



**THE LAKES DEVELOPMENT
STAGE 2F
PYES PA, TAURANGA**

Report on Earthworks and
Recommendations for Development

Our ref: 20180
July 2012

CONTENTS

1.0	Introduction	3
2.0	Original Landform and Geology	3
3.0	Presubdivision Investigations	4
4.0	Scope of Subdivision Earthworks	4
5.0	Earthworks Standards	5
6.0	Summary and Recommendations	5
6.1	<u>Building on Subdivision Construction Filling</u>	5
6.2	<u>Land Stability</u>	6
7.0	Assessment of Liquefaction Potential	7
8.0	Topsoil Thickness	8
9.0	Professional Opinion	9
10.0	Applicability	9

Appendices

Appendix 1	Drawings	Subdivision Scheme Plan As Built Plans	Harrison and Grierson 20180-AB7 20180-AB8
Appendix 2	Producer Statement - Suitability of Land for Building Development (G2) Summary of Geotechnical Data for Individual Lots (G3)		
Appendix 3	Compaction Test Results Settlement Monitoring Data		
Appendix 4	Liquefaction Analyses Plots		
Appendix 5	Post Construction Borehole Logs Pre Construction Borehole Logs		

1.0 Introduction

Approval for the Lakes Development was initially granted jointly by the Tauranga City Council and Western Bay of Plenty District Council on 24 May 2004 based on subdivision plan 16916 dated 20 April 2004 prepared by S&L Consultants Ltd.

The Stage 2 development is broken down into a number of sub stages. On 3 December 2011 the Tauranga City Council issued resource consent RC15622 for further subdivision of development blocks 2B, 2F, 2Ga and 2Gb to create 53 residential lots.

The distribution of 14 residential lots within Stage 2F is shown on subdivision scheme plan 129843-RC03 prepared by Harrison Grierson Consultants. A copy of that plan is included in Appendix 1 of this report. Access to the Stage 2F development is by the major subdivision road, Lakes Boulevard from the subdivision entrance at Takitimu Drive.

The Stage 2F area is located on the lower lying areas within the former flood plain of the Kopurererua stream which flows past the Lakes development to the west.

East of the Stage 2F area the ground rises within the Stage 2D and 2E areas.

This report describes the earthworks undertaken in the formation of Stage 2F of the subdivision and summarises the suitability of the prepared ground in cut and fill for future urban housing development. The report states the relevant standards adopted for the placement of filling to support residential buildings and recommendations for developing building sites.

During the report reference is made to drawings 20180-AB7 and 20180-AB8 which are also in Appendix 1 of this report.

Appended drawing 20180-AB7 indicates the finished ground contours as the result of the completed earthworks and the positions of compaction tests undertaken during the earthworks, and post construction settlement control markers. Drawing 20180-AB8 shows the depths of the filling that was placed. As shown on 20180-AB7 the finished ground levels are essentially flat.

2.0 Original Landform and Geology

The landform prior to the commencement of the Lakes Development construction comprised:

- Elevated areas along the eastern side as a central plateau described locally as the Te Ranga Tablelands. These areas have been variously used for farming and horticultural cropping. The existing Pyes Pa residential area further to the east has been established on similar level areas of the same elevation.
- Lower lying areas mainly along and adjacent to the Kopurererua Stream to the west and extending eastwards.
- Transitional slopes of varying steepness between the lower lying areas and the elevated central plateau. Re entrant erosion gullies were present on some of these slopes but most were uniform in slope gradient, albeit steep in some locations.

The geological setting for the development area can be derived from the publication:
Occasional Report 22 – Department of Earth Sciences University of Waikato
“Geology of the Tauranga Area” by Briggs et al – 1996

The geology within the Stage 2F area can be described as

- Alluvial silts, sands and gravels transported by the stream.
- Organic peat at the existing ground surfaces or overlaid by alluvial soils at depth.
- Eroded sections of the more elevated Taupo volcanic zone tephra that have been reduced to the levels of the stream plain or rise above these levels as mounds or ridges that extend in to the stream plain area.

3.0 Presubdivision Investigations

Prior to obtaining subdivision approval on 24 May 2004 a comprehensive geotechnical assessment was undertaken by S&L Consultants Ltd. The subsequent report that accompanied the consent application was titled “Pyes Pa West Urbanisation Development, Geotechnical Assessment Report, reference 16944” and was dated October 2003.

Fifty two machine drilled boreholes and twenty six excavated pits were used to identify the subsoils that are present on the development area. Machine drilled boreholes 20, 49 and 50 were located within or close to the Stage 2F area, at locations shown on 20180-AB7. Each of these test positions showed the presence of similar subsoils being:

- Peat (organic silt) to depths ranging from zero (borehole 49) to 1.2m (boreholes 20 and 50).
- Grey sandy silts and sands underlying the surface peat. These inorganic soils were found to be of varying densities and strengths with uncorrected SPT N values in the range of 1 to 6. The borehole depths in the Stages 2E and 2F areas varied to 10.5m. No further organic soils were encountered below the surface cover of peat.

The presubdivision investigations concluded that:

- The soils to be obtained in areas of cut on the higher ground in the Stage 2 area would be suitable for placement as filling to support future houses although some conditioning may be required so that placement would be near optimum moisture contents.
- Variations in soil type may be encountered in road subgrades and in situ testing would be required to determine pavement depths applicable to the subgrade conditions present.
- The peat soils can be removed to depths governed by the capability of the earthmoving machinery on the site and the cost effectiveness of removing the peat and undertaking its replacement with filling obtained from elsewhere within the subdivision development area.

4.0 Scope of Subdivision Earthworks

The earthworks undertaken in the Stage 2F area and as shown on 20180-AB8 comprised the removal of the surface peats and the replacement of the peat with filling obtained from borrow areas within The Lakes development. The areas where the peat was removed and replaced were governed by the capacity of the earthmoving machinery on the site and the cost effectiveness of removing the peat and undertaking its replacement.

The depths of cut and filling shown on 20180-AB8 were derived from surveyed contours of the finished surface taken on completion of the earthworks compared with topographical surveys undertaken by S&L Consultants Ltd prior to the subdivision construction and also surveys at the bases of excavations prior to the placement of the replacement filling.

The earthworks were undertaken by Hick Bros Earthmoving during the 2006-2007 earthworks season and the earthworks were undertaken in compliance with consent 62387 issued by Environment Bay of Plenty.

5.0 Earthworks Standards

The performance specification required of the Contractor for the earthworks was based on the guidelines contained in NZS 4431:1989 "Code of Practice for Earthfill for Residential Development". Compliance with the compaction requirements listed below satisfies the standards listed in Section 7 of the NZS 4431.

Air voids percentage (as defined in NZS 4402: Part 1:1980)

- Average value less than 10% (any 10 tests)
- Maximum single value 12%

Undrained shear strength (measured by in situ vane)

- Average value not less than 150kPa (any 10 tests)
- Minimum single value 100kPa

The calculation of air voids percentages is dependant on the determination of the solid densities of the soils used in the filling. These soils mainly comprised mixed silts, clayey silts, sandy silts and sands depending on the depths below the original ground surfaces that the cuts were made for obtaining fill materials. For cohesive silt/clay soil mixtures a value of specific gravity of 2.65 was used in the calculation of air voids. Where the sample taken for laboratory determination of insitu water content comprised pumiceous sands and was indicative of the soils in which the nuclear densometer test was undertaken, a lower value of specific gravity was used in the calculation based on specific tests for solid density.

The earthworks were supervised by site engineering technicians employed by the developer and observed by engineering staff from S&L Consultants Ltd during specific site inspections.

Compaction and strength control testing was undertaken by IANZ accredited Opus International Consultants Ltd both on site and in their Tauranga laboratory.

27 compaction tests were undertaken within the areas of filling within the Stage 2F area at locations shown on 20180-AB7. The results of these tests are summarised in Appendix 3.

The test results meet the specification criteria.

6.0 Summary and Recommendations

6.1 Building on Subdivision Construction Filling

Supervised structural filling as shown on drawings 20180-AB7 and AB8 was placed in accordance with the methods and standards quoted in NZS 4431 under the management of S & L Consultants Ltd. Compaction testing on site confirmed that a high and uniform degree of compaction had been achieved suitable for the support of buildings.

After placement of the filling in Stage 2F, six settlement markers were installed at locations shown on 20180-AB7. The levels on these markers were surveyed over a period of up to 180 days. The survey results are within Appendix 3. The degrees of settlement fluctuated over the monitoring period with variations up or down possibly due to the expected accuracy of the survey. Recorded monthly settlements in the period of 12 September to 10 October 2007 when the surveys ceased were in the range of 1 to 3mm. The trends during the monitoring period indicate that any future settlement will be within tolerable limits for future buildings constructed on surface foundations.

