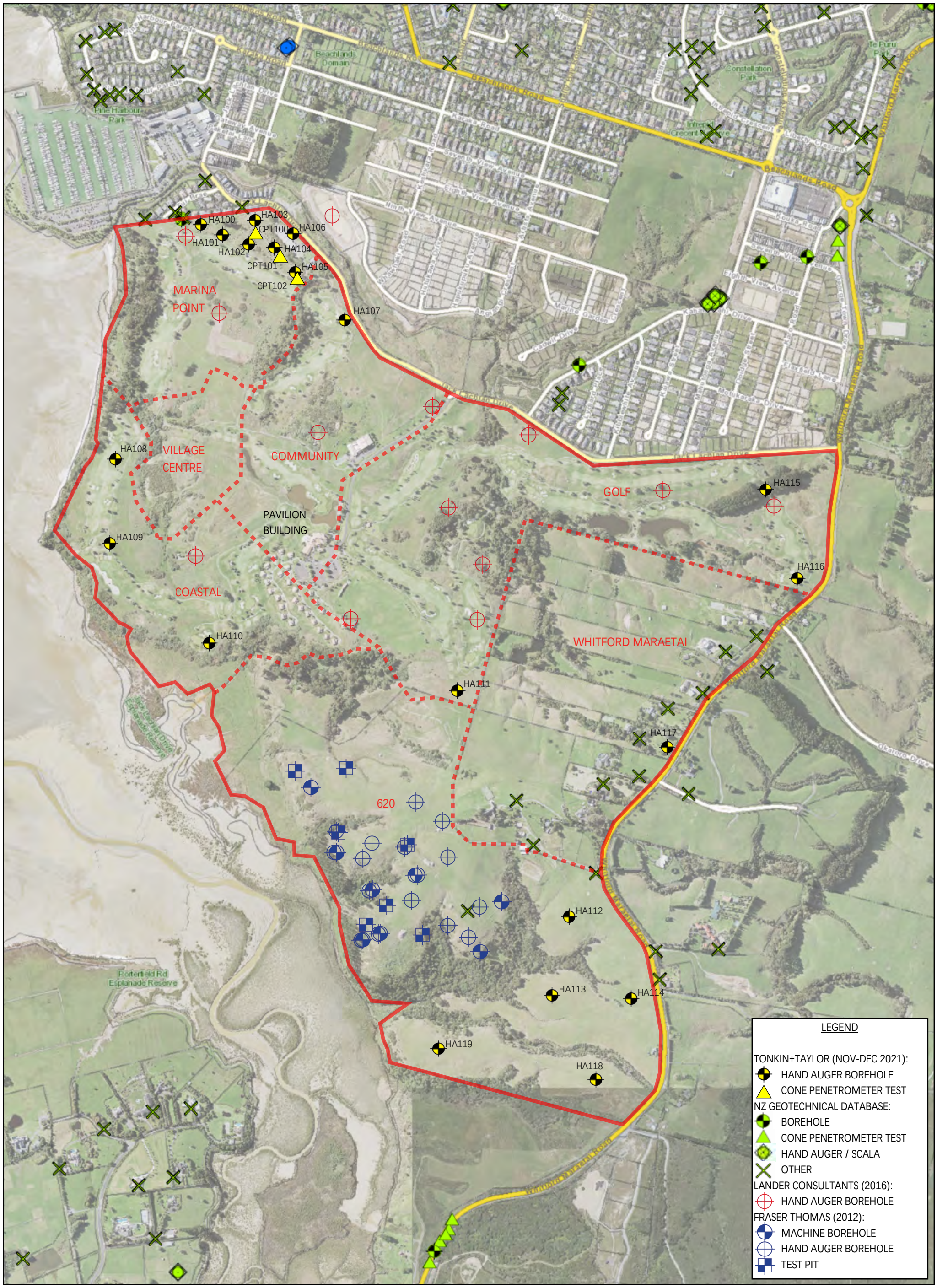
Appendix D: Historical geotechnical investigations

- **Sketch plan, historical geotechnical investigations**
- **Statement of Evidence by Shane Gareth Lander**
- **Fraser Thomas, Geotechnical Investigation Report, 650 Whitford-Maraetai Road**
- **Partial records, Foundation Engineering, Pavilion Building**
- **New Zealand Geotechnical Database, various nearby borehole logs**



Tonkin+Taylor

DRAWN: M THOMAS 09/21
CHECKED: B WESTGATE
APPROVED: P MILLAR
JOB No: 1014358.3000
SCALE: 1:10,000 AT A3
INVESTIGATION LOCATIONS ARE APPROXIMATE

BEACHLANDS SOUTH LIMITED PARTNERSHIP
STRUCTURE PLAN
KNOWN GEOTECHNICAL INVESTIGATIONS
SKETCH PLAN

V 1.1

Statement of Evidence by Shane Gareth Lander

BEFORE THE AUCKLAND UNITARY PLAN INDEPENDENT HEARINGS PANEL

IN THE MATTER:	of the Resource Management Act 1991 and the Local Government (Auckland Transitional Provisions) Act 2010
AND	
IN THE MATTER:	Proposed Auckland Unitary Plan
SUBMITTER:	110 Formosa (NZ) Limited Submission 7318
HEARING TOPIC:	081 – Rezoning and Precincts (Geographic Areas)

STATEMENT OF EVIDENCE BY SHANE GARETH LANDER

ON BEHALF OF 110 FORMOSA (NZ) LIMITED

110A JACK LACHLAN DRIVE, BEACHLANDS

10 FEBRUARY 2016

Introduction

1. My name is Shane Gareth Lander. I am the Owner, Director and Principal Geotechnical Engineer at Lander Geotechnical Consultants Limited, and have held that role for the past 15 months.

2. This statement of evidence is given in support of 110 Formosa (NZ) Limited to address their submission in relation to the Proposed Auckland Unitary Plan ("**PAUP**") Topic 081 - Rezoning and Precincts (Geographical Areas). In particular, this evidence relates to 110A Jack Lachlan Drive, Beachlands ("**the Site**") and a request to support re-zoning of the site from its current use as a Golf Course in order to provide additional Residential and Commercial activity. An outline of a possible scheme arrangement and lot use is given on the attached Thresher Limited drawings (refer Appendix A herein).

3. I hold a Bachelor of Engineering from Auckland University (1998) and a New Zealand Certificate of Engineering (Civil) from Carrington Polytechnic (1995). I am a member of the Institute of Profession Engineers New Zealand (MIPENZ), a Chartered Professional Engineer (CPEng) and am on the register of International Professional Engineers New Zealand (Int.PE(NZ)). I have practised as a professional geotechnical engineer for over 20 years in Auckland on numerous minor and major land development projects in the following capacities:

   (a) As a geotechnical engineer for various Auckland firms since graduating in 1998

   (b) As a principal geotechnical engineer for Coffey Geotechnics (NZ) Limited (Auckland) since 2007

   (c) As owner and director of Lander Geotechnical Consultants Limited (Auckland) since November 2014

4. My involvement with the Site commenced in 1995 when I was involved in geotechnical investigations and numerous geotechnical reports associated with the original golf course development. I was subsequently commissioned by a Client in 2014 to review existing relevant geotechnical reports and undertake preliminary site investigations across the western portion of the site. In November 2015 I was retained by the Submitter, 110 Formosa (NZ) Limited, and returned to the site in January 2016 to undertake additional site investigations in preparation for my evidence.

5. I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014 and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise.

Scope of evidence

6. My evidence will address the following topics:

   (a) Geological setting and changes in geomorphology

   (b) Summary of my site specific geotechnical knowledge

   (c) Conclusions / Recommendations

7. My conclusions are as follows:

   (a) There have been significant modifications to most of the landform during the original Golf Course development via earthworks in the mid 1990's, and there is also evidence of dredging's from the 1980's Pine Harbour Marina development (to the north-west) placed in an isolated location within the Site. I am not aware of any engineering certification attesting to the construction and compaction standard achieved (for the placed earth fills or dredging's), but this is not to say that such documentation does not exist. These previous land modifications may provide geotechnical constraints for future development and will need to be the subject of future consideration.

   (b) Notwithstanding these issues, it is my opinion that the geotechnical site history and present day geomorphology (i.e. physical surface features) are reasonably well understood at 110A Jack Lachlan Drive. I conclude that the Site should be suitable for future residential and commercial development along the lines of that shown in the Thresher scheme, with appropriate detailed geotechnical site investigations, set back distances from coastal cliffs and/ or slope gradients of steeper than 1(v) in 4(h) (or provision of other mitigation measures in this regard), remediation of existing filling where required to reach a standard suitable to support development, and engineering design and construction of future building foundations and infrastructure.

Geological Setting and Changes in Geomorphology

8. The irregularly shaped site is legally described as Lot 2 DP 420017 and covers an area of approximately 170 hectares. The topography encompasses a number of gully systems in the central-northern, south-western and eastern portion of the site. The flanks of these gully systems are characterised by moderately steep to steep land gradients. The western portion of the site is dominated by steep coastal cliffs with a cross fall of approximately 20 metres to 30 metres towards the Tamaki Strait.

9. Geological maps reviewed indicate that the majority of the site is likely to comprise soils of the weathered East Coast Bays Formation, while alluvial and colluvial deposits of the Tauranga Group are likely to be encountered in the north western portion of the site.

   Weathered East Coast Bays Formation soils comprise a mixture of silts, clays and sands being predominantly orange, brown, and grey in colour and often containing hard dark- brown iron oxide concentrations which are indicative of long term fluctuations in ground water levels. Alluvial and colluvial deposits are likely to comprise sand, clays, silt mud and peat deposits. Soft alluvial deposits in the inverts of existing and historic gully systems across the site can also be anticipated.

10. The Geological Maps do not depict man made filling, but as mentioned such deposits have historically been placed on the site during construction of the golf course and associated structures and infrastructure, as well as during the construction of the Pine Harbour marina.

11. My recollection of geomorphic mapping of the site in 1995 prior to golf course development pointed to localised shallow land instability of ground flanking incised gullies, and deeper seated movement at the coastal margins associated with the erosional processes of steep cliffs (i.e. removal of toe support by wave action etc). Since this geomorphic assessment was undertaken the site has been significantly modified with golf course earthworks masking previous geomorphic features (cliff environment aside).

12. To appreciate historic earthworks, a series of historic aerial photographs dating from 1988 through to 2010 were reviewed in the preparation of my evidence to illustrate the magnitude of land modifications over the past 25 years or so.

13. In 1988 (refer Appendix B, Figure 1) the site was largely undeveloped, and in use as pastoral farmland. However, the photograph also depicts earthworks being carried out on the northern portion of the site (within the Terrace Housing and Apartment Building Zones adjacent to Jack Lachlan Drive of the Thresher scheme). My understanding infers that these earthworks were associated with the construction of the Pine Harbour marina and likely shows the placement of dredged deposits from the marina complex or channel.

14. In 1996 (Appendix B, Figure 2) it can be seen that the site is under development and earthworks across most of the Site are being carried out to form the present day golf course.

15. In 2008 the site is seen in its present day use and no other obvious site modifications are noted in the years between 2008 and 2010 (Appendix B, Figure 3).

Summary of my Site Specific Geotechnical Knowledge

16. My understanding of geotechnical investigations and reports stems back to 1995, and to the best of my recollection:

17. In 1995, while working for Foundation Engineering Consultants Limited, I assisted in the preparation a supplementary report specifically addressing site specific locations of the proposed impoundment embankments for irrigation ponds for the golf course. This work comprised a series of machine boreholes, trial pits and hand augers.

18. At this time, a series of trial pits were also put down in the location of the then proposed maintenance depot (now existing) near Jack Lachlan Drive (i.e. within the Terrace Housing and Apartment Building Zones adjacent to Jack Lachlan Drive of the Thresher scheme), which in 1995 identified a large area of non-engineered filling associated with tailings from the Pine Harbour marina development, thereby confirming inferences made from the 1988 aerial photograph interpretations.

19. In 1996, I recall undertaking supplementary trial pit investigations in the vicinity of the building footprint of the then proposed maintenance facility. I recall recommendations were made in relation to future building upon this area, with a view to piling through the pre-existing marina tailings, or removing these materials and reinstating the building platform with engineered filling. Based on my

recollection of findings from my subsequent work in 2014 (discussed below), I venture that the current maintenance building may have been piled and the deposits left un-remediated, although I have not sighted any as-built foundation drawings in the regard.

20. In 2014, while working for Coffey Geotechnical (NZ) Limited, I oversaw additional investigations primarily on the western portion of the Site but excluding the coastal cliffs. My recollection of approximately 70 hand auger tests indicated fills associated with the Golf Course development existed to depths of up to approximately 3 metres in places, and these deposits appeared well compacted, and free of deleterious materials. The natural deposits were to the best of my knowledge quite competent, as expected for East Coast Bays Formation lithology in the region. I also recall that variable strength marine dredging deposits were encountered near the existing maintenance facility adjacent to Jack Lachlan Drive.

21. In 2014 I also investigated an existing pond bund to the south of the maintenance building, and I recall that the fill materials appeared well compacted, however the bund itself and some pipework had degraded over the years and would require some maintenance to preserve its function.

22. In January 2016 my firm (Lander Geotechnical Consultants Limited) undertook 12 hand auger tests to confirm my recollection of ground conditions from previous site investigation, and the results of these tests and a test locality plan are presented in Appendix C. These tests were spread site wide and did not include any investigation of existing pond bunds or the marine fill at the maintenance facility. The results show consistency with my recollection from the historical testing (described above).

Conclusions and Recommendations

23. There is precedence with urbanisation to the north of the Site (Plan Change 8), where the geological setting is similar.

24. However, unique to the Site are geotechnical constraints associated with historic wide spread filling during the golf course development, marine dredging fills from the Pine Harbour Marina in an isolated location, plus proximity of future development areas to slope gradients of steeper than 1(v) in 4(v) (i.e. 14 degrees) and/ or steep coastal cliffs. In my opinion and experience such risks are usually and appropriately addressed (and mitigated if required) during the consenting processes for subdivision design by site investigations, remedial earthworks during subdivision (if required), specific building foundation design (if required),

and the establishment of adequate building setbacks from slopes / cliffs, or other mitigation measures such as retaining walls or in-ground pile systems.

25. Having undertaken numerous site investigations on this Site previously, and having knowledge of land modification occurrences over the past 25 years or so on this Site, coupled with my most recent site observations and additional borehole drilling (2016), I consider the land is suitable for future residential and commercial building development along the lines of the Thresher scheme presented in Appendix A.

Shane Gareth Lander
10 February 2016

APPENDIX A

BEACHLANDS 2: CONCEPT DEVELOPMENT PLAN

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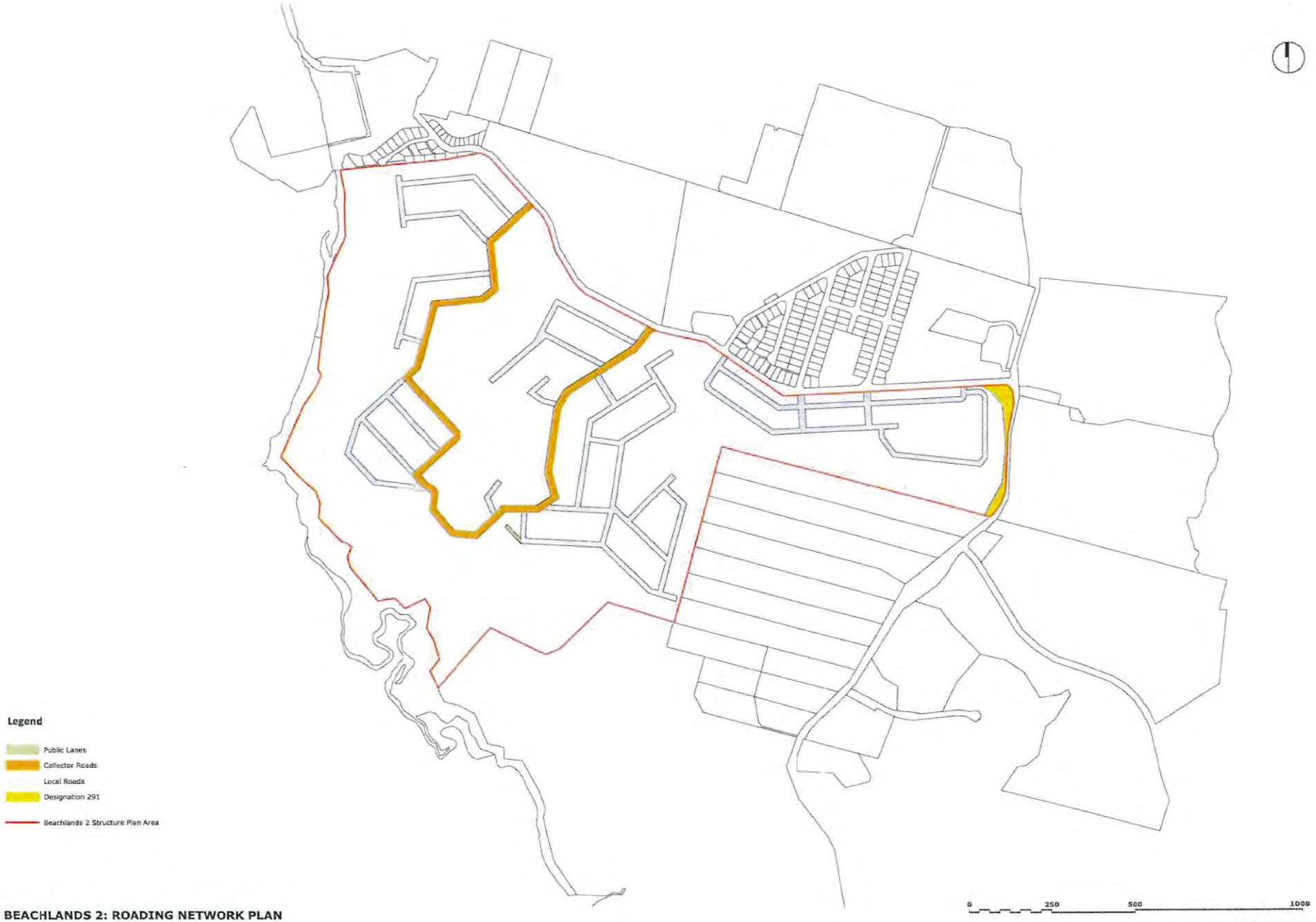
BEACHLANDS 2: STRUCTURE PLAN

SCALE: 1:10000



BEACHLANDS 2: ROADING NETWORK PLAN

SCALE: 1:10000

APPENDIX B

revision	description	drawn	approved	date

drawn	sl
approved	sgl
date	Feb 2016
scale	NTS
original size	A3

LANDER geotechnical

client: 110 Formosa (NZ) Limited

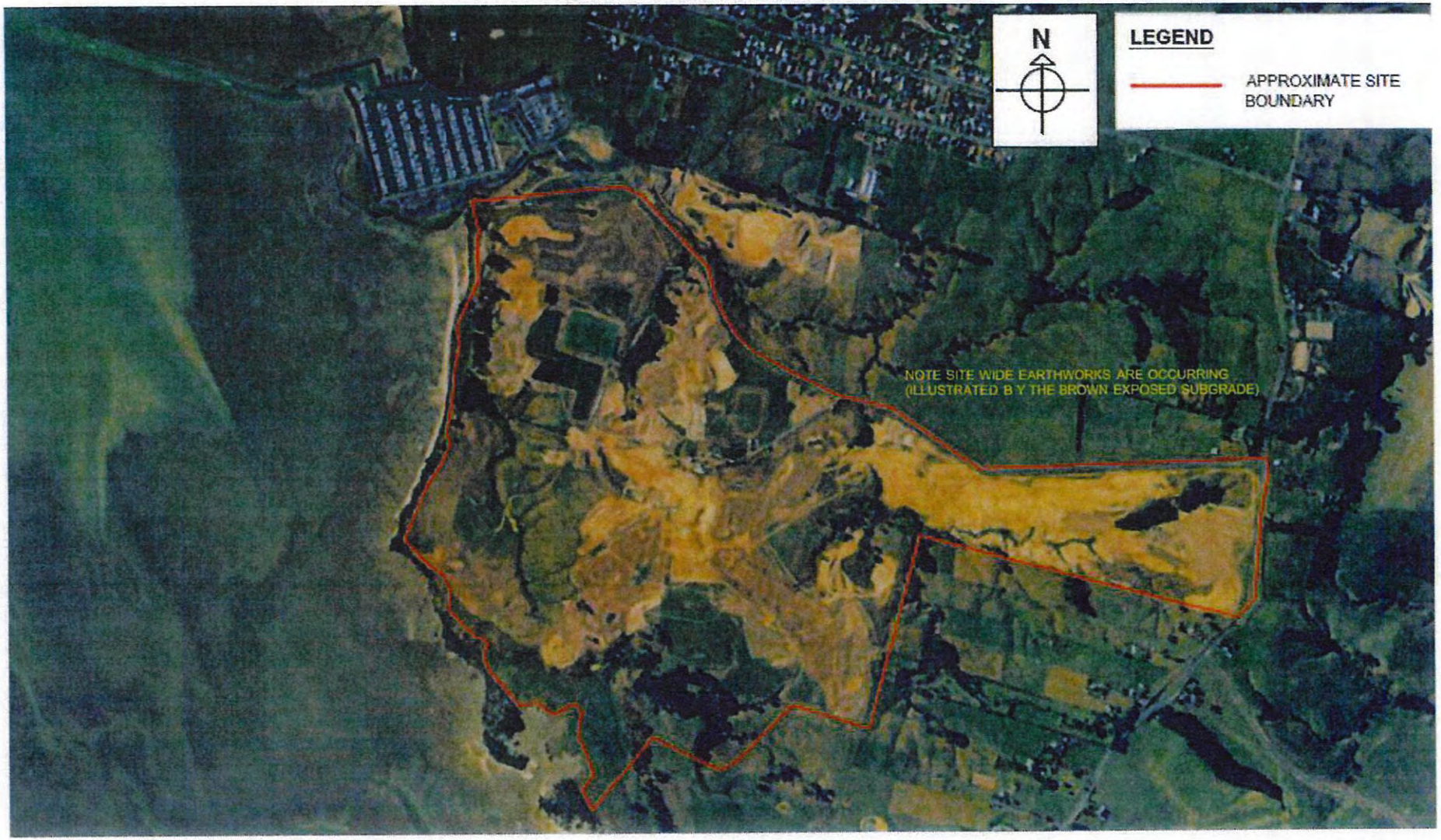
project: 110A Jack Lachlan Drive, Beachlands

title: 1988 AERIAL PHOTO

project no: J00253

figure no: Appendix B Fig 01

Template revision: 1:100 (10/12/14)



revision	description	drawn	approved	date

drawn	sl
approved	sgl
date	Feb 2016
scale	NTS
original size	A3

LANDER geotechnical

client:	110 Formosa (NZ) Limited
project:	110A Jack Lachlan Drive, Beachlands
title:	1996 AERIAL PHOTO
project no:	J00253
figure no:	Appendix B Fig 02

Template revision: 1:100 (10/12/14)

revision	description	drawn	approved	date

Template revision: 1:100 (15/12/14)

drawn	sl
approved	sgl
date	Feb 2016
scale	NTS
original size	A3

LANDER geotechnical

client:	110 Formosa (NZ) Limited
project:	110A Jack Lachlan Drive, Beachlands
title:	2008 AERIAL PHOTO
project no:	J00253
figure no:	Appendix B Fig 03

In the absence of existing public connections for these services, and due to unknown timeframes for future extensions to the site, it is proposed that onsite schemes would continue to be used for future development on the site. The typical nature and form of these private onsite services is discussed in further detail below.

4.2 Water Supply

As outlined above, water supply for the existing golf facilities, associated buildings and existing dwellings is from water collected in rain water tanks and from an existing water supply bore onsite.

For future development scenarios, it is proposed that new private water supply scheme be developed in conjunction with the neighbouring property located to the north of the site (preliminary discussions are already under way between the owners on this basis). Under this proposed scenario, some land within 110a Jack Lachlan Drive would be set aside for the neighbouring site to expand their current water supply system to allow servicing of the future development. A private water reticulation network would be constructed with individual dwelling units metered, and a private water company would charge for the service.

Water mains, service connections, water meters and associated equipment could readily be installed within the proposed private roading corridors as is the case with a typical town water supply system. The design and construction of any such network would be done in accordance with relevant local and territorial authority guidelines for future vesting, ownership or integration with any future extension to public water supply services to the site.

4.3 Wastewater

As outlined above, wastewater from the buildings located onsite is currently treated via single onsite wastewater treatment system, with disposal to land following treatment. The status and condition of the existing wastewater system is not fully known, though it is understood to be performing as designed, based on anecdotal reports from operating staff. Given the age of the system, and changes which would be required for future development of the site, it is most likely that the existing system would be decommissioned, with wastewater from remaining development treated via the new onsite wastewater system(s) proposed.

For future development scenarios, it is proposed that new private onsite wastewater treatment and land disposal systems could be developed to treat the wastewater through the site on a decentralised basis. Under a decentralised model, a number of small package plants would established to treat, reuse and dispose of wastewater from the various development precincts proposed.

This method of wastewater management is common in private residential developments as it provides localised infrastructure on a small scale, avoiding unnecessary costs associated with pumping wastewater long distances. Individual dwelling units would connect to a reticulated wastewater network as would be the case for a residential development on a full public municipal service.

To determine land requirements for onsite wastewater treatment and disposal, assumptions have been made as outlined in Table 1.

Table 1: Onsite Wastewater Design Basis

Number of Equivalent Dwellings	1,800
Flow per dwelling[1]	1,000 litres per day
Land Application Loading rate[2]	3 litres per m^2 per day
Reserve Area requirement[3]	33%
Potential Recycle Ratio[4]	30%

1.) 1,000 litres per day equates to 5.6 people per equivalent household at 180 litres per day (TP58, Table 6.2, houses low flush toilets on reticulated community/bore supply)
2.) 3 litres per m^2 per day as a conservative assumption for Category 5-6 soil (TP58, Table 9.2)
3.) Reserve area of 33% currently requires discretionary consent. For a centrally-managed onsite wastewater system 33% considered appropriate and conservative
4.) Recycle ratio for return of water for non-potable use, as approved for select private schemes in New Zealand

Based on these assumptions, it has been determined that a total land area of **~80 hectares** would be required for land disposal, with **60 hectares required for primary area** and the balance **18 hectares set aside as potential reserve**. If tertiary treatment was provided to return a portion of the water back to dwellings for non-potable reuse, the land area could be reduced to **42 hectares for primary disposal and 14 hectares reserve for a total of 56 hectares**. Comparing these requirements against the proposed development form for the site, with approximately **113 hectares retained open space available** around the development precincts (including the golf course), it can be demonstrated there is far more than enough land for onsite treatment, even when considerations for setback distances to watercourses, boundaries and buildings is proposed.

