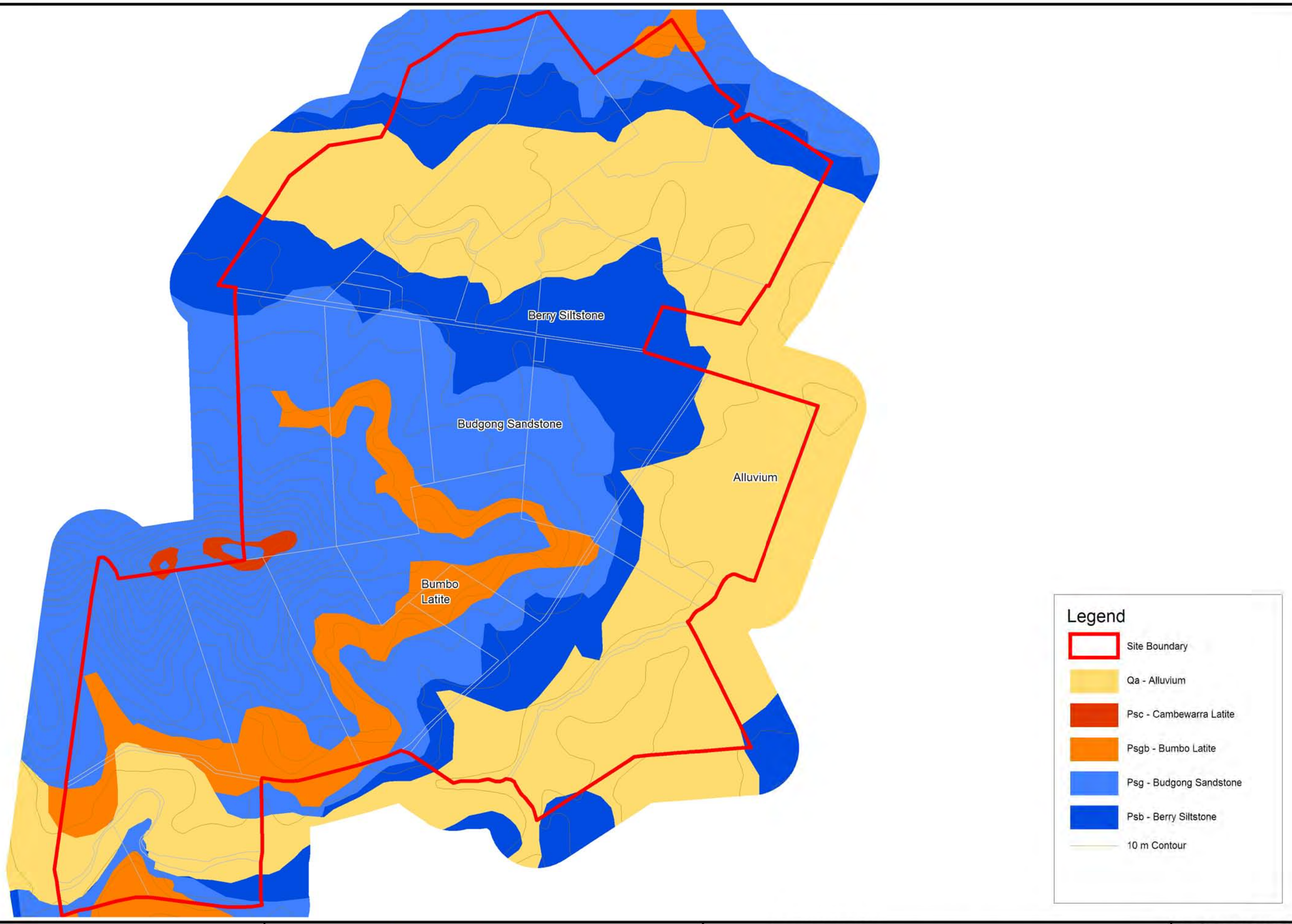
	APPROVED BY: CCK	DATE: 18 FEB 10	

PROJECT: 48742.02
DRAWING: 2
REVISION: 1



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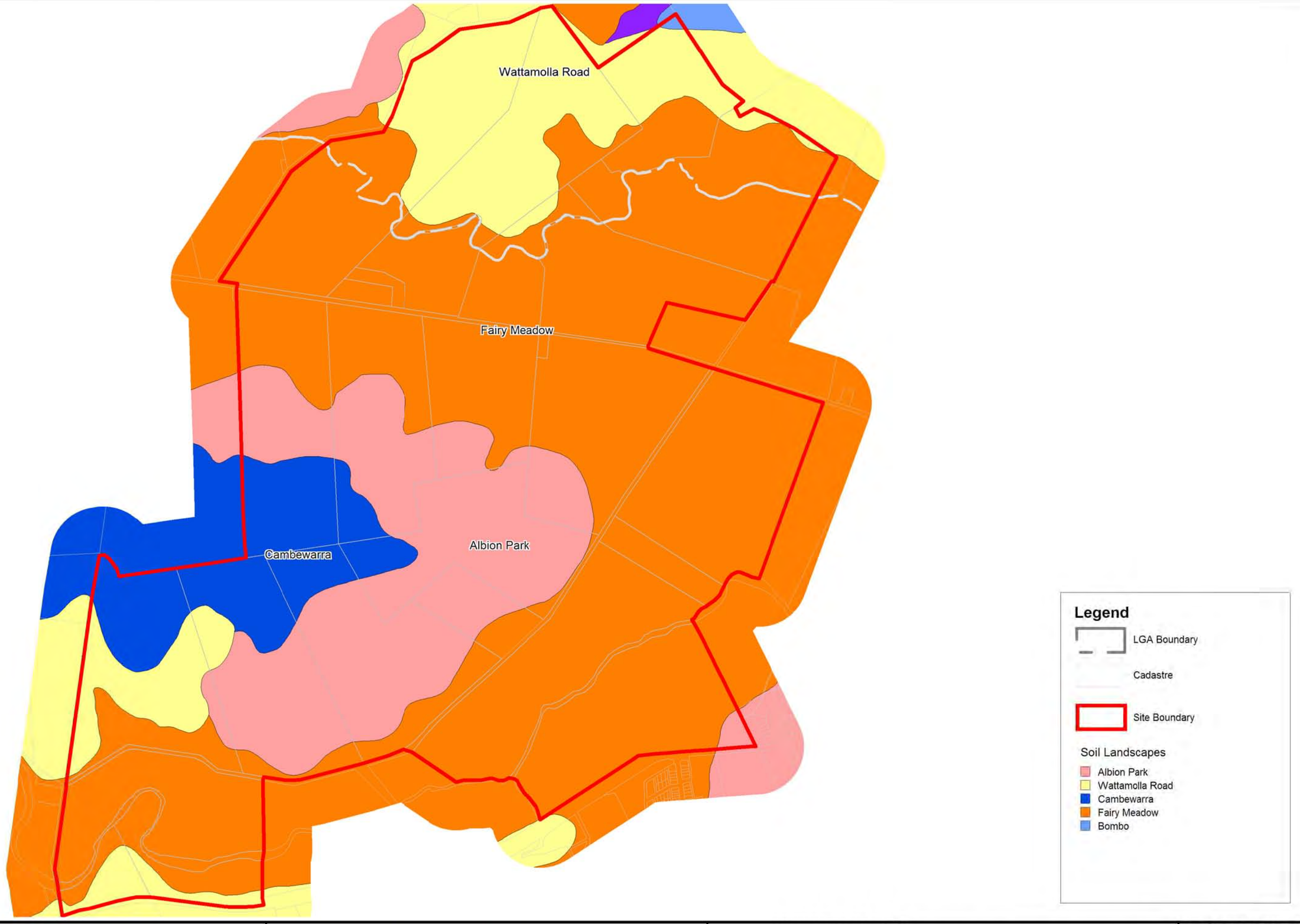
	APPROVED BY: CCK	DATE: 18 FEB 10	DRAWING: 3 REVISION: 1