For all of the lots which will be located in the areas of fill the ultimate ground bearing capacity in the limit state may be taken at 300kPa and this capacity meets the definition of "good ground" as defined in NZS3604. Future buildings may therefore be detailed in accordance with NZS3604.

A statement in support of the suitability of the filled areas for building is contained in Appendix 2 of this report.

However, within areas of the structural filling on which buildings may be erected the possibility of variations of soil types and strengths may exist away from observation or compaction tests locations. The normal inspection of foundation conditions during construction of buildings by competent tradesmen as described in NZS 3604 and by building inspectors would still be undertaken. If for any reason, areas of low soil strength are found professional geotechnical advice should then be sought.

Summary logs of the soils found in the post construction boreholes and the results of insitu testing are contained in Appendix 4 of this report.

6.2 Land Stability

The only stability issues relevant to Stage 2F are those relating to the replacement filling for the peat that was present and the potential for possible damage to buildings due to liquefaction during seismic activity. The liquefaction potential is discussed in section 7.0 of this report.

The extent of the structural filling shown on 18264-AB8 along the northern, southern and western margins of Stage 2F was determined by the practical limits to which the surface peat soils could be removed. The extent of the

filling shown was determined by survey as being at the base of the excavation. For stability purposes during construction the excavations were battered into the remaining peat before the controlled backfilling took place. Additional filling was placed over the peat beyond the replacement filling areas to raise ground levels above potential flooding inundation levels.

A building restriction line is applicable to limit future buildings to be located on the structural filling where reliable ground will be present to support conventional buildings with surface foundations. Beyond the restriction lines filling will be present which may not be suitable to support buildings and ground settlement may occur where this filling has been placed over organic soils which were not removed during the subdivision earthworks.

It is possible to cantilever floor slabs beyond the building restriction lines with the cantilevered span being determined by the structural strength of the slab beyond the building restriction line. The structural designer shall assume a fulcrum line for the cantilever at the building restriction line. With the cantilever in place it is possible that the ground may settle under the cantilevered section of the structure.

To confirm that the building restriction lines identified by survey are in the correct places, additional boreholes were machine drilled along the building restriction lines in February 2008. The test positions are shown on 20180-AB7 and the summary logs are in Appendix 5. Each borehole showed the depth of filling present and that the absence of any former peat indicates that the correctly filled ground extends beyond the building restriction lines.

Further investigations in 2012 found that on lots 530 and 537, the structural and non structural filling that is present on either side of the building restriction line at locations shown on 20180-AB8 revision 2 was not brought up to the finished ground surface in tandem. Some of the organic filling or topsoil beyond the building restriction line intrudes into the buildable areas by up to 2m and is up to 1.8m deep at the building restriction line on lot 530 and 1.0m deep on lot 537. In the future development of these lots the unsuitable filling is to be removed for a distance of 2m beyond the building restriction line and be replaced in accordance with NZS 4431 and be managed by a geotechnical consultant prequalified category 2 with the Tauranga City Council. The areas in which this work is to be undertaken on both lots are shown on 20180-AB8 revision 2.

The building restriction lines are indicated on 20180-AB8 and are shown on DP 454401.

7.0 Assessment of Liquefaction Potential

As a result of the ground damage caused by liquefaction from significant earthquakes in Christchurch in September 2010 and February 2011, the policy of the Tauranga City Council is to require a report on the effects of liquefaction on all greenfields subdivisions developed since the 2011 earthquake.

For the study on the liquefaction potential in the Stage 2F area, 1 cone penetrometer (CPT) test was undertaken by Perry Drilling at locations shown on 20180-AB7. At the probe position the static groundwater level depth was recorded at 2.80m

Liquefaction can occur in saturated sands or low plasticity silts during intense cyclic seismic loadings when porewater pressures reduce effective strengths and drainage takes place so that soil particles are resorted to a more dense state with subsequent reductions in soil volumes. The main effects of liquefaction are that ground settlement can occur with some settlement being differential. Where slopes or watercourses are present lateral spread may also take place.

The liquefaction assessment methodology adopted is that described by the New Zealand Geotechnical Society, July 2010 "Geotechnical Earthquake Engineering Practice – Module 1, Guidelines for the Identification, Assessment and Mitigation of Liquefaction Hazards".

NZS 1170.0:2004 "Structural Design Actions" requires that two seismic events be considered namely

- In the ultimate limit state (ULS) with a 1 in 500 year return period event whereby buildings should not collapse but may be beyond economic repair, and
- In the serviceability limit state (SLS) with a 1 in 25 year return period event whereby buildings should remain functional and not require significant repair

Specific liquefaction analyses have been undertaken using the software package Clig (Geologismiki 2011). The factors input into this software were

- an earthquake magnitude of 7.5 on the Richter scale
- class D – Deep Soil – subsoil class condition as described in NZS 1170.5:2004
- a site response factor of 1.12 (class D soil)
- a return period factor of 1.0 for the ULS and 0.25 for SLS
- a base peak ground acceleration of 0.2g (Tauranga)
- an importance level of 2 applicable to domestic buildings

From this data the design peak ground accelerations are:

- in the ULS, 0.22g
- in the SLS, 0.06g

The results of the analysis are shown on the summary sheets in Appendix 5. These results for Stage 2F, as based on data at CPT 2F1, show that some of the deeper layers are expected to be potentially susceptible to liquefaction in the ULS especially those layers at the depth range immediately below the groundwater level. At depth, additional liquefaction may take place where factors of safety are less than 1.0.

Total settlements are estimated to be 65 mm at CPT 2F1. As there is a consistent stiff raft of subdivision filling it is probable that differential settlements will be minimal.

As a result of the seismic events in Christchurch the Department of Building and Housing has prepared guidelines for the repairing or rebuilding of houses in Christchurch. For vertical settlements in the ULS of up to 100 mm, as may be the case in Stage 2F, the use of rib raft or waffle slab type foundations is appropriate as specified in Christchurch. It is

recommended that such foundation details are incorporated for all houses constructed in Stage 2F.

8.0 Topsoil Thickness

During the subdivision earthworks, areas of cut or fill were initially stripped of topsoil and this was then replaced to target depths of up to 300mm. No guarantee is implied or given that the topsoil on any part of any lot is 300mm deep or less and it is recommended that future owners or builders check topsoil depths when preparing site development plans and cost schedules

9.0 Professional Opinion

A statement in the format of Form G2 of Council's Infrastructure Development Code is attached in Appendix 2 of this report as confirmation that all of the lots in Stage 2F of The Lakes Development are suitable for residential building construction.

A summary of Geotechnical Data for Individual Lots in the format of G3 of the Code is also in Appendix 2.

10.0 Applicability

Recommendations contained in this document are based on data from pre and post subdivision boreholes, observations of soil exposures during earthworks, and the results of tests in filling placed. Inferences about the nature and continuity of subsoils away from these locations are made but cannot be guaranteed.

In all circumstances, if variations in the subsoils occur which differ from those described or are assumed to exist, the site should be inspected by an engineer suitably qualified to make an informed judgement and provide advice on appropriate improvement measures.

This report has been prepared specifically for the proposed subdivision development on Stage 2F of the Lakes Development and no responsibility is accepted by S & L Consultants Ltd for the use of any part of this report for other development sites without their written approval.