On a decentralised basis, the total area required for treatment and disposal could be separated to provide a number of onsite treatment and disposal systems to practically and pragmatically match the proposed development precincts. As an example referencing the Concept Development Drawing prepared by Thresher Urban Design, a wastewater plant servicing development area 'A' would require 22 hectares of land (most conservatively), readily accommodated within the fairways and green space adjacent to the precinct.

In terms of specifics regarding the type of wastewater reticulation and treatment plant to be installed, there are a number of technologies on the market which meet or exceed the requirements of secondary and tertiary treatment as set-out in Auckland Council's TP58 publication, related guidelines and standards. Any one of them would be suitable for the development form proposed, subject to detailed design against a specific layout.

For disposal of the wastewater following treatment, again a number of solutions are available though it is likely small diameter drip irrigation would be utilised for such a scheme. This method of land disposal is easy to install in existing terrain with little disruption, and is flexible in layout for 'irregular' shaped area, such as the existing fairways and proposed green space between development precincts.

Drip irrigation for final wastewater disposal also meets the values of Mana Whenua, where wastewater generated is returned to the land prior to inception into underlying groundwater.

4.4 Stormwater

As indicated above, stormwater is currently managed onsite through a private drainage system with final discharge to the various water bodies located throughout the site. Given the low level of formed development, no stormwater detention is provided onsite other than some tanks for the collection and reuse of rain water. Stormwater treatment is not formally provided onsite, though some passive treatment would occur for discharges to the various water bodies.

For future development scenarios, it is proposed that a private stormwater network/system could be developed, providing each dwelling unit with a connection to a stormwater reticulation, as would be the case for a publicly serviced development or subdivision. The stormwater network/system itself would need to consider stormwater management in terms of both quantity (detention) and quality (treatment) and could comprise a number of mechanisms to achieve this, including but not limited to;

- Onsite rain water tanks for reuse and detention.
- Onsite treatment through green roofs, private rain gardens.
- Centralised detention in the form of ponds, wetlands.
- Treatment from road run-off through low impact means – rain gardens, swales.
- Treatment from road run-off through manufactured means – proprietary stormwater treatment devices.

It is likely that a stormwater design for the site would comprise a number of these mechanisms in tandem, and the development concept prepared by Thresher has been developed on this basis, in particular:

- Development precincts have been clustered around existing water bodies which could be upgraded to function and detention/treatment devices
- Road corridors have been developed large enough to allow inclusion of swales and/or rain gardens
- Development types such as terraced houses and courtyard areas include landscaping which would be suitable as private rain gardens if required.

As with wastewater services for the site above, stormwater management mechanisms could be separated and clustered to match the development precincts.

5.0 OVERLAND FLOW

As indicated on Council's GIS system, and further confirmed through a review of GIS contour information, the site contains a number of overland flow paths, with Council's rough-order LIDAR modelling also showing rapid hazard flooding resulting from the overland flow. While the major overland flows are generally correct – following existing water courses onsite, some of the smaller ones are likely modelled incorrectly and could be considered as minor sheet flow having less bearing on future development.

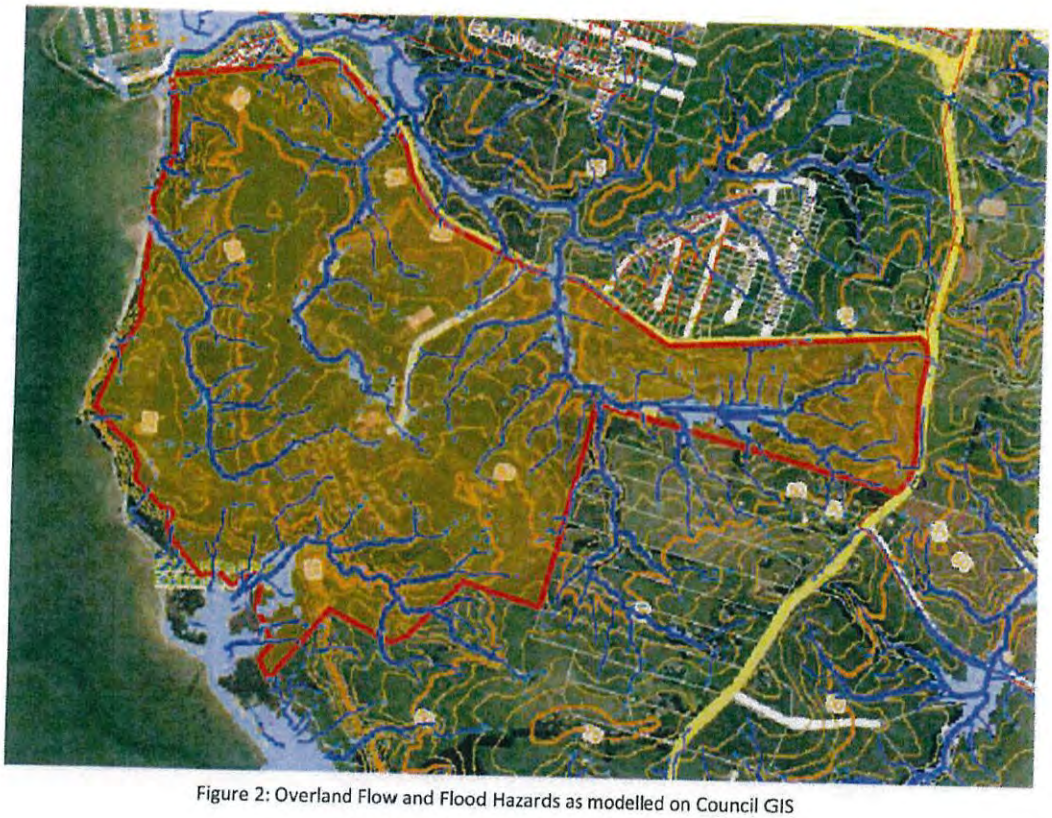


Figure 2: Overland Flow and Flood Hazards as modelled on Council GIS

The major overland flow paths have been considered as part of the master-plan development with neighbourhood precincts drawn to accommodate the paths wherever practical. Some of the minor flow paths will need to be diverted or piped as part of development works onsite; this would be readily achievable with little or no effect on the catchment as a whole. As part of detailed design for a development form for the site, minimum floor levels may need to be considered for some of the major flow paths, such reporting forming part of a Resource Consent and Building Consent for any such future development design.

It is not envisaged that the entry or exit point of any major overland flow path into and out of the site would need to be modified as part of a future development.

6.0 ACCESS TO LOTS

As discussed above, access to the site is currently via a private road off Jack Lachlan Drive which leads to the main clubhouse.

For the future development of the site, a roading network has been proposed as indicated on plans prepared by Thresher Urban Design. The roading network comprises 20m and 16m wide road corridors both of which provide ample width for carriageway, pedestrian requirements, service strips and stormwater management areas as required. Given the topography of the site where the roads are proposed, or where roads would logically be formed, there are no concerns with regard to gradient or formation in compliance with relevant standards and guidelines.

In terms of traffic and transportation matters related to the proposed road network and connections from the site, these are being considered by Mr. Hughes of Traffic Design Group.

7.0 IN SUMMARY

- This report has been prepared to discuss civil engineering servicing matters and solutions as they relate to future residential/mixed use development of land at 110a Jack Lachlan Drive.
- The report has been written to support evidence under Topic 081 Precincts and Zoning of the Proposed Auckland Unitary Plan.
- The report should be read in conjunction with evidence and information by others relating to planning matters, urban design and master-planning, geotechnical and traffic considerations.
- The report has specifically considered a concept development layout as prepared by Thresher Urban Design, though the principles could be applied to a number of different development forms.
- In terms of existing services in place, these are all private onsite systems.
- Water is supplied via an onsite bore and also through collection of rain water.
- Wastewater is treated and disposed of within the site via a private onsite wastewater system.
- Stormwater is managed passively via private onsite systems, drainage and connection to existing water bodies onsite.
- For future development of the site, in the absence of publically-provided solutions for the above, it is suggested private solutions could be further implemented.
- For water supply, it is proposed that a private water supply network could be provided in conjunction with the neighbouring site to the north, with preliminary negotiations underway on this basis
- For wastewater, it is proposed that a number of decentralised treatment and disposal plants are established to practically and pragmatically match the development precincts. Preliminary calculations in accordance with recognised guidelines demonstrate there is substantial land available for such a scheme.
- For stormwater, it is proposed that a private stormwater network be established, with a number of mechanisms able to be implemented to provide management and mitigation

of stormwater effects in terms of quantity (detention/retention) and quality (source control, low impact and engineered treatment).

- Overland flow effects have been considered, with the Concept Development plan showing the major paths readily accommodated in amongst development precincts.
- Minor flow paths would require redirection and/or mitigation against a specific development design and minimum floor levels would need to be considered.
- Any such works would be designed and implemented to comply with or address relevant standards, guidelines and requirements.
- In terms of roading, the Concept Development Plan prepared shows a roading network comprising 20m and 16m roads.
- These roads provide ample width for the to accommodate carriageway, pedestrian requirements, service strips and stormwater management areas as required.
- Topography of the site is such that there would be no issue with gradients or formation in compliance with relevant standards and guidelines.
- The above confirms that future development of the site at 110a Jack Lachlan Road, as generally indicated in the plans prepared can be readily achieved from a civil engineering, infrastructure, servicing, access and stormwater/overland flow management

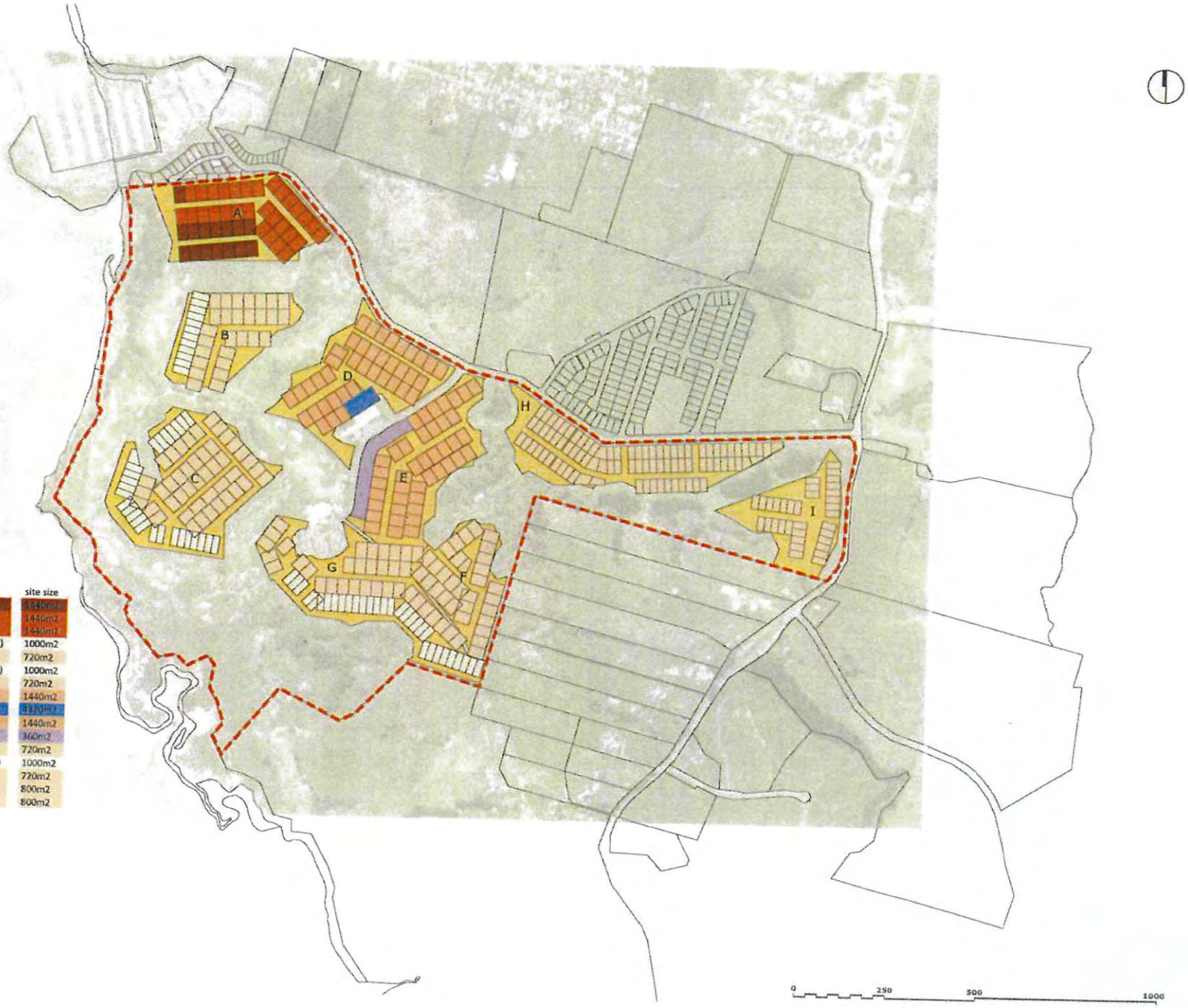
Report prepared by:

Chris Shortt
Manager, Civil Engineering Design
BE CPEng Ianthe(NZ) MIPENZ

Report reviewed by:

James Hook
Planning Director
BSurv MRRP(Dist) MNZPI RMLA
james.hook@envivo.co.nz

Date: 9 February 2016



KEY

Lot	type	site size
A part	apartments (3 storey)	1440m2
A part	street facing terrace (2 storey)	1440m2
A part	terraced laneway (2 storey)	1440m2
B part (sea view)	single family house (1 or 2 storey)	1000m2
B part	single family house (2 storey)	720m2
C part (sea view)	single family house (1 or 2 storey)	1000m2
C part	single family house (2 storey)	720m2
D1	detached court (2 storey)	1440m2
D2	hotel (3 storey)	3370m2
E1	detached court (2 storey)	1440m2
E2	live/work (3 storey)	360m2
F	single family house (2 storey)	720m2
G part (estuary view)	single family house (1 or 2 storey)	1000m2
G part	single family house (2 storey)	720m2
H	single family house (2 storey)	800m2
I	single family house (2 storey)	800m2

LOT ARRANGEMENT PLAN

0 250 500 1000

SCALE: 1:10000

CIRCULATION PLAN

SCALE: 1:10000

P806_FORMOSA GOLF COURSE

22.01.16

Preliminary site capacity and development scenario evaluation

SCENARIO 1

Lot	gross dev area	net dev area	type	site size	density dw/ha	dwellings [net dev area x density]
A	94,697	66,288	single family house (2 storey)	800m2	12.5	83
B	70,465	49,326	single family house (2 storey)	800m2	12.5	62
C	126,770	88,739	single family house (2 storey)	800m2	12.5	111
D	93,354	65,348	single family house (2 storey)	800m2	12.5	82
E	107,945	75,562	single family house (2 storey)	800m2	12.5	94
F	57,460	40,222	single family house (2 storey)	800m2	12.5	50
G	111,521	78,065	single family house (2 storey)	800m2	12.5	98
H	100,449	70,314	single family house (2 storey)	800m2	12.5	88
I	61,182	42,827	single family house (2 storey)	800m2	12.5	54
	823,843	**576,690**				**721**

SCENARIO 2

Lot	gross dev area	net dev area	type	site size	density dw/ha	dwellings [net dev area x density]
A	94,697	66,288	detached court (2 storey)	800m2	27.7	184
B	70,465	49,326	single family house (2 storey)	800m2	12.5	62
C	126,770	88,739	single family house (2 storey)	800m2	12.5	111
D	93,354	65,348	detached court (2 storey)	360m2	27.7	181
E	107,945	75,562	detached court (2 storey)	360m2	27.7	209
F	57,460	40,222	single family house (2 storey)	800m2	12.5	50
G	111,521	78,065	single family house (2 storey)	800m2	12.5	98
H	100,449	70,314	single family house (2 storey)	800m2	12.5	88
I	61,182	42,827	single family house (2 storey)	800m2	12.5	54
	823,843	**576,690**				**1,036**

SCENARIO 3

Lot	gross dev area	net dev area	type	dwelling /site	site size	density dw/ha	dwellings [net dev area x density]	SITE TEST actual dwellings from site layout	dw mix %	dw type	dw % by type	net dev area %	net dev area % by type
A part	31,566	22,096	apartments (3 storey)	12	1440m2	83.3	264	240	22.3	apartments	22.3	3.8	3.8
A part	31,566	22,096	street facing terrace (2 storey)	10	1440m2	69.4	153	150	10.2	terrace	19.5	3.8	7.7
A part	31,566	22,096	terraced laneway (2 storey)	9	1440m2	62.5	138	135	9.2	terraced		3.8	
B part (sea view)	35,233	24,663	single family house (1 or 2 storey)	1	1000m2	10	25	12	0.8	house	54.5	4.3	86.3
B part	35,233	24,663	single family house (2 storey)	1	720m2	13.9	34	58	4.0	house		4.3	
C part (sea view)	44,370	31,059	single family house (1 or 2 storey)	1	1000m2	10	31	29	2.0	house		5.4	
C part	82,401	57,680	single family house (2 storey)	1	720m2	13.9	80	88	6.0	house		10.0	
D1	89,034	62,324	detached court (2 storey)	4	1440m2	27.7	173	160	10.9	house		10.8	
D2	4,320	3,024	hotel (3 storey)		432m2		160	160	10.9	hotel	10.9	10.5	10.5
E1	94,464	66,125	detached court (2 storey)	4	1440m2	27.7	183	176	12.0	house		11.5	
E2	13,481	9,437	live/work (3 storey)	1	360m2		42	42	2.9	live/work	2.9	1.6	1.6
F	57,460	40,222	single family house (2 storey)	1	720m2	13.9	56	64	4.4	house		7.0	
G part (estuary view)	44,608	31,226	single family house (1 or 2 storey)	1	1000m2	10	31	29	2.0	house		5.4	
G part	66,913	46,839	single family house (2 storey)	1	720m2	13.9	65	62	4.2	house		8.1	
H	100,449	70,314	single family house (2 storey)	1	800m2	12.5	88	86	5.9	house		12.2	
I	61,182	42,827	single family house (2 storey)	1	800m2	12.5	54	34	2.3	house		7.4	
	823,843	**576,690**					**1,497**	**1,465**	**100.0**				

APPENDIX C

Client : 110 FORMOSA (NZ) LIMITED

Project Location : FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

Job Number: J00253

Auger Borehole No. BH1

Sheet 1 of 12

Vane Head:	Logged By:	Processor :	Date:
1900	TT	TT	21.01.16

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
silty CLAY, red, grey and orange mottled. Hard, moist, medium plasticity [FILL]						
becoming dark brown		0.5		208+		
silty CLAY, red and orange streaked grey. Hard, moist, medium plasticity [NATURAL]						
becoming brown/orange streaked grey, with some limonite silt inclusions		1.0		208+		
		1.5		208+		
becoming red and orange streaked grey						
becoming slightly silty CLAY, very stiff, insensitive		2.0		190/98	1.9	
becoming orange mottled light grey, hard		2.5		208+		
becoming light grey mottled orange						
becoming very stiff		3.0		157/92	1.7	
CLAY, grey. Hard, moist, high plasticity		3.5		208+		
clayey SILT, red mottled grey. Hard, moist, low plasticity						
EOB at 4.0m. Target Depth.		4.0		UTP		
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: UB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : 110 FORMOSA (NZ) LIMITED

Project Location : FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

Job Number: J00253

Auger Borehole No. BH2

Sheet 2 of 12

Vane Head:	Logged By:	Processor :	Date:
307	AB	TT	21.01.16

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
silty CLAY, brown. Very stiff, moist, high plasticity, moderately sensitive, with minor orange limonite silt inclusions and staining, with minor topsoil leaching [NATURAL]		0.5		160/80	2.0	
becoming grey mottled orange/brown		1.0		151/82	1.8	
becoming insensitive becoming slightly silty CLAY, orange/brown mottled grey, with occasional limonite silt inclusions and staining		1.5		109/64	1.7	
with occasional pink streaking		2.0		111/89	1.2	
becoming medium plasticity, with some fine sand inclusions		2.5		148/67	2.2	
becoming moderately sensitive becoming high plasticity, without fine sand inclusions		3.0		162/86	1.9	
becoming medium plasticity, insensitive		3.5		119/65	1.8	
becoming orange and pink streaked grey, high plasticity		4.0		163/87	1.9	
EOB at 4.0m. Target Depth.		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: CB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client :	110 FORMOSA (NZ) LIMITED	**Auger Borehole No.**	BH3
Project Location :	FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS		Sheet 3 of 12
Job Number:	J00253	Vane Head: 1750 / Logged By: GB / Processor : TT / Date: 21.01.16	

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Vane Shear(kPa) peak / residual	Soil Sensitivity
TOPSOIL			
silty CLAY, grey mottled orange/brown. Very stiff, moist, high plasticity, moderately sensitive [NATURAL]	0.5	183/89	2.1
becoming orange/brown mottled grey			
becoming medium plasticity	1.0	186+	
clayey SILT, orange/brown mottled grey. Very stiff, moist, low to medium plasticity, insensitive	1.5	175/90	1.9
becoming moderately sensitive	2.0	151/77	2.0
becoming grey, low plasticity	2.5	159/73	2.2
becoming light brown/grey	3.0	178/89	2.0
becoming light brown/orange			
becoming insensitive becoming light grey	3.5	162/106	1.5
at 4.0m, becoming moderately sensitive			
EOB at 4.0m. Target Depth.	4.0	122/60	2.0
	4.5		
	5.0		
	5.5		
	6.0		

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: GB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : 110 FORMOSA (NZ) LIMITED

Project Location : FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

Job Number: J00253

Auger Borehole No. BH4

Sheet 4 of 12

Vane Head:	Logged By:	Processor :	Date:
1900	TT	TT	21.01.16

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
slightly silty CLAY, orange streaked grey. Very stiff, moist, high plasticity, moderately sensitive, with trace limonite silt inclusions [FILL]	0.5		101/44	2.3	
becoming orange and light grey mottled yellow/brown					
becoming stiff becoming mottled dark brown, brown and orange	1.0		71/36	2.0	
with major gravel inclusions becoming silty CLAY, orange streaked light grey, with minor fine sand becoming very stiff	1.5	▽	196/92	2.1	
silty CLAY, orange streaked light grey. Hard, moist, high plasticity [NATURAL]	2.0		208+		
with some fine sand					
becoming orange	2.5		208+		
with occasional purple streaking	3.0		208+		
CLAY, grey. Very stiff, wet, high plasticity, insensitive	3.5		107/77	1.4	
at 4.0m, becoming stiff					
EOB at 4.0m. Target Depth.	4.0		89/47	1.9	
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater encountered 1.4m
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: GB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client :	110 FORMOSA (NZ) LIMITED	**Auger Borehole No.**	BH5
Project Location :	FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS		Sheet 5 of 12
Job Number:	J00253	Vane Head: 307 / Logged By: AB / Processor : TT / Date: 21.01.16	
Borehole Location:	mN / mE / Ground R.L.		
	Description: Refer to site plan		

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
clayey SILT with some fine sand, mottled brown and grey. Very stiff, moist, medium to low plasticity, sensitive, with some topsoil leaching [FILL]						
at 0.4m, without topsoil leaching						
becoming silty CLAY with minor fine sand, mottled brown, grey and orange, medium plasticity		0.5		154/26	5.9	
becoming dark brown		1.0		107/19	5.6	
becoming mottled dark brown, orange/brown and grey						
becoming moderately sensitive		1.5		152/67	2.3	
becoming grey streaked orange, with some limonite streaking and silt inclusions						
becoming stiff		2.0		84/24	3.5	
becoming dark brown						
silty CLAY, dark brown/grey. Very stiff, moist to wet, high plasticity, moderately sensitive, with minor rootlet inclusions [NATURAL]		2.5		114/35	3.3	
becoming slightly silty CLAY, orange streaked grey, moist, without rootlet inclusions						
becoming grey		3.0		121/56	2.2	
with minor dark orange limonite silt inclusions		3.5		125/40	3.1	
EOB at 4.0m. Target Depth.		4.0		133/58	2.3	
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: GB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : 110 FORMOSA (NZ) LIMITED

Project Location : FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

Job Number: J00253

Auger Borehole No. BH6

Sheet 6 of 12

Vane Head:	Logged By:	Processor :	Date:
1750	GB	TT	21.01.16

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
silty CLAY, grey/brown mottled orange/brown. Very stiff, moist, medium plasticity [NATURAL]					
becoming orange/brown mottled grey, high plasticity	0.5		186+		
becoming moderately sensitive					
becoming light grey, with minor orange/brown streaking and mottles	1.0		162/74	2.2	
becoming insensitive	1.5		143/84	1.7	
becoming moderately sensitive					
becoming low to medium plasticity	2.0		129/66	2.0	
clayey SILT, orange/brown streaked light grey. Very stiff, moist, low to medium plasticity					
becoming low plasticity	2.5		186+		
becoming light grey, moderately sensitive	3.0		163/50	3.3	
silty CLAY, light grey mottled orange/brown. Very stiff, wet, low to medium plasticity					
clayey SILT, orange streaked light grey. Very stiff, wet, low plasticity	3.5		186+		
at 3.6m, becoming moist					
EOB at 4.0m. Target Depth.	4.0		186+		
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: GB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : 110 FORMOSA (NZ) LIMITED