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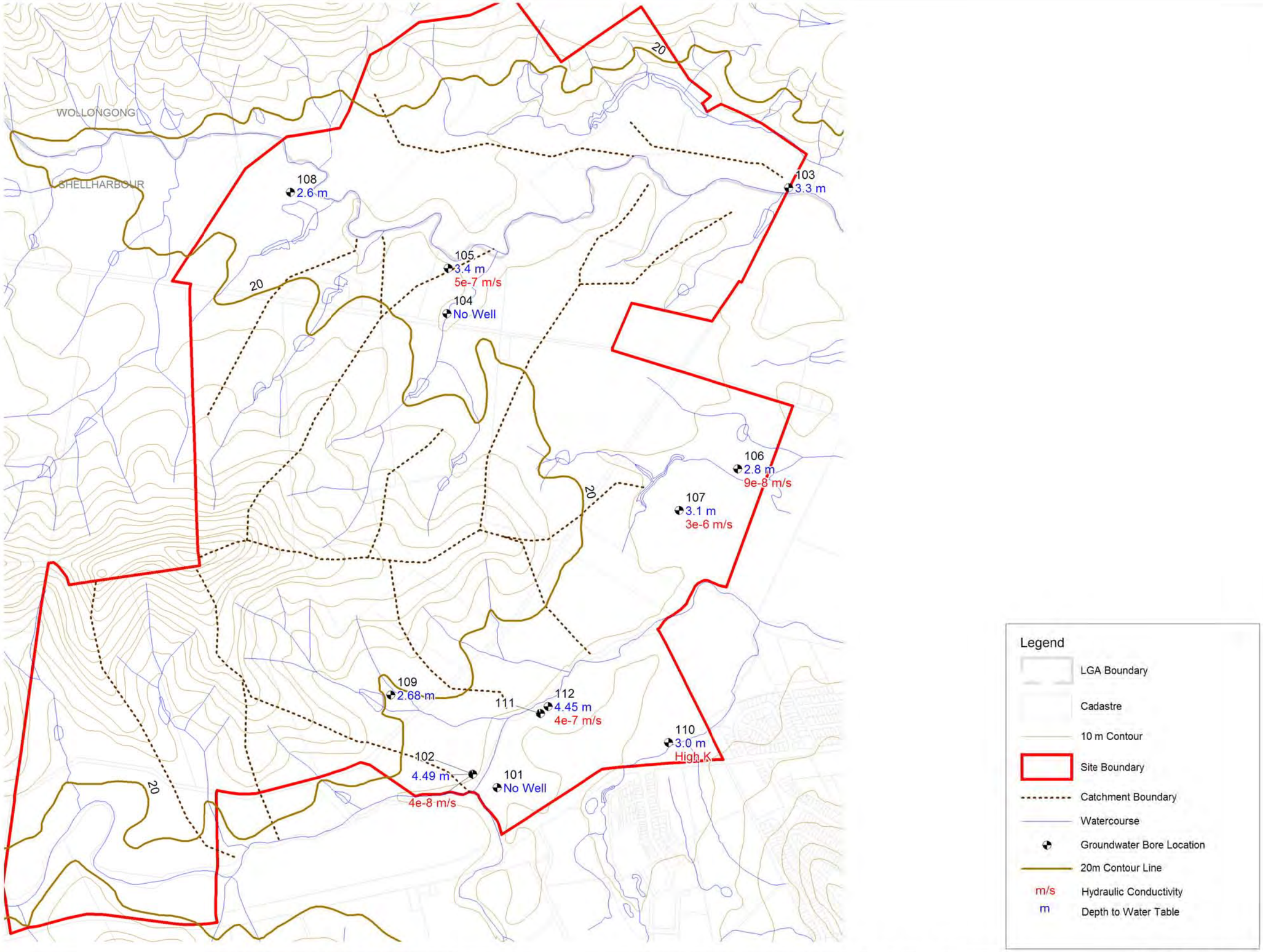

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	APPROVED BY: CCK	DATE: 18 FEB 10		REVISION: 1

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

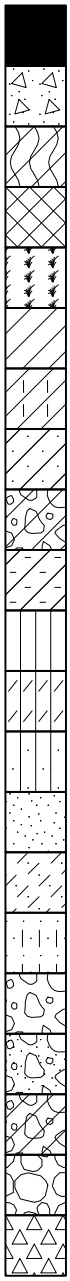
is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

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

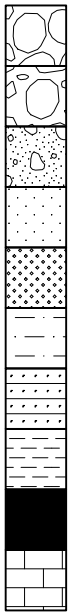
SANDY GRAVEL

CLAYEY GRAVEL

COBBLES/BOULDERS

TALUS

SEDIMENTARY ROCK



BOULDER CONGLOMERATE

CONGLOMERATE

CONGLOMERATIC SANDSTONE

SANDSTONE FINE GRAINED

SANDSTONE COARSE GRAINED

SILTSTONE

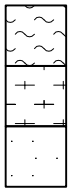
LAMINITE

MUDSTONE, CLAYSTONE, SHALE

COAL

LIMESTONE

METAMORPHIC ROCK

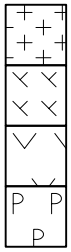


SLATE, PHYLITTE, SCHIST

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:

Douglas Partners
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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