S & L Consultants Ltd
Consulting Engineers, Surveyors, Planners



Prepared by
M W Hughes CPEng MIPENZ
Geotechnical Engineer

10 July 2012

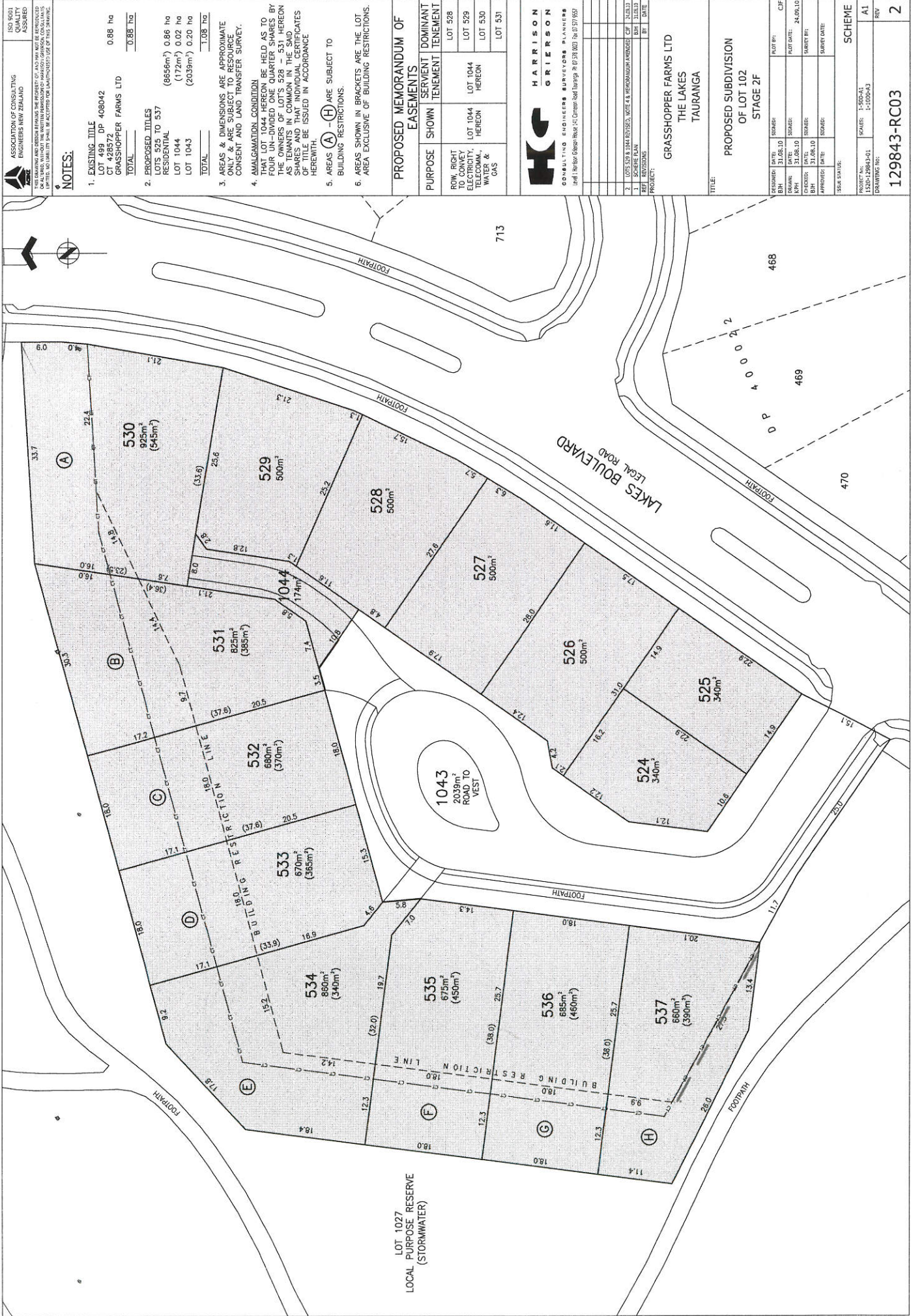
Appendix One

Drawings

Subdivision Scheme Plan by Harrison Grierson

Reference Plans - 20180-AB7

Earthworks Asbuilt Plan - 20180-AB8



ASSOCIATION OF CONSULTING ENGINEERS NEW ZEALAND		ISO 9001 QUALITY ASSURED
NOTES:		
1. EXISTING TITLE LOT 499 DP 408042 CT 428572 GRASSHOPPER FARMS LTD TOTAL 0.88 ha		
2. PROPOSED TITLES LOTS 525 TO 537 RESIDENTIAL LOT 1044 LOT 1043 TOTAL 1.08 ha		
3. AREAS & DIMENSIONS ARE APPROXIMATE ONLY & ARE SUBJECT TO RESOURCE CONSENT AND LAND TRANSFER SURVEY.		
4. AMALGAMATION CONDITION THAT LOT 1044 HEREON BE HELD AS TO FOUR UN-DIVIDED ONE QUARTER SHARES BY THE OWNERS OF LOTS 525 TO 537 HEREON AS TENANTS IN COMMON IN THE SAID SHARES AND THAT INDIVIDUAL CERTIFICATES OF TITLE BE ISSUED IN ACCORDANCE HEREWITH.		
5. AREAS (A)-(H) ARE SUBJECT TO BUILDING RESTRICTIONS.		
6. AREAS SHOWN IN BRACKETS ARE THE LOT AREA EXCLUSIVE OF BUILDING RESTRICTIONS.		
PROPOSED MEMORANDUM OF EASEMENTS		
PURPOSE	SHOWN	SERVIENT TENEMENT
ROW, RIGHT TO CONVEY ELECTRICITY, TELECOMM., WATER & GAS	LOT 1044 HEREON	LOT 528 LOT 529 LOT 530 LOT 531
HARRISON ENGINEERS CONSULTING ENGINEERS SURVEYORS PLANNERS Level 1, Northern Cross House, 101 Green Road, Tauranga, PO Box 577 9507		
2. LOTS 525 & 1044 REVISED, NOTE 4 & 6, MEMORANDUM AMENDED, CIP 26/03/10		
1. SCHEME PLAN		
REF: REVISIONS		
PROJECT:		
GRASSHOPPER FARMS LTD THE LAKES TAURANGA		
TITLE PROPOSED SUBDIVISION OF LOT 102 STAGE 2F		
PREPARED: DATE: 31.08.10 DRAWN: DATE: 31.08.10 CIP: 26/03/10		
CHECKED: DATE: 31.08.10 SURVEY: DATE: 24.08.10		
APPROVED: DATE: 31.08.10 SURVEY: DATE: 24.08.10		
SCALE: 1:500		
SCHEME		
1:500 A1		
DRAWING NO: 129843-RC03		
REV		
2		



1		Issued with Report		04/12
CKD BY	REV No.	DESCRIPTION		DATE
		NAME	DATE	SIGNED
Surveyed				
Designed				
Drawn		NP	4/12	
Checked				
Approved				
REFERENCES				

S & L CONSULTANTS LTD
SURVEYORS - ENGINEERS
PLANNERS
111 Cameron Road, Tauranga
New Zealand
P.O. Box 231 Ph.(07)577-6069
Fax(07)577-6065
Email: slconsultants@sltga.co.nz

TITLE	THE LAKES -BUILDING COMMITTEES- Stage 2F Geotechnical Report Reference Plan
Copyright on this drawing is reserved	
ORIGINAL SCALES	DATE
1:500 @ A3	4/12
DRAWING No	
20180 - AB7	
REVISION: 1	
	METRIC DESIGN







FILL Subdivision Cut and
CUT Fill Areas

1 ——— Fill Contour

-1 ——— Cut Contour

Building
Restriction Line

 Ground Improvement
Required on Lots 530
& 537

		2	Lots 530, 537 Amended		06/12
		1	Issued with Report		04/12
CKD BY	REV No.	DESCRIPTION			DATE
		NAME	DATE	SIGNED	
Surveyed					
Designed					
Drawn		NP	4/12		
Checked					
Approved					
REFERENCES					

REFERENCES



S & L CONSULTANTS LTD
SURVEYORS - ENGINEERS
PLANNERS
111 Cameron Road, Tauranga
New Zealand
P.O. Box 231 Ph.(07)577-6069
Fax(07)577-6065
Email: sconsultants@sltga.co.nz

TITLE



Stage 2F

Earthworks Asbuilt
Depth of Cut / Fill

Copyright on this drawing is reserved

ORIGINAL SCALES	DATE
1:500 @ A3	4/12

DRAWING No	20180 - AB8
------------	-------------

REVISION:	1	2				
-----------	---	---	--	--	--	--



Appendix Two

Producer Statement – Suitability of
Land for Building Development

Summary of Geotechnical Data for Individual Lots

CERTIFICATION**G2****STATEMENT OF PROFESSIONAL OPINION AS TO THE
GEOTECHNICAL SUITABILITY OF LAND FOR BUILDING**

NAME OF SUBDIVISION	The Lakes – Stage 2F
COUNCIL FILE NUMBER RC No:	15266
ENGINEER RESPONSIBLE FOR DEVELOPMENT:	M W Hughes of S & L Consultants Ltd
QUALIFICATIONS:	BE(Civil)CPEng MIPENZ Int PE

I **Michael William Hughes**..... of **S & L Consultants Ltd**,
(Full Name) (Name & Address of Firm)

Hereby confirm that;

1. I am a professional person, appropriately qualified with experience in geotechnical engineering to ascertain the suitability of the land for building development and was retained as the Soils Engineer to the above development.