Project Location : FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

Job Number: J00253

Auger Borehole No. BH7

Sheet 7 of 12

Vane Head:	Logged By:	Processor :	Date:
1750	GB	TT	21.01.16

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
silty CLAY, mottled orange/brown and light grey. Very stiff, moist, medium plasticity [NATURAL]						
becoming orange/brown mottled grey, high plasticity		0.5		186+		
becoming insensitive		1.0		162/101	1.6	
becoming moderately sensitive		1.5		173/82	2.1	
clayey SILT, orange/brown mottled light grey. Very stiff, moist, low to no plasticity		2.0		186+		
at 2.1m, becoming orange/brown, with occasional grey specking						
at 2.3m, becoming grey mottled orange/brown		2.5		186+		
becoming orange/brown mottled grey		3.0		UTP		
becoming grey/blue		3.5		UTP		
EOB at 4.0m. Target Depth.		4.0		UTP		
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: GB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : 110 FORMOSA (NZ) LIMITED

Project Location : FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

Job Number: J00253

Auger Borehole No. BH8

Sheet 8 of 12

Vane Head:	Logged By:	Processor :	Date:
307	AB	TT	21.01.16

Borehole Location:	mN	mE	Ground R.L.
	Description:	Refer to site plan	

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
silty CLAY, mottled brown, dark brown and grey. Very stiff, dry, medium plasticity, moderately sensitive, with rootlet inclusions, with minor red/pink streaking [FILL]		0.5		163/54	3.0	
becoming dark brown, with some organic staining						
becoming orange mottled brown, hard, moist, high plasticity		1.0		229+		
becoming dark brown						
becoming light grey and pink streaked orange/brown, with occasional limonite silt inclusions						
becoming streaked light grey, orange and pink, very stiff		1.5		184/71	2.6	
becoming dark brown, hard, medium plasticity, with some organic staining		2.0		229+		
silty CLAY, dark brown. Very stiff, moist, medium plasticity [NATURAL]						
becoming grey mottled orange/brown						
becoming mottled orange/brown and grey, insensitive		2.5		179/100	1.8	
becoming orange/brown streaked light grey						
with minor pink streaking						
becoming pink streaked light grey		3.0		166/93	1.8	
becoming streaked pink and light grey						
becoming grey streaked pink		3.5		175/100	1.8	
EOB at 4.0m. Target Depth.		4.0		175/100	1.8	
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: GB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : 110 FORMOSA (NZ) LIMITED

Project Location : FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

Job Number: J00253

Auger Borehole No. BH9

Sheet 9 of 12

Vane Head:	Logged By:	Processor :	Date:
1900	TT	TT	21.01.16

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
clayey SILT, orange mottled brown/grey. Hard, dry, low plasticity [NATURAL]		0.5		UTP		
silty CLAY, orange mottled light grey. Hard, dry to moist, medium plasticity		1.0		UTP		
becoming moist, high plasticity becoming very stiff, moderately sensitive		1.5		193/92	2.1	
becoming hard with moderately thin orange limonite band		2.0		208+		
sandy SILT with trace clay, orange mottled grey/brown. Loose, moist, no plasticity at 2.4m, becoming orange becoming grey		2.5		UTP		
silty CLAY, dark grey. Hard, moist, medium plasticity [TRANSITION TO BEDROCK] with minor fine sand		3.0		UTP		
slightly clayey SAND, dark grey. Loose, moist, no plasticity		3.5		208+		
EOB at 4.0m. Target Depth.		4.0		UTP		
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: GB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : 110 FORMOSA (NZ) LIMITED

Project Location : FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

Job Number: J00253

Auger Borehole No. BH10

Sheet 10 of 12

Vane Head:	Logged By:	Processor :	Date:
307	AB	TT	21.01.16

Borehole Location:	mN	mE	Ground R.L.
	Description:	Refer to site plan	

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
clayey SILT, blue/grey. Hard, moist, medium to low plasticity [NATURAL]					
at 0.3m, becoming slightly clayey SILT, light brown, low plasticity, with occasional fine gravel sized limonite inclusions					
at 0.5m, becoming moderately sensitive	0.5	▽	204/64	3.2	
silty CLAY, grey mottled orange/brown. Very stiff, moist, high plasticity, moderately sensitive, with minor limonite silt inclusions and staining					
with some coarse sand to fine gravel sized dark orange limonite silt clast inclusions	1.0		114/54	2.1	
becoming slightly silty CLAY, orange/brown streaked grey, wet, without limonite silt inclusions	1.5		109/51	2.1	
becoming grey mottled orange	2.0		121/48	2.1	
becoming silty CLAY, grey	2.5		125/58	2.2	
SILT with trace sand, dark grey. Loose, moist, no plasticity	3.0		229+		
clayey SILT, dark grey. Hard, moist, low to medium plasticity	3.5		UTP		
EOB at 4.0m. Target Depth.	4.0		UTP		
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater encountered 1.7m
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: LrB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client :	110 FORMOSA (NZ) LIMITED	**Auger Borehole No.**	BH11
Project Location :	FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS		Sheet 11 of 12
Job Number:	J00253	Vane Head: 1900 / Logged By: TT / Processor: TT / Date: 21.01.16	

Borehole Location: mN | mE | Ground R.L.
Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
clayey SILT, light orange and white mottled yellow/brown. Very stiff, dry, low to medium plasticity [FILL]						
becoming silty CLAY, light grey streaked orange, moist, medium to high plasticity, moderately sensitive		0.5		151/42	3.6	
becoming brown and light grey mottled orange/brown						
becoming mottled dark brown, light grey and orange		1.0		160/47	3.4	
becoming hard with minor topsoil streaking		1.5		208+		
becoming orange streaked grey, high plasticity						
becoming mottled dark brown, orange and grey, with trace fine to medium gravel inclusions		2.0		208+		
becoming slightly silty CLAY, dark green/brown, very stiff, moderately sensitive, with minor fine sand sized clast inclusions becoming dark brown		2.5		104/44	2.4	
silty CLAY, green/brown. Hard, moist, high plasticity, with trace organic staining [NATURAL]		3.0		208+		
becoming orange streaked grey						
becoming very stiff, insensitive		3.5		157/92	1.7	
becoming slightly silty CLAY at 4.0m, becoming sensitive						
EOB at 4.0m. Target Depth.		4.0		160/37	4.3	
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm
Checked: GB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : 110 FORMOSA (NZ) LIMITED

Project Location : FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

Job Number: J00253

Auger Borehole No. BH12

Sheet 12 of 12

Vane Head:	Logged By:	Processor :	Date:
1750	GB	TT	21.01.16

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
silty CLAY, orange mottled light brown/yellow. Very stiff, moist, high plasticity [NATURAL]		0.5		186+		
becoming grey and orange/brown mottled light brown, with some well cemented angular medium gravel sized inclusions		1.0		186+		
becoming grey streaked orange/brown, without gravel inclusions		1.5		186+		
with minor limonite silt inclusions with minor well cemented gravel inclusions becoming grey mottled light yellow/brown without gravel inclusions		2.0		173/40	4.3	
becoming sensitive		2.5		159/61	2.6	
becoming grey/white specked orange/brown, with coarse sand sized silt clasts		3.0		118/66	1.8	
becoming moderately sensitive, with well cemented medium to coarse gravel sized inclusions becoming grey mottled orange/brown, without gravel inclusions		3.5		135/104	1.3	
becoming insensitive becoming slightly silty CLAY, orange/brown, with minor manganese oxide inclusions		4.0				
CLAY, grey/white. Very stiff, moist, high plasticity		4.5				
EOB at 4.0m. Target Depth.		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: LTB

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Legend and/or Notes:

Hand Auger Borehole

BASE PLAN SOURCE: AUCKLAND COUNCIL GIS DATABASE, DATED 26/01/16

revision	description	drawn	approved	date

Template revision: 1.2000 (10/12/14)

0 120 240 360 480
Horizontal Scale (metres)

0 120 240 360 480
Vertical Scale (metres)

drawn	TT
approved	SGL
date	02/02/16
scale	1:8000
original size	A3

LANDER geotechnical

client: 110 FORMOSA (NZ) LIMITED

project: FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

title: SITE PLAN (without contours)

project no: J 00253

figure no: 01

BASE PLAN SOURCE: AUCKLAND COUNCIL GIS DATABASE, DATED 26/01/16

revision	description	drawn	approved	date

Template revision: 1:2000 (10/12/14)

0 120 240 360 480
Horizontal Scale (metres)
0 120 240 360 480
Vertical Scale (metres)

drawn	TT
approved	SGL
date	02/02/16
scale	1:8000
original size	A3

LANDER geotechnical

client: 110 FORMOSA (NZ) LIMITED

project: FORMOSA, JACK LACHLAN DRIVE, BEACHLANDS

title: SITE PLAN (with contours)

project no: J 00253

figure no: 02

Pine Harbour • Auckland

Monday to Friday Only (Exc. Public Holidays)

From Pine Harbour	6.20am	*From Auckland (Pier 3)*	7.00am
	6.50am		7.30am
	7.20am		8.00am
	7.40am		8.20am
	8.10am		8.50am
	8.40am		9.20am
	10.00am		10.40am
	11.20am		12.00pm
	1.20pm		2.00pm
	2.40pm		3.20pm
	3.10pm		3.50pm
	4.00pm		4.40pm
	4.30pm		5.10pm
	4.40pm		5.20pm
	5.20pm		6.00pm
	6.00pm		6.40pm

* Travel time to and from Auckland approximately 35 minutes
This service is provided by SeaLink Pine Harbour

Public Holiday Timetable
No service.

Christmas and New Year
Over the Christmas and New Year period, some services may not operate.
Please always check with Auckland Transport before travelling over this time.

Other timetables in this area that may interest you

Destination	Bus route numbers
Howick, Bucklands Beach, Botany Downs, Mission Heights including Beachlands and Maraetai	358, 500, 501, 550, 551, 552, 553, 554, 589
Botany and Howick Local	545, 565, 575, 580
Eastern Guide	Introduction to public transport in the East

to Botany Downs via Maraetai and Whitford

	Route	Shelly Bay Rd	Beachlands Post Office	Maraetai	Whitford	Botany Town Centre
	Monday to Friday					589
AM	589	6.15	6.20	6.30	6.40	7.00
	589	7.50	7.55	8.05	8.15	8.35
	589	9.20	9.25	9.35	9.45	10.05
PM	589	12.55	1.00	1.10	1.20	1.35
	589	3.35	3.40	3.50	4.00	4.20
	589	5.10	5.15	5.25	5.35	5.55
	589	6.35	6.40	6.50	-	-
	Saturday					589
AM	589	8.50	8.55	9.05	9.15	9.35
	589	10.10	10.15	10.25	10.35	10.55
	589	11.30	11.35	11.45	11.55	12.15
PM	589	1.30	1.35	1.45	1.55	2.15
	589	2.50	2.55	3.05	-	-

Times in **bold** are scheduled, all other times are approximate
Route 589 does not operate on Sunday and Public Holidays.
This service is provided by Howick and Eastern

Ferry Fares to Auckland

Fare Type	Cash	AT HOP Card
Adult One Way	$12.80	$10.20
Adult 40 Trip	$395.00	N/A
Child One Way (under 5 free)	$7.60	$5.16
Tertiary One Way*	N/A	$7.60
Family Pass Return: 2 Adults & 2 Children	$59.00	N/A

***Single trip tertiary fare only available using AT HOP card loaded with tertiary concession.**

Free senior citizens fares are available for travel after 9.00am with a valid SuperGold Card or Auckland Transport approved senior citizen ID card. For travel prior to 9.00am, adult fares apply.

Purchase your AT HOP card from Pier 1 ticket office at the Downtown Ferry Terminal, Britomart Transport Centre, Newmarket, New Lynn and Papakura train stations.

Baggage other than "Cabin Baggage" may be charged for.

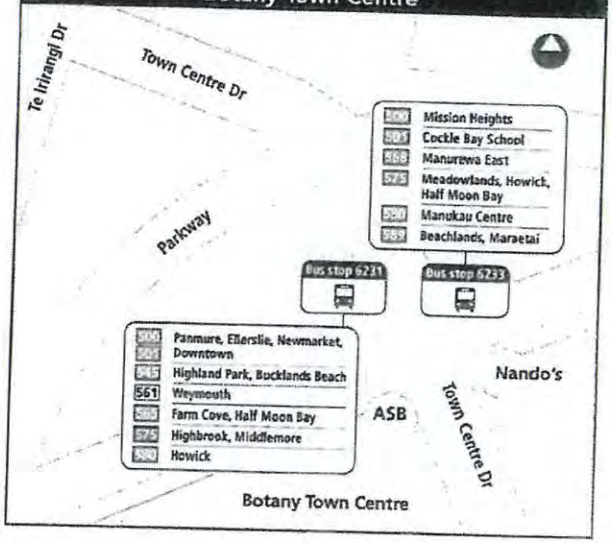
Terms of use and registered prospectus for the AT HOP cards are available on AT.govt.nz/athop or at the Transport Information Centre, Britomart. The obligations of Auckland Transport under the AT HOP cards are unsecured.

to Beachlands • Maraetai via Whitford

	Route	Botany Town Centre (Stop 6233)	Whitford	Shelly Bay Rd	Beachlands Post Office	Maraetai
	Monday to Friday					589
AM	589	7.20	7.40	7.50	7.55	8.05
	589	8.50	9.10	9.20	9.25	9.35
PM	589	12.25	12.45	12.55	1.00	1.10
	589	3.05	3.25	3.35	3.40	3.50
	589	4.40	5.00	5.10	5.15	5.25
	589	6.05	6.25	6.35	6.40	6.50
	Saturday					589
AM	589	9.40	10.00	10.10	10.15	10.25
	589	11.00	11.20	11.30	11.35	11.45
PM	589	1.00	1.20	1.30	1.35	1.45
	589	2.20	2.40	2.50	2.55	3.05

Times in **bold** are scheduled, all other times are approximate
Route 589 does not operate on Sunday and Public Holidays.
This service is provided by Howick and Eastern

Botany Town Centre



ATTACHMENT 2

Attachment 2

PART 2 - REGIONAL AND DISTRICT OBJECTIVES AND POLICIES»Chapter F: Precinct objectives and policies»6 South»6. X Beachlands 3

6. X Beachlands 3

The Countryside Living, Single House, Mixed Housing Urban, Mixed Housing Suburban, Terraced and Apartment Building, Neighbourhood Centre and Mixed Use zone objectives and policies apply to the Beachlands 3 precinct unless otherwise specified. Refer to planning maps for the location and extent of the precinct.

Precinct description

The Beachlands 3 precinct is located on the site of the Formosa Golf course and covers approximately 170ha of land. Its purpose is to provide for clustered residential development and complementary commercial activities around open space and recreation land on the site. It adjoins the Beachlands 1 and Pine Harbour Precincts in a way that integrates with those recently expanded and intensified areas of Beachlands while maintaining and enhancing the key features of Beachlands village.

Precinct Plan 2: Beachlands 3 precinct guides the future development of this precinct. The roading pattern shown on Precinct Plan 2: Beachlands 3 precinct road network is a critical element in achieving integration between the natural landscape of the precinct, retained open space, adjoining Countryside Living land, the Beachlands 1 Precinct and Pine Harbour marina.

Site sizes, site shape, pedestrian linkages and reserve network connectivity in the precinct enables integration with the Pine Harbour and Beachlands 1 Precincts to the south of the existing village.

Objectives

The objectives are as listed in the Countryside Living, Single House, Mixed Housing Urban, Mixed Housing Suburban, Terraced and Apartment Building, Neighbourhood Centre and Mixed Use zones except as specified below:

1. The precinct contributes to the growth and development of Beachlands and ensures that future land use, subdivision and development is contained within the precinct and integrates with the existing Beachlands 1 Precinct to the north, the Pine Harbour marina development to the northwest and Countryside living areas to the south and east.

2. A mixed density, but open coastal village character is established and maintained.

3. Subdivision, use and development maintains and enhances the coastal character, and natural drainage systems of the Formosa site and is complementary to the Beachlands 1 and Pine Harbour Precincts.

4. A well connected and integrated multi-modal transport network is achieved that reflects the landform and reinforces transportation links between Beachlands and Pine Harbour Marina.

5. The golf course and areas of public open space are retained for and treated as integrated features in any development.

6. Infrastructure is provided in an effective and efficient way.

7. Stormwater runoff and riparian margins are managed in a sustainable way.

8. Jack Lachlan Drive is maintained as an avenue with no direct property access.

Policies

The policies are as listed in the Countryside Living, Single House, Mixed Housing Urban, Mixed Housing Suburban, Terraced and Apartment Building, Neighbourhood Centre and Mixed Use zones unless as specified below:

1. Require that land use, subdivision and development be generally in accordance with the Beachlands 3 precinct structure plan shown in the Precinct Plan 1: Beachlands 3 precinct

2. Maintain the long-term growth limit of Beachlands village with the precinct boundary.

3. Retain and enhance landscape character by requiring edge treatment planting along Jack Lachlan Drive adjacent to development.

4. Create a clear distinction between the Beachlands 3 Precinct and the Whitford Countryside Living area to the south and east by landscaping treatment of the boundary interface

Integrated growth

5. Require subdivision and land use activities to be designed in a way that integrates with the roads pattern, open space pattern and rural and coastal character of the Beachlands 1 Precinct.

Subdivision, use and development

6. Require the road layout to be designed and constructed to achieve a pattern of development as shown in the Precinct Plan 1: Beachlands 3 precinct.

7. Avoid the creation of rear sites unless otherwise shown in the Precinct Plan 1: Beachlands 3 precinct.

8. Encourage the development of buildings that have a coastal appearance using materials, colours and features that complement the rural and coastal character of the Beachlands 3 precinct.

9. Require that accessory buildings are single storey.

10. Retain a sense of openness between development clusters, and create a vegetated appearance through tree planting.

11. Limit high fencing that dominates the streetscape and creates an urban appearance.

12. Encourage the retention of significant native vegetation and trees.

13. Require planting of new vegetation to achieve privacy and maintain a coastal landscaped appearance.

14. Encourage development to front onto the golf course, natural watercourses and public open spaces.

Business development

15. Require commercial and mixed use activity to be established in accordance with Precinct Plan 1: Beachlands 3 precinct.

16. Avoid activities that adversely affect the amenities of residential or mixed/use sites.

Public open space

17. Require public open spaces to generally be fronted by the private open space of adjacent dwellings or edge roads as shown in the Precinct Plan 1: Beachlands 3 precinct.

Infrastructure

18. Require that all development is connected to a reticulated sewerage system.

19. Require sustainable supply of potable water to meet the servicing demands of expected activities on the site.

Stormwater **management**

20. Require the design and management of stormwater to incorporate the stormwater management areas shown in the Precinct Plan 1: Beachlands 3 precinct.

21. Require the planting of vegetation along the riparian margins of stormwater management areas shown in the Precinct Plan 1: Beachlands 3 precinct.

22. Require development to front to natural watercourses as shown in the Precinct Plan 1: Beachlands 3 precinct.

Landscaping along Whitford–Maraetai Road

23. Require the provision of a landscaped buffer area along the full length of Whitford-Maraetai Road as shown in the Precinct Plan 1: Beachlands 3 precinct.

Jack Lachlan Drive

24. Limit the number of roads that intersect with Jack Lachlan Drive.

25. Limit direct vehicle access from adjoining sites to Jack Lachlan Drive, and where direct access is required, encourage the use of shared driveways.

26. Require street tree planting on the south side of Jack Lachlan Drive to create a lineal effect and reduce the visual impact of urban development.

6. X Beachlands 3

The activities, controls and assessment criteria in the underlying Countryside Living, Single House, Mixed Housing Urban, Mixed Housing Suburban, Terraced and Apartment Building, Neighbourhood Centre and Mixed Use zone rules apply to the Beachlands 3 precinct unless otherwise specified.

Refer to planning maps and the precinct plans in clause 8 below for the location and extent of the precinct.

1. Activity table

The activities in the Beachlands 3 precinct are those in the Countryside Living, Single House, Mixed Housing Urban, Mixed Housing Suburban, Terraced and Apartment Building zones except as specified in the activity table below.

Activity	Activity status
Commerce	
Dairies up to 100m2 GFA per site	NC
Service station on an arterial road	NC
Park-and-Ride	D
Development	
The conversion of an existing dwelling into two dwellings where the dwelling complies with clause 3. 3. of the Residential zones rules	NC

2. Development controls

The development controls in the Countryside Living, Single House, Mixed Housing Urban, Mixed Housing Suburban, Terraced and Apartment Building zones apply in the Beachlands 3 Precinct unless otherwise specified below.

2. 1 Beachlands 3 precinct plan

1. All land use must be in accordance with the Beachlands 3 precinct plan.

2. Any activity that does not comply with the above is a non-complying activity.

2. 2 Building height

1. Accessory buildings must not exceed a height of 4m and must be single storey.

2. Buildings in the Mixed Use zone shall not exceed 12. 5m and 3 storeys in height.

2. 3 Yards

Table 1

Yard	Minimum dimension
Front and corner sites in Single House Zone	

Front	6m for - sites adjoining Jack Lachlan Drive - yards adjoining a stormwater management area or public open space. 3m for - one yard only on a corner site - sites that adjoin a stormwater management area or public open space and a street.
Side	One yard must be a minimum of 2m and one yard must be a minimum of 3m
Rear	6m
Rear sites	
All yards	6m for at least two yards and 3m for any other yard

2. 4 Impervious area threshold and building coverage – Single House Zone
Table 2

Impervious area threshold	50 per cent of net site area

2. 5 Wastewater servicing
1. All activities requiring wastewater servicing must be connected to a reticulated sewerage system.

2. Any activity that does not comply with the above is a non-complying activity.

2. 6 Water storage tank
1. Provision must be made for minimum water storage per dwelling of two 25,000 litre tanks.

2. All dwellings must comply with the following minimum roof areas:

Table 3

Number of bedrooms	**Minimum roof area (m2) connected to the water storage tank**
1	100
2	160
3 and above	230

3. Private water storage tanks must not be visible from the street.

4. Clauses 2. 6. 1, 1, 2 and3 do not apply to activities where a connection to a reticulated water supply is provided to the site.

2. 7 Fences
1. Fences along side and rear boundaries must not exceed 1. 8m in height.

2. Fences adjoining areas shown as public open space or stormwater management areas on Figure 2 must not exceed 1. 2m in height and must comprise at least 50 per cent visually permeable fencing.

2. 8 Landscaping

1. New dwellings within the Single House zone must provide for at least two trees in the front yard and two trees in the rear yard. The trees must be planted in the next planting season following the issue of the code of compliance certificate for the dwelling. Each tree at the time of planting must have a minimum in ground height of 2m. Tree species must be selected that are appropriate to the soils, microclimate and the street environment and be typically capable of reaching a minimum height of 4m after five years.

3. Subdivision controls

The subdivision controls in the Auckland-wide rules apply in the Beachlands 3 Precinct unless otherwise specified below.

3. 1 Road network

1. All roads must be constructed in accordance with the grid road layout shown in the precinct – Roading Network plan in Precinct Plan 2.

2. Where the subdivision is of an existing site that adjoins Jack Lachlan Drive, the first stage of subdivision must include a public road connection to Jack Lachlan Drive.

3. There must be no direct vehicle access off the Whitford-Maraetai Road.

4. Direct vehicle access to Jack Lachlan Drive must not be provided in the area specified as 'no direct site access permitted' on the Beachlands 3 precinct plan.

5. Where a site adjoins Jack Lachlan Drive and direct vehicle access is permitted, shared access driveways must be used.

6. Subject to the following exceptions, Jack Lachlan Drive is to be retained in its current rural standard formation to maintain its appearance as a rural rather than urban road. Where any alteration to the current rural standard formation is proposed it must be limited to:

a. kerb and channelling of the road edge for those areas of Jack Lachlan Drive where there is no alternative to provide for stormwater runoff from adjacent residential development, and/or

b. kerb and channelling of the road edge which is necessary to provide for vehicle access from adjacent residential development or new road intersections with Jack Lachlan Drive, and/or

c. a footpath of appropriate rural character (gravelled surface or similar).

3. 4 Rear sites

1. There shall be no rear sites, unless shown on the Precinct Plan 1: Beachlands 3 precinct.

2. Any activity that does not comply with clause 3. 4. 1 above is a non-complying activity.

3. 6 Reserves

1. All land shown as public open space or stormwater management area must be provided in the location Precinct Plan 1: Beachlands 3 precinct.

2. Any activity which does not comply with 3. 6. 1 above is a discretionary activity.

3. 7 Stormwater management areas

1. All building platforms and access to sites must be wholly outside the stormwater management area.

2. All riparian margin areas within the stormwater management area must comprise planting at a minimum density of 1. 4m centres (5100 stems per hectare) provided that a greater density may be required in some situations, for instance where there is significant weed infestation or planting is in the proximity of streams or wetlands.

3. The applicant will be responsible for implementing the revegetation plan/programme for a period of two years from the time of planting, which must be secured by suitable legal instrument on the certificate of title.

4. Any activity which does not comply with clauses 3. 7. 1-3 above is a discretionary activity.

3. 9 Street trees

1. Street tree planting on the south side of Jack Lachlan Drive must create a lineal effect so that the trees, rather than the built development behind, become the dominant visual feature as viewed from the road.

2. All species selected for street tree planting must be approved by the council.

3. Any activity which does not comply with clause 3. 9. 1-2 above is a discretionary activity.

3. 10 Wastewater servicing

1. All sites capable of accommodating future buildings must be provided with a connection to a reticulated sewerage system.

2. Any activity which does not comply with clause 3. 10. 1 above is a discretionary activity.

3. 11 Landscape buffer area

1. A landscape buffer area must be developed along Whitford–Maraetai Road as shown in the Precinct Plan 1: Beachlands 3 precinct. The buffer area must:

a. be a minimum width of 15m at any point

b. where it is within any existing site, must be established as a condition of any subdivision of that site

c. be planted prior to the issuing by the council of any s. 224(c) certificate for subdivision within the Beachlands 3 Precinct creating allotments of less than 1ha (10,000m²), unless created for infrastructure or roading purposes.

2. The applicant is responsible for the maintenance of the buffer area, including weed control, mulching and watering and any necessary plant replacement, for a period of three years from the time of planting.

3. The buffer area must be vested in the council free-of-charge (and without any impact on the development contribution required for the subdivision) at a time to be

determined in the subdivision consent, being no more than two years after council issues the s. 224(c) certificate under the RMA.