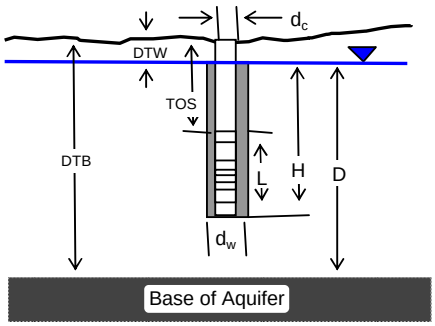
Laboratory Test Report Sheets

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

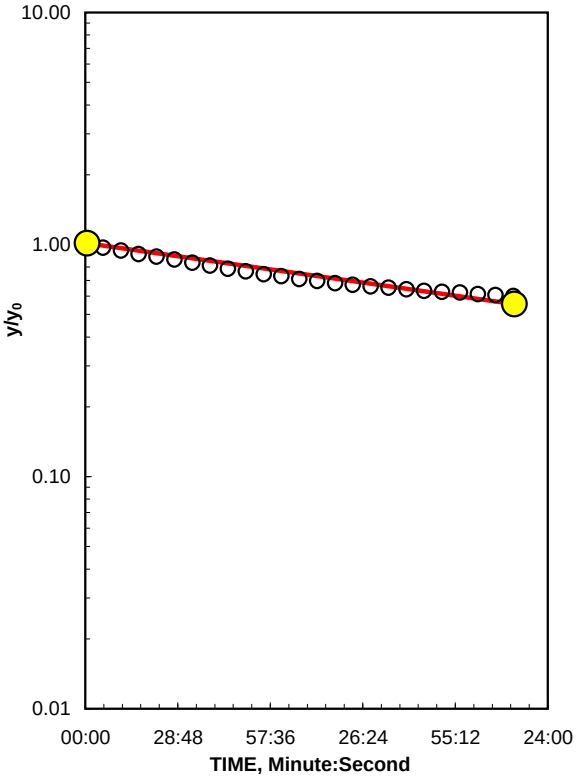
From look-up table using L/r_w

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

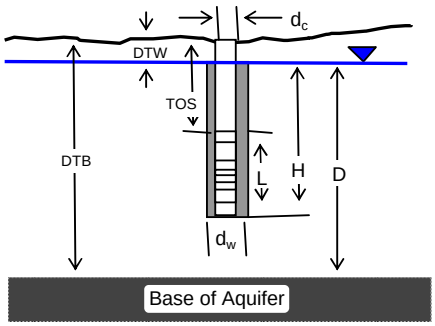
Initial test

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

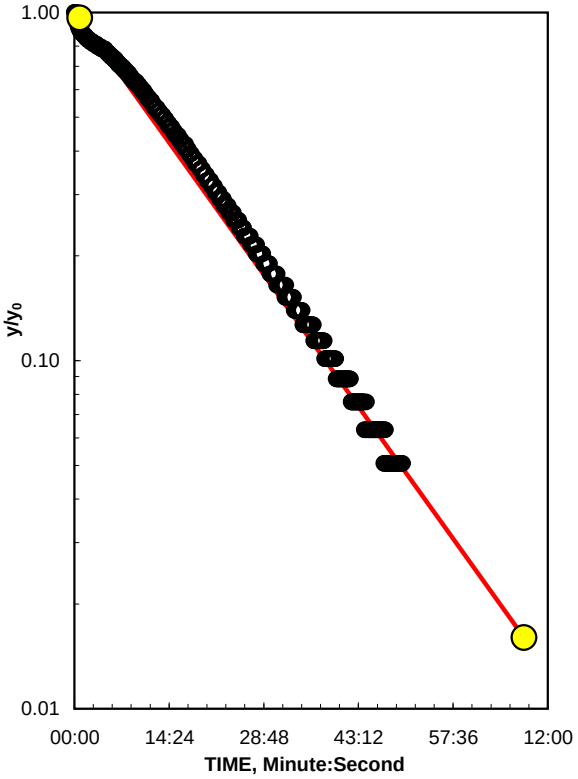
From look-up table using L/r_w

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

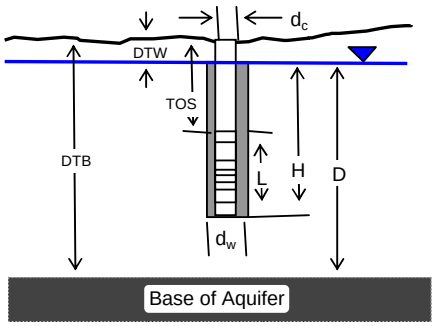
Initial test

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

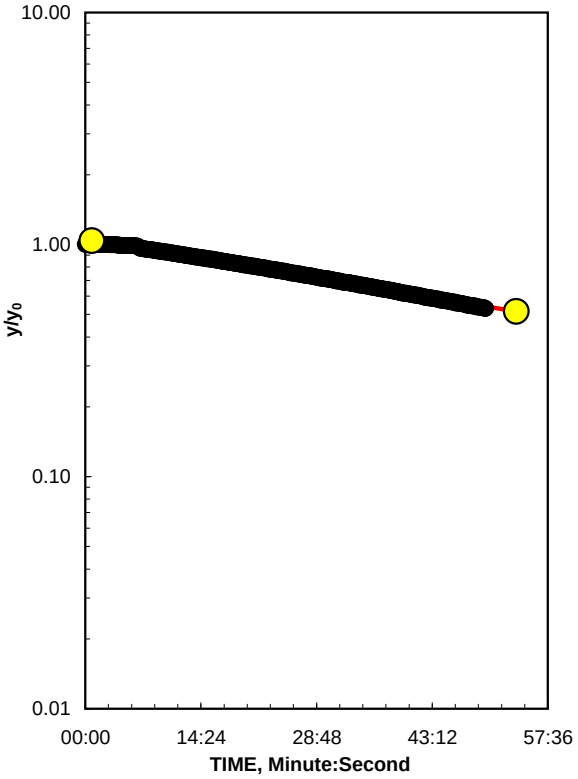
From look-up table using L/r_w

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

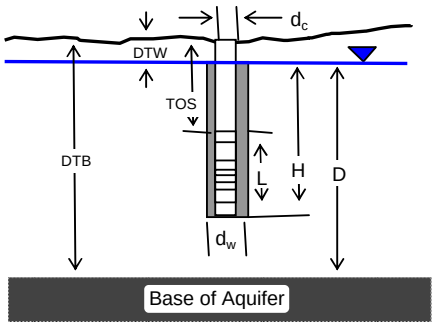
Initial test

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	



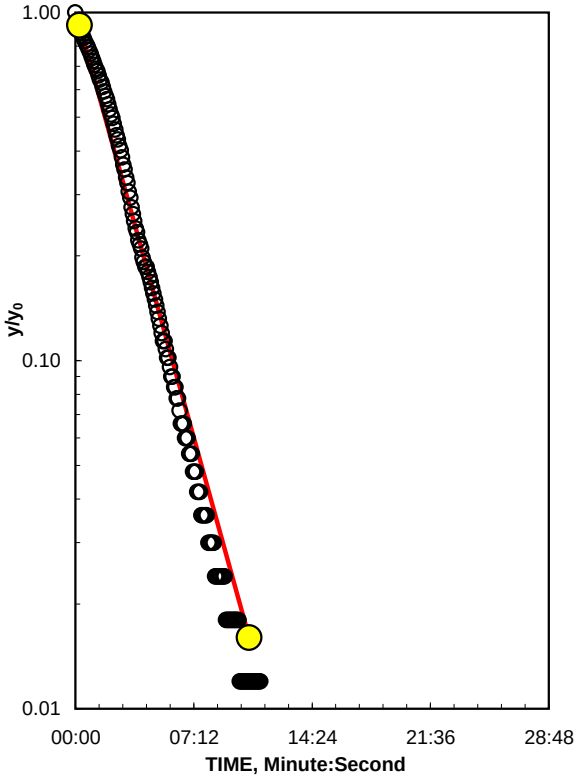
COMPUTED

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

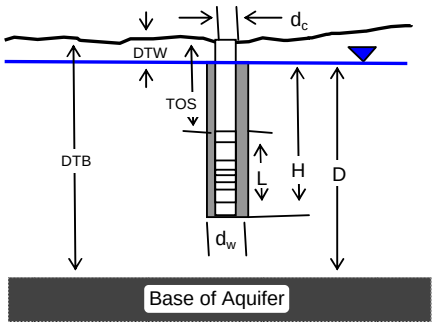
Initial test

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

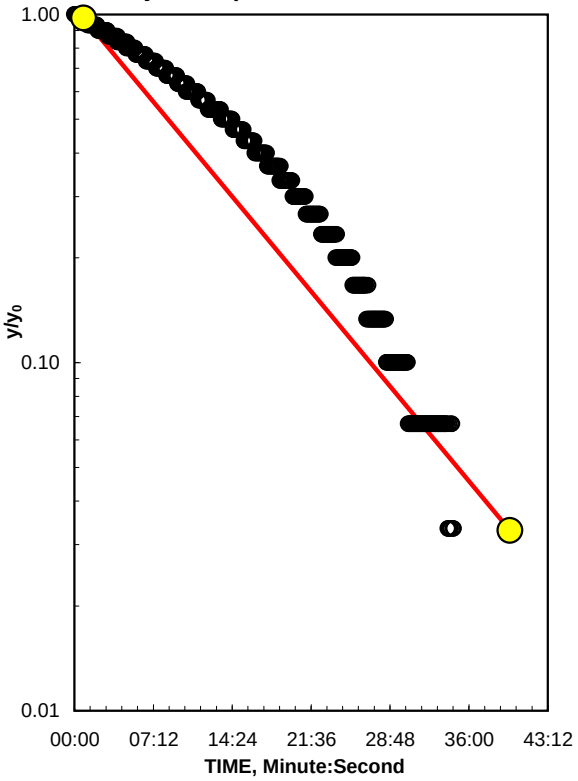
From look-up table using L/r_w

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

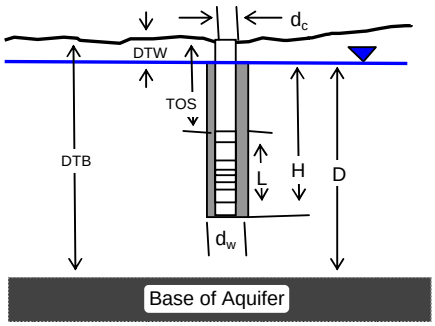
Initial test

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)	



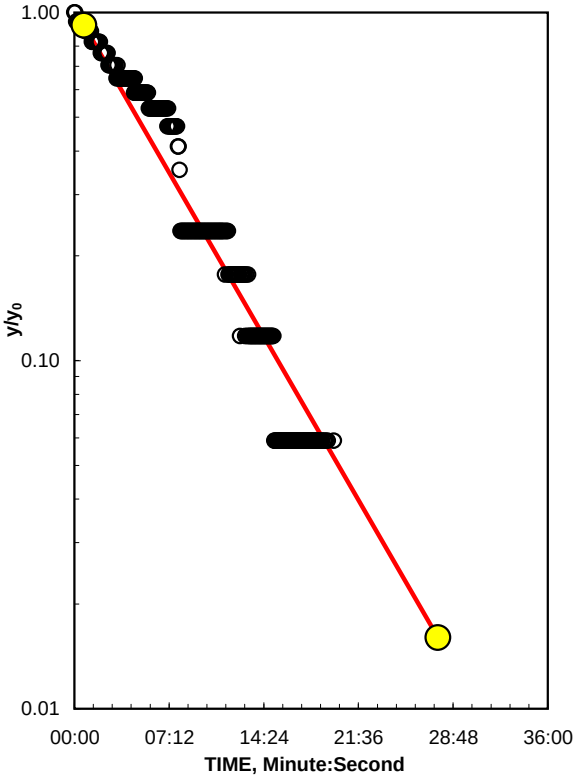
COMPUTED

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
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

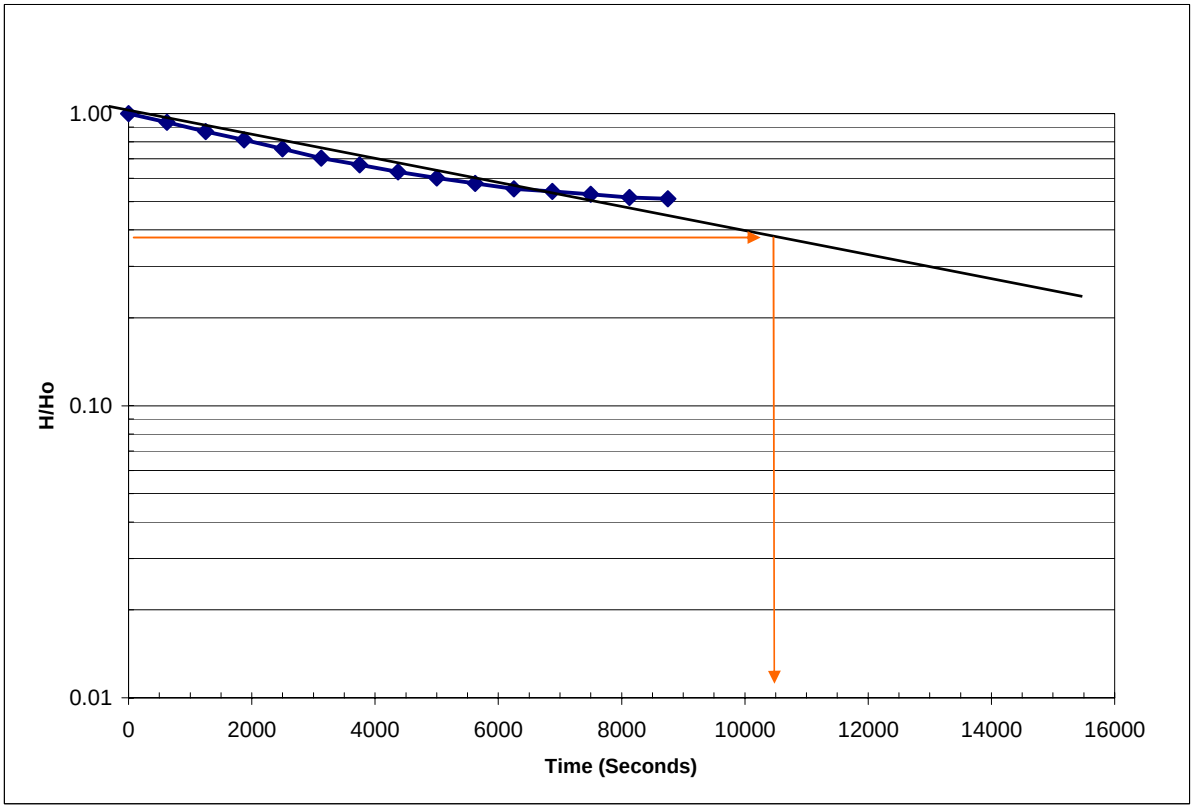
Description:	Borjeson Property	**Bore No.**	**BH2**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Rising Head, pumped and bailed dry	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