2. An appropriate level of site investigation and construction supervision has been carried out under my direction and is described in my development evaluation report dated: **10 July 2012**

3. In my professional opinion, not to be construed as a guarantee, I consider that;

a) The areas shown in my report dated **10 July 2012** of each new allotment are suitable for the erection thereon of the building types appropriate to the zoning of the land, provided that **building restriction lines are observed and ground improvement work is undertaken on lots 530 and 537 as described in mv report of 10 July 2012..**

c) The earth fills shown on the attached **Plan No. 20180-AB8** have been placed in accordance with the requirements of the Infrastructure Development Code.

d) The completed works give due regard to all land slope and foundation stability considerations.

e) The filled ground is suitable for the erection thereon of residential buildings not requiring specific design in terms of NZS 3604: 2011 and related documents.

b) The original ground not affected by filling is suitable for the erection thereon of residential buildings not requiring specific design in terms of NZS 3604: 2011 and related documents.

4. This professional opinion is furnished to the Council and the owner for their purpose alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection for any dwelling.

Signed Date 10 July 2012



TaurangaCity

PRODUCER STATEMENT
SUITABILITY OF LAND FOR BUILDING DEVELOPMENT

INFRASTRUCTURE DEVELOPMENT CODE

G2

VERSION 1
July 2011

1

DP NO	Property Address:	Lakes Subdivision Stage 2F	RC: 15266																
Lot No	Area (m²)	Shear Strength (kPa)	Subsurface Data				Foundations												
			Subdivision Filling		Natural Topography Unworked	Natural Topography Earthworked	Conventional Shallow Foundation to NZS 3604:2011	Specific Design											
	Y/N	Depth (m)	Y/N	Y/N	Y/N/NA	Y/N/NA	Y/N/NA												
	*		Y/N	Depth (m)															
	524	340	150	2-3	Y	N	N	Y	N						N	N			
	525	340	150	2-3	Y	N	N	Y	N						N	N			
	526	500	150	1-2	Y	N	N	Y	N						N	N			
	527	500	150	1	Y	N	N	Y	N						N	N			
	528	500	150	1	Y	N	N	Y	N						N	N			
	529	500	150	1-3	Y	N	N	Y	N						N	N			
	530	925	150	3-4	Y	N	N	Y	N						N	N			
	531	825	150	1-4	Y	N	N	Y	N						N	N			
	532	680	150	1-4	Y	N	N	Y	N						N	N			
	533	670	150	1-4	Y	N	N	Y	N						N	N			
	Consent notices refer to Geotechnical Completion Report of 20 April 2012																		
	* Subdivision Filling as replacement of peat																		
Rib raft or waffle slab floor systems are to be adopted for all buildings - refer to Section 7.0																			

DP NO	Property Address:	Lakes Subdivision Stage 2F	RC: 15266															
Lot No	Area (m ²)	Shear Strength (kPa)	Subsurface Data				Foundations			Building Restriction Line	S/W Specific Design	S/W Soakage	S/W Reticulate	Designated Building Platform	Minimum Building Platform	Compressible Soils	On-Site Effluent Disposal	Consent Notice
			Subdivision Filling	Natural Topography Unworked	Natural Topography Earthworked	Conventional Shallow Foundation to NZS 3604:2011	Specific Design											
			Y/N	Depth (m)	Y/N	Depth (m)	Y/N/NA	Y/N/NA										
534	860	150	*	1-4	N		Y	N		N	N	Y	Y	N	N	N	N	Y
535	675	150	Y	1-4	N		Y	N		N	N	Y	Y	N	N	N	N	Y
536	685	150	Y	2-3	N		Y	N		N	N	Y	Y	N	N	N	N	Y
537	660	150	Y	3-4	N		Y	N		N	N	Y	Y	N	N	N	N	Y
Consent notices refer to Geotechnical Completion Report of 20 April 2012																		
* Subdivision Filling as replacement of peat																		
Rib raft or waffle slab floor systems are to be adopted for all buildings - refer to Section 7.0																		

Appendix Three

Compaction Test Results
Settlement Monitoring Results

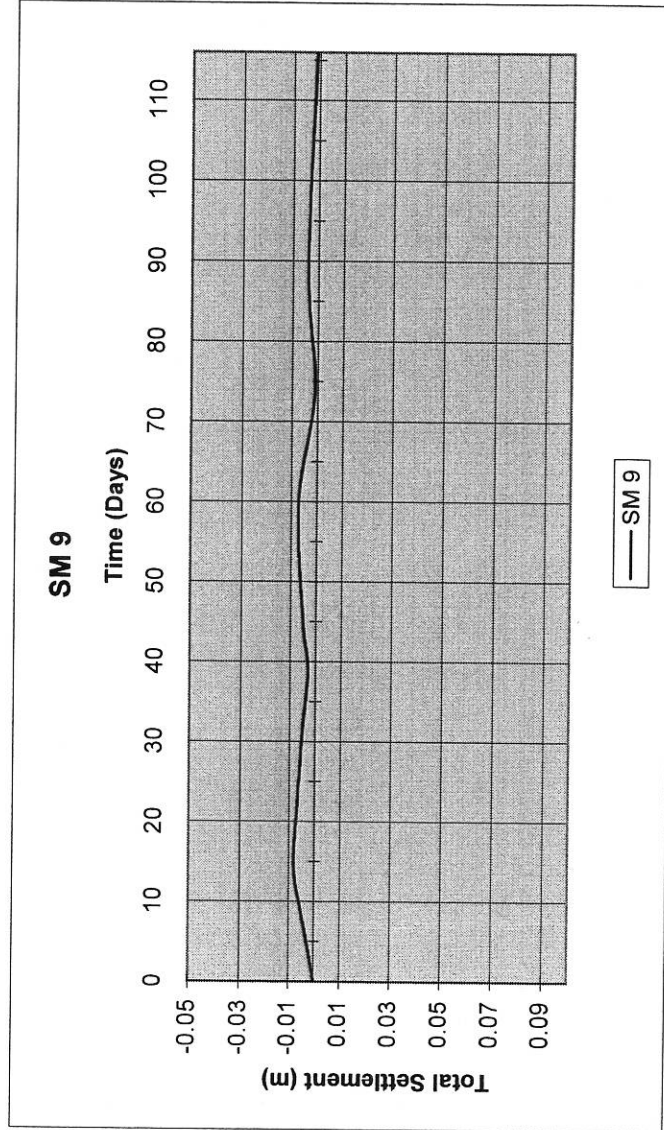
**Summary of Compaction Test Results
Stages 2F**

Test No.	Date	Soil Type	Percentage Air Voids	Undrained Shear Strength (kPa)
71	23.11.06	Silt/Ash	3.0	153
72	23.11.06	Silt/Ash	1.0	179+
73	23.11.06	Silt/Ash	8.9	179+
74	23.11.06	Silt/Ash	2.1	164+
75	23.11.06	Silt/Ash	6.9	167+
76	23.11.06	Silt/Ash	9.0	179+
77	23.11.06	Silt/Ash	3.1	UTP
78	23.11.06	Silt/Ash	12.8	165+
79	23.11.06	Silt/Ash	3.9	UTP
80	23.11.06	Silt/Ash	7.9	175+
95	06.12.06	Silt/Ash	1.0	180+
96	06.12.06	Silt/Ash	2.5	UTP
97	06.12.06	Silt/Ash	0.0	174+
98	06.12.06	Silt/Ash	9.2	UTP
99	06.12.06	Silt/Ash	1.2	171+
100	06.12.06	Silt/Ash	2.7	UTP
105	11.12.06	Silt/Ash	5.7	167+
111	15.12.06	Silt/Ash	6.8	UTP
113	15.12.06	Silt/Ash	5.4	181+
114	15.12.06	Silt/Ash	10.5	154
115	15.12.06	Silt/Ash	1.0	165
116	15.12.06	Silt/Ash	9.2	159+
132	08.01.07	Silt/Ash	6.0	149
134	08.01.07	Silt/Ash	0.00	172
135	08.01.07	Silt/Ash	7.5	188+
136	08.01.07	Silt/Ash	2.0	188+
137	08.01.07	Silt/Ash	2.3	188+
138	08.01.07	Silt/Ash	5.2	UTP
139	08.01.07	Silt/Ash	9.7	UTP
168	25.01.07	Silt/Ash	4.6	153