4. Any activity that does not comply with clauses 3. 11. 1-3 above is a discretionary activity.

3. 12 Planted hedge – Jack Lachlan Drive

1. Where a site adjoins that part of Jack Lachlan Drive specified as 'no direct site access permitted' on the precinct plan a planted hedge is to be provided for the full length of the Jack Lachlan Drive boundary of the site. The hedge species selected must be capable of reaching and be maintained at a height of no less than 2m. The planted hedge will be subject to appropriate legal protection, arranged at the time of subdivision.

2. Any activity that does not comply with clause 3. 12. 1 above is a discretionary activity.

4. Assessment - Restricted discretionary activities

Matters of discretion

1. The council will restrict its discretion to the following matters, in addition to the matters specified for the relevant restricted discretionary activities in the underlying zone:

a. character and amenity of the neighbourhood

b. Beachlands Village Precinct Design Guidelines.

Assessment criteria

1. The following assessment criteria apply in addition to the matters specified for the relevant restricted discretionary activities in the underlying zone:

a. Character and amenity of the neighbourhood

i. The design, layout, intensity, external appearance and landscaping of buildings and sites should maintain and enhance the rural and coastal village character and amenity values identified in the Beachlands 3 precinct objectives and policies.

ii. In the case of non-residential activities, the character of the activity and its effects should be compatible with the rural and coastal village character and amenity values identified in the Beachlands 3 Precinct objectives and policies.

5. Assessment - Development control infringements

Matters of discretion

1. Where a building exceeds the maximum building height in the Beachlands 3 Precinct, the council will restrict its discretion to the following matters, in addition to those set out in the underlying zone for the same infringement:

a. obstruction of coastal views

Assessment criteria

1. The following assessment criteria apply to buildings that exceed the maximum building height in the Beachlands 3 precinct, in addition to that specified in the underlying zone for the same infringement:

a. buildings should be compatible with the height and visual character of the streetscape, surrounding area and the character of the Beachlands village

b. buildings should not disrupt the views to the sea and the coastal edge from Whitford-Maraetai Road.

6. Assessment - Subdivision

Assessment criteria

1. For subdivision that is a restricted discretionary activity in the Beachlands 3 Precinct, the council will restrict its discretion to the following matters, in addition to the matters specified for the relevant restricted discretionary activities in the Auckland-wide rules - subdivision:

a. road network

b. stormwater management

c. Beachlands Village Design Guidelines

d. rear sites.

2. For subdivision that is a restricted discretionary activity in the Beachlands 3 precinct because it is listed as a restricted discretionary activity in the Auckland-wide rules - subdivision, the following assessment criteria apply in addition to the matters specified in the Auckland-wide rules - subdivision:

a. Road network

i. The road pattern should be designed to enhance public access to reserves and take advantage of coastal and rural vistas.

b. Stormwater management

i. The revegetation plan for stormwater management areas should consider retaining existing trees either on a permanent basis or until the new planting has been established.

c. Beachlands Village Design Guidelines

i. The proposed subdivision should meet the principles contained in the Beachlands Village Design Guidelines.

d. Rear sites

i. Rear sites that will ultimately front a proposed local road should be designed to enable all future buildings to face and front the proposed local road.

7. Special information requirements

1. Where landscaping is required, a resource consent application must be accompanied by the following information:

a. A planting plan for the landscape buffer area that provides detail of the:

i. site preparation for planting, weed and pest control

ii. existing trees to be retained, species to be planted, size of plants, where they are to be planted and density of planting

iii. maintenance of planting, including fertiliser, replacing dead plants, animal and plant pest control and mulching.

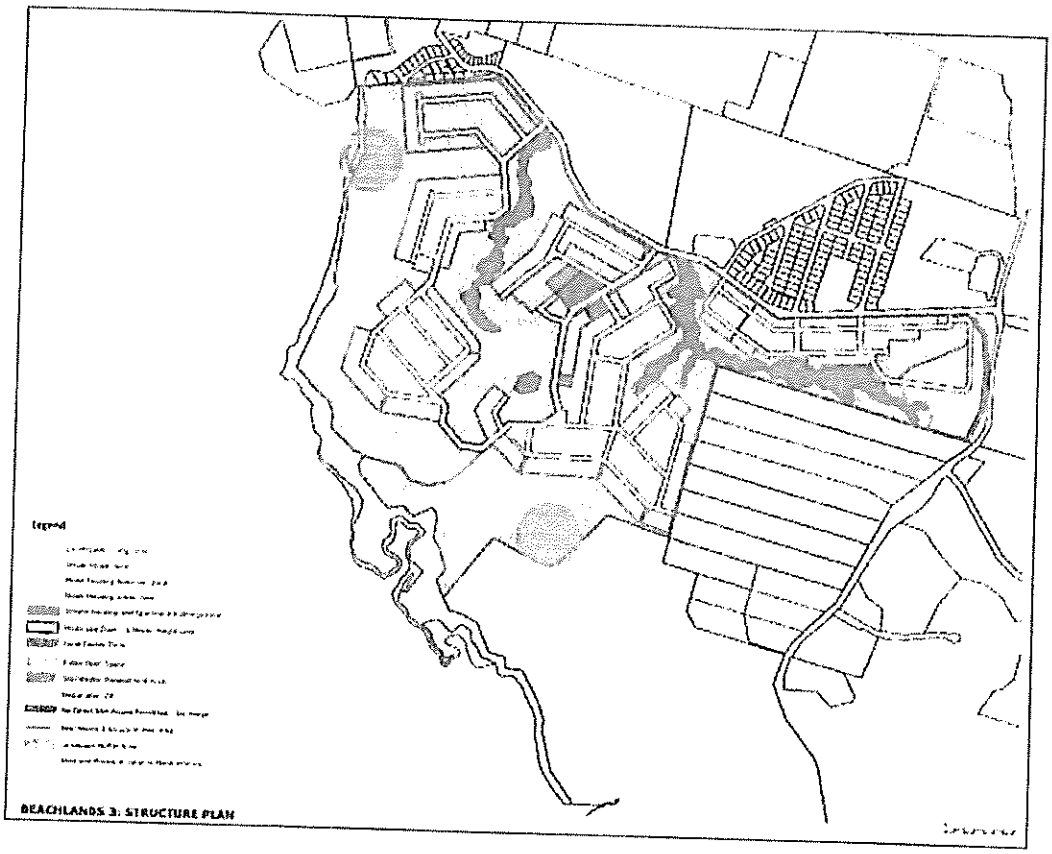
b. A re-vegetation plan/programme, including:

i. pre-planting site assessment and planting plan assessment

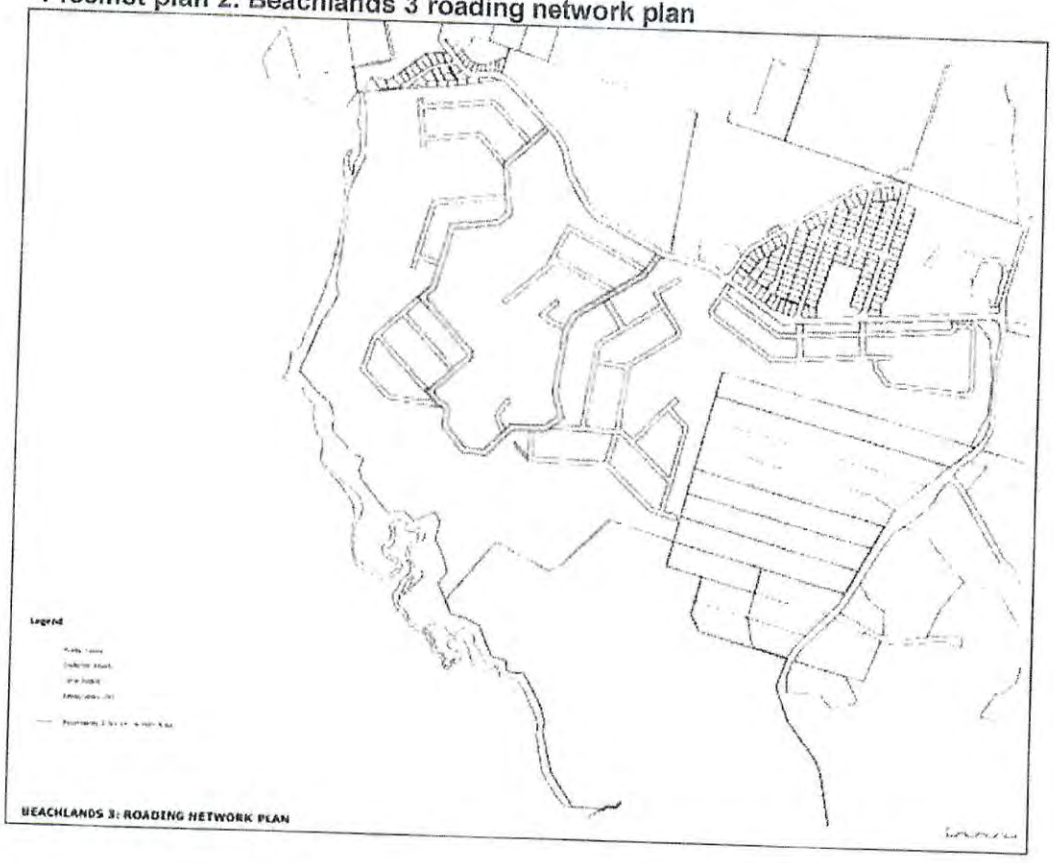
ii. an annual monitoring programme.

8. Precinct plans

Precinct plan 1: Beachlands 3 precinct



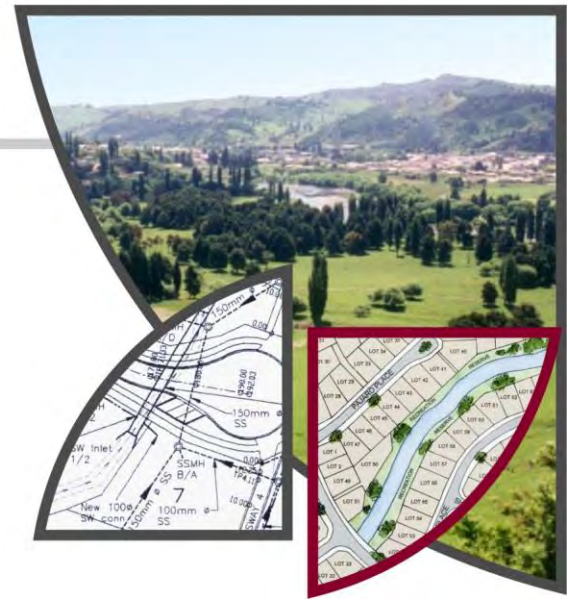
Precinct plan 2: Beachlands 3 roading network plan



Geotechnical Investigation Report, 620 Whitford Maraetai Road

Ahuareka Trust
No 2 Ltd

Fraser Thomas
ENGINEERS: RESOURCE MANAGERS: SURVEYORS



AHUAREKA SPECIAL
RURAL SETTLEMENT

650 WHITFORD-MARAETAI
ROAD, WHITFORD

GEOTECHNICAL INVESTIGATION REPORT

SUMMARY

The visual appraisal and geotechnical investigations reported herein address the geotechnical considerations relating to the proposed Ahuareka Special Rural Settlement development at 650 Whitford-Maraetai Road, Whitford.

The borehole and test pit data, in general, indicate that the site is underlain by soils which are inferred to be weathering products of the underlying Waitemata Group mudstone and sandstone.

Based on the site appraisal and borehole investigation, as reported herein, and on the basis of ground conditions existing at the time of the investigation reported herein, a "Recommended Building Line Limitation" has been determined for the proposed development.

In general terms and within the limits of the investigation as outlined and reported herein, except for the slope stability issues discussed in Sections 7.0 and 9.0 of this report, and provided proper control of any proposed earthworks is exercised, no unusual problems are anticipated with the development of the site along the general lines shown on Fraser Thomas Ltd drawings 60834/1A and 2A.

The site is, in general, considered suitable for its intended use for residential and commercial purposes with satisfactory conditions for buildings, subject to the recommendations and qualifications reported herein, provided the design and inspection of foundations are carried out as would be done under normal circumstances in accordance with the requirements of the relevant New Zealand Standard Codes of Practice.

Conclusions and recommendations arising from the investigations are summarised in Section 20.0 of this report.

GEOTECHNICAL INVESTIGATION REPORT

AHUAREKA SPECIAL RURAL SETTLEMENT

650 WHITFORD –MARAETAI ROAD, WHITFORD

AHUAREKA TRUST NO 2 LTD

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AHUAREKA SPECIAL RURAL SETTLEMENT

650 WHITFORD –MARAETAI ROAD, WHITFORD

AHUAREKA TRUST NO 2 LTD

1.0 INTRODUCTION

This report forms part of an application by Ahuareka Trustees (No.2) Limited for land use consent to provide for a proposal to establish 189 household units in a focused central cluster akin to a rural village, surrounded by a buffer of open farmland and bush, on what is currently an existing cattle farm. As an entirely new way of providing for growth in a rural style and context, a new name has been coined for this: "Special Rural Settlement".

The subject site comprises 92.7589 hectares and is legally described as Lot 2, DP 166414, Lot 2 DP 208997, Lot 2 DP 197719 & Lot 2 DP 187934, North Auckland Land District. The land is presently contained in a single Certificate of Title (NA 137A/537) and is identified for the purposes of this report as 650 Whitford-Maraetai Road, Whitford.

This report presents the results of a visual appraisal and a geotechnical investigation undertaken for the proposed Ahuareka Special Rural Settlement development at 650 Whitford-Maraetai Road, Whitford.

It is understood that it is proposed to subdivide the subject site in order to create 189 new residential lots, and 7 new lots which may be used for other uses (e.g. retail or commercial). The proposed development also involves the construction of new roads.

The subsurface conditions at the site have been investigated by means of twenty three hand augered boreholes and associated dynamic cone (DCP) penetrometer (Scala) tests, nine rotary cored machine boreholes and thirteen machine excavated test pits. A visual appraisal of the site, a study of geological maps and a stereoscopic study of aerial photographs have also been undertaken.

The purpose of the geotechnical investigation reported herein was to determine the subsoil conditions at the site as they may affect the proposed development, with particular regard to slope stability and foundation considerations and to confirm the suitability of the site, in support of an application for land use consent.

2.0 GEOLOGY

In carrying out the appraisal of the site, reference has been made to the New Zealand Geological Map, scale 1:50,000, Auckland Urban Area, Sheet R11.

This geological map indicates that the site is underlain by muddy sandstone and mudstone of the Waitemata Group of Miocene age.

The results of the borehole investigation reported herein generally confirm the stratigraphy as indicated by the geological map.

3.0 PROPOSED DEVELOPMENT

It is understood that it is proposed to subdivide the subject site in order to create 189 new residential lots, and 7 new lots which may be used for other uses (e.g. retail or commercial). The proposed development also involves the construction of new roads.

The proposed subdivisional layout is shown on drawings 60834/1A and 2A.

It is understood that it is proposed to undertake cut and fill earthworks at the site in order to form level subgrades for the proposed new roads and in order to create, in some places, level building platforms.

4.0 AERIAL PHOTOGRAPHS

Stereoscopic pairs of aerial photographs for the year 1961were examined as part of the site appreciation.

The site generally appeared to be vegetated with paddock grass.

Deep steeply sloping gullies are observed within the site. The gullies were generally well vegetated with trees.

Very steep slopes generally abut the western and southern parts of the site. These slopes slope down to the Waikopua Creek, which feeds into the Tamaki Strait. The south facing slopes were generally well vegetated with trees. The west facing slopes were generally vegetated with occasional trees.

A bench is evident along the upper parts of the west facing slopes, within the south western corner of the site. The bench appears to slope slightly in a northerly direction. This bench is also evident extending around the south western corner of the site. The approximate location and extent of the bench observed on the aerial photographs is shown on the appended Fraser Thomas Ltd drawing 60834/1A.

The bench is not evident on the west facing slopes between Gullies A and B, as shown on drawing 60834/1A.

A bench is also evident on the lower parts of the west facing slopes, within the north western part of the site. This bench appears to be not as wide as the bench observed in the south

western part of the site. The bench located in the north western part of the site appears to have formed on the same bedding plane as the bench located in the south western part of the site. The direction and dip of the bedding plane observed in the aerial photographs appears to be consistent with that observed for the bedrock exposed in Gullies A and B, discussed in Section 5.2 of this report. The approximate location of this bench is shown drawing 60834/1A.

No benches are evident on any other slopes in the vicinity of the site.

Two structures were observed located in the north eastern part of the site. These structures are likely to be barns associated with farming works at the site.

5.0 FIELD INVESTIGATION

5.1 GENERAL

The field investigation comprised a visual appraisal, twenty three hand augered boreholes, thirteen machine excavated test pits, and nine machine drilled boreholes. Dynamic Cone Penetrometer (DCP) tests (scalas) were carried out beyond the base of seventeen of the hand augered boreholes. The site was surveyed using a tape and clinometer to produce eleven cross sections, Cross Sections AA to KK inclusive, for slope stability appraisal purposes.

The locations of the relevant cross sections, test pits, and boreholes are shown on the appended drawing 60834/1A.

5.2 RESULTS OF VISUAL APPRAISAL

A visual appraisal of the site was undertaken by a Fraser Thomas senior geotechnical engineer on 15 January 2008.

The site is generally located at the western end of an existing access track which extends from the western side of Whitford-Maraetai Road.

The site is presently being used for “dry stock” farming activities.

Existing light timber framed structures, associated with the existing farming activities, are located in the north eastern part of the site. An existing horse equestrian area is also located in this area. Existing dwellings are located to the north west of the farm related structures. The approximate locations of the existing structures are shown on drawing 60834/1A.

The site generally slopes slightly, with a westerly to south westerly aspect, towards the crest of very steep slopes located in the western and southern parts of the site. These slopes slope down to the Waikopua Creek.

The very steep slopes located in the western part of the site generally slope with a westerly aspect at slopes ranging between approximately 20^{o} to the horizontal (1V:2.74H) and 40^{o} to the horizontal (1V:1.19H).

The west facing slopes were generally vegetated with pine trees, up to approximately 1.2 m bole diameter, at the time of the investigation reported herein. The existing trees in general show no significant signs of past slope instability by way of bole curvature or inclined bole orientation. Signs of surficial soil creep were observed on steeper parts of the slopes.

The slopes located in the southern part of the site generally slope with a southerly aspect at slopes ranging between approximately 20° to the horizontal (1V:2.74H) and 36° to the horizontal (1V:1.37H).

The south facing slopes were generally well vegetated with trees, up to approximately 1.2 m bole diameter, at the time of the investigation reported herein. The existing trees in general show no significant signs of past slope instability by way of bole curvature or inclined bole orientation. Signs of surficial soil creep were observed on steeper parts of the slopes.

Evidence of past shallow seated slope instability was also observed on the west facing slopes at the site. Localised steeper areas, inferred to be weathered head scarps, were observed on the upper parts of the steeper slopes. Hummocky ground was observed downslope of these features, inferred to be indicative of colluvium associated with past shallow-seated slope instability.

A bench is located on the upper parts of the west facing slope, within the south western part of the site. A bench is also located on the lower parts of the west facing slope within the north western part of the site. No obvious bench was observed on the west facing slopes between Gullies A and B, shown on drawing 60834/1A. The approximate location and extent of the bench, as observed in the stereoscopic study of aerial photographs for the site is shown on drawing 60834/1A.

The site is generally incised by four deep gullies, identified as Gullies A, B, C and D on drawing 60834/1A.

Gullies A and B are generally located in the western part of the site and extend in a westerly direction through the site.

Gullies C and D are generally located in the southern part of the site and extend in a southerly direction through the site.

The gully slopes associated with these gullies are generally steep to very steep and slope at between approximately 30° to the horizontal (1V:1.73H) and 48° to the horizontal (1V:0.90H). The gully slopes were generally vegetated with trees at the time of the investigation reported herein.

Signs of shallow-seated slope instability and surficial soil creep were observed on steeper parts of these slopes.

Generally ephemeral watercourses are located at the base of the gullies. The watercourses were dry at the time of the investigation reported herein.

Material, inferred to be slightly weathered Waitemata Group muddy sandstone and mudstone, was generally observed in exposures in the base of the gullies.

Measurements were undertaken on bedrock exposed in Gullies A and B. The bedding of the rock exposed in these gullies appeared to be dipping at an angle of between approximately 3° and 5° to the horizontal, generally in a north westerly direction.

5.3 HAND AUGERED BOREHOLES

Twenty three augered boreholes, numbered H1 to H23 inclusive, were put down at the site in order to investigate the subsurface conditions. The approximate locations of the boreholes are shown on drawing 60834/1A.

The boreholes were put down by qualified Fraser Thomas Ltd engineering geologists and field technicians. The logs of the boreholes are presented in Appendix A of this report.

The boreholes were generally terminated when the soils became too hard to auger further, at depths ranging between approximately 0.7 m and 4.4 m below the ground surface existing at the time of the investigation reported herein (the existing ground surface). In situ undrained shear strength measurements were carried out in the boreholes at approximately 0.5 m intervals of depth using hand held field shear vane equipment. These tests were carried out down the hole and enabled a strength profile to be obtained from the boreholes. All soils in the boreholes were carefully logged.

A dynamic cone (Scala) penetrometer (DCP) test was performed beyond the base of Boreholes H2 to H18 inclusive. The results of the DCP tests are also presented in Appendix A of this report.

5.4 TEST PIT INVESTIGATION

Thirteen machine excavated test pits, numbered TP1 to TP13 inclusive, were put down on 27 February and 21 September 2009, in order to examine the nature and fabric of the soils underlying the site, and to expose the underlying bedrock. The test pits were inspected and logged by a Fraser Thomas engineering geologist.

The test pits were excavated to depths ranging between approximately 1.8 m and 4.4 m below the existing ground surface. Where possible, in situ undrained shear strength measurements were carried out in the sides of the test pits using hand held field shear vane equipment. These tests were carried out down the test pit and enabled a strength profile to be obtained from the test pits.

The logs of the test pits are presented in Appendix A of this report. The locations of the test pits are shown on drawing 60834/1A.

5.5 MACHINE BOREHOLE INVESTIGATION

Nine rotary cored machine boreholes, numbered M1 to M9 inclusive, were put down between 28 February and 4 March 2008, and between 17 and 22 September 2009, in order to identify any potential slip surfaces and weak layers within the subsoils, to determine the presence of possible clay seams within the bedrock materials which could act as a mechanism for potential block sliding, to determine the depth of soil veneer and to investigate the strength and nature of the bedrock materials.

The machine boreholes were put down to depths ranging between approximately 6.0 m and 30.0 m below the existing ground surface.

The machine boreholes were logged by qualified Fraser Thomas engineering geologists. The logs of the boreholes are presented in Appendix A of this report. The locations of the machine boreholes are shown on drawing 60834/1A.

Standpipe piezometers were installed in Machine Boreholes M1, M2, M6, M7, M8 and M9 to measure the groundwater levels within the underlying soils and bedrock materials. The piezometer details and measured groundwater levels are shown on the borehole logs.

5.6 LABORATORY INVESTIGATION

A test to determine the linear shrinkage value for the site soils, undertaken in accordance with NZS 4404:1986, Test 2.6, was conducted on disturbed soil samples recovered from Boreholes H2, H8 and H20. The laboratory testing was carried out by Stevenson's Civil Engineering Laboratory, an IANZ accredited soils and materials testing laboratory, under the instruction of Fraser Thomas Ltd.

The results of the laboratory tests are presented in Appendix A of this report and are summarised in Table 1.

TABLE 1: LABORATORY TEST RESULTS

Sample	Depth Below Ground Surface (m)	Field Water Content (%)	Linear Shrinkage (%)
Borehole H2	0.5-0.7	28.8	20
Borehole H8	0.5-0.7	32.5	21
Borehole H20	0.5-0.7	24.7	16

6.0 SUBSURFACE CONDITIONS

6.1 GENERAL

The borehole and test pit data, in general, indicate that the site is underlain by soils which are inferred to be weathering products of the underlying Waitemata Group mudstone and sandstone.

It has been assumed that even though the various subsoil strata, their depths and thicknesses and the locations of groundwater levels have been determined only at the locations and within the depths of the various boreholes and test pits recorded herein, these various subsurface features can be projected between the various locations. Even though such inference is made, no guarantee can be given as to the validity of this inference or of the nature and continuity of these various subsurface features.

6.2 TOPSOIL

Topsoil was generally encountered to depths ranging between approximately 0.1 m and 0.3 m below the existing ground surface at the locations of the boreholes and test pits put down during the investigation reported herein.

A surficial layer of material, generally comprising black silt intermixed with shell fragments, was also encountered on the west facing slopes at the site. This surficial layer generally ranged between approximately 0.2 m and 0.3 m depth, however the material was encountered to a depth of approximately 0.9 m on the lower bench in the north western part of the site. This material is believed to be dredgings associated with the construction of the nearby Pine Harbour marina. The dredgings are believed to have been spread over the west facing slopes during the previous dredging works.

6.3 COLLUVIUM

Material, generally comprising clayey silts intermixed with mudstone fragments, was encountered to a depth of approximately 0.7 m below the existing ground surface at the location of Test Pit TP6, put down on the existing bench on the west facing slopes.

This material is inferred to be colluvium associated with past slope instability of the upper parts of the west facing slopes in this area.

6.4 RESIDUAL SOILS

The residual soils, inferred to be weathering products of the underlying Waitemata Group bedrock, generally comprised silty clays and clayey silts. In situ undrained shear strength values measured in the soils generally ranged from 100 kPa to greater than 231 kPa, corresponding to a stiff to hard consistency. The residual soils were generally encountered to the extent of the hand augered boreholes put down at the site.

6.5 MUDSTONE AND SANDSTONE BEDROCK

The surficial soils at the site are inferred to be underlain by slightly to moderately weathered sandstone and mudstone of the Waitemata Group of Miocene age.

It is usual to take a DCP blow count of about 5 to 10 blows per 50 mm penetration as being indicative of the level of the highly weathered, very weak to extremely weak sandstone and mudstone. From the DCP results, the depth to the highly weathered, very weak to extremely weak sandstone and mudstone has been inferred, at the time of the investigation reported herein, to be between approximately 0.7 m and 4.9 m below the existing ground surface at the site.

Highly weathered, very weak to extremely weak sandstone and mudstone was encountered at depths ranging between approximately 0.6 m and 4.0 m below the existing ground surface at the locations of the test pits put down at the site.