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

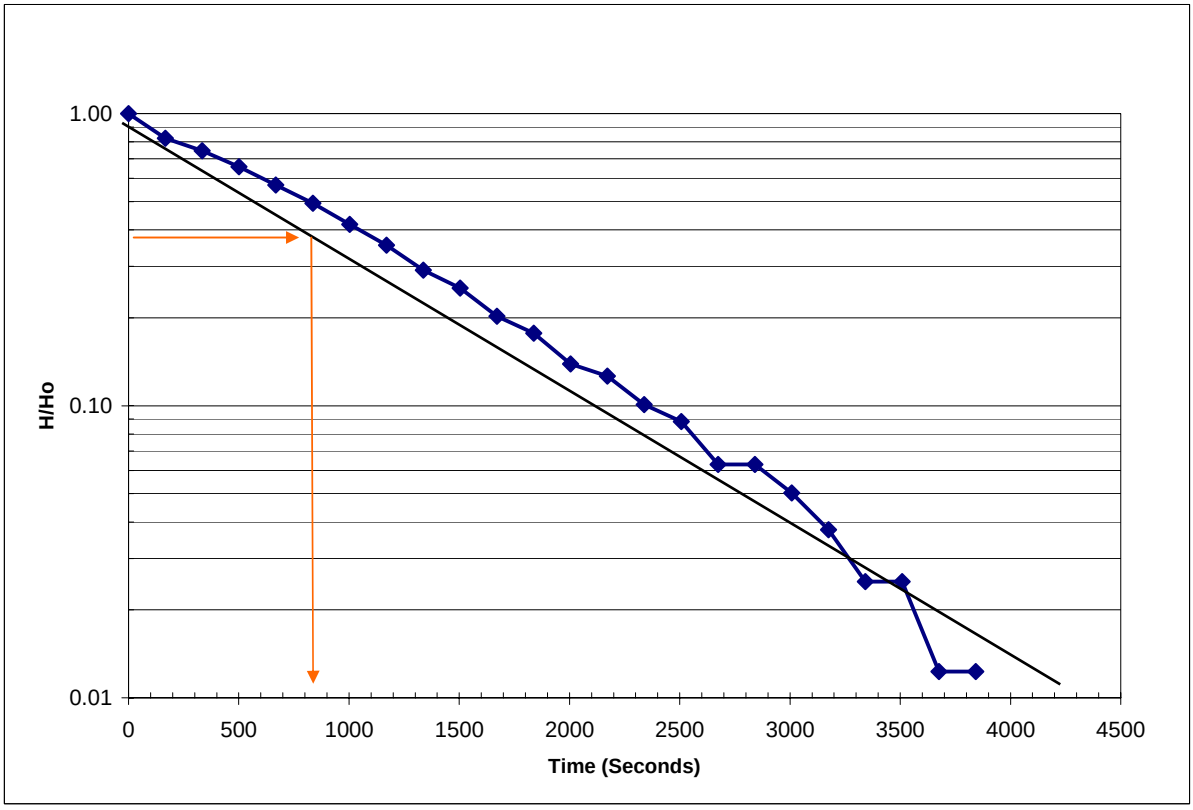
Description:	Novero Property	**Bore No.**	**BH5**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Rising Head, pumped and bailed dry	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

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

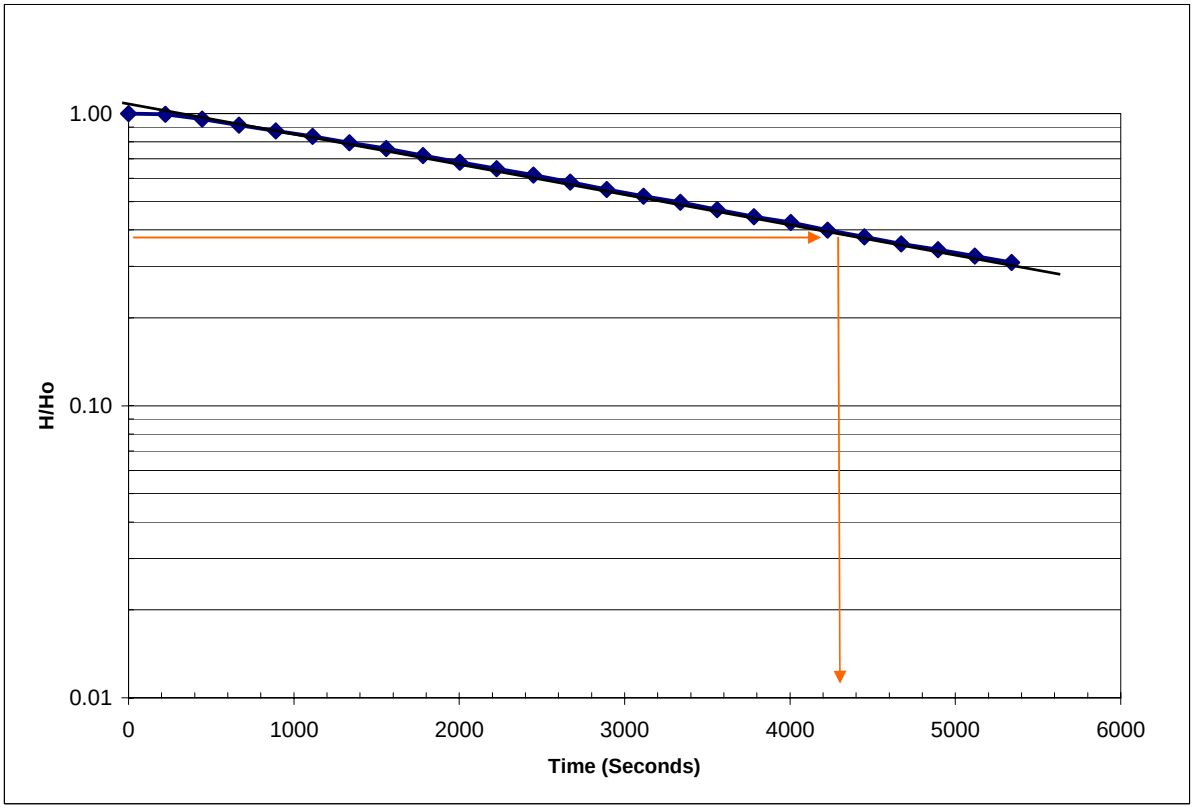
Description:	Swan Property	**Bore No.**	**BH6**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Rising Head, pumped and bailed dry	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

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

Phone: (02) 4271 1836
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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