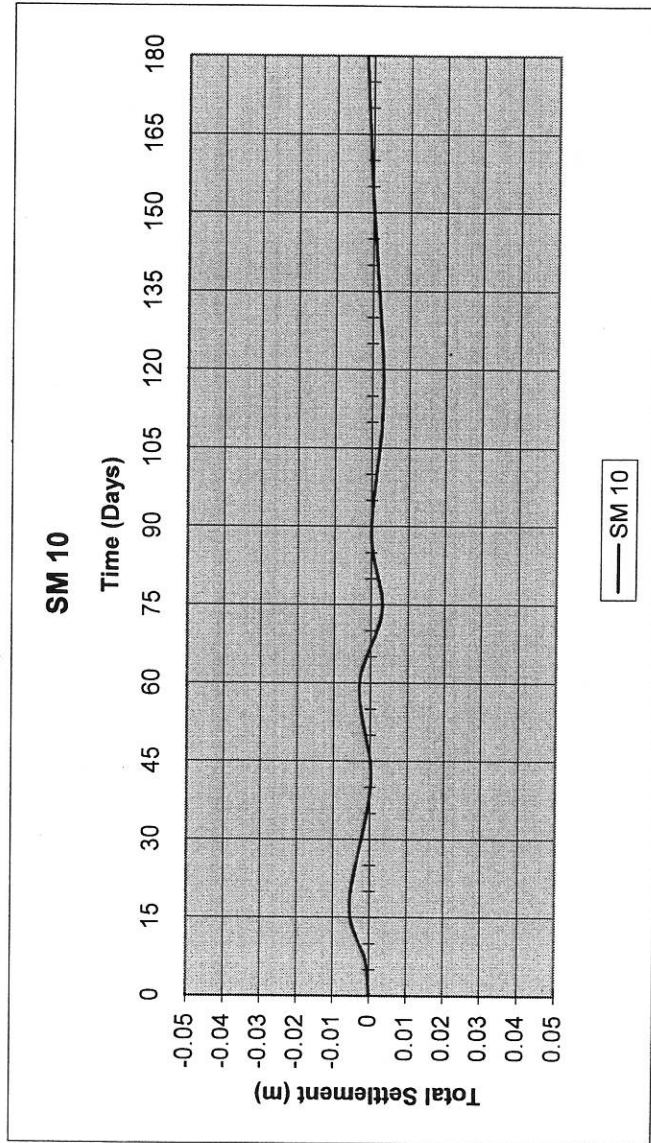
Notes:

UTP Unable to penetrate with vane head
Test positions shown on 20180-AB7

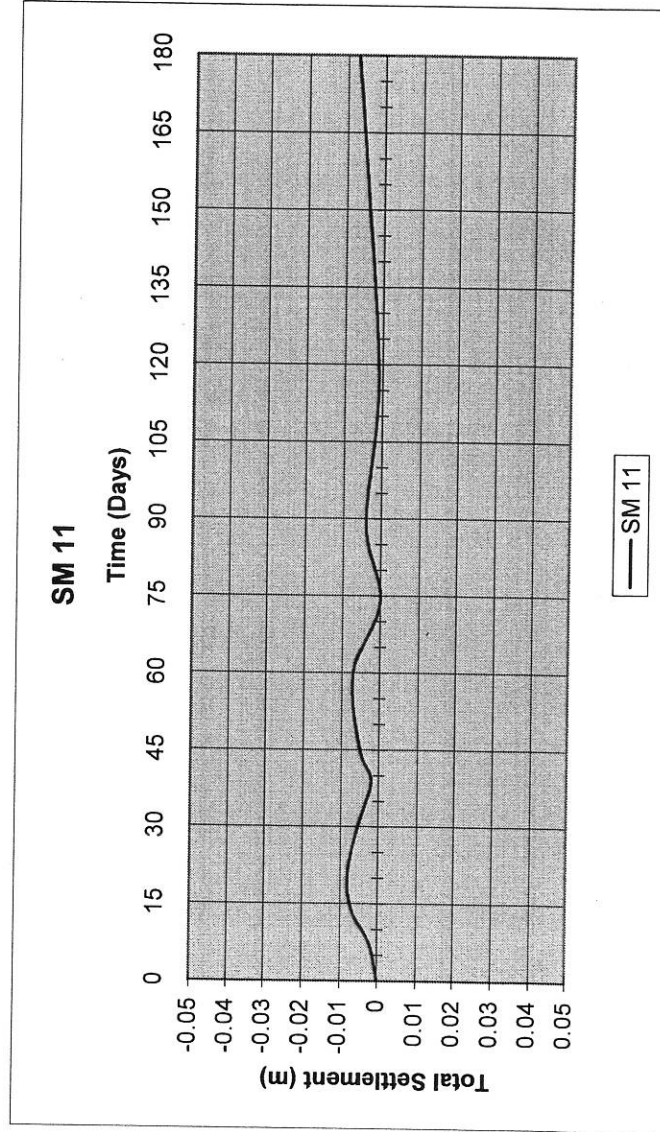
<u>Settlement Mark</u>	<u>Date</u>	<u>Warratah RL</u>	<u>Settlement</u>	<u>Total Settlement</u>	<u>Days Between readings</u>	<u>Total Days</u>	<u>Comments</u>	<u>Equipment</u>
SM 9	13 April 2007	9.790	0	0	0	0	Warratah	Level
SM 9	20 April 2007	9.794	-0.004	-0.004	7	7	Warratah	Level
SM 9	27 April 2007	9.798	-0.004	-0.008	7	14	Warratah	Level
SM 9	4 May 2007	9.797	0.001	-0.007	7	21	Warratah	Level
SM 9	14 May 2007	9.795	0.002	-0.005	10	31	Warratah	Level
SM 9	22 May 2007	9.793	0.002	-0.003	8	39	Warratah	Level
SM 9	28 May 2007	9.795	-0.002	-0.005	6	45	Warratah	Level
SM 9	12 June 2007	9.797	-0.002	-0.007	15	60	Warratah	Level
SM 9	26 June 2007	9.791	0.006	-0.001	14	74	Warratah	Level
SM 9	11 July 2007	9.794	-0.003	-0.004	15	89	Warratah	Level
SM 9	7 August 2007	9.791	0.003	-0.001	27	116	Warratah	Level
	12 September 2007							



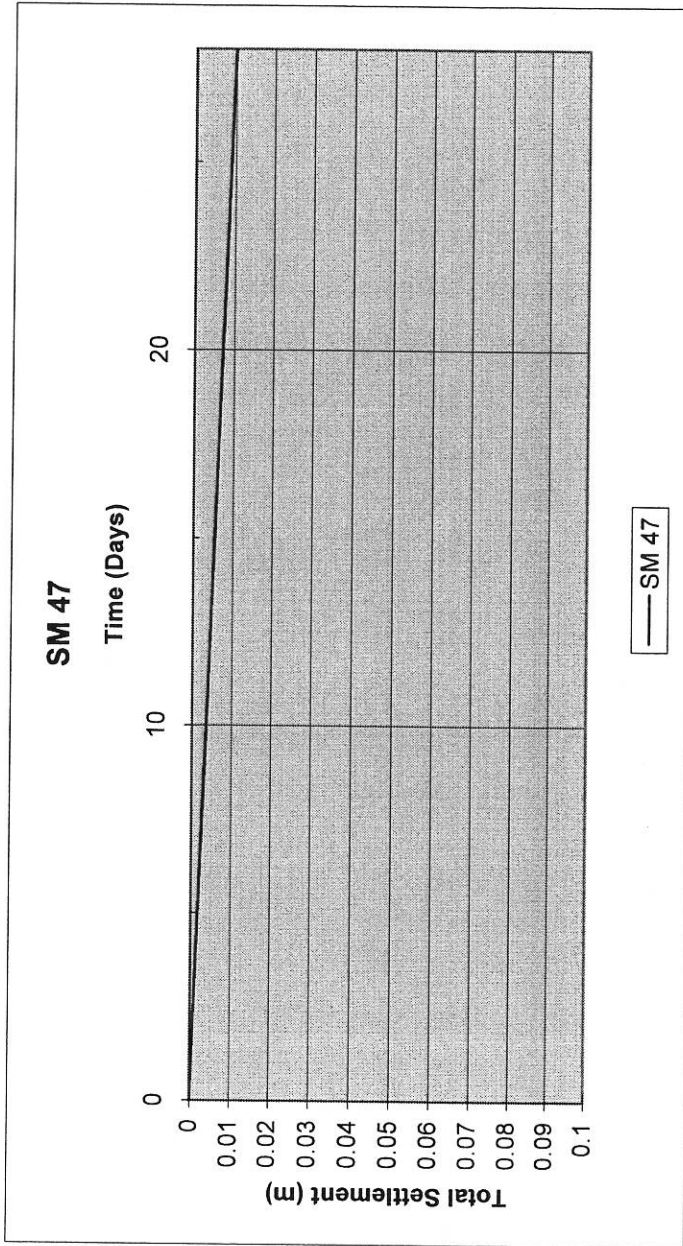
<u>Settlement Mark</u>	<u>Date</u>	<u>Warratah RL</u>	<u>Settlement</u>	<u>Total Settlement</u>	<u>Days Between readings</u>	<u>Total Days</u>	<u>Comments</u>	<u>Equipment</u>
SM 10	13 April 2007	9.704	0	0	0	0	Warratah	Level
SM 10	20 April 2007	9.705	-0.001	-0.001	7	7	Warratah	Level
SM 10	27 April 2007	9.709	-0.004	-0.005	7	14	Warratah	Level
SM 10	4 May 2007	9.709	0	-0.005	7	21	Warratah	Level
SM 10	14 May 2007	9.706	0.003	-0.002	10	31	Warratah	Level
SM 10	22 May 2007	9.704	0.002	0	8	39	Warratah	Level
SM 10	28 May 2007	9.704	0	0	6	45	Warratah	Level
SM 10	12 June 2007	9.707	-0.003	-0.003	15	60	Warratah	Level
SM 10	26 June 2007	9.701	0.006	0.003	14	74	Warratah	Level
SM 10	11 July 2007	9.704	-0.003	0	15	89	Warratah	Level
SM 10	7 August 2007	9.701	0.003	0.003	27	116	Warratah	Level
SM 10	12 September 2007	9.704	-0.003	0	36	152	Warratah	Level
SM 10	10 October 2007	9.706	-0.002	-0.002	28	180	Warratah	Level