Highly weathered, very weak to extremely weak sandstone and mudstone was also encountered at the locations of the machine boreholes put down at the site. The very weak to extremely weak sandstone and mudstone was encountered at depths ranging between approximately 1.5 m and 5.5 m below the existing ground surface. Generally the very weak

to extremely weak sandstone and mudstone was encountered at depths no shallower than approximately 2.0 m below the existing ground surface.

The very weak to extremely weak sandstone and mudstone was encountered to depths ranging between approximately 5.0 m and 17.8 m. Layers of very weak to extremely weak sandstone were also encountered below 21.0 m depth at the location of Machine Borehole M8.

SPT 'N' values ranging between approximately 9 and greater than 50 were measured in the very weak to extremely weak sandstone and mudstone.

Material, inferred to be slightly to moderately weathered, moderately strong to weak sandstone and mudstone was encountered at the locations of Machine Boreholes M1 to M5 M7, M8 and M9. The moderately strong to weak sandstone and mudstone was generally encountered at depths ranging between approximately 5.0 m and 17.8 m below the existing ground surface. Generally the moderately strong to weak sandstone and mudstone was encountered to the extent of the boreholes. However layers of very weak to extremely weak sandstone were encountered below 21.0 m depth at the location of Machine Borehole M8.

The depth to moderately to slightly weathered, moderately strong to weak sandstone and mudstone was approximately 17.8 m and 14.0 m below the existing ground surface at the locations of Boreholes M2 and M9 respectively, which are greater than the depths encountered at the locations of the other machine boreholes put down at the site. The bedrock material underlying the benches, located along the west facing slopes at the site, appears to have been subject to a greater degree of weathering than the bedrock material encountered elsewhere on the site.

As discussed in Section 5.2 of this report, material inferred to be slightly weathered Waitemata Group muddy sandstone and mudstone was generally observed exposed in the base of the gullies. Measurements were undertaken on bedrock exposed in Gullies A and B. The bedding of the rock exposed in these gullies appeared to be dipping at an angle of between approximately 3^{o} and 5^{o} to the horizontal in a westerly to north westerly direction.

It should be noted that no clay seams or slickensided joint surfaces were identified at the locations of the machine boreholes put down at the site. No evidence of block sliding, by way of disturbed, highly fractured bedrock, was observed in the machine boreholes in the zones where disturbance would be expected to be encountered, had the existing benches been formed by block slides.

Test Pits TP5, TP6, TP10 and TP12 were put down along the upslope edge of the benches, in order to determine the nature and consistency of the material in these areas. It would be expected, if the existing benches affecting the west facing slopes was formed by way of a block slide movement, that the material along the upslope edge of the bench (i.e. in the vicinity of the expected failure plane of any such block slide) would comprise disturbed highly fractured bedrock. Material generally comprising highly weathered, very weak to extremely weak mudstone and sandstone was encountered at the locations of TP5, TP6, TP10 and TP12 at depths of approximately 0.7 m, 1.2 m, 0.6 m and 3.4 m respectively below the existing ground surface. The bedrock encountered appeared to be intact and did not appear to be highly fractured or disturbed, i.e no evidence of block sliding, by way of disturbed, slightly fractured bedrock, was observed at the locations of Test Pits TP5, TP6, TP10 and TP12 put down along the upslope edge of the benches on the west facing slopes.

6.6 GROUNDWATER

Groundwater was not encountered at the locations of the hand augered boreholes and test pits put down during the field investigation reported herein.

The groundwater levels within the piezometers installed in Machine Boreholes M1, M2, M6 and M7 were measured on 6 March, 2 April and 1 September 2008, and 7 May and 22 September 2009. The groundwater levels within the piezometers installed in Machine Boreholes M8 and M9 were measured on 6 October 2009.

The groundwater levels measured at the locations of the machine boreholes are shown on the borehole logs presented in Appendix A, and are also shown on drawings 60834/3A to 13A inclusive.

7.0 SLOPE STABILITY APPRAISAL

7.1 GENERAL

An analysis of potential deep-seated movement within the Waitemata Group bedrock (block sliding) has been undertaken for the slope profiles represented by Cross Sections FF and JJ.

Analyses have also been undertaken to determine the theoretical slope angle for the soil veneer materials of the steep slopes at the site, represented by Cross Sections AA to KK inclusive, which would yield satisfactory theoretical factor of safety values, using the soil strength parameters discussed in Section 7.2 of this report. For the purposes of the slope stability analyses it was assumed that the soil veneer overlying the steep slopes at the site would be subject to slope instability and that the soil veneer materials at the crest of the slopes would regress back to a "safe" regressed slope profile. The analyses were undertaken in order to determine the slope angle of a likely regression line should the veneer materials overlying the steep slopes be subject to slope instability.

The locations of Cross Sections AA to KK inclusive are shown on drawing 60834/1A.

7.2 METHOD OF ANALYSIS

The stability of the assumed regressed slope profiles shown on Cross Sections AA to KK inclusive have been analysed using the computer programme Slope/W for various potential slip surfaces, and for two groundwater conditions, corresponding to the estimated "wet winter" and assumed "extreme transient" cases.

Slope/W is a computer programme that uses the limit equilibrium theory to solve for the theoretical factor of safety of earth and rock slopes. The comprehensive formulation of Slope/W makes it possible to select a variety of methods for computing the factor of safety, and to analyse both simple and complex geometric, stratigraphic, and loading conditions. Slope/W allows slope stability to be analysed by up to nine methods, including the more mathematically rigorous Morgenstern-Price and Generalised Limit Equilibrium (GLE) methods. For the purpose of the analyses reported herein, the theoretical factor of safety values derived from the Morgenstern-Price method of analysis have been adopted for the potential slip surfaces.

For the soil veneer analyses, potential slip surfaces have been considered which pass through the natural soil veneer at the crest of the slope, assuming that the soil veneer materials

overlying the steep slopes have been removed by slope instability. Analyses were undertaken using the Slope/W computer programme to determine the theoretical regressed slope profile for the soil veneer materials at the crest of the steep slopes at the site which would yield satisfactory theoretical factor of safety values of 1.5 and 1.2 to 1.3 for wet winter and extreme transient groundwater conditions respectively.

The soil veneer material at the crest of the slopes at the site has been analysed for circular slip surfaces, as appropriate to the slope geometry and stratigraphy, using the computer programme Slope/W, and assuming design effective strength parameters of 30^o friction angle and 7 kPa cohesion, for the residual soil veneer materials.

The analyses were undertaken under two different inferred groundwater surfaces, estimated to represent wet winter and extreme transient groundwater conditions. The wet winter and extreme transient groundwater conditions were based on the conservative assumption that the soil veneer material at the crest of the slopes will become partially saturated during periods of prolonged intense rainfall.

For the block slide analyses of Cross Sections FF and JJ, it has been assumed that the existing "benched" slope profile at these cross sections is the result of a block slide failure. The assumed slope profile for Cross Section FF, prior to this theoretical block slide failure, has been back analysed for a defined potential slope movement assuming a weak layer extending through the bedrock and along a horizontal clay seam, extending from the toe of the steep west facing slope, into the slope. The back analyses have been carried out in order to determine the soil strength parameters for the theoretical horizontal clay seam for a block slide to have occurred in this area in the past. The approximate location of the defined potential slope movement, inferred for the purposes of the block slide analyses reported herein, is shown on drawing 60834/8A.

The assumed slope profile was then back analysed under near fully saturated groundwater conditions in order to obtain a theoretical factor of safety value of 1.00 (ie an assumed failure condition). The back analyses yielded effective strength parameters of zero cohesion and 28^o friction angle, for the potential clay seam. These effective strength parameters were then used in forward analyses for the existing slope profiles represented by Cross Section FF and JJ and for the assumed wet winter and extreme transient groundwater conditions in the bedrock.

For the purposes of the back analyses design effective strength parameters of 30^o friction angle and 40 kPa cohesion, were assumed for the weak zone extending through the bedrock, and design effective strength parameters of 30^o friction angle and 80 kPa cohesion, were assumed for the bedrock material.

7.3 RISK CATEGORIES

Traditionally, if a theoretical factor of safety value of 1.5 can be achieved by analysis, then the slope is considered to be stable. The problem arises in determining the correct parameters to use and the influence of subsurface conditions on the form of analysis, and which is consequently dependent on the nature and level of investigation.

Cumulating experience suggests that the proper selection of a theoretical factor of safety value for slope stability purposes is dependent upon a proper assessment of the level of risk.

The risk category of a particular slope is governed by the consequences of failure in terms of loss of life, property damage, or destruction of communications and services.

Typical high risk slopes are those where there is a likelihood of loss of life should the slope fail, eg. schools or apartments below cut slopes. A low risk slope, for example, is one which will only threaten a secondary road.

Brand (1982) cites design theoretical factor of safety values for residual soils for a 1 in 10 year return period storm for various risk categories as shown in Table 2 of this report.

TABLE 2: ACCEPTABLE FACTORS OF SAFETY FOR VARIOUS CATEGORIES OF RISK AS PROPOSED BY BRAND (1982)

Risk Category	Minimum Factor of Safety for Transient Conditions (eg. a 1 in 10 Year Storm)
Low	1.2
Significant	1.3
High	1.4

Factors of safety have been adopted in geotechnical design to cover the uncertainties in slope geology, soil data, the method of analysis adopted and the validity of assumptions made.

For these reasons, it is customary to adopt a theoretical factor of safety value of 1.5 for subdivisions or housing development. This factor of safety does not in every case assure safety from instability or slope movement. Based on published literature, the average risk of failure, or the probability of failure occurring, for different adopted factors of safety, is given in Table 3.

TABLE 3: RISK OF FAILURE OCCURRING FOR VARIOUS FACTORS OF SAFETY

Factor of Safety	Risk of Failure Per Annum
1.1	1:10
1.3	1:50
1.5	1:200
1.7	1:1000

It is our opinion that the slopes on the subject site fall into the low to possibly significant risk category. It is, therefore, concluded that while the conventionally accepted minimum value of approximately 1.5 should be adopted for the conventional stability analyses relating to groundwater levels “raised” for wet winter conditions, a lower acceptable theoretical factor

of safety value of between 1.2 and 1.3 could be adopted for the transient groundwater condition for saturation states that could occur during a period of prolonged intense rainfall, such as a 1 in 10 year return period storm.

7.4 RESULTS

7.4.1 Regression Line Analyses for Soil Veneer Materials at the Crest of the Steep Slopes

Based on the results of the investigations reported herein it is evident that the soil veneer at the crest of the steep slopes at the site generally ranges between approximately 1.5 m and 5.0 m thickness.

The regression line analyses, undertaken in order to determine the slope angle of a likely regression line, should the surficial soil veneer materials overlying the steep slopes be subject to slope instability, indicates that a regressed slope profile of 30^{o} to the horizontal (1V:1.73H) for the soil veneer materials at the crest of the steep slopes represented by Cross Sections AA to KK inclusive, obtains theoretical factor of safety values greater than the conventionally acceptable limiting values for slope stability purposes. This slope has been adopted as the regressed slope for the determination of the regression line for the site.

The regression line allows for the loss of the soil veneer materials at the crest of the steep slopes at the site, assuming that the soil veneer materials overlying the steep slopes have been removed by slope instability, and assumes that the soil veneer materials at the crest of the slopes will regress to a slope angle of 30^{o} to the horizontal (1V:1.73H) under assumed wet winter and extreme transient conditions.

7.4.2 Results of Potential Block Slide Analyses

A back analysis was performed on the assumed slope profile for the "benched" slope profile represented by Cross Section FF, prior to a theoretical block slide failure, with an assumed failure surface extending along an inferred low strength layer passing through the bedrock and along a horizontal clay seam at an elevation coincident with the toe of the steep slope in this area, based on the assumption, if the existing slope profile represented by Cross Section FF is the result of a bock slide failure, that the assumed slope profile comprises a block slide feature with a theoretical factor of safety value of unity, ie. an inferred failure condition. The analysis yielded an effective friction angle of 28^{o} and a cohesion value of zero for the assumed clay seam, for the assumed failure condition, assumed to be represented by near fully saturated groundwater conditions.

Forward Slope/W analyses yielded theoretical factor of safety values of 1.53 and 1.34 for the assumed wet winter and extreme transient groundwater conditions respectively within the bedrock, using the friction angle obtained from the back analysis (ie. assuming the presence of an inferred clay seam), for the existing slope profile represented by Cross Section FF. Forward Slope/W analyses yielded theoretical factor of safety values of 1.50 and 1.39 for the assumed wet winter and extreme transient groundwater conditions respectively within the bedrock, for the existing slope profile represented by Cross Section JJ.

These values are considered to be satisfactory, either approximating of being greater than the limiting values of 1.5 and 1.2 to 1.3 for wet winter and extreme transient groundwater conditions respectively.

It should be noted, as discussed in Section 6.5 of this report, that no evidence of block sliding, by way of disturbed, highly fractured bedrock, was observed in the machine boreholes in the zones where disturbance would be expected to be encountered, had the existing benches been formed by bock slides. Furthermore, no identifiable disturbed zone was detected within the bedrock at the locations of Test Pits TP5, TP6, TP10 and TP12, put down along the upslope edge of the benches shown on Cross Sections FF and JJ.

It is our opinion that the benches located on the steep west facing slopes, shown on Cross Sections FF and JJ, have developed due to differential erosion processes rather than being surficial evidence of the occurrence of deep-seated block sliding within the Waitemata Group bedrock underlying the site. This process would have primarily involved erosion by surface water and shallow landslides within the residual soil veneer materials.

It is our opinion that the benched profile observed for the west facing slopes at the site may also have been formed by coastal erosion processes, at a time when the sea levels were higher than they are today.

It is therefore concluded that deep-seated block slide movement is unlikely to occur and that the main risk to any proposed development is defined by the development of shallow seated soil veneer failures, and by the reactivation or continued movement of existing soil veneer failures.

No further consideration is therefore given within this report to the possibility of deep-seated block slide movement occurring at the site.

8.0 VEGETATION

As a vegetative mantle on a slope tends to improve the stability of that slope, it is recommended, as far as practicable, that the existing vegetation on the slopes at the site be retained and protected from damage by felling or clearing. Slope stability is enhanced by binding of the soil by the root systems of trees and other vegetation, which provides mechanical reinforcement and resists erosion by surface water, and by shedding of water by transpiration processes.

9.0 LIMITATIONS ON BUILDING CONSTRUCTION

9.1 GENERAL

This section of the report provides the location of a “Recommended Building Line Limitation” for the proposed development.

9.2 RECOMMENDED BUILDING LINE LIMITATION

Based on the site appraisal and investigations, as reported herein, and on the basis of ground conditions existing at the time of the investigation reported herein, a “Recommended Building Line Limitation” has been determined for the site.

The "Recommended Building Line Limitation" shown in plan on drawings 60834/1A and 2A, and on Cross Sections AA to KK inclusive of this report, represents, in our opinion, the limit up to which residential buildings can be constructed in accordance with the requirements of NZS 3604:1999, New Zealand Standard, Timber Framed Buildings.

The "Recommended Building Line Limitation" has generally been developed by projecting a regression line at an angle of 30^{o} to the horizontal (1V:1.73H) into the slope commencing from the top of the inferred bedrock beneath the crest of the steep slopes at the site. The location of the interface between the soil veneer and the bedrock underlying the crest of the steep slopes at the site, has been determined from the borehole and test pit investigations reported herein.

A five metre margin of safety has been applied at the point where the theoretical regression line intersects the ground surface existing at the time of the investigation reported herein, in order to define the "Recommended Building Line Limitation" for Cross Sections BB, CC, FF, HH, II, JJ and KK.

A fifteen metre margin of safety has been applied at the point where the theoretical regression line intersects the ground surface existing at the time of the investigation reported herein, in order to define the "Recommended Building Line Limitation" for Cross Section AA. Cross Section AA represents the profile of the steep west facing slope located in the north western part of the site. As indicated on drawing 60834/3A, the slope profile represented by Cross Section AA is not benched. However the results of the stereoscopic study of aerial photographs for the site reported herein, indicates that benches are evident on similar west facing slopes located to the north and south of the slope represented by Cross Section AA. Although the coastal erosion processes, which are believed to have resulted in the formation of the benches observed at the site, are unlikely to adversely affect the slope profile represented by Cross Section AA within the next 100 years, there is in our opinion a risk, albeit slight, that the slopes located in the vicinity of Cross Section AA, may be subject to regression consistent with the west facing slopes located to the north and south of the subject area. For this reason, a greater margin of safety of fifteen metres has been applied to determine the "Recommended Building Line Limitation" for Cross Section AA, which equates to a horizontal distance of approximately 25 m upslope from the steep slopes in this area.

The “Recommended Building Line Limitation” for the slope profiles represented by Cross Sections DD, EE and GG, has been located a horizontal distance of approximately fifteen metres upslope from side slopes steeper than 18^{o} to the horizontal (1V:3H).

The “Recommended Building Line Limitation” defines the boundary between:-

(a) A non specific building foundation design zone, in which the foundations of any proposed residential building do not require specific design and which may, therefore, be constructed in accordance with the relevant New Zealand Standard Codes of Practice, providing the inspection and design of foundations are carried out as would be done under normal circumstances in accordance with the requirements of relevant New Zealand Standard Codes of Practice.

(b) A specific building foundation design zone, in which the foundations of any proposed residential building should be subject to specific design with particular regard to slope stability and settlement by a chartered professional engineer either experienced in geotechnical engineering or with the assistance of an engineer experienced in geotechnical engineering. Within this zone, the designer should, along with other criteria considered appropriate, undertake the following:

    (i) The design of a foundation system which properly takes into account the ground conditions at the specific location of any proposed structure.

(ii) An assessment of founding depths and the locations of foundation lines to provide secure foundations for any proposed structure in the event of slope movement.

(iii) The design of a foundation type to suit the proposed structure and to allow for soil creep and the distribution of lateral loads from the structure.

It should be noted that the "Recommended Building Line Limitation" shown in plan on drawings 60834/1A and 2A and on the cross section profiles on drawings 60834/3A to 13A, is based on the existing ground surface profile. Subdivisional earthworks in the vicinity of the "Recommended Building Line Limitation" are likely to change the location of the "Recommended Building Line Limitation" in some places. It is envisaged that the location of the "Recommended Building Line Limitation" will be reviewed following the completion of any subdivisional earthworks and the revised location will be presented in the Geotechnical Completion Report to be prepared for the site.

It is recommended that any proposed building development be designed to satisfy the relevant requirements of the Building Code, so as to ensure compliance with the Building Act.

It should also be noted, based on the results of the investigation and appraisal reported herein, there is, in our opinion, a risk that land located within the specific foundation design zone determined for the site, may be subject to slope instability during or following heavy rainfall, which may result in the loss of land within the specific foundation design zone. It is, however, our opinion, providing any proposed building development at the site located within the specific foundation design zone is subject to specific foundation design, as discussed in the foregoing Item (b), and is designed in accordance with the recommendations reported herein, that slope instability is unlikely to adversely affect future residential buildings at the site.

10.0 FOUNDATION AND SETTLEMENT CONSIDERATIONS

10.1 PROPOSED RESIDENTIAL DEVELOPMENT

As discussed in Section 3.0 of this report, it is understood that it is proposed to subdivide the subject site in order to create 189 new residential lots.

It is our opinion that settlement at the site should not present a problem within the proposed subdivisional development, for residential buildings founded on the Waitemata Group residual soils, providing the inspection and design of foundations are carried out in accordance with the requirements of NZS 3604, including the provisions of Clauses 3.1.2 and 3.1.3 of NZS 3604, and providing the recommendations in this report are adopted.

It is nevertheless recommended that, where brick veneer construction is proposed, consideration be given to minimising potentially unsightly cracking of veneer cladding due to possible differential settlement or movement, by ensuring that the veneer is erected in discrete panels of maximum length of approximately three metres, or greater if permitted by the cladding manufacturer's instructions. In general, however, if the good practices of NZS 3604 are adhered to, any settlement during the service life of any residential buildings so constructed should not, in our opinion, be a problem.

To assist in the interpretation of this recommendation, and by way of "good practice", it is expected that the recommendation would be applied, for example, for concrete slab-on-ground construction, in the following manner:

(a) If a design proposal involves full height expanses of brick veneer cladding in excess of three metres in length, and without substantial openings such as windows and doors, then it is our opinion that consideration should be given by the designer to incorporate movement control joints, unless other measures are applied such as the deepening or strengthening of foundations in excess of minimum code requirements, so as to minimise the risk of differential swell/shrink movements, and

(b) If a design proposal involves numerous window and door openings, so as to ensure that height expanses of brick veneer cladding are less than three metres in length, and the cladding was to be supported on continuous reinforced concrete foundation walls integrally keyed and connected to the foundation slab, so as to ensure that the foundation wall and slab act as an integrated rigid structure, and the foundation wall is appropriately designed to mitigate against the effects of soil swell/shrink, then it is our opinion that movement control joints need not be incorporated into the cladding design.

10.2 PROPOSED RESIDENTIAL DEVELOPMENT

As discussed in Section 3.0 of this report, it is understood that 7 new lots within the subdivision may be used for other uses (e.g. retail or commercial).

It is recommended that specific appraisals be undertaken for any proposed heavy structures (i.e. structures outside the scope of NZS 3604) by a chartered professional engineer experienced in geotechnical engineering in order to assess the risk of differential foundation settlement adversely affecting the proposed structure. It is anticipated that the specific settlement appraisal works would be undertaken in support of an application for building consent for any such structure.

11.0 ALLOWABLE FOUNDATION BEARING PRESSURES

11.1 GENERAL

In this section of the report, ultimate bearing capacity values and strength reduction factors are provided in order to allow calculation of design (dependable) foundation bearing capacities, in accordance with the limit state design methods outlined in AS/NZS 1170, Structural Design Actions, by applying the appropriate strength reduction factors, as provided in this report, and the factored load combinations required by AS/NZS 1170. Allowable foundation bearing pressures are also provided, based on conventional factors of safety, for cases where unfactored load combinations are being considered.

11.2 SHALLOW PAD OR STRIP FOOTINGS

From the in situ undrained shear strengths obtained in the field investigation, a design in situ undrained shear strength value of 100 kPa has been determined for the natural residual soil veneer materials.

On the basis of the design undrained shear strength value of 100 kPa, and assuming the subsoil is saturated and that the soil friction angle is zero, an ultimate static bearing capacity value for vertical loading of 600 kPa is recommended for shallow strip and pad footings. It is recommended that a strength reduction factor (Φ_{bc}) of 0.5 be adopted for limit state design in accordance with the requirements of AS/NZS 1170, resulting in a design (dependable) bearing capacity value of 300 kPa.

If unfactored load combinations are to be considered, the allowable foundation bearing pressures presented in Table 4 are recommended for shallow pad or strip footings founded on natural residual soils.

The allowable foundation bearing pressures shown in Table 4 are based on the design in situ undrained shear strength value of 100 kPa, and on the assumption that the subsoil is saturated and that the soil friction angle is zero.

TABLE 4: ALLOWABLE FOUNDATION BEARING PRESSURES FOR SHALLOW PAD OR STRIP FOOTINGS ON NATURAL RESIDUAL SOILS

Load Case	Factor of Safety	Allowable Bearing Pressure (kPa)
Dead Load and Permanent Live Load	3.0	200
Dead plus Live plus Transient Load	2.0	300

11.3 PILES FOUNDED IN THE SOIL VENEER

From the in situ undrained shear strengths obtained in the field investigation, a design in situ undrained shear strength value of 100 kPa has been determined for the residual soil veneer materials.

On the basis of the design undrained shear strength value of 100 kPa and assuming the subsoil is saturated and that the soil friction angle is zero, an ultimate static bearing capacity value for vertical loading of 900 kPa is recommended for piled foundations founded in the soil veneer. It is recommended that a strength reduction factor (Φ_{bc}) of 0.5 be adopted for limit state design in accordance with the requirements of AS/NZS 1170, resulting in a design (dependable) bearing capacity value of 450 kPa

If unfactored load combinations are to be considered, the allowable foundation bearing pressures presented in Table 5 are recommended for piles founded in the soil veneer.

It is recommended that an ultimate skin friction value of 40 kPa be used for the design of piled foundations. It is recommended that a strength reduction factor (Φ_{sf}) of 0.5 be adopted for limit state design, resulting in a design (dependable) skin friction value of

20 kPa. If unfactored load combinations are to be considered, the allowable skin friction values presented in Table 5 are recommended.

TABLE 5: ALLOWABLE END BEARING PRESSURES AND SKIN FRICTION VALUES FOR PILES FOUNDED IN THE RESIDUAL SOIL VENEER

Load Case	Factor of safety	Allowable End Bearing Pressure (kPa)	Allowable Skin Friction (kPa)
Dead Load and Permanent Live Load	3.0	300	13
Dead plus Live plus Transient Load	2.0	450	20

11.4 PILES FOUNDED IN BEDROCK

Based on results of pile load tests undertaken by others on Waitemata Group bedrock in the Auckland area, it is our opinion and recommendation that an ultimate static bearing capacity for vertical loading of 6.0 MPa be adopted for piled foundations founded in rock, provided that the piles are socketted into bedrock with an SPT "N" value of 50 or greater or a DCP test result value greater than 11 blows per 50 mm of penetration, to a minimum depth equivalent to four pile diameters. It is recommended that a strength reduction factor (Φ_{bc}) of 0.5 be adopted for limit state design in accordance with the requirements of AS/NZS 1170, resulting in a design (dependable) bearing capacity value of 3.0 MPa. The allowable design end bearing pressures indicated in Table 6 of this report are recommended for bored cast in situ piled foundations in rock.

The results of pile load tests undertaken on bored pile sockets in the Waitemata Group siltstone and sandstone and in similar material in Australia indicate that for soft rock with an unconfined compressive strength (UCS) greater than 2 MPa and less than 10 MPa, an end bearing pressure of 0.8 UCS and a shaft shear stress of 0.4 UCS are mobilised at a pile settlement equivalent to 2% of the pile socket diameter, (the shaft shear stress relates to a grooved socket). For an ungrooved rock socket the shaft shear stress reduces from 0.4 UCS to 0.1 UCS.