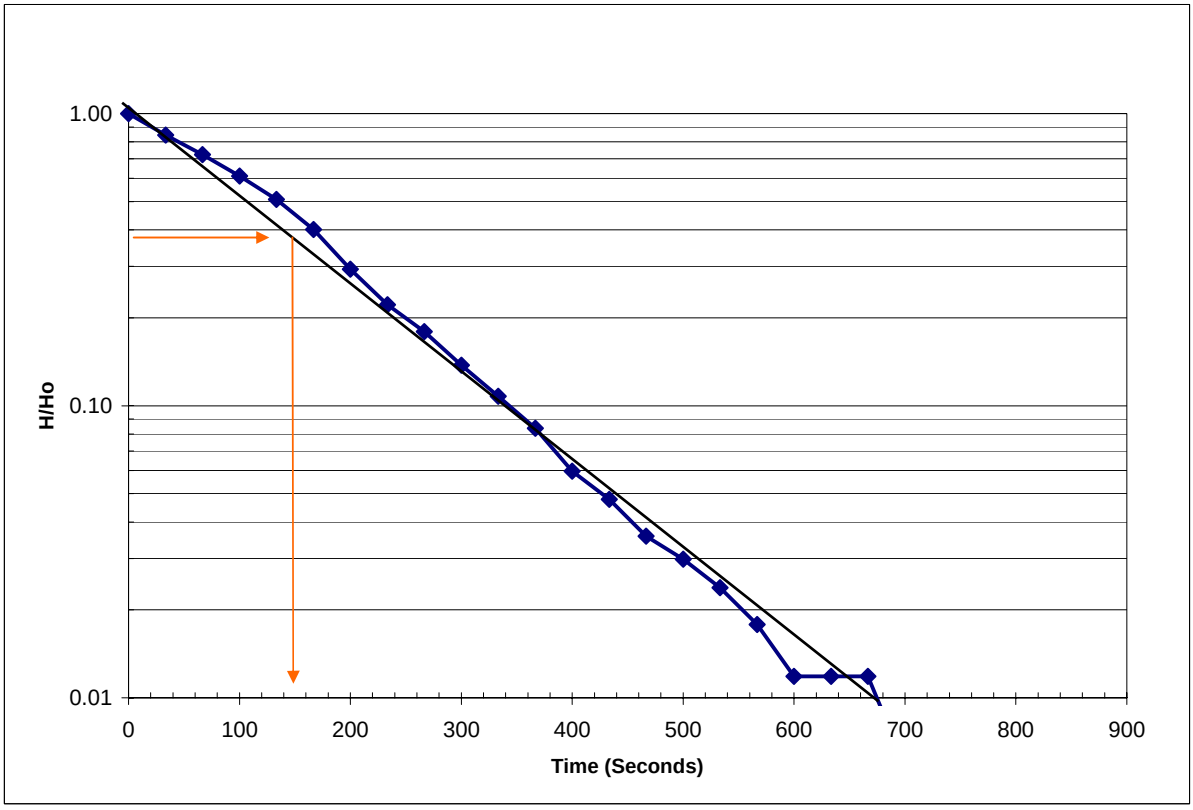
Precipitation Comments: nil

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

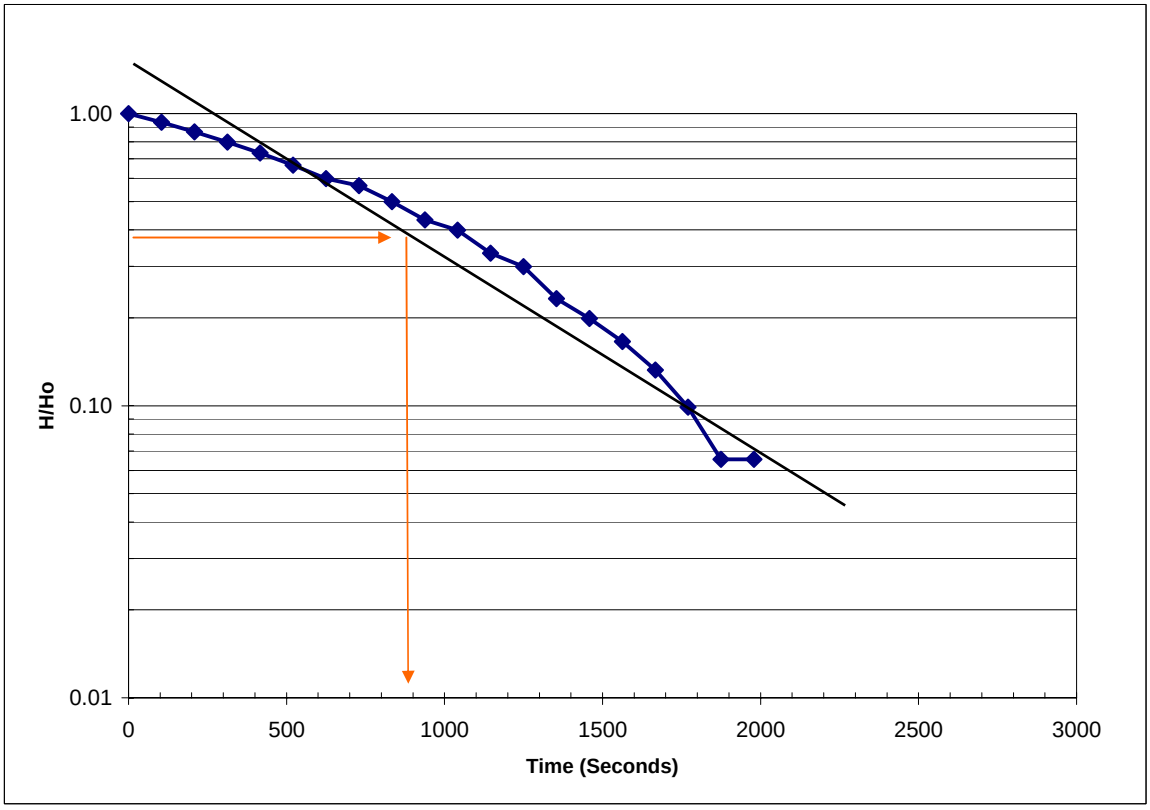
Description:	Keys Property	**Bore No.**	**BH12**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Rising Head, pumped and bailed dry	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

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

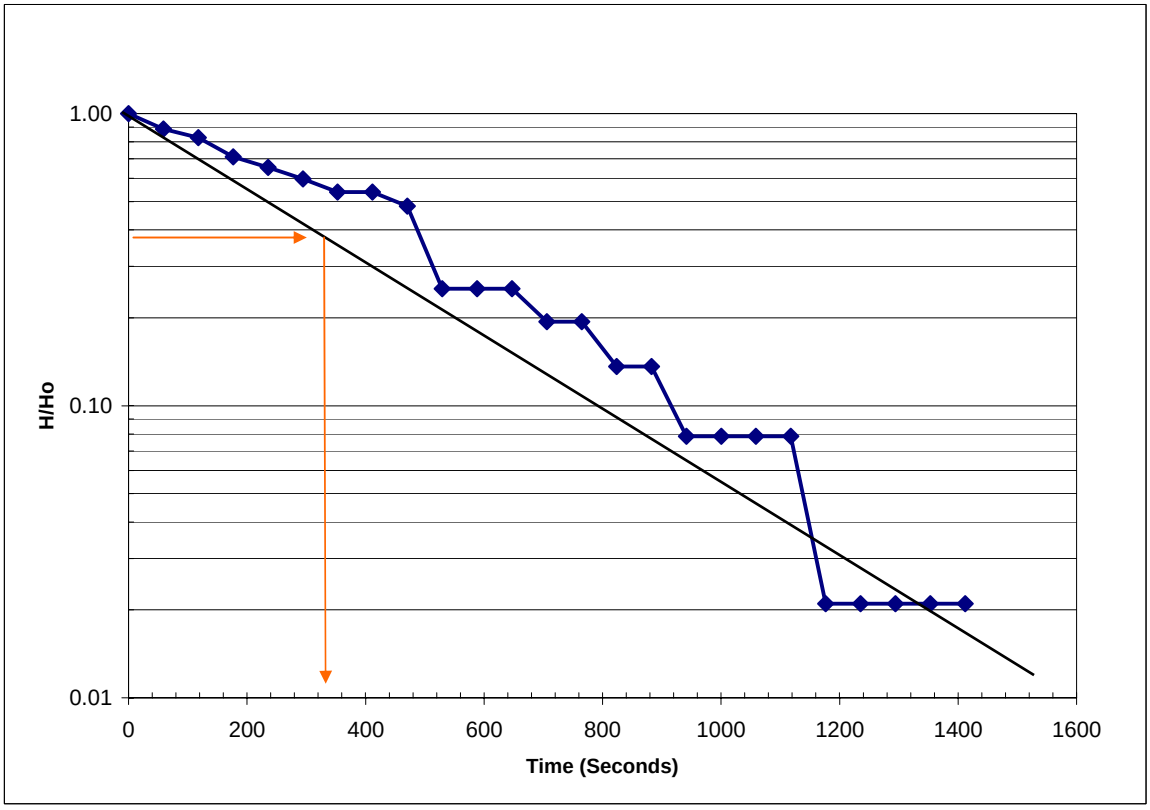
Description:	Keys Property	**Bore No.**	**BH12**
Material type:	Clayey Sand	*Easting:*	293421 *m*
Type of Test:	Falling Head, water added	*Northing*	6172019 *m*
Precipitation Comments:	nil	*Surface Level:*	- *m AHD*

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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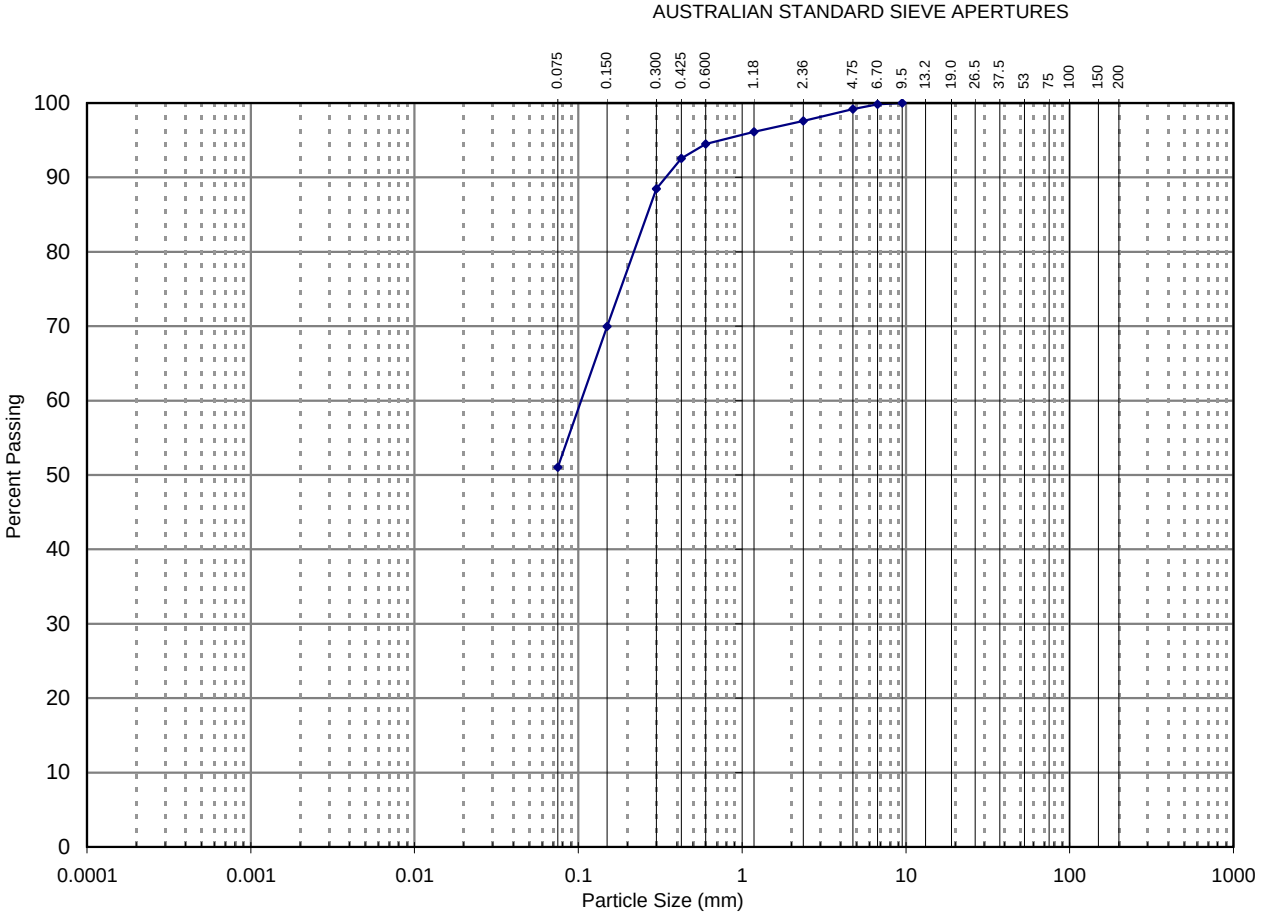
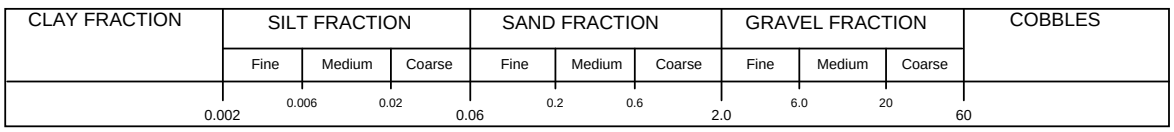
wollongong@douglaspartners.com.au