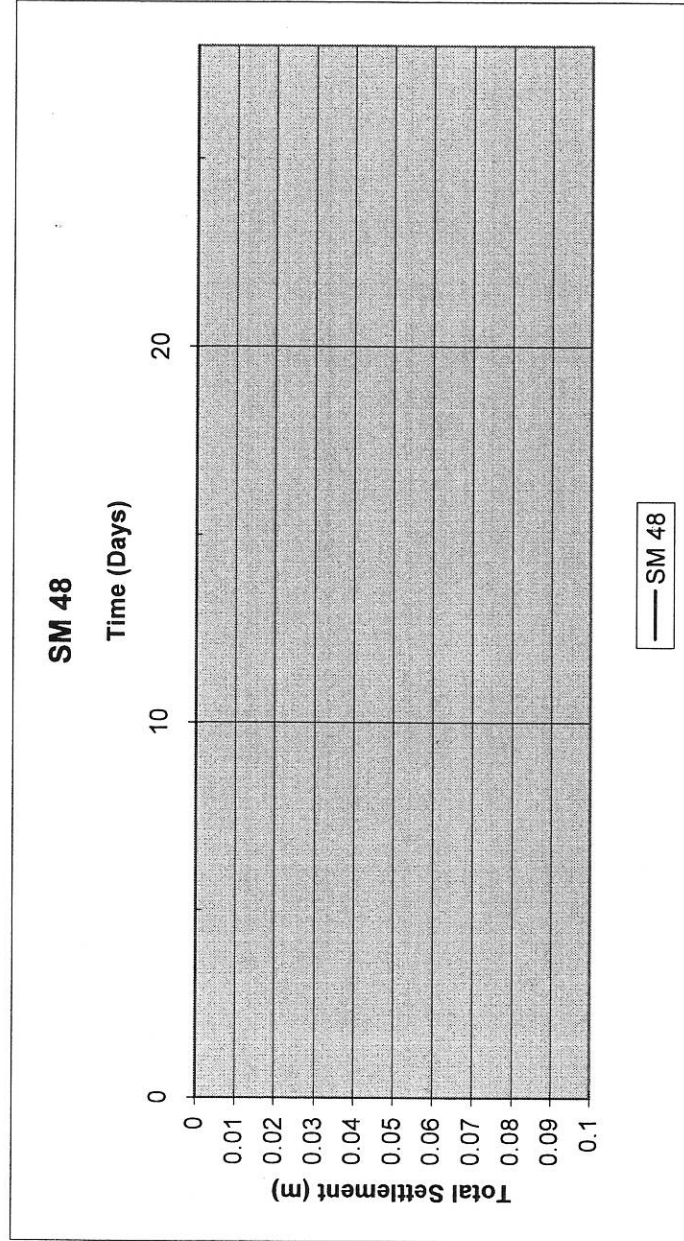
<u>Settlement Mark</u>	<u>Date</u>	<u>Warratah RL</u>	<u>Settlement</u>	<u>Total Settlement</u>	<u>Days Between readings</u>	<u>Total Days</u>	<u>Comments</u>	<u>Equipment</u>
SM 11	13 April 2007	10.025	0	0	0	0	Warratah	Level
SM11	20 April 2007	10.027	-0.002	-0.002	7	7	Warratah	Level
SM 11	27 April 2007	10.032	-0.005	-0.007	7	14	Warratah	Level
SM 11	4 May 2007	10.033	-0.001	-0.008	7	21	Warratah	Level
SM 11	14 May 2007	10.03	0.003	-0.005	10	31	Warratah	Level
SM 11	22 May 2007	10.027	0.003	-0.002	8	39	Warratah	Level
SM 11	28 May 2007	10.03	-0.003	-0.005	6	45	Warratah	Level
SM 11	12 June 2007	10.032	-0.002	-0.007	15	60	Warratah	Level
SM 11	26 June 2007	10.025	0.007	0	14	74	Warratah	Level
SM 11	11 July 2007	10.029	-0.004	-0.004	15	89	Warratah	Level
SM 11	7 August 2007	10.026	0.003	-0.001	27	116	Warratah	Level
SM 11	12 September 2007	10.029	-0.003	-0.004	36	152	Warratah	Level
SM 11	10 October 2007	10.032	-0.003	-0.007	28	180	Warratah	Level



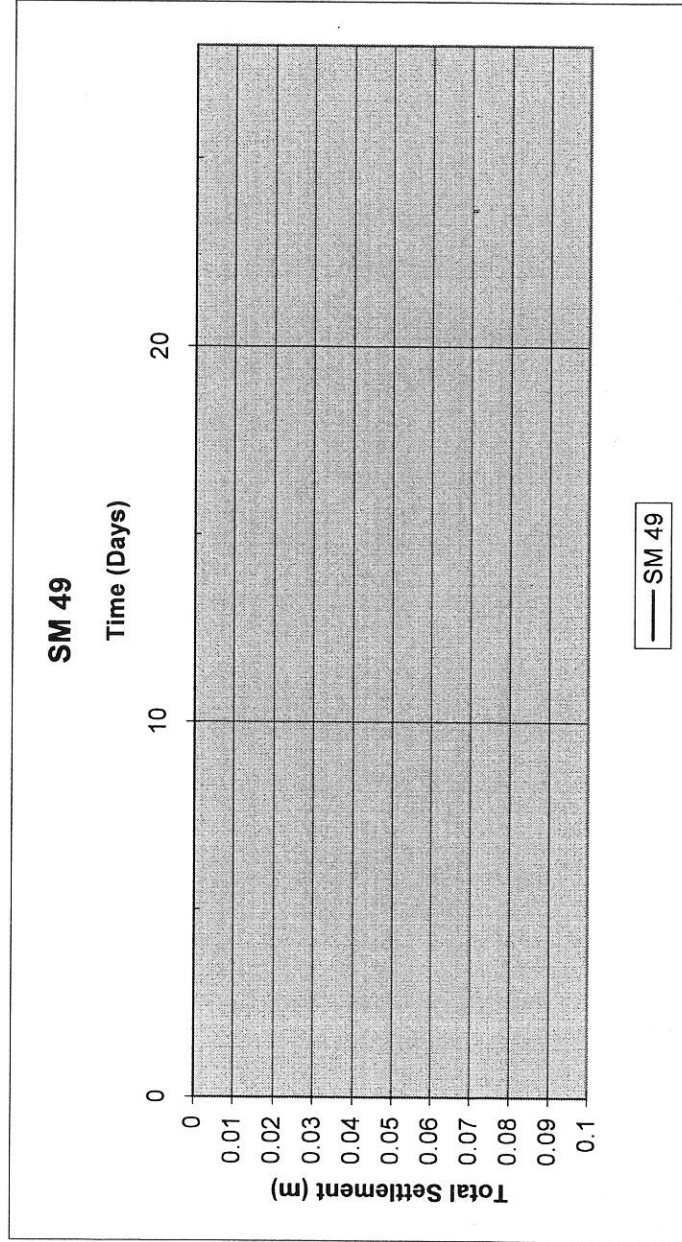
<u>Settlement Mark</u>	<u>Date</u>	<u>Warratah RL</u>	<u>Settlement</u>	<u>Total Settlement</u>	<u>Days Between readings</u>	<u>Total Days</u>	<u>Comments</u>	<u>Equipment</u>
SM47	12 September 2007	9.514	0	0	0	0	Warratah	Level
SM47	10 October 2007	9.504	0.01	0.01	28	28	Warratah	Level