If, therefore, a pile settlement equivalent to 2% of the pile socket diameter is considered acceptable for a pile with loading stresses equivalent to the dependable values, it is recommended that design (dependable) pile socket skin friction values of 1.2 MPa and 0.3 MPa be adopted for the cases of spiral grooved and ungrooved pile sockets respectively in bedrock with an SPT "N" value of 50 or greater.

If unfactored load combinations are to be considered, the allowable pile end bearing and shaft friction values presented in Table 6 are recommended.

TABLE 6: ALLOWABLE END BEARING PRESSURES AND SKIN FRICTION VALUES FOR PILE SOCKETS IN WAITEMATA GROUP BEDROCK WITH AN SPT "N" VALUE OF 50 OR GREATER

Load Case	Factor of Safety	**Allowable End Bearing Pressure (MPa)**	**Allowable Skin Friction* (MPa)**	**Allowable Skin Friction** (MPa)**
Dead Load plus Permanent Live Load	3.0	2.0	0.8	0.2
Dead plus Live plus Transient Loads	2.0	3.0	1.2	0.3

NOTE: * Relates to a spiral grooved pile socket.
** Relates to an ungrooved pile socket

It is recommended that no reliance on skin friction be allowed for within the soil zone.

It is further recommended that Fraser Thomas Ltd be engaged to inspect any pile bores prior to placing of any foundation materials to confirm that the bores are drilled to an appropriate depth.

11.5 SAFE MAXIMUM VALUES

The allowable foundation bearing pressures indicated in Tables 4, 5 and 6 are, in our opinion, safe maximum values. These values do not, however, take account of settlement considerations or the need to limit the foundation bearing pressures so as to limit the associated settlement. However it is our opinion, providing the proposed foundations are designed in accordance with the requirements of NZS 3604:1999, New Zealand Standard, Timber Framed Buildings, and in accordance with the recommendations reported herein, that settlement should not present a problem for proposed residential dwellings at the site.

12.0 GROUNDWATER FLUCTUATIONS AND SOIL MOISTURE CHANGES

Building foundation settlements can be affected by seasonal variations in groundwater levels. The seasonal raising of groundwater levels affecting the site could result in a reduction of the in situ soil strengths, however, with particular regard to the development site, it is our opinion that the subsoil conditions are not likely to be significantly altered as a result of the proposed residential development at the site.

Nevertheless, seasonal moisture variations and associated swelling and shrinking of the soil mass is a characteristic of the type of surface soils encountered in the area under consideration and is likely to occur.

Even well constructed buildings on clay soils are likely to show minor cracking of plaster walls and ceilings and in masonry. In extreme cases, distortion of building frames may

cause doors and windows to jam, however, these effects usually occur only after a long dry summer. Without considerable expenditure on the part of the individual responsible for building or financing any particular residential construction, it is generally not possible to entirely eliminate such troubles. Provided that the good practices of NZS 3604:1999, New Zealand Standard, Timber Framed Buildings, including the provisions of Clauses 3.1.2 and 3.1.3 of NZS 3604, are complied with, it is probable that any such influences should be minimised, although some shrinking and swelling of the surficial soils under seasonal influences will probably continue to occur and may affect such residential construction.

It should be noted that the foundation provisions of NZS 3604 apply only to buildings which, along with other requirements of the Standard, are supported on "good ground". The definition of "good ground" excludes soils which are classified as being "expansive soils". In particular, Clause 3.2.1.2 of the Standard requires that "clays shall be regarded as expansive clays if their soil properties, in soil mechanic terms, exceed the values listed in the definition of good ground."

Expansive soils are defined by the Code as those soils that have a liquid limit of more than 50% and a linear shrinkage of more than 15 %, determined in accordance with the test procedures described in NZS 4404:1986. As discussed in Section 5.6 of this report, the linear shrinkage values obtained by the specified test procedure were 20%, 21% and 16% in Boreholes H2, H8 and H20 respectively, which exceed the limiting value of 15%. Based on the foregoing linear shrinkage values, and on our experience with similar soils elsewhere in the Auckland region, it is our opinion that the surficial soils at the site are slightly to moderately expansive.

It is noted that Clause 3.3.2 of the 1990 edition of the Code required a minimum founding depth below cleared ground level of 450 mm in expansive clay. The 1999 edition does not provide a minimum depth for footings in expansive clay. Section 3.1.1 of the Code states that:

> ".... If a site does not comply with [the code site requirements] the foundations only shall be the subject of specific engineering design.
>
> Foundations on expansive soils are outside of the scope of this standard as an Acceptable Solution to the NZBC. [New Zealand Building Code]"

The Commentary clause to Section 3.1.1 of the Code (C3.1.1) directs the designer to Section 17 of the Code "which may be of assistance to those designing foundations on expansive soils". Clause 17.3 refers the designer to Sections 3, 5 and 6 of the Australian Standard AS 2870 "Residential Slabs and Footings".

Figure 3.1 of AS 2870 for concrete slabs on ground and stiffened concrete slabs specifies a minimum edge beam depth of up to 450 mm for Class S soil sites and up to 800 mm for Class M sites. Class S soil sites are defined as "slightly reactive clay sites with only slight ground movement from moisture changes". Class M soil sites are defined as "moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes."

Clause 7.5.2 of NZS 3604:1999 requires that the floor level of a slab on ground floor shall be a minimum height above the level of adjoining ground which is not protected by paving of 150 mm for masonry veneer exterior wall cladding, and 225 mm for other exterior wall

coverings (these values reduce to 100 mm and 150 mm respectively when the adjoining ground is protected by paving).

The recommended foundation embedment depth of the 1990 edition of 450 mm below cleared ground level, based on the condition of adjoining ground which is not protected by paving, therefore equates to minimum edge beam depths in terms of AS 2870 of between 600 mm and 675 mm. These depths are greater than the minimum edge beam depths of between 300 mm and 400 mm specified for slightly to moderately reactive sites in AS 2870 for masonry veneer construction, and are comparable to the minimum edge beam depths of 450 mm to 800 mm specified respectively for slightly to moderately reactive sites in AS 2870 for full masonry construction.

Based on our experience of the type of soils encountered at the subject site, our determination that the subject site soils are slightly to moderately expansive (or slightly to moderately reactive as expressed for Class S and M soils in AS 2870) it is our experience and recommendation, that a minimum founding depth of 450 mm below finished external cleared ground levels, for conventional shallow concrete foundations, provides an appropriate specific foundation design embedment depth so as to minimise the effects of ground swelling and shrinkage for clad timber frame and masonry veneer construction, and should also be appropriate for full masonry construction.

It is recommended that the earthworks subgrade within the footprint of any proposed building be maintained at or close to its natural water content to avoid drying out and associated shrinkage of the subgrade. Any drying out of the subgrade may result in the subgrade swelling after building construction, resulting in the possibility of heaving and cracking of the floor slab. This risk may be mitigated during construction by placement of a minimum 300 mm thick granular layer or some other suitable barrier to soil water loss, such as a Damp Proof Membrane (DPM) underlain with a 50mm thick cushion course of sand, within three days following excavation of the building subgrade.

Nevertheless, should the exposed building subgrade be subject to drying during the three day period prior to the placement of the barrier to soil water loss, it is recommended that consideration be given to wetting up the building subgrade prior to the placement of the barrier.

13.0 EXISTING SERVICE LINES

It is expected that any existing service line trenches underlying the site were backfilled by conventionally acceptable means, which did not involve specific compaction. It would therefore be expected that some consolidation settlement of the service trench backfill could occur, which could result in lateral and vertical deformation of the undisturbed ground on each side of the trench backfill. The deformation is caused by the soil wedge behind the side wall of the trench moving downwards and inwards with time, towards the trench backfill as the backfill consolidates. The geometry of the soil wedge defines the theoretical zone of influence of the service trench backfill.

Due to the risk of consolidation settlement of the trench backfill occurring, it is recommended, if any foundations of any proposed building are located within the zone of influence of existing service lines, that either the trench backfill be excavated and replaced with compacted hardfill, or that the foundations and floor of the proposed building be designed to span across the trench backfill and the adjacent zone of influence.

The zone of influence is defined by a theoretical line projecting upwards in both directions from the centreline of the pipeline at the invert level of the pipeline at an angle of 45^{o} to the vertical. The zone of influence is defined by the zone between the intersection point of the theoretical line and the ground surface on each side of the pipeline.

It is recommended that any proposed foundation excavations in the vicinity of the inferred extent of the zone of influence of the existing service lines be inspected by Fraser Thomas Ltd to ensure that the foundations are not underlain by any trench backfill which may be associated with the existing service lines.

14.0 EARTHWORKS CONSIDERATIONS

14.1 GENERAL

It is understood that it is proposed to undertake cut and fill earthworks at the site in order form the subgrade for the proposed new roads. Earthworks will also be undertaken in order to create level building platforms in some places.

It is understood that the fill material for the proposed fill earthworks will be borrowed from cut earthworks undertaken within the site.

It s understood that any excess material associated with the proposed cut earthworks at the site, will be placed as non-engineered to the north of the proposed development.

It should be anticipated that the soils in the proposed fill and cut areas may be sensitive to disturbance by earthworks plant and inclement weather. These two factors together could result in plant trafficability problems, and which may result in the artificial creation, by virtue of ill conceived construction efforts, of excessive quantities of unsuitable (i.e. unworkable) materials, unless earthworks construction activities and the nature of the earthmoving plant used in the site development are selected and controlled in cognisance of the particular characteristics of the site materials.

14.2 PROPOSED FILL AREAS

The maximum depth of filling anticipated at the site for the construction of the proposed new access roads is approximately 7.0 m, at the northern end of Gully D. Earthworks in this area are expected to involve the backfilling of the head of Gully D in order to form a level platform for the construction of a proposed new road in this area. The fill end slopes associated with these earthworks are proposed to be permanently retained by a retaining wall.

Fill earthworks, up to approximately 10.5 m depth, are proposed to be undertaken in order to backfill the head of Gully A, in order to form a level building platform in this area. The fill end slopes associated with these earthworks are proposed to be formed to a safe permanent batter slope profile.

Fill earthworks, up to approximately 6.0 m depth, are proposed to be undertaken in order to backfill the head of Gully B, in order to form a level building platform in this area. The fill end slopes associated with these earthworks are proposed to be formed to a safe permanent batter slope profile.

Fill earthworks, up to approximately 5.5 m depth, are also proposed to be undertaken in order to backfill the head of Gully C, in order to form a level building platform in this area. The fill end slopes associated with these earthworks are proposed to be permanently retained by a retaining wall.

The foregoing proposed fill earthworks are generally located downslope of the "Recommended Building Line Limitation" determined for the site.

Generally fill earthworks ranging between approximately 1.0 m and 3.5 m depth are proposed for the areas located upslope of the "Recommended Building Line Limitation", within the non-specific foundation design zone at the site.

It is understood that it is proposed to place fill material, up to approximately 6.0 m depth, to the north of the proposed development area in order to dispose of excess cut material associated with the proposed cut and fill earthworks at the site. It is understood that this material will not be “engineered fill” but will be subject to some specific compaction to ensure that the fill material has adequate effective strength parameters to ensure stability of the fill.

The approximate location and extent of the proposed fill areas are shown on drawing 60834/2A.

14.3 PROPOSED CUT AREAS

It is understood that the fill material for the proposed fill earthworks at the site will be borrowed from cut earthworks undertaken generally in the central and southern parts of the site.

It is anticipated that the borrow material will generally comprise silty clays and clayey silts, inferred to be residual soils of the Waitemata Group.

The maximum depth of cut is expected to be located in the central and southern parts of the site and is expected to be up to approximately 5.0 m depth.

The undrained shear strength values in the proposed cut materials, as determined from the borehole logs of Appendix A, are expected to generally be in excess of 100 kPa, corresponding to a very stiff consistency.

Based on our observation of the residual soils encountered at the site during the investigations reported herein, and our experience with similar soils in the Auckland area, it is our opinion that the residual soils should be suitable for placement and compaction as engineered fill for the formation of the proposed new road subgrades and proposed building platforms. It is recommended, however , that specific compaction tests be undertaken on selected samples of the proposed borrow material, prior to the commencement of fill earthworks, in order to determine the compactability of the residual soils.

14.4 SITE PREPARATION

Preparation prior to placing and compaction of any fill at the site should involve the stripping of any topsoil material to stockpile and also the undercutting of any unsuitable material.

It is recommended that Fraser Thomas be engaged to observe any stripping/undercutting prior to the placement of any fill material, so that the adequacy of any stripping/undercutting can be verified.

14.5 BENCHING

It is recommended that any fill placed downslope of the "Recommended Building Line Limitation", or on existing slopes steeper than 15^{o} to the horizontal (1V:3.73H), be placed and compacted on benches cut into the slopes at the site. It is recommended that the benches be slightly sloping into the existing natural slope, and that the surface of the benches be scarified prior to placement of any fill material in order to improve the bond between the bench subgrade and the proposed fill material. The benches should be a minimum width of 5.0 m.

14.6 UNDERFILL DRAINAGE

It may, in our opinion, be necessary to install underfill drainage or a drainage blanket where groundwater seepage is encountered. If underfill drainage is required, it should be directed in a controlled manner to the discharge into the existing watercourses at the site.

14.7 COMPACTION CRITERIA

It is recommended that any fill material placed within the proposed development at the site be placed are in accordance with the general requirements described in NZS 4431: 1989; Earth Fill for Residential Development, and in accordance with the recommended fill specification presented in Appendix B of this report.

It is recommended that Fraser Thomas Ltd be engaged to observe the placement and compaction of the proposed fill material to confirm that the fill has been placed in accordance with the recommended fill specification.

14.8 BULKING FACTORS

On the basis of experience with similar soils in the Auckland area, a bulking factor from solid in situ cut to solid in situ fill for earthworks calculations in the range of 10% to 20% is considered appropriate. In our opinion, a value of 15% could reasonably be taken for design purposes for the soils expected to be encountered during the bulk earthworks at the site. This recommended bulking factor relates to the volume reduction from cut to fill and does not include an allowance for spillage, wastage or otherwise unsuitable materials.
An indicative bulking increase factor for solid cut to loose spoil of 30% is, in our opinion, appropriate for excavation of the site materials to stockpile.

14.9 BUTTRESS TRENCH DRAINS

In order to control the groundwater level in the vicinity of the proposed filling to be undertaken at the heads of Gullies A, B and C and to enhance the stability of the slopes in these areas, it is recommended that buttress trench drains be installed in these slopes prior to the placement of any fill material.

The buttress trench drains should be spaced no further apart than approximately 12 m. The approximate recommended locations and extents of the proposed buttress trench drains are shown on drawing 60834/2A.

typical schematic buttress trench drain detail is shown on the attached Figure 1. It is recommended that the trench width be a minimum of 0.5 m.

It is recommended that the buttress trench drains be excavated, in general, down to a depth of up to approximately 4.0 m below the existing ground surface, at the upslope end of each drain. It is recommended that the drains be backfilled with a lightly compacted SAP 20 scoria drainage material or similar and sealed with compacted clay to prevent ingress of surface water.

It is recommended that the drains be appropriately directed to discharge at the downslope end of any proposed filling, into the existing watercourses.

It is recommended that Fraser Thomas Ltd be engaged to observe the excavation of the buttress trench drains to confirm that they are founded at appropriate depths and are appropriately constructed.

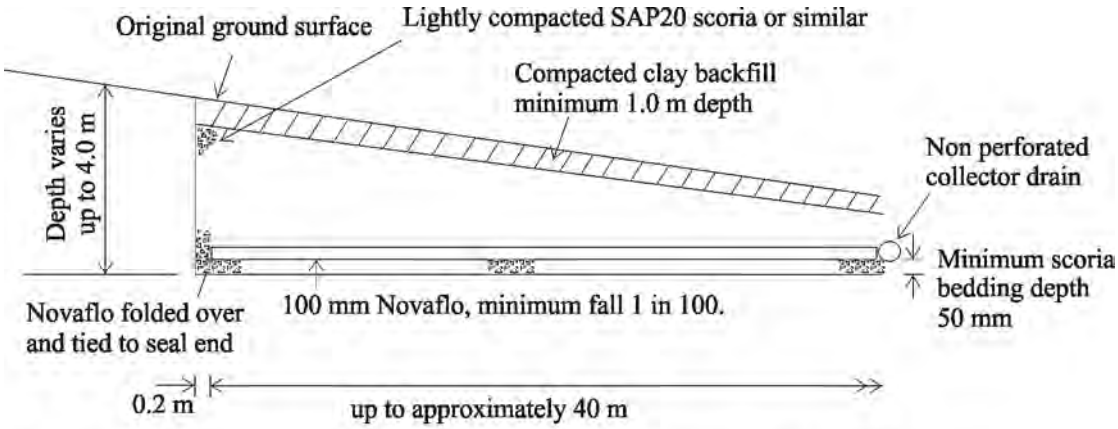


FIGURE 1: SCHEMATIC BUTTRESS TRENCH DRAIN DETAIL (NOT TO SCALE).

14.10 PERMANENT FILL END BATTER SLOPES

It is recommended that, unless the stability of any developmental earthworks is considered in detail by a chartered professional engineer experienced in geotechnical engineering, and particularly slope stability considerations, permanent fill end slopes (comprising engineered fill) should be constructed to a maximum batter slope of 26^{o} (1V:2H) with maximum batter height of approximately 16.0 m. Any proposed higher batter slopes should be subject to specific stability appreciation so as to determine stable limiting batter slopes.

Unless a bench is incorporated into the batter slope profile, it is recommend that batter slopes be a maximum 10.0 m in vertical height.

Any benches should be a minimum 4.5 m wide and should be constructed so as to slope back into the slope at a minimum gradient of 1.5%. An appropriately constructed drain should be installed along the upslope edge of the bench so as to collect the stormwater collected by the bench. This stormwater should be piped in sealed pipes to discharge to the base of the batter slope. An appropriately designed energy dissipation structure will be required to installed at the discharge point of the sealed pipes.

It is further recommended, in order to mitigate against shallow sloughing of the permanent batter slope face due to concentrated stormwater runoff over the batter face, that stormwater runoff be diverted away from the crest of any proposed permanent batter slope.

14.11 SLOPE STABILITY CONSIDERATONS

The maximum depths of proposed filling are located downslope of the "Recommend Building Line Limitation", within the specific foundation design zone.

Providing any fill earthworks are undertaken in accordance with the relevant New Zealand Standard Codes of Practice, and in accordance with the recommendations presented herein, it is our opinion that the proposed fill earthworks as indicated on drawing 60834/2A, are unlikely to adversely affect the stability of the existing slopes at the site.

15.0 RETAINING WALLS

15.1 GENERAL

It is understood that the proposed subdivisional earthworks at the site will involve the construction of retaining walls at three main locations. The proposed retaining walls are identified as Proposed Retaining Walls A, B, C and D, for the purposes of this report.

Proposed Retaining Wall A is located at the head of Gully D. Proposed Retaining Wall C is located at the head of Gully C.

Proposed Retaining Walls B and D are located in the central and western parts of the site respectively.

The approximate locations and extents of the proposed retaining walls are shown on drawing 60834/2A.

15.2 PROPOSED RETAINING WALL A

Proposed Retaining Wall A will be up to approximately 7.0 m in vertical height and approximately 160 m long. Proposed Retaining Wall A is associated with the formation of a proposed new road.

On the basis of the logs of the boreholes put down at the site and our experience with similar soils elsewhere, the following **preliminary** soil parameters are recommended for the design of Proposed Retaining Wall A:

(a)	Effective friction angle of fill being retained:	30^o
(b)	Effective cohesion of soils:	0 kPa
(c)	Bulk density of soil:	18 kN/m^3

(d) Active soil pressure coefficient (K_a) for cases where lateral soil movement will be able to occur against a flexible retaining wall structure and assuming no slope surcharge: 0.33

(e) At rest pressure coefficient (K_o) for cases where lateral soil movement will not be able to occur against a rigid retaining wall structure and assuming no slope surcharge: 0.50

(f) Undrained shear strength of the residual soil in the retaining wall foundation embedment zone: 100 kPa

It should be noted that recent alluvial sediments may underlie the footprint of the proposed retaining wall. It is recommended that the proposed retaining wall be founded beneath any highly compressible recent alluvial sediments into competent residual soils or bedrock.

The proposed retaining wall should be provided with an adequate free draining zone to the rear with a suitable drainage outlet, so as to ensure the wall will not be subject to hydrostatic pressure.

It is recommended that the proposed retaining wall be appropriately designed to take account of the loss of support due to sloping ground located downslope of the base of the proposed retaining wall. It is recommended, for design purposes, that the upper 0.6 m of soil veneer located downslope for the retaining wall be assumed to not provide any ground support for the proposed retaining wall.

15.3 PROPOSED RETAINING WALL B

Proposed Retaining Wall B will be up to approximately 2.6 m in vertical height and approximately 80 m long. Proposed Retaining Wall B is associated with the formation of proposed level building platforms in the central part of the site.

On the basis of the logs of the boreholes put down at the site and our experience with similar soils elsewhere, the following **preliminary** soil parameters are recommended for the design of Proposed Retaining Wall B:

(a) Effective friction angle of fill being retained: 30^o

(b) Effective cohesion of soils: 0 kPa

(c) Bulk density of soil: 18 kN/m^3

(d) Active soil pressure coefficient (K_a) for cases where lateral soil movement will be able to occur against a flexible retaining wall structure and assuming no slope surcharge: 0.33

(e) At rest pressure coefficient (K_o) for cases where lateral soil movement will not be able to occur against a rigid retaining wall structure and assuming no slope surcharge: 0.50

(f) Undrained shear strength of soil in the retaining wall foundation embedment zone 100 kPa

The proposed retaining wall should be provided with an adequate free draining zone to the rear with a suitable drainage outlet, so as to ensure the wall will not be subject to hydrostatic pressure.

15.4 PROPOSED RETAINING WALL C

Proposed Retaining Wall C will be up to approximately 5.8 m in vertical height and approximately 60 m long. Proposed Retaining Wall C is a two-tiered wall and is associated with the formation of proposed level building platforms in the southern part of the site.

On the basis of the logs of the boreholes put down at the site and our experience with similar soils elsewhere, the following **preliminary** soil parameters are recommended for the design of Proposed Retaining Wall C:

(a) Effective friction angle of fill being retained: 30^o

(b) Effective cohesion of soils: 0 kPa

(c) Bulk density of soil: 18 kN/m^3

(d) Active soil pressure coefficient (K_a) for cases where lateral soil movement will be able to occur against a flexible retaining wall structure and assuming a slope surcharge of 5^o to the horizontal: 0.35

(e) At rest pressure coefficient (K_o) for cases where lateral soil movement will not be able to occur against a rigid retaining wall structure and assuming no slope surcharge: 0.53

(f) Undrained shear strength of soil in the retaining wall foundation embedment zone 100 kPa

The proposed retaining wall should be provided with an adequate free draining zone to the rear with a suitable drainage outlet, so as to ensure the wall will not be subject to hydrostatic pressure.

It is recommended that the proposed retaining wall be appropriately designed to take account of the loss of support due to sloping ground located downslope of the base of the proposed retaining wall. It is recommended, for design purposes, that the upper 0.6 m of soil veneer located downslope for the retaining wall be assumed to not provide any ground support for the proposed retaining wall.

15.5 PROPOSED RETAINING WALL D

Proposed Retaining Wall D will be up to approximately 2.4 m in vertical height and approximately 60 m long. Proposed Retaining Wall D is associated with the formation of proposed level building platforms in the western part of the site.

On the basis of the logs of the boreholes put down at the site and our experience with similar soils elsewhere, the following **preliminary** soil parameters are recommended for the design of Proposed Retaining Wall D:

(a)	Effective friction angle of fill being retained:	30^o
(b)	Effective cohesion of soils:	0 kPa
(c)	Bulk density of soil:	18 kN/m^3
(d)	Active soil pressure coefficient (K_a) for cases where lateral soil movement will be able to occur against a flexible retaining wall structure and assuming no slope surcharge:	0.33
(e)	At rest pressure coefficient (K_o) for cases where lateral soil movement will not be able to occur against a rigid retaining wall structure and assuming no slope surcharge:	0.50
(f)	Undrained shear strength of soil in the retaining wall foundation embedment zone	100 kPa

The proposed retaining wall should be provided with an adequate free draining zone to the rear with a suitable drainage outlet, so as to ensure the wall will not be subject to hydrostatic pressure.

15.6 RETAINING WALL SURCHARGES

It should be noted, depending on the locations of the proposed walls at the site and the finished site profile, that traffic surcharges may be imposed on the proposed retaining walls. It is recommended that any proposed retaining wall at the site be appropriately designed to take account of any traffic surcharges, and any other surcharges, which may be imposed on the retaining walls.

15.7 SPECIFIC GEOTECHNICAL INVESTIGATIONS

The retaining wall preliminary design parameters presented in Sections 15.2, 15.3, 15.4 and 15.5 are based on limited field investigation data. The type and configuration of the proposed retaining walls are also not known at this stage. It is recommended, once the type and configuration of the proposed retaining walls is known, that a specific geotechnical investigation be undertaken for proposed Walls A to D, in order to provide reliable retaining wall design parameters and recommendations for detailed design purposes.

16.0 DEVELOPMENTAL EARTHWORKS

It is recommended, unless the stability of any developmental earthworks is considered in detail by a chartered professional engineer experienced in geotechnical engineering, that **temporary** cut and fill slopes should be constructed to a maximum slope angle of 30^{o} (1V:1.73) with maximum batter height of approximately 2.0 m. Any proposed higher batter slopes should be subject to specific stability appreciation so as to determine stable limiting batter slopes.

It is further recommended, in order to mitigate against shallow sloughing of the temporary batter slope face due to concentrated stormwater runoff over the batter face, that stormwater runoff be diverted away from the crest of any proposed temporary batter slope.

17.0 EXCAVATABILITY

As discussed in Section 3.0 of this report, it is understood that it is proposed to undertake cut and fill earthworks at the site. The maximum depth of cut is expected to be located in the central and southern parts of the site and is expected to be up to approximately 5.0 m depth.

It is anticipated that the excavations will generally be undertaken within residual soils and very weak to extremely weak Waitemata Group sandstone and mudstone.

It is anticipated that the residual soils and the very weak to extremely weak Waitemata Group sandstone and mudstone will be able to be excavated using conventional hydraulic excavation equipment and techniques.