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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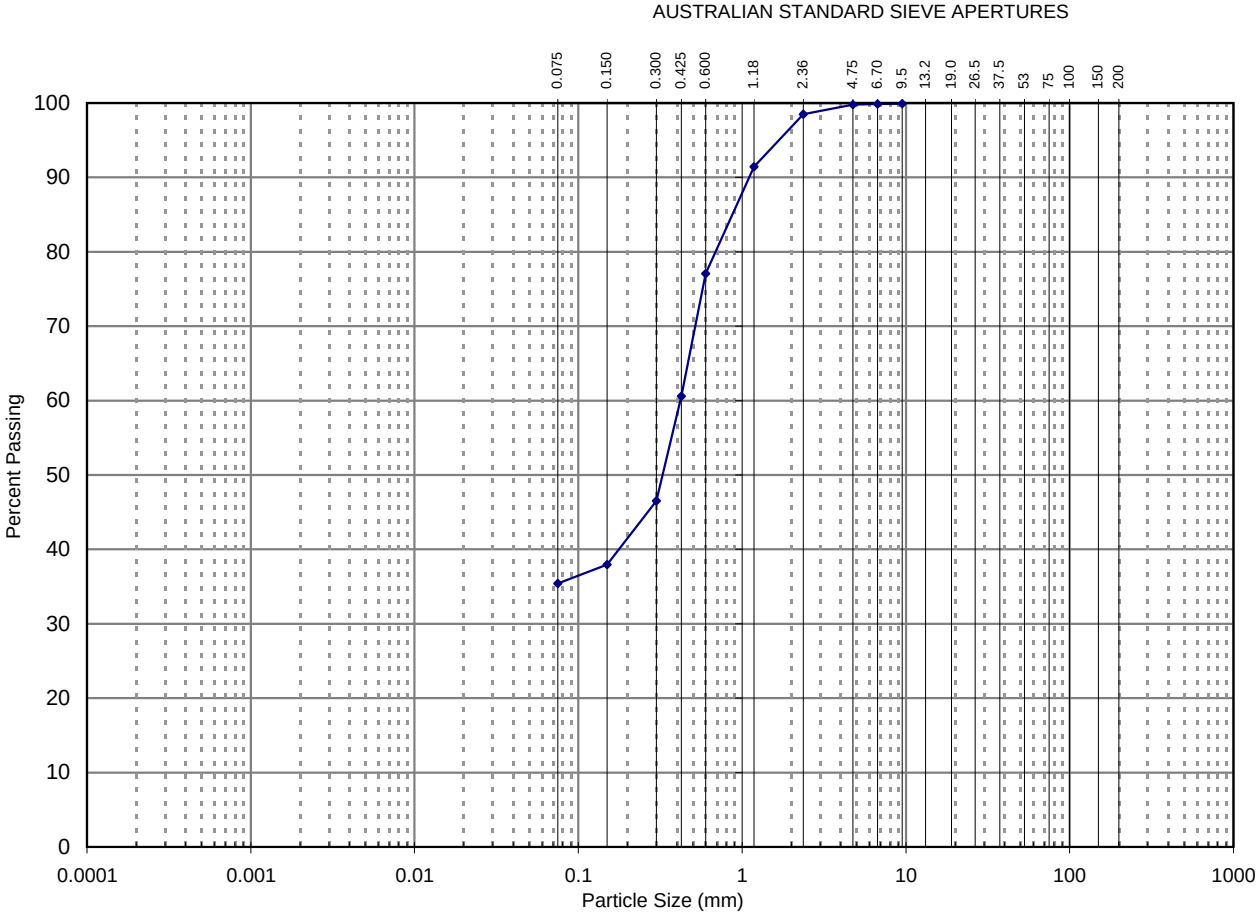
RESULTS OF PARTICLE SIZE DISTRIBUTION

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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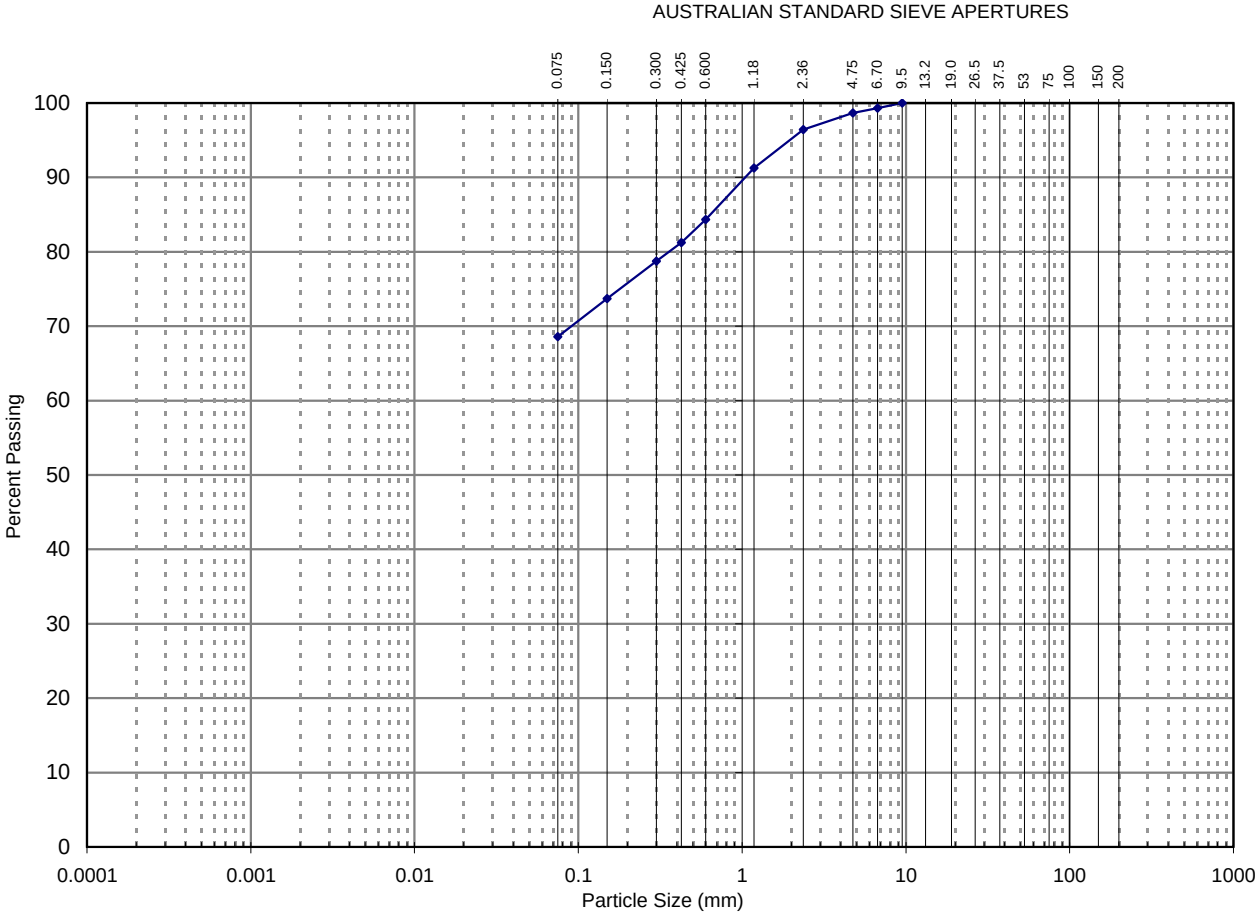
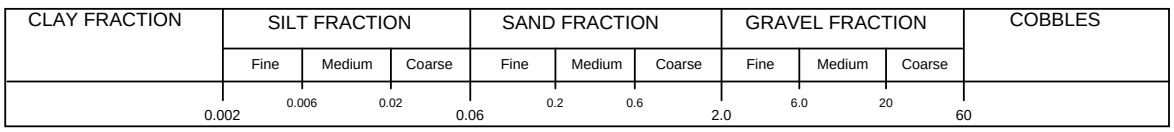
RESULTS OF PARTICLE SIZE DISTRIBUTION