<u>Settlement Mark</u>	<u>Date</u>	<u>Warratah RL</u>	<u>Settlement</u>	<u>Total Settlement</u>	<u>Days Between readings</u>	<u>Total Days</u>	<u>Comments</u>	<u>Equipment</u>
SM48	12 September 2007	9.33	0	0	0	0	Warratah	Level
SM48	10 October 2007	9.33	0	0	28	28	Warratah	Level



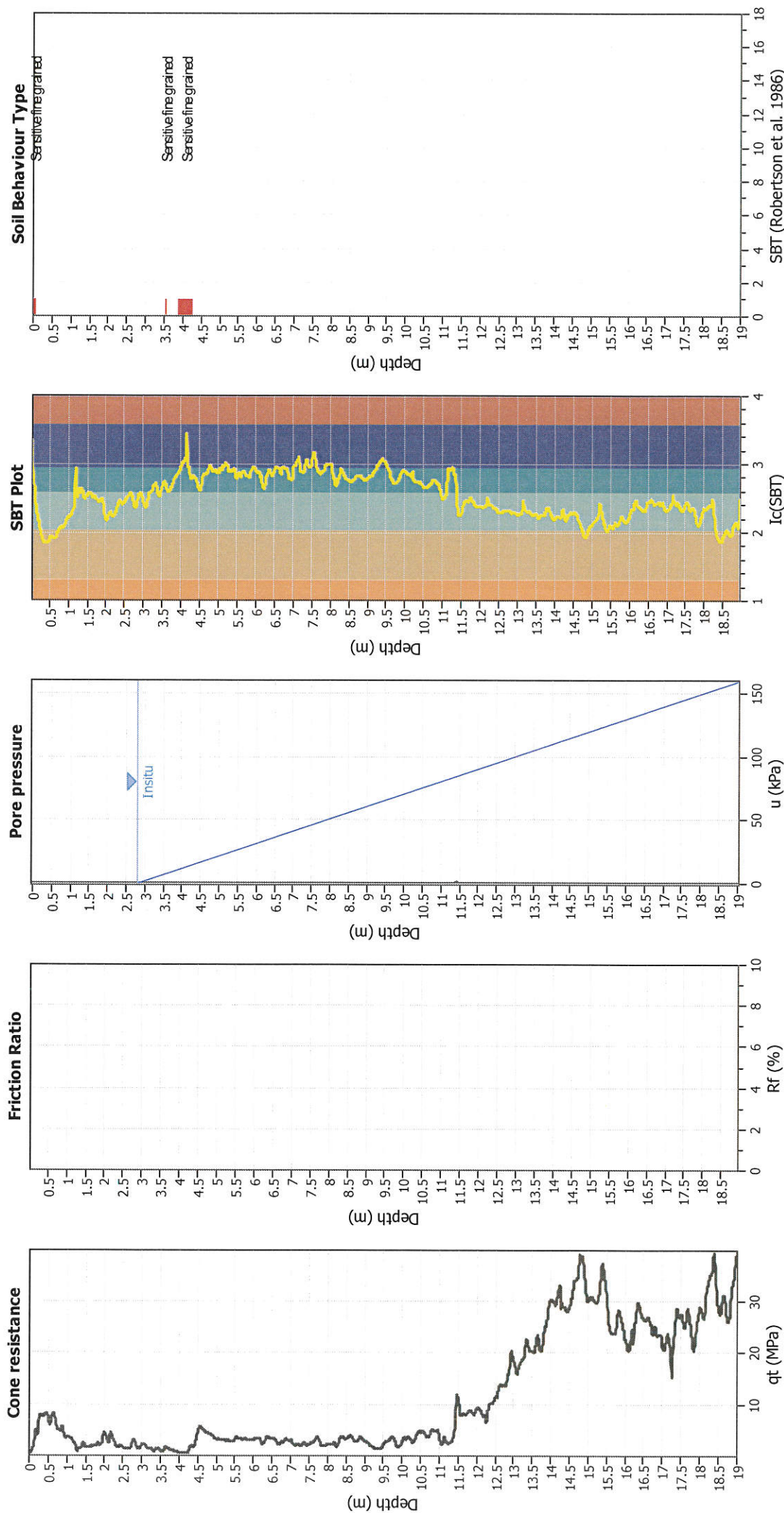
<u>Settlement Mark</u>	<u>Date</u>	<u>Warratah RL</u>	<u>Settlement</u>	<u>Total Settlement</u>	<u>Days Between readings</u>	<u>Total Days</u>	<u>Comments</u>	<u>Equipment</u>
SM49	12 September 2007	9.412	0	0	0	0	Warratah	Level
SM49	10 October 2007	9.412	0	0	28	28	Warratah	Level



Appendix Four

Liquefaction Analyses Plots

CPT basic interpretation plots



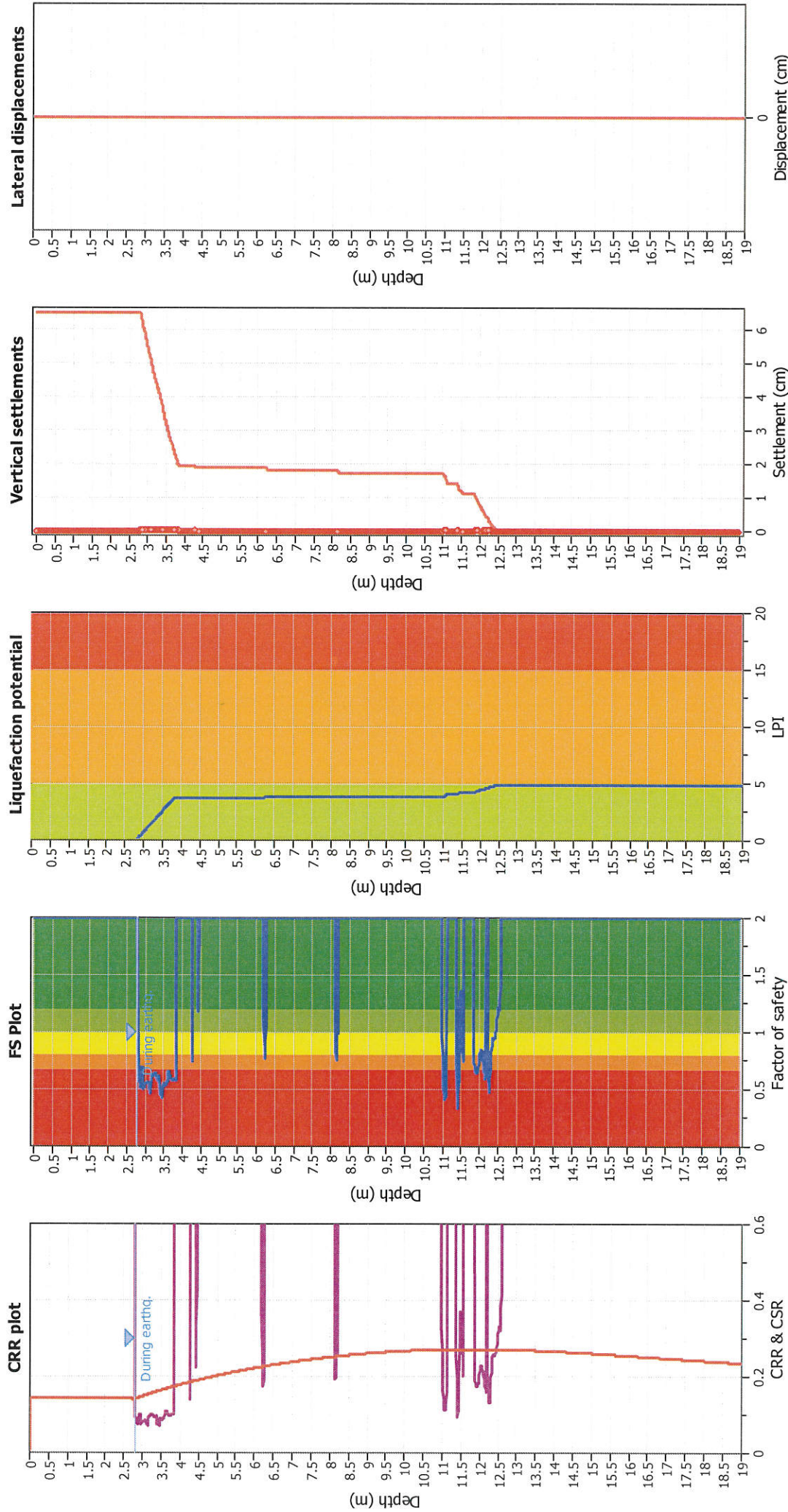
Input parameters and analysis data

Analysis method:	NCEER (1998)	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Transition detect. applied:	No
Points to test:	Based on I_c value	K_0 applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.22	Limit depth applied:	No
Depth to water table (insitu):	2.80 m	Limit depth:	N/A
Depth to water table (earthq.):	2.80 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: NCEER (1998)
Fines correction method: NCEER (1998)
Points to test: Based on I_c value
Earthquake magnitude M_w : 7.50
Peak ground acceleration: 0.22
Depth to water table (insitu): 2.80 m