It is however anticipated that either a ripping hook or a pneumatic breaker may be required to excavate moderately strong to weak bedrock material, if these materials are encountered during the proposed excavations.

18.0 STORMWATER DISPOSAL

Stormwater disposal issues associated with the proposed development at the site will be addressed by Fraser Thomas Ltd in a separate report.

Unless Fraser Thomas Ltd are engaged to undertake further specific appraisal works to assess the risk of stormwater discharge on the stability of slopes at the site, it is recommended that the stormwater from the roof area of any proposed new buildings, that is not retained for domestic use, or paved areas, be directed in a controlled manner in sealed pipes to the proposed reticulated stormwater system or to the toe of the slopes at the site.

It is recommended, if the water is directed to discharge at the toe of the steep slopes at the site, that an appropriately designed energy dissipation structure be constructed at the outlet of any such pipe so as to the prevent any localised soil erosion at the discharge point.

It is our opinion that the site soils are not suitable for stormwater disposal by means of ground soakage, and accordingly any stormwater disposal methods involving soak pits or similar systems should not be permitted.

It is our opinion based on our experience with similar soils in the greater Auckland area that the site is unlikely to be suitable for the disposal of stormwater to ground soakage and, accordingly, any stormwater disposal involving soak pits or similar systems, which rely only on ground soakage for the disposal of stormwater, are unlikely to be effective.

It is recommended that, in order to mitigate the risk adversely affecting the stability of the steep slopes at the site, any proposed combined soakage/overflow systems at the site be located within the non specific building foundation design zone (i.e. not within the specific building foundation design zone shown on drawings 60834/1A and 2A, unless a specific geotechnical appraisal is undertaken.

19.0 HOUSEHOLD EFFLUENT DISPOSAL

Wastewater disposal issues associated with the proposed development at the site will be addressed by Fraser Thomas Ltd in a separate report.

It is our opinion that effluent disposal fields, comprising drip irrigation systems with a loading application rate of not more than 3 mm per day, can generally be located outside the non specific foundation design zone determined for the site, shown on drawings 60834/1A and 2A, without adversely affecting the stability of the slopes at the site.

It should be noted that although, in our opinion, effluent disposal fields, comprising drip irrigation systems with a loading application rate of not more than 3 mm per day, are unlikely to adversely affect the stability of the slopes at the site, there is, in our opinion, a risk that slope instability may adversely affect drip irrigation systems located within the specific foundation design zone. It is possible that maintenance and/or repositioning of drip irrigation systems may be required, should the systems be adversely affected by slope instability.

It is recommended that the design of any effluent disposal field at the site be undertaken and the construction supervised and certified by a chartered professional engineer experienced in wastewater disposal.

20.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations should be read together and not be taken in isolation.

20.1 CONCLUSIONS

(a) In general terms and within the limits of the investigation as outlined and reported herein, except for the slope stability issues discussed in Sections 7.0 and 9.0 of this report, and provided proper control of any proposed earthworks is exercised, no

unusual problems are anticipated with the development of the site along the general lines shown on drawings 60834/1A and 2A.

The site is, in general, considered suitable for its intended use for residential and commercial purposes with satisfactory conditions for buildings, subject to the recommendations and qualifications reported herein, provided the design and inspection of foundations are carried out as would be done under normal circumstances in accordance with the requirements of the relevant New Zealand Standard Codes of Practice.

In arriving at this conclusion and expressing this opinion, reliance has been based on the various topographical data as discussed herein and on subsoil strata, their depths and thicknesses, and the location of groundwater levels, which have only been obtained at the locations and within the depths of the boreholes and test pits reported herein. It has been assumed that these subsoil features can be projected between the various boreholes. Even though such inference is made and forms the basis of the conclusions and opinions expressed herein, no guarantee can be given as to the validity of this inference or of the nature and continuity of the subsoil features underlying the proposed development.

(b) The purpose of the geotechnical investigation reported herein was to determine the subsoil conditions at the site as they may affect the proposed development, with particular regard to slope stability; and foundation considerations; and to confirm the suitability of the site, in support of an application for land use consent.

(c) Topsoil was generally encountered to depths ranging between approximately 0.1 m and 0.3 m below the existing ground surface at the locations of the boreholes and test pits put down during the investigation reported herein.

(d) A surficial layer of material, generally comprising black silt intermixed with shell fragments, was also encountered on the west facing slopes at the site. Generally this surficial layer ranged between approximately 0.2 m and 0.3 m depth, however the material was encountered to a depth of approximately 0.9 m on the lower bench affecting the north western part of the site. This material is believed to be dredgings associated with the construction of the nearby Pine Harbour marina. The dredgings are believed to have been spread over the west facing slopes at the site during the previous dredging works.

(e) Material, generally comprising clayey silts intermixed with mudstone fragments, was encountered to a depth of approximately 0.7 m below the existing ground surface at the location of Test Pit TP6, put down on the existing bench located on the west facing slopes at the site. This material is inferred to be colluvium associated with past slope instability of the upper parts of the west facing slopes in this area.

(f) The residual soils, inferred to be weathering products of the underlying Waitemata Group bedrock, generally comprised silty clays and clayey silts. In situ undrained shear strength values measured in the soils generally ranged from 100 kPa to greater than 231 kPa, corresponding to a stiff to hard consistency. The residual soils were generally encountered to the extent of the hand augered boreholes put down at the site.

(g) From the DCP results, the depth to the highly weathered very weak to extremely weak sandstone and mudstone has been inferred, at the time of the investigation reported herein, to be between approximately 0.7 m and 4.9 m below the existing ground surface at the site.

(h) Material inferred to be highly weathered, very weak to extremely weak sandstone and mudstone was encountered at depths ranging between approximately 0.6 m and 4.0 m below the existing ground surface at the locations of the test pits put down at the site.

(i) Highly weathered, very weak to extremely weak sandstone and mudstone was also encountered at the locations of the machine boreholes put down at the site. The very weak to extremely weak sandstone and mudstone was encountered at depths ranging between approximately 1.5 m and 5.5 m below the existing ground surface. Generally the very weak to extremely weak sandstone and mudstone was encountered at depths no shallower than approximately 2.0 m below the existing ground surface.

(j) Material, inferred to be slightly to moderately weathered, moderately strong to weak sandstone and mudstone was encountered at the locations of Machine Boreholes M1 to M5 M7, M8 and M9. The moderately strong to weak sandstone and mudstone was generally encountered at depths ranging between approximately 5.0 m and 17.8 m below the existing ground surface. Generally the moderately strong to weak sandstone and mudstone was encountered to the extent of the boreholes. However layers of very weak to extremely weak sandstone were encountered below 21.0 m depth at the location of Machine Borehole M8.

(k) The depth to moderately to slightly weathered, moderately strong to weak sandstone and mudstone was approximately 17.8 m and 14.0 m below the existing ground surface at the locations of Boreholes M2 and M9 respectively, which are greater than the depths encountered at the locations of the other machine boreholes put down at the site. The bedrock material underlying the benches, located along the west facing slopes at the site, appears to have been subject to a greater degree of weathering than the bedrock material encountered elsewhere on the site.

(l) As discussed in Section 5.2 of this report, material inferred to be slightly weathered Waitemata Group muddy sandstone and mudstone was generally observed exposed in the base of the gullies. Measurements were undertaken on bedrock exposed in Gullies A and B. The bedding of the rock exposed in these gullies appeared to be dipping at an angle of between approximately 3^{o} and 5^{o} to the horizontal in a westerly to north westerly direction.

(m) It should be noted that no clay seams or slickensided joint surfaces were identified at the locations of the machine boreholes put down at the site. No evidence of block sliding, by way of disturbed, highly fractured bedrock, was observed in the machine boreholes in the zones where disturbance would be expected to be encountered, had the existing benches been formed by block slides.

(n) Test Pits TP5, TP6, TP10 and TP12 were put down along the upslope edge of the benches, in order to determine the nature and consistency of the material in these areas. It would be expected if the existing benches affecting the west facing slopes was formed by way of a block slide movement that the material along the upslope

edge of the bench i.e. in the vicinity of the expected failure plane of any such block slide) would comprise disturbed highly fractured bedrock. Material generally comprising highly weathered, very weak to extremely weak mudstone and sandstone was encountered at the locations of TP5, TP6, TP10 and TP12 at depths of approximately 0.7 m, 1.2 m, 0.6 m and 3.4 m respectively below the existing ground surface. The bedrock encountered appeared to be intact and did not appear to be highly fractured or disturbed, i.e. no evidence of block sliding, by way of disturbed, slightly fractured bedrock, was observed at the locations of Test Pits TP5, TP6, TP10 and TP12 put down along the upslope edge of the benches on the west facing slopes.

(o) Groundwater was not encountered at the locations of the hand augered boreholes and test pits put down during the field investigation reported herein. The groundwater levels within the piezometers installed in Machine Boreholes M1, M2, M6 and M7 were measured on 6 March, 2 April and 1 September 2008, and 7 May and 22 September 2009. The groundwater levels within the piezometers installed in Machine Boreholes M8 and M9 were measured on 6 October 2009.

(p) An analysis of potential deep-seated movement within the Waitemata Group bedrock (block sliding) has been undertaken for the slope profiles represented by Cross Sections FF and JJ.

(q) Analyses have also been undertaken to determine the theoretical slope angle for the soil veneer materials of the steep slopes at the site, represented by Cross Sections AA to KK inclusive, which would yield satisfactory theoretical factor of safety values, using the soil strength parameters discussed in Section 7.2 of this report. For the purposes of the slope stability analyses, it was assumed that the soil veneer overlying the steep slopes at the site would be subject to slope instability and that the soil veneer materials at the crest of the slopes would regress back to a "safe" regressed slope profile. The analyses were undertaken in order to determine the slope angle of a likely regression line should the veneer materials overlying the steep slopes be subject to slope instability.

(r) For the block slide analyses of Cross Sections FF and JJ, it has been assumed that the existing "benched" slope profile of these cross section profiles is the result of a block slide failure. The assumed slope profile for Cross Section FF, prior to this theoretical block slide failure, has been back analysed for a defined potential slope movement assuming a weak layer extending through the bedrock and along a horizontal clay seam, extending from the toe of the steep west facing slope, into the slope. The back analyses have been carried out in order to determine the soil strength parameters for the theoretical horizontal clay seam for a block slide to have occurred in this area in the past. The approximate location of the defined potential slope movement, inferred for the purposes of the block slide analyses reported herein, is shown on drawing 60834/8A.

(s) The assumed slope profile was then back analysed under near fully saturated groundwater conditions in order to obtain a theoretical factor of safety value of 1.00 (i.e. an assumed failure condition). The back analyses yielded effective strength parameters of zero cohesion and 28^{o} friction angle, for the potential clay seam. These effective strength parameters were then used in forward analyses for the existing slope profiles represented by Cross Section FF and JJ and for the assumed wet winter and extreme transient groundwater conditions in the bedrock.

(t) For the purposes of the back analyses design effective strength parameters of 30^{o} friction angle and 40 kPa cohesion, were assumed for the weak zone extending through the bedrock, and design effective strength parameters of 30^{o} friction angle and 80 kPa cohesion, were assumed for the bedrock material.

(u) Based on the results of the investigations reported herein it is evident that the soil veneer at the crest of the steep slopes at the site generally ranges between approximately 1.5 m and 5.0 m thickness.

(v) The regression line analyses, undertaken in order to determine the slope angle of a likely regression line, should the surficial soil veneer materials overlying the steep slopes be subject to slope instability, indicates that a regressed slope profile of 30^{o} to the horizontal (1V:1.73H) for the soil veneer materials at the crest of the steep slopes represented by Cross Sections AA to KK inclusive, obtains theoretical factor of safety values greater than the conventionally acceptable limiting values for slope stability purposes. This slope has been adopted as the regressed slope for the determination of the regression line for the site.

(w) The regression line allows for the loss of the soil veneer materials at the crest of the steep slopes at the site, assuming that the soil veneer materials overlying the steep slopes have been removed by slope instability, and assumes that the soil veneer materials at the crest of the slopes will regress to a slope angle of 30^{o} to the horizontal (1V:1.73H) under assumed wet winter and extreme transient conditions.

(x) The back analysis undertaken for the assumed block slide at the location of Cross Section FF yielded an effective friction angle of 28^{o} and a cohesion value of zero for the assumed clay seam, for the assumed failure condition, assumed to be represented by near fully saturated groundwater conditions.

(y) Forward Slope/W analyses yielded theoretical factor of safety values of 1.53 and 1.34 for the assumed wet winter and extreme transient groundwater conditions respectively within the bedrock, using the friction angle obtained from the back analysis (ie. assuming the presence of an inferred clay seam), for the existing slope profile represented by Cross Section FF. Forward Slope/W analyses yielded theoretical factor of safety values of 1.50 and 1.39 for the assumed wet winter and extreme transient groundwater conditions respectively within the bedrock, for the existing slope profile represented by Cross Section JJ. These values are considered to be satisfactory, either approximating of being greater than the limiting values of 1.5 and 1.2 to 1.3 for wet winter and extreme transient groundwater conditions respectively.

(z) It is our opinion that the benches located on the steep west facing slopes, shown on Cross Sections FF and JJ, have developed due to differential erosion processes rather than being surficial evidence of the occurrence of deep-seated block sliding within the Waitemata Group bedrock underlying the site. It is our opinion that the benched profile observed for the west facing slopes at the site may also have been formed by coastal erosion processes, at a time when the sea levels were higher than they are today.

(aa) It is concluded that deep-seated block slide movement is unlikely to occur and that the main risk to any proposed development is defined by the development of shallow seated soil veneer failures, and by the reactivation or continued movement of existing soil veneer failures.

(bb) Based on the site appraisal and investigations, as reported herein, and on the basis of ground conditions existing at the time of the investigation reported herein, a "Recommended Building Line Limitation" has been determined for the site.

(cc) The "Recommended Building Line Limitation" defines the boundary between:-

(i) A non specific building foundation design zone, in which the foundations of any proposed residential building do not require specific design and which may, therefore, be constructed in accordance with the requirements of the relevant New Zealand Standard Codes of Practice, providing the inspection and design of foundations are carried out as would be done under normal circumstances in accordance with the requirements of the relevant New Zealand Standard Codes of Practice.

(ii) A specific building foundation design zone, in which the foundations of any proposed residential building should be subject to specific design with particular regard to slope stability and settlement by a chartered professional engineer either experienced in geotechnical engineering or with the assistance of an engineer experienced in geotechnical engineering. Within this zone, the designer should, along with other criteria considered appropriate, undertake the following:

(a) The design of a foundation system which properly takes into account the ground conditions at the specific location of any proposed structure.

(b) An assessment of founding depths and the locations of foundation lines to provide secure foundations for any proposed structure in the event of slope movement.

(dd) **It should be noted that the "Recommended Building Line Limitation" shown in plan on drawings 60834/1A and 2A and on the cross section profiles on drawings 60834/3A to 13A, is based on the existing ground surface profile. Subdivisional earthworks in the vicinity of the "Recommended Building Line Limitation" are likely to change the location of the "Recommended Building Line Limitation" in some places. It is envisaged that the location of the "Recommended Building Line Limitation" will be reviewed following the completion of any subdivisional earthworks and the revised location will be presented in the Geotechnical Completion Report to be prepared for the site.**

(ee) It should also be noted, based on the results of the investigation and appraisal reported herein, there is, in our opinion, a risk that land located within the specific foundation design zone determined for the site, may be subject to slope instability during or following heavy rainfall, which may result in the loss of land within the specific foundation design zone. It is, however, our opinion, providing any proposed building development at the site located within the specific foundation design zone is

subject to specific foundation design, as discussed in the foregoing Conclusion (cc)(ii), and is designed in accordance with the recommendations reported herein, that slope instability is unlikely to adversely affect future residential buildings at the site.

(ff) It is our opinion that settlement at the site should not present a problem within the proposed subdivisional development, for buildings founded on the Waitemata Group residual soils, providing the inspection and design of foundations are carried out in accordance with the requirements of NZS 3604, including the provisions of Clauses 3.1.2 and 3.1.3 of NZS 3604, and providing the recommendations in this report are adopted.

(gg) Expansive soils are defined by the Code as those soils that have a liquid limit of more than 50% and a linear shrinkage of more than 15 %, determined in accordance with the test procedures described in NZS 4404:1986. As discussed in Section 5.6 of this report, the linear shrinkage values obtained by the specified test procedure were 20%, 21% and 16% in Boreholes H2, H8 and H20 respectively, which exceed the limiting value of 15%. Based on the foregoing linear shrinkage values, and on our experience with similar soils elsewhere in the Auckland region, it is our opinion that the surficial soils at the site are slightly to moderately expansive.

(hh) It is understood that the fill material for the proposed fill earthworks at the site will be borrowed from cut earthworks undertaken generally in the central and southern parts of the site. It is anticipated that the borrow material will generally comprise silty clays and clayey silts inferred to be residual soils of the Waitemata Group. The undrained shear strength values in the proposed cut materials, as determined from the borehole logs of Appendix A, are expected to generally be in excess of 100 kPa, corresponding to a very stiff consistency.

(ii) Based on our observation of the residual soils encountered at the site during the investigations reported herein, and our experience with similar soils in the Auckland area, it is our opinion that the residual soils should be suitable for placement and compaction as engineered fill for the formation of the proposed new road subgrades and proposed building platforms.

(jj) It may, in our opinion, be necessary to install underfill drainage or a drainage blanket where groundwater seepage is encountered. If underfill drainage is required, it should be directed in a controlled manner to the discharge into the existing watercourses at the site.

(kk) The maximum depths of proposed filling are located downslope of the "Recommend Building Line Limitation", within the specific foundations design zone. Providing any fill earthworks are undertaken in accordance with the relevant New Zealand Standard Codes of Practice, and in accordance with the recommendations presented herein, it is our opinion that the proposed fill earthworks as indicated on drawing 60834/2A, are unlikely to adversely affect the stability of the existing slopes at the site.

(ll) Stormwater disposal issues associated with the proposed development at the site will be addressed by Fraser Thomas Ltd in a separate report. It is our opinion based on our experience with similar soils in the greater Auckland area that the site is unlikely to be suitable for the disposal of stormwater to ground soakage and, accordingly, any

stormwater disposal involving soak pits or similar systems, which rely only on ground soakage for the disposal of stormwater, are unlikely to be effective.

(mm) Wastewater disposal issues associated with the proposed development at the site will be addressed by Fraser Thomas Ltd in a separate report. It is our opinion that effluent disposal fields, comprising drip irrigation systems with a loading application rate of not more than 3 mm per day, can generally be located outside the non specific foundation design zone determined for the site, shown on drawings 60834/1A and 2A, without adversely affecting the stability of the slopes at the site.

(nn) It should be noted that although, in our opinion, effluent disposal fields, comprising drip irrigation systems with a loading application rate of not more than 3 mm per day, are unlikely to adversely affect the stability of the slopes at the site, there is, in our opinion, a risk that slope instability may adversely affect drip irrigation systems located within the specific foundation design zone. It is possible that maintenance and/or repositioning of drip irrigation systems may be required, should the systems be adversely affected by slope instability.

20.2 RECOMMENDATIONS

Our recommendations based on the field data obtained from the site and as presented in this report, our visual appraisal of the site, our study of the geological maps relating to the area and our professional judgement and opinions, are as follows:

(a) That all building construction undertaken at the site within the non specific foundation design zone, as shown on drawings 60834/1A and 2A, should be constructed in accordance with the requirements of the relevant New Zealand Standard Codes of Practice, providing the inspection and design of foundations are carried out as would be done under normal circumstances in accordance with the requirements of the relevant New Zealand Standard Codes of Practice

(b) That all building construction undertaken within the zone located downslope of the "Recommended Building Line Limitation", should be subject to specific foundation design with particular regard to slope stability by a chartered professional engineer either experienced in geotechnical engineering or with the assistance of an engineer experienced in geotechnical engineering.

(c) That, as far as practicable, the existing vegetation on the slopes at the site be retained and protected from damage by felling or clearing. Slope stability is enhanced by binding of the soil by the root systems of trees and other vegetation, which provides mechanical reinforcement and resists erosion by surface water, and by shedding of water by transpiration processes.

(d) That any proposed building development be designed to satisfy the relevant requirements of the Building Code, so as to ensure compliance with the Building Act.

(e) That specific appraisals be undertaken for any proposed heavy structures (i.e. structures outside the scope of NZS 3604) by a chartered professional engineer experienced in geotechnical engineering in order to assess the risk of differential foundation settlement adversely affecting the proposed structure. It is anticipated

that the specific settlement appraisal works would be undertaken in support of an application for building consent for any such structure.

(f) That the ultimate static bearing capacity for vertical loading of shallow pad or strip footings and the corresponding strength reduction factor and dependable bearing capacity values presented in Section 11.0 of this report be adopted for limit state design in accordance with AS/NZS 1170, Structural Design Actions.

(g) That, if unfactored load combinations are to be considered, the allowable foundation bearing pressures presented in Table 4 of this report be adopted for shallow pad or strip footings.

(h) That the ultimate static bearing capacity and skin friction values for vertical loading of piled foundations, founded in the soil veneer and the underlying bedrock, and the corresponding strength reduction factor and dependable bearing capacity values presented in Section 11.0 of this report, be adopted for limit state design in accordance with the requirements of AS/NZS 1170.

(i) That, if unfactored load combinations are to be considered, the allowable end bearing pressures and skin friction values presented in Tables 5 and 6 of this report be adopted for piled foundations founded in the soil veneer and underlying bedrock respectively.

(j) The allowable foundation bearing pressures indicated in Tables 4, 5 and 6 are, in our opinion, safe maximum values. These values do not, however, take account of settlement considerations or the need to limit the foundation bearing pressures so as to limit the associated settlement. However it is our opinion, providing the proposed foundations are designed in accordance with the requirements of NZS 3604:1999, New Zealand Standard, Timber Framed Buildings, and in accordance with the recommendations reported herein, that settlement should not present a problem for proposed residential dwellings at the site.

(k) That the earthworks subgrade within the footprint of any proposed building be maintained at or close to its natural water content to avoid drying out and associated shrinkage of the subgrade. Any drying out of the subgrade may result in the subgrade swelling after building construction, resulting in the possibility of heaving and cracking of the floor slab. This risk may be mitigated during construction by placement of a minimum 300 mm thick granular layer or some other suitable barrier to soil water loss, such as a Damp Proof Membrane (DPM) underlain with a 50mm thick cushion course of sand, within three days following excavation of the building subgrade.

Nevertheless, should the exposed building subgrade be subject to drying during the three day period prior to the placement of the barrier to soil water loss, it is recommended that consideration be given to wetting up the building subgrade prior to the placement of the barrier.

(l) That, due to the risk of consolidation settlement of the trench backfill occurring, if any foundations of any proposed building are located within the zone of influence of existing service lines, either the trench backfill be excavated and replaced with compacted hardfill, or that the foundations and floor of the proposed building be designed to span across the trench backfill and the adjacent zone of influence.

The zone of influence is defined by a theoretical line projecting upwards in both directions from the centreline of the pipeline at the invert level of the pipeline at an angle of 45^{o} to the vertical. The zone of influence is defined by the zone between the intersection point of the theoretical line and the ground surface on each side of the pipeline.

(m) That any proposed foundation excavations in the vicinity of the inferred extent of the zone of influence of the existing service lines be inspected by Fraser Thomas Ltd to ensure that the foundations are not underlain by any trench backfill which may be associated with the existing service lines.

(n) That specific compaction tests be undertaken on selected samples of the proposed borrow material, prior to the commencement of fill earthworks, in order to determine the compaction characteristics of the residual soils.

(o) Preparation prior to placing and compaction of any fill at the site should involve the stripping of any topsoil material to stockpile and also the undercutting of any unsuitable material.

(p) That Fraser Thomas be engaged to observe any stripping/undercutting prior to the placement of any fill material, so that the adequacy of any stripping/undercutting can be verified.

(q) That any fill placed downslope of the "Recommended Building Line Limitation", or on existing slopes steeper than 15^{o} to the horizontal (1V:3.73H), be placed and compacted on benches cut into the slopes at the site. It is recommended that the benches be slightly sloping into the existing natural slope, and that the surface of the benches be scarified prior to placement of any fill material in order to improve the bond between the bench subgrade and the proposed fill material. The benches should be a minimum width of 5.0 m.

(r) That any fill material placed within the proposed development at the site be placed are in accordance with the general requirements described in NZS 4431: 1989; Earth Fill for Residential Development, and in accordance with the recommended fill specification presented in Appendix B of this report.

(s) That Fraser Thomas Ltd be engaged to observe the placement and compaction of the proposed fill material to confirm that the fill has been placed in accordance with the recommended fill specification.

(t) On the basis of experience with similar soils in the Auckland area, a bulking factor from solid in situ cut to solid in situ fill for earthworks calculations in the range of 10% to 20% is considered appropriate. In our opinion, a value of 15% could reasonably be taken for design purposes for the soils expected to be encountered during the bulk earthworks at the site. This recommended bulking factor relates to the volume reduction from cut to fill and does not include an allowance for spillage, wastage or otherwise unsuitable materials. An indicative bulking increase factor for solid cut to loose spoil of 30% is, in our opinion, appropriate for excavation of the site materials to stockpile.

(u) That, in order to control the groundwater level in the vicinity of the proposed filling to be undertaken at the heads of Gullies A, B and C and to enhance the stability of the slopes in these areas, buttress trench drains be installed in these slopes prior to the placement of any fill material. The buttress trench drains should be spaced no further apart than approximately 12 m. The approximate recommended locations and extents of the proposed buttress trench drains are shown on drawing 60834/2A.

(v) That the buttress trench drains be excavated, in general, down to a depth of up to approximately 4.0 m below the existing ground surface, at the upslope end of the drain. It is recommended that the drains be backfilled with a lightly compacted SAP 20 scoria drainage material or similar and sealed with compacted clay to prevent ingress of surface water. It is recommended that the drains be appropriately directed to discharge at the downslope end of any proposed filling, into the existing watercourses.

(w) That Fraser Thomas Ltd be engaged to observe the excavation of the buttress trench drains to confirm that they are founded at appropriate depths and are appropriately constructed.