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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Tested:	JR
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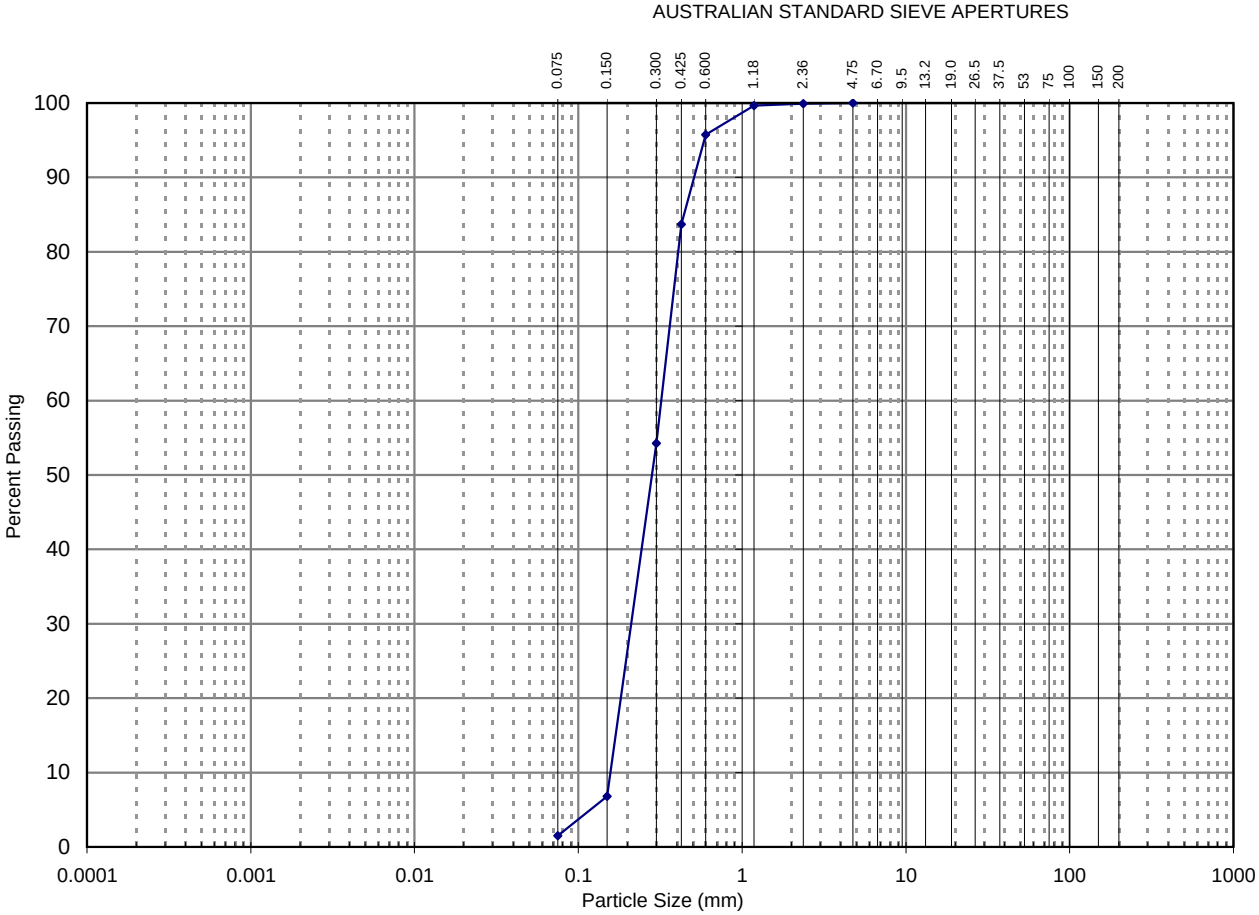
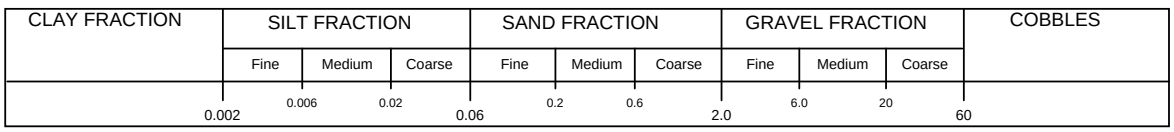
RESULTS OF PARTICLE SIZE DISTRIBUTION

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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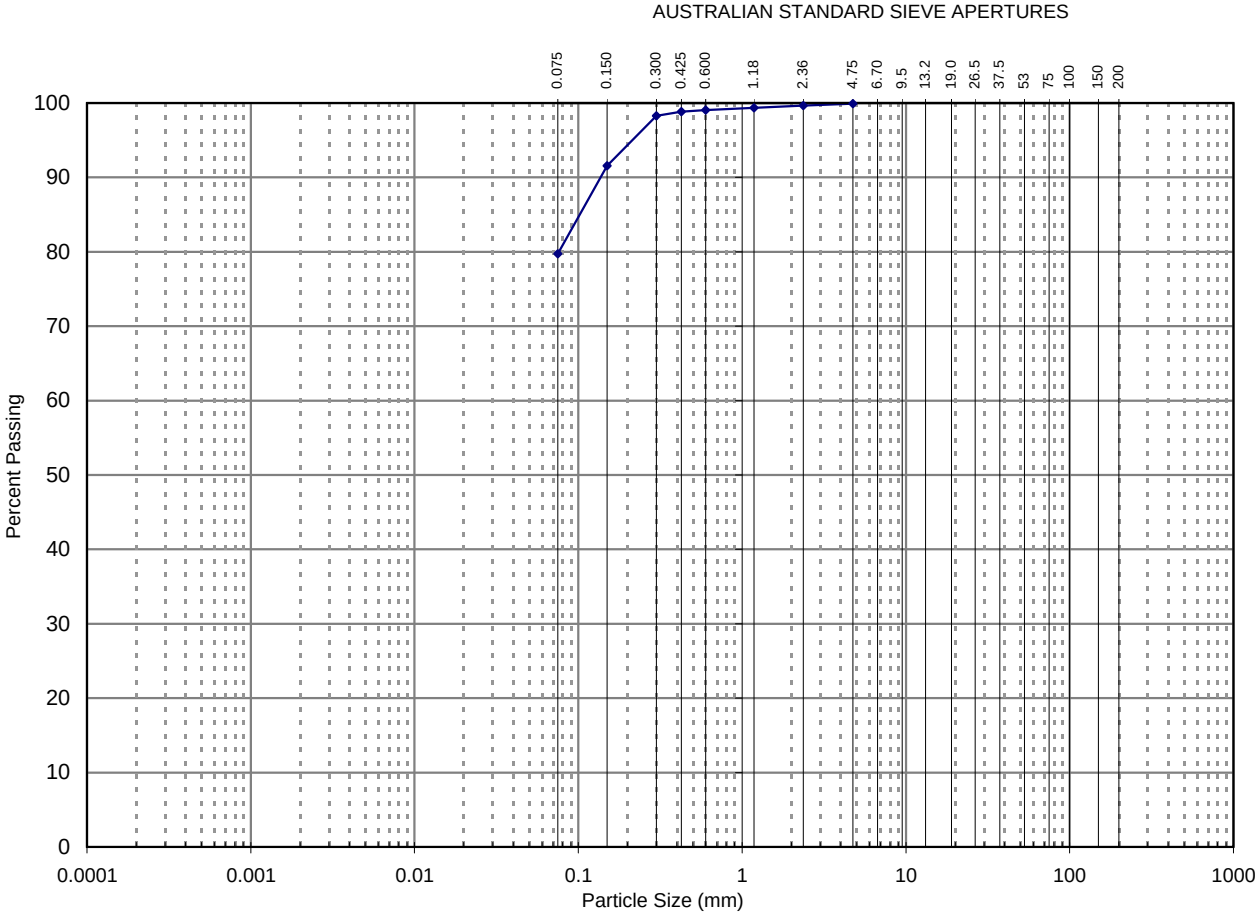
RESULTS OF PARTICLE SIZE DISTRIBUTION

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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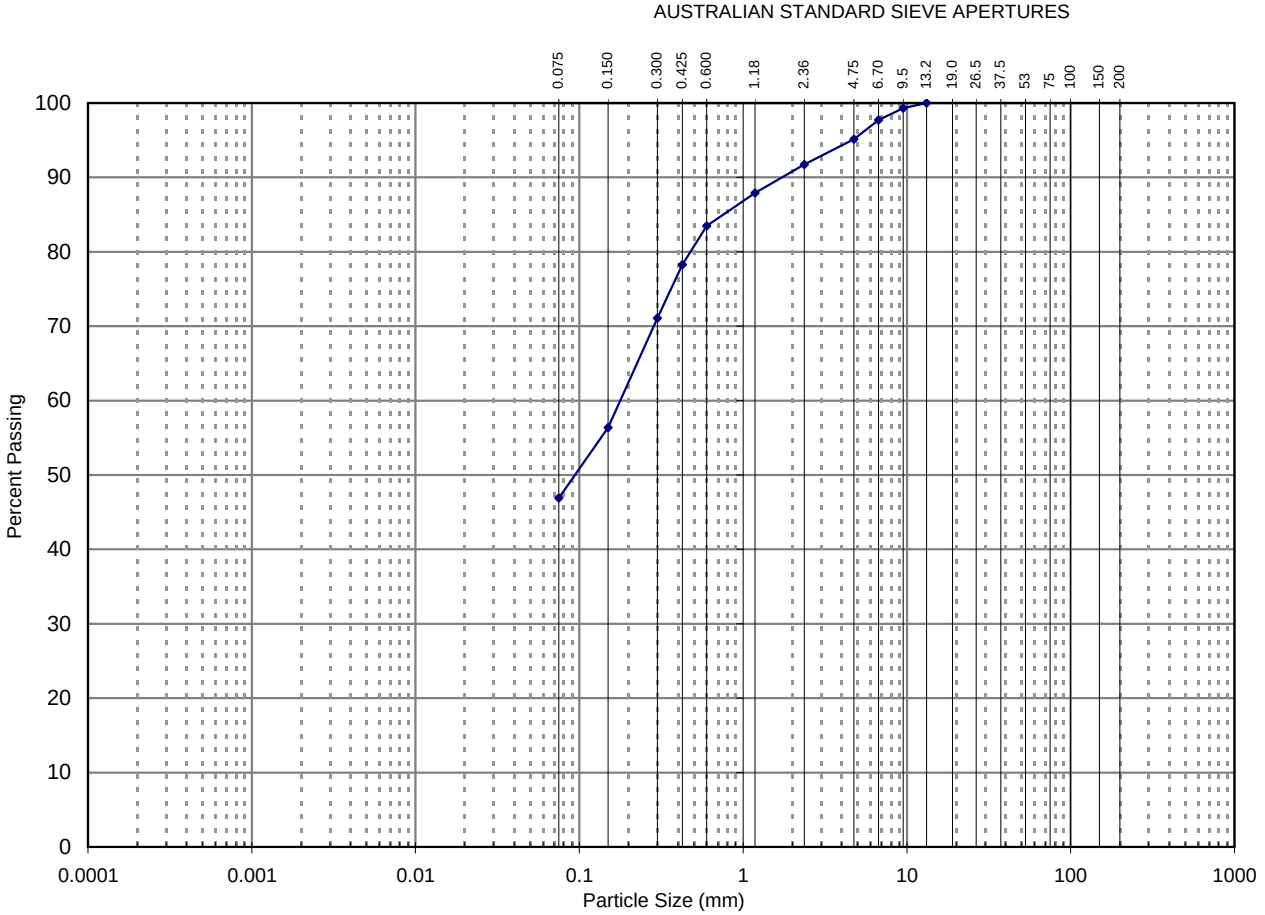
RESULTS OF PARTICLE SIZE DISTRIBUTION