Depth to water table (earthq.): 2.80 m
Average results interval: 3
 I_c cut-off value: 2.60
Unit weight calculation: Based on SPT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
 K_0 applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

F.S. color scheme

Almost certain it will liquefy
Very likely to liquefy
Liquefaction and no liquefaction are equally likely
Unlike to liquefy
Almost certain it will not liquefy

LPI color scheme

Very high risk
High risk
Low risk

Appendix Five

Pre and Post Construction Borehole Logs



Stage 2F
Lot 532A
Stake Ref No 212

Site: The Lakes Residential Subdivision

Sheet: 1 Of: 1

Job No: 18264

Date Excavated: W.20/2/08

RL Ground:

Logged By: MH

Description of Soil	Soil Symbol	Depth (m)	Groundwater	Core Recovery			
					50	100	150
No topsoil Clean, clayey, SILT; cohesive, orange very stiff, damp, uniform	Subdivision Filling	1.0	Borehole Dry	1.5m Runs with 100% Recovery			
Minor grey mottles		2.0					
		3.0					
Mixed grey silt, stiff, slightly moist		4.0					
		5.0					
Silt: Sandy, grey, very stiff, very moist (Natural Insitu Subsoils)	x x	6.0					
EOB @ 6.0m							

EXCAVATION METHOD: 50 mm Diameter Handauger



Stage 2F
Lot 532B
Stake Ref No 228

Site: The Lakes Residential Subdivision

Sheet: 1 Of: 1

Job No: 18264

Date Excavated: W.20/2/08

RL Ground:

Logged By: MH

Description of Soil	Soil Symbol	Depth (m)	Groundwater	Core Recovery			
					50	100	150
No topsoil Clean, clayey, SILT; cohesive, dark orange, very stiff, slightly moist, uniform	Subdivision Filling	1.0	Borehole Dry	1.5m Runs with 100% Recovery			
		2.0					
Mixed cream grey sandy silt		3.0					
		4.0					
Pale orange, stiff to very stiff very moist		5.0					
Silt: Sandy, grey, very stiff, very moist (Natural Insitu Subsoils)		6.0					
EOB @ 6.0m							

EXCAVATION METHOD: 50 mm Diameter Handauger



Stage 2F
Lot 534
Stake Ref No 214

Site: The Lakes Residential Subdivision

Sheet: 1 Of: 1

Job No: 18264

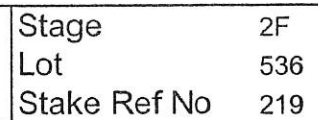
Date Excavated: W.20/2/08

RL Ground:

Logged By: MH

Description of Soil	Soil Symbol	Depth (m)	Groundwater	Core Recovery			
					50	100	150
No topsoil Clean, clayey, SILT; cohesive, brown orange, very stiff, slightly moist, uniform	Subdivision Filling	1.0	Borehole Dry	1.5m Runs with 100% Recovery			
		2.0					
Silt: Sandy, pale grey, very stiff (Natural Insitu Subsoils)	X-X	3.0					
		4.0					
EOB @ 4.5m							

EXCAVATION METHOD: Machine Rotary

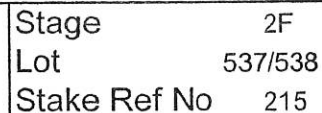


Sheet: 1 Of: 1

Logged By: MH

Description of Soil	Soil Symbol	Depth (m)	Groundwater	Core Recovery			
					50	100	150
<div>No topsoil</div> <div>Clean, clayey, SILT; cohesive, brown stiff, moist, uniform</div>	Subdivision Filling	1.0	DAY	1.5m Runs with 100% Recovery			
		2.0					
Mixed grey sandy silt		2.6					
Brown orange		3.0					
		4.0					
Silt: Sandy, friable, cream, firm, very moist (Natural Subsoils)	X X	5.0					
	X X	6.0					
EOB @ 6.0m							

EXCAVATION METHOD: Machine Rotary



Sheet: 1 Of: 1

Logged By: MH

EXCAVATION METHOD: 50 mm Diameter Handauger



Stage 2F
Lot 539A
Stake Ref No 216

Site: The Lakes Residential Subdivision

Sheet: 1 Of: 1

Job No: 18264

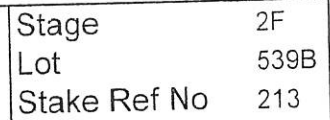
Date Excavated: W.20/2/08

RL Ground:

Logged By: MH

Description of Soil	Soil Symbol	Depth (m)	Groundwater	Core Recovery			
					50	100	150
No Topsoil Clean, clayey, SILT; cohesive, pale brown, very stiff, slightly moist, uniform	Subdivision Filling	1.0	Borehole Dry	1.5m Runs with 100% Recovery			
Stiff, very moist		2.0					
Brown orange, stiff to very stiff, slightly moist		3.0					
		4.0					
Silt: Sandy, pale grey, firm, very moist (Natural Subsoils)	x x	5.0					
	x x	6.0					
EOB @ 6.0m							

EXCAVATION METHOD: Machine Rotary



Sheet: 1 Of: 1

Logged By: MH

EXCAVATION METHOD: Machine Rotary



Borehole No. MB20

Site:

Pyres Pa West Urbanisation

Sheet: 1 Of: 2

Job No. 16944

Date Excavated: 29/4/03

RL Ground:

Logged By: MAA

Description of Soil

Soil Symbol

Depth (m)

SPT

GROUNDWATER

CORE RECOVERY

Undrained Shear Strength (kPa)

50 100 150

PEAT : Youthful, spongy, Dark brown
highly compressible

ORGANIC SEDIMENTS

SAND : Pumiceous, Very silty, pale brown
yellow, loose, sensitive, DilatantVery silty pale cream
grey loose sand

NON ORGANIC LOOSE

SPT 450 : Slightly Silty, pale brown
RECOVERY yellow pumice sand, Dense

SAND : Silty, grey cream, Dense

DENSE

EXCAVATION METHOD: 100mm.φ Machine Auger Et Hollow SPT



Borehole No. MB 20

Site:

Pyes Pa West Urbanisation

Sheet: 2 of 2

Job No. 16944

Date Excavated: 29/4/03

RL Ground:

Logged By: MHH

Description of Soil

Soil Symbol

Depth (m)

Undrained Shear Strength
(kPa)

50 100 150

SPT 450 : Pumice sand, medium
RECOVERY Grained, pale grey, DenseSAND : Silty, pumice, pale brown
yellow, DenseSPT 450 : Pumice sand, pale brown
RECOVERY some gravels, DenseSilty sand, Dense
pale brown yellow

FOR @ 7.5m : TARGET DEPTH

EXCAVATION METHOD: 100mm ϕ Machine Auger Et Hollow SPT.



Borehole No. MB 49

Site: Pyes Pa West Urbanisation

Sheet: 1 Of: 1

Job No. 16944

Date Excavated: 19/9/03

RL Ground:

Logged By: MAA

Description of Soil

Soil Symbol

Depth (m)

SPT

CURE RECOVERY

Undrained Shear Strength (kPa)

50 100 150

Sand: Silty, cream, loose

medium Dense

PUMICE SAND

17

N=4

100g

N=3

100g

EOB @ 6.0m: TARGET DEPTH

EXCAVATION METHOD: 75mm ϕ MACHINE AUGER + HOLLOW SPT