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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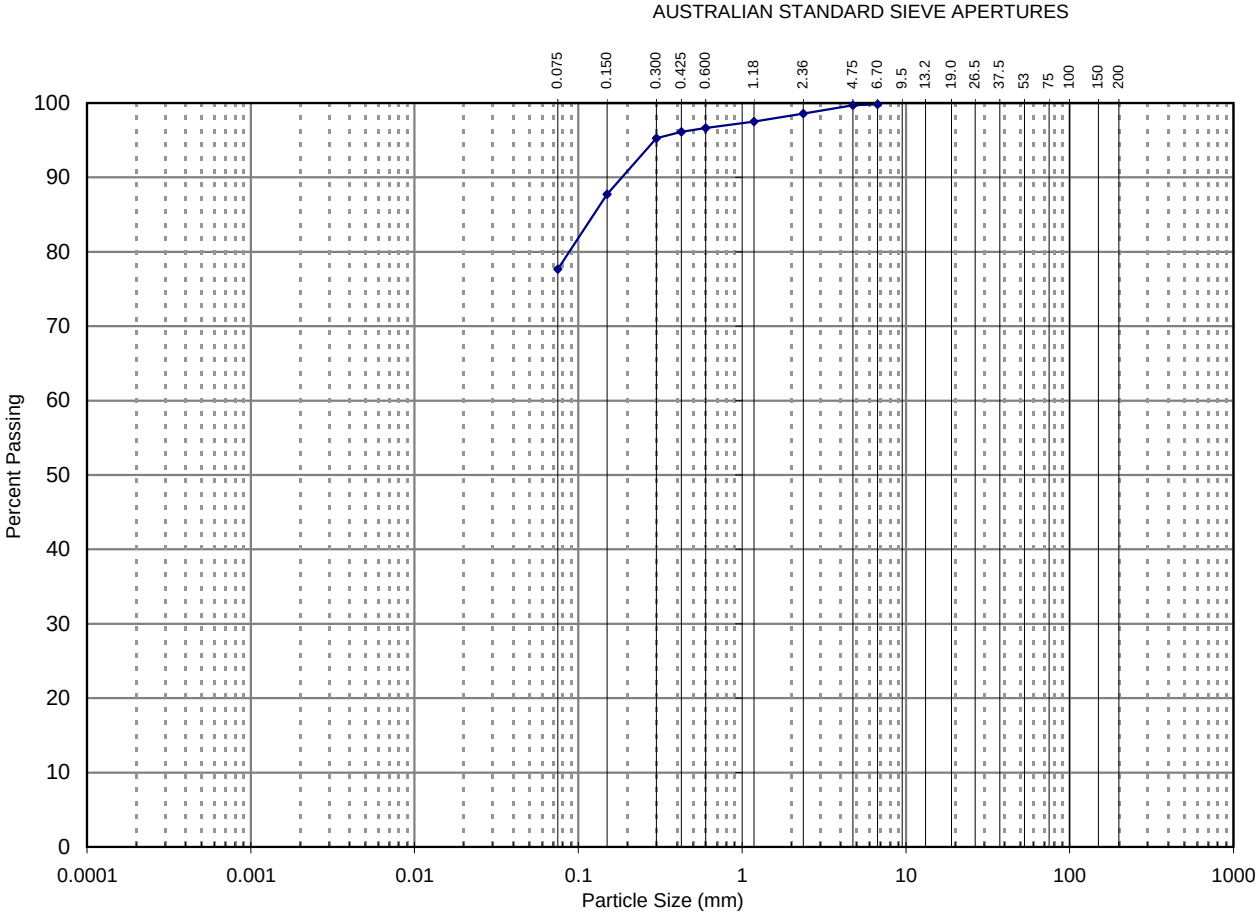
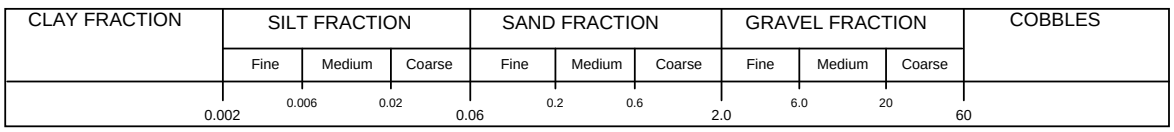
RESULTS OF PARTICLE SIZE DISTRIBUTION

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: -

NATA Accredited Laboratory Number: 828
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Approved Signatory:

Tested:	JR
Checked:	DE

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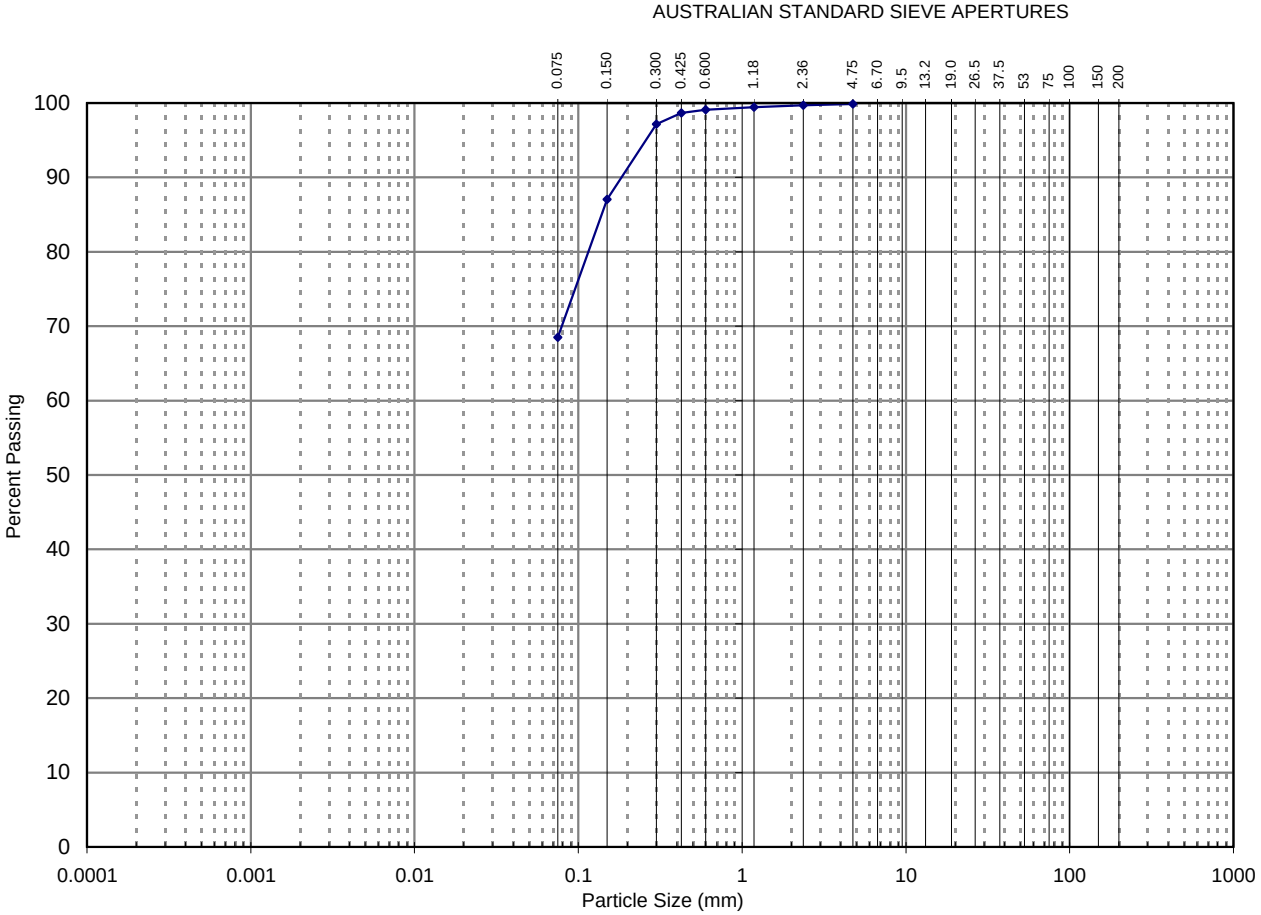
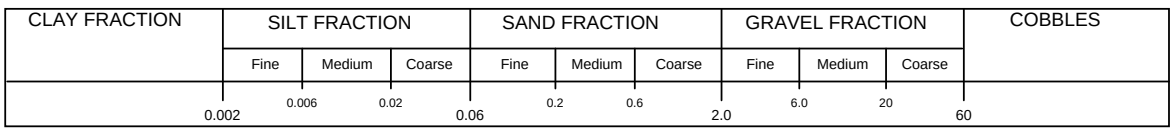
RESULTS OF PARTICLE SIZE DISTRIBUTION

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: -

NATA Accredited Laboratory Number: 828
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Approved Signatory:

Tested:	JR
Checked:	DE

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