(x) That, unless the stability of any developmental earthworks is considered in detail by a chartered professional engineer experienced in geotechnical engineering, and particularly slope stability considerations, permanent fill end slopes (comprising engineered fill) should be constructed to a maximum batter slope of 26o (1V:2H) with maximum batter height of approximately 16.0 m. Any proposed higher batter slopes should be subject to specific stability appreciation so as to determine stable limiting batter slopes.

(y) That, unless a bench is incorporated into the batter slope profile, permanent batter slopes should be a maximum 10.0 m in vertical height. Any benches should be a minimum 4.5 m wide and should be constructed so as to slope back into the slope at a minimum gradient of 1.5%. An appropriately constructed drain should be installed along the upslope edge of the bench so as to collect the stormwater collected by the bench. This stormwater should be piped in sealed pipes to discharge to the base of the batter slope. An appropriately designed energy dissipation structure will be required to installed at the discharge point of the sealed pipes.

(z) That, in order to mitigate against shallow sloughing of the permanent or temporary batter slope faces due to concentrated stormwater runoff over the batter face, stormwater runoff should be diverted away from the crest of any proposed permanent or temporary batter slope.

(aa) That the proposed retaining walls at the site be designed for the **preliminary** soil parameters and in accordance with the recommendations presented in Section 15.0 of this report.

(bb) That, once the type and configuration of the proposed retaining walls is known, specific geotechnical investigations should be undertaken for proposed Walls A to D, in order to provide reliable retaining wall design parameters and recommendations for detailed design purposes.

(cc) That, unless the stability of any developmental earthworks is considered in detail by a chartered professional engineer experienced in geotechnical engineering, that **temporary** cut and fill slopes should be constructed to a maximum slope angle of 30^{o} (1V:1.73) with maximum batter height of approximately 2.0 m. Any proposed higher batter slopes should be subject to specific stability appreciation so as to determine stable limiting batter slopes.

(dd) That, unless Fraser Thomas Ltd are engaged to undertake further specific appraisal works to assess the risk of stormwater discharge on the stability of slopes at the site, the stormwater from the roof area of any proposed new buildings, that is not retained for domestic use, or paved areas, should be directed in a controlled manner in sealed pipes to the proposed reticulated stormwater system or to the toe of the slopes at the site.

(ee) That, if the water is directed to discharge at the toe of the steep slopes at the site, that an appropriately designed energy dissipation structure be constructed at the outlet of any such pipe so as to the prevent any localised soil erosion at the discharge point.

(ff) That, in order to mitigate the risk adversely affecting the stability of the steep slopes at the site, any proposed combined soakage/overflow systems at the site be located within the non specific building foundation design zone (i.e. not within the specific building foundation design zone shown on drawings 60834/1A and 2A, unless a specific geotechnical appraisal is undertaken.

21.0 LIMITATION

The professional opinion expressed herein has been prepared solely for, and is furnished to the Auckland Council and our client, Ahuareka Trust No 2 Ltd, for their purposes only, on the express condition that it will not be relied upon by any other person.

No liability is accepted by this firm or by any principal, or director, or any servant or agent of this firm, in respect of its use by any other person, and any other person who relies upon any matter contained in this report does so entirely at its own risk. This disclaimer shall apply notwithstanding that this report may be made available to any person by any person in connection with any application for permission or approval, or pursuant to any requirement of law.

Notwithstanding the foregoing, if the circumstances at the subject site change with respect to topography or the proposed development concept, or if a period of more than three years has elapsed since the date of this report, this report should not be used without our prior review and written agreement.

Notwithstanding the foregoing conclusions and recommendations, any proposed building development should be designed to satisfy the relevant requirements of the Building Code, so as to ensure compliance with the Building Act.

The conclusions and recommendations expressed herein should be read in conjunction with the remainder of this Geotechnical Investigation Report and should not be referred to out of context with the remainder of this report.

Report prepared by:
FRASER THOMAS LTD.

M V REED
Senior Geotechnical Engineer
Chartered Professional Engineer

Report reviewed and approved by:

JPM SHORTEN
Director
Chartered Professional Engineer

AHUA rep 120321 MVRmvr.doc

Appendix A

Field Test Results

Machine Excavated Test Pits

Fraser Thomas Ltd

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP1

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

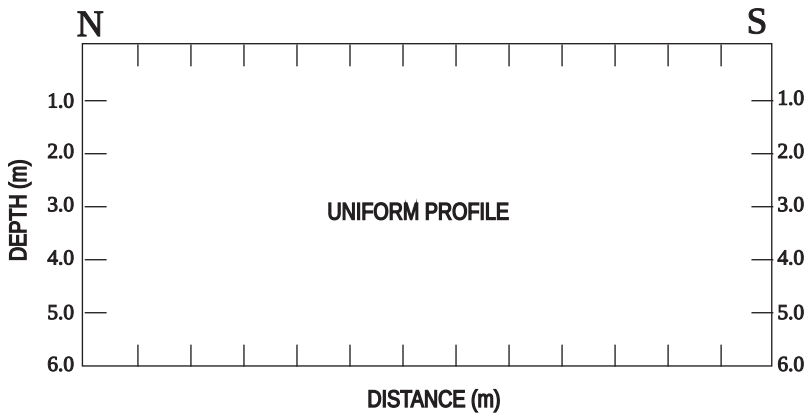
GROUND LEVEL DATUM

Date Drilled 27.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
0.5	CLAY, silty, sandy, light grey streaked yellow, slightly plastic, very stiff to hard [WAITEMATA GROUP]						
1.0	becomes streaked red						
1.5	MUDSTONE, light grey/white streaked orange, highly weathered, very weak to extremely weak						
2.0							
2.5							
2.7	EOTP @ 2.7 m TARGET DEPTH						
3.0							
3.5							
4.0							
4.5							
5.0							

UTP

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 27.02.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP2

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 27.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
0.5	CLAY, silty, sandy, light grey streaked yellow, slightly to moderately plastic, very stiff [WAITEMATA GROUP]			x x x >231	X — ● — I		
1.0							
1.5	MUDSTONE, light grey/white streaked orange, highly weathered, very weak to extremely weak						
2.0	EOTP @ 2.0 m TARGET DEPTH						
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

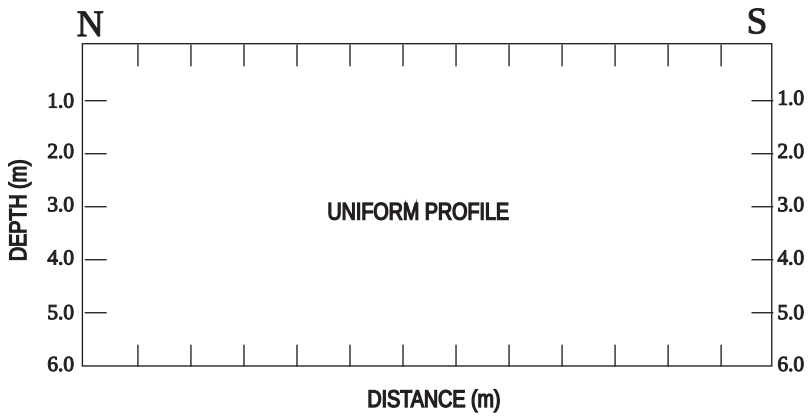
UNDRAINED SHEAR STRENGTH (kPa): 50 100 150 200

WATER CONTENT (%): 20 40 60 80

EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 27.02.08

TEST PIT PROFILE:



Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP3

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

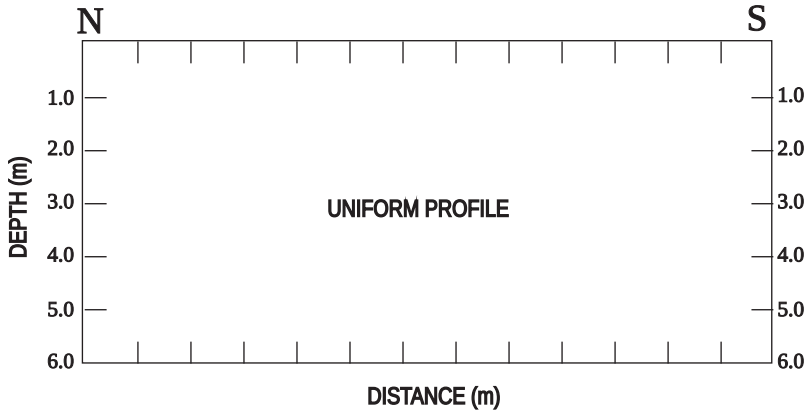
Date Drilled 27.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
0.5	SILT, clayey, brown/yellow, slightly plastic, hard [WAITEMATA GROUP]			>231			
1.0	MUDSTONE, light grey/white streaked orange, highly weathered, very weak to extremely weak			>231			
1.5				>231			
2.0	EOTP @ 1.8 m TARGET DEPTH			>231			
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

UNDRAINED SHEAR STRENGTH (kPa) scale: 50, 100, 150, 200

WATER CONTENT (%) scale: 20, 40, 60, 80

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 27.02.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP4

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

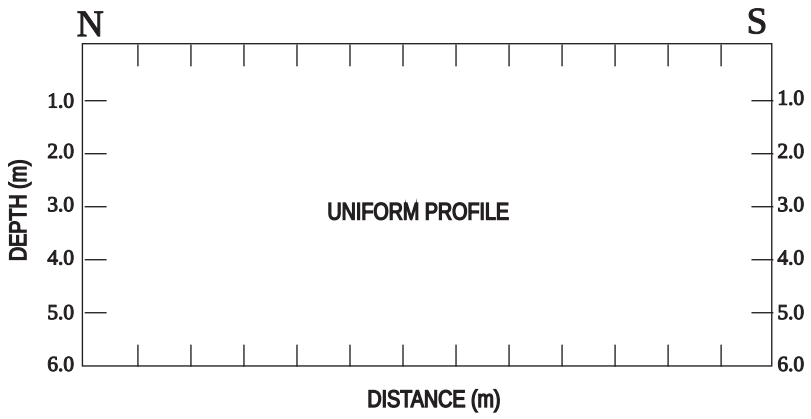
Date Drilled 27.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
0.5	SILT, clayey, orange, slightly plastic, hard [WAITEMATA GROUP] becomes sandy (fine grained), yellow			x			
1.0	MUDSTONE, light grey/white streaked orange, highly weathered, very weak to extremely weak			x >231			
1.5				>231			
2.0							
2.5				>231			
2.7	EOTP @ 2.7 m TARGET DEPTH						
3.0							
3.5							
4.0							
4.5							
5.0							

UNDRAINED SHEAR STRENGTH (kPa): 50 100 150 200

WATER CONTENT (%): 20 40 60 80

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 27.02.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP5

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 27.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, black/brown, friable, dry, contains large amounts of shells						
0.5	SILT, clayey, sandy (fine grained), orange, slightly plastic, hard [WAITEMATA GROUP]						
1.0	MUDSTONE, light grey/white streaked orange, highly weathered, very weak to extremely weak			>231			
1.5				>231			
2.0	EOTP @ 2.0 m TARGET DEPTH			>231			
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

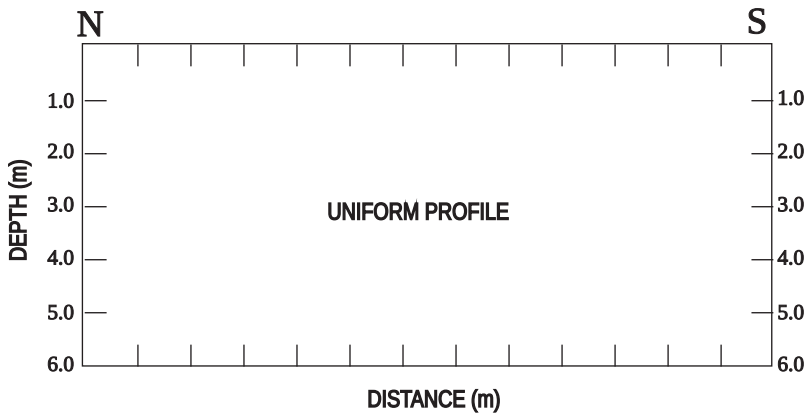
UNDRAINED SHEAR STRENGTH (kPa): 50 100 150 200

WATER CONTENT (%): 20 40 60 80

EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 27.02.08

TEST PIT PROFILE:



Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP6

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

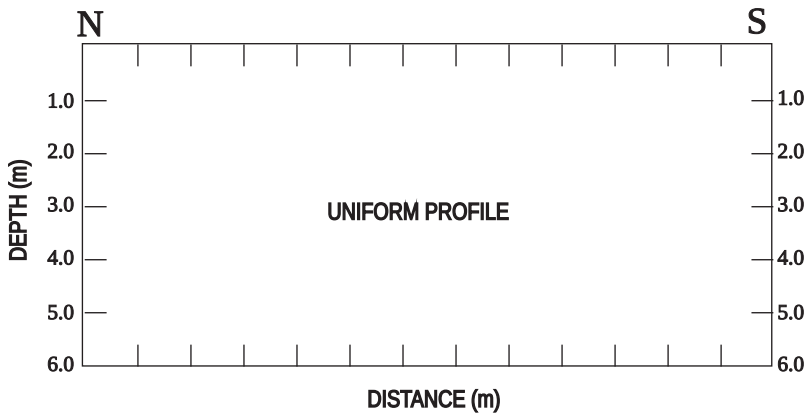
CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 27.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, black/brown, friable, dry, contains large amounts of shells						
0.5	SILT, clayey, slightly sandy (fine grained), black/brown, slightly plastic, clasts of mudstone, slope debris [COLLUVIUM]			>231			
1.0	SILT, clayey, sandy (fine grained), orange, slightly plastic, hard [WAITEMATA GROUP]						
1.5	MUDSTONE, light grey/white streaked orange, highly weathered, very weak to extremely weak			>231			
2.0							
2.5	EOTP @ 2.4 m TARGET DEPTH			>231			
3.0							
3.5							
4.0							
4.5							
5.0							

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 27.02.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP7

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

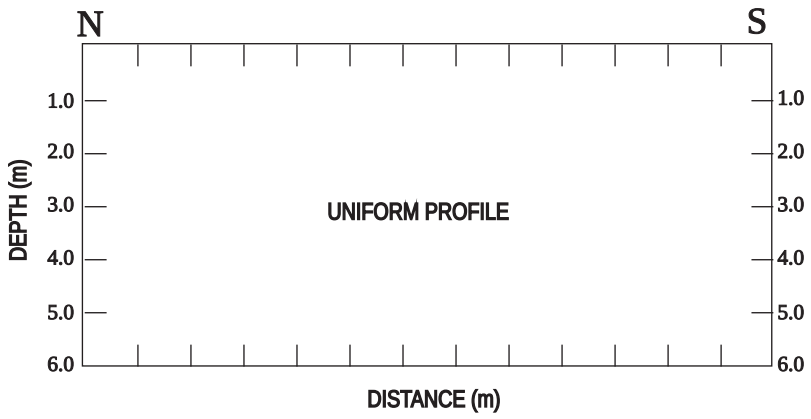
Date Drilled 27.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
0.5	CLAY, silty, orange/light grey, moderately plastic, very stiff, moist [WAITEMATA GROUP]						
4.0	SANDSTONE, coarse, dark grey/green, moderately weathered, very weak						
4.4	EOTP @ 4.4 m TARGET DEPTH						
5.0							

UNDRAINED SHEAR STRENGTH (kPa): 50, 100, 150, 200

WATER CONTENT (%): 20, 40, 60, 80

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 27.02.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP8

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

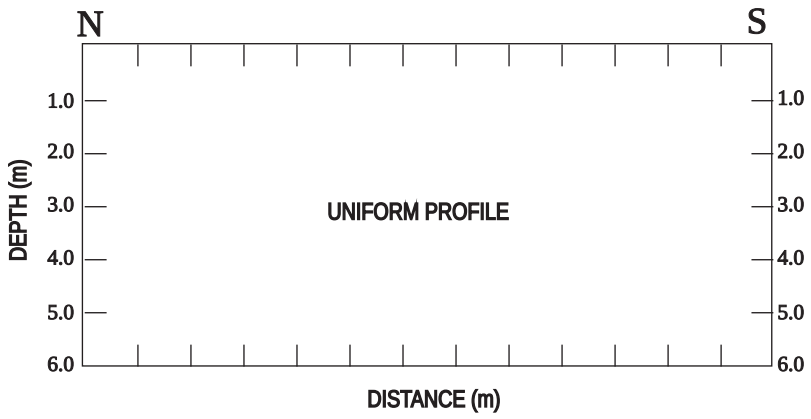
Date Drilled 21.09.09 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, black/brown, friable, dry						
0.5	CLAY, silty, light grey/orange/yellow, slightly to moderately plastic, very stiff [WAITEMATA GROUP]						
1.0	becomes SILT, sandy clayey, white/grey mottled yellow/orange, moist						
1.5							
2.0							
2.5							
3.0	becomes yellow/orange						
3.5	EOTP @ 3.5 m TARGET DEPTH						
4.0							
4.5							
5.0							

UNDRAINED SHEAR STRENGTH (kPa): 50, 100, 150, 200

WATER CONTENT (%): 20, 40, 60, 80

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 21.09.09

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP9

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

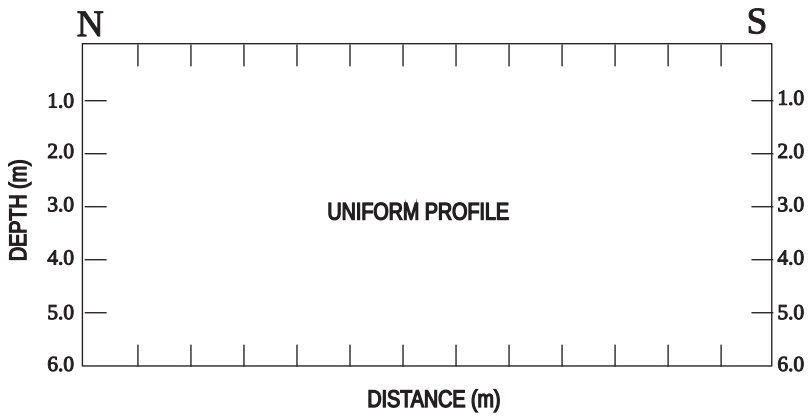
CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 21.09.09 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l (20, 40, 60, 80)	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, black/brown, friable, dry						
0.5	CLAY, silty, light grey mottled orange, slightly to moderately plastic, very stiff [WAITEMATA GROUP]			x			
1.0				x			
1.5	MUDSTONE light grey/white streaked orange, highly weathered, very weak				UTP		
2.0							
2.5	EOTP @ 2.5 m TARGET DEPTH				UTP		
3.0							
3.5							
4.0							
4.5							
5.0							

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 21.09.09

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP10

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

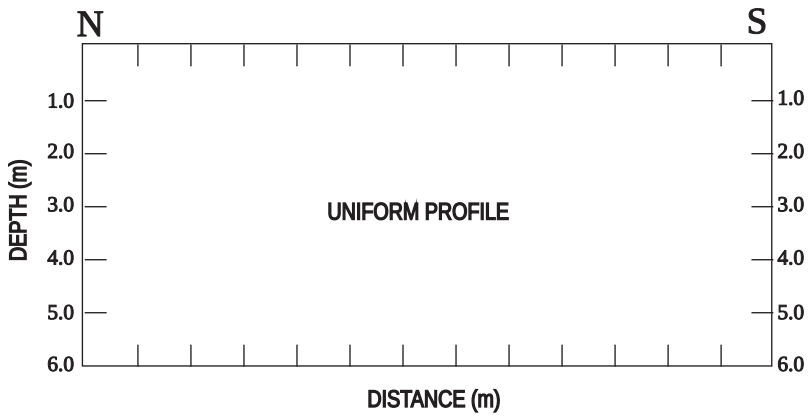
CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 21.09.09 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — • — I (20, 40, 60, 80)	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, black/brown, friable, dry, contains large amounts of shells						
0.5				UTP			
1.0	SANDSTONE light brown/grey/orange, highly to completely weathered, contains orange limonite staining, very weak to extremely weak, corestones up to approximately 200 mm in size						
1.5							
2.0							
2.5				UTP			
2.6	EOTP @ 2.6 m TARGET DEPTH						
3.0							
3.5							
4.0							
4.5							
5.0							

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 21.09.09

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP11

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 21.09.09 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, black/brown, friable, dry						
0.5	CLAY, silty, light grey streaked orange/yellow, slightly to moderately plastic, very stiff [WAITEMATA GROUP]						
1.0							
1.5	MUDSTONE light grey/white streaked orange, highly weathered, very weak to extremely weak						
2.0							
2.5							
3.0							
3.5	EOTP @ 3.3 m TARGET DEPTH						
4.0							
4.5							
5.0							

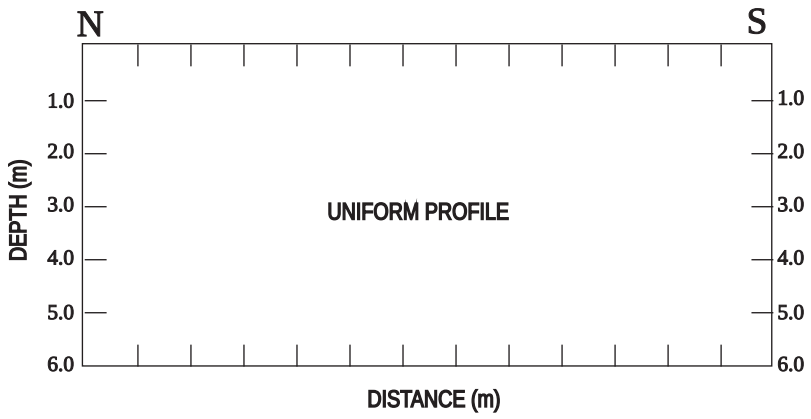
UNDRAINED SHEAR STRENGTH (kPa): 50, 100, 150, 200

WATER CONTENT (%): 20, 40, 60, 80

UTP

UTP

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 21.09.09

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP12

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

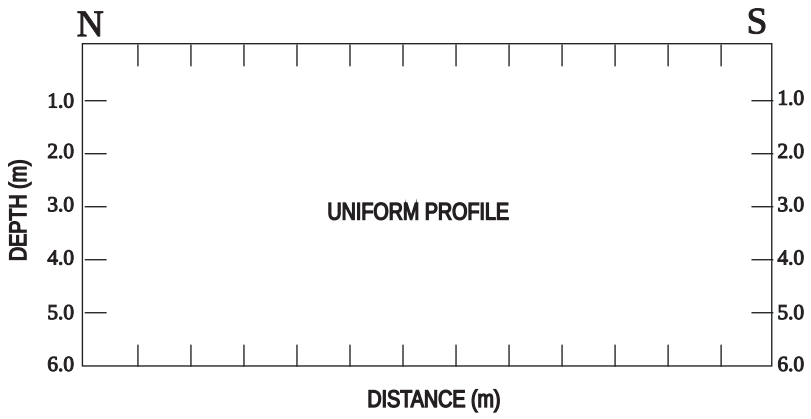
Date Drilled 21.09.09 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.5	[TOPSOIL] SILT, black/brown, friable, dry, contains large amounts of shells						
1.0	CLAY, silty, light grey streaked orange/yellow, slightly to moderately plastic, very stiff [WAITEMATA GROUP]						
1.5							
2.0							
2.5							
3.0							
3.5	MUDSTONE light grey/white streaked orange, highly weathered, very weak to extremely weak						
4.0	EOTP @ 3.7 m TARGET DEPTH			UTP			
4.5							
5.0							

UNDRAINED SHEAR STRENGTH (kPa): 50, 100, 150, 200

WATER CONTENT (%): 20, 40, 60, 80

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 21.09.09

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

TEST PIT LOG

SHEET 1 OF 1

TEST PIT NO. TP13

PROJECT AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

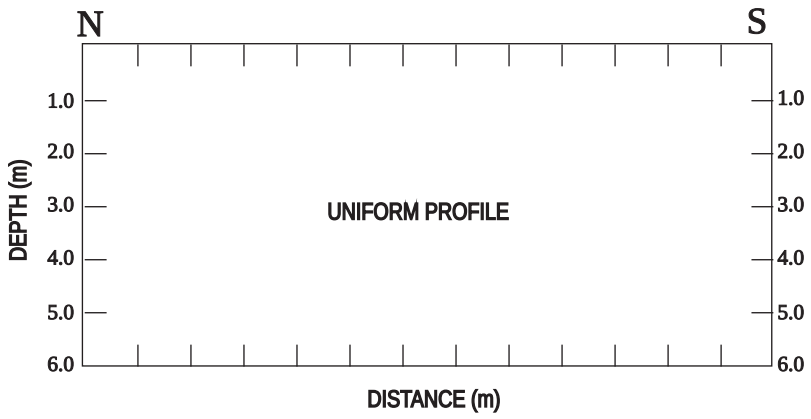
CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 21.09.09 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l (20, 40, 60, 80)	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, black/brown, friable, dry, contains large amounts of shells						
0.5	CLAY, silty, light grey streaked orange/yellow, slightly to moderately plastic, very stiff [WAITEMATA GROUP]			x			
1.0				x			
1.5							
2.0				x			
2.5							
3.0							
3.5	MUDSTONE light grey/blue streaked orange, highly weathered, very weak to extremely weak						
4.0	EOTP @ 3.8 m TARGET DEPTH			UTP			
4.5							
5.0							

TEST PIT PROFILE:



EXCAVATION METHOD:

GROUNDWATER DATA AND REMARKS:
Groundwater not encountered on 21.09.09

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

Machine Boreholes

Fraser Thomas Ltd

MACHINE BOREHOLE LOG

SHEET 1 OF 2

BOREHOLE NO. M1

PROJECT. AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 29.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
0.0	[TOPSOIL] SILT, black/brown, friable, dry		90				
0.5	CLAY, silty, yellow/orange streaked grey, slightly to moderately plastic, very stiff [WAITEMATA GROUP]			>231			
1.0	becomes light grey streaked orange		90				
1.5	SILT, clayey, sandy (fine grained), light grey streaked orange, slightly plastic, very stiff to hard		80	x			3 5 8 N = 13
2.0							
2.5	(1.9.08)		90				
3.0	(22.9.09)		95	x			3 3 4 N = 7
3.5	MUDSTONE, light grey/white streaked orange/red, highly to completely weathered, contains orange/red limonite staining, very to extremely weak		90				
4.0							
4.5	becomes very weak		80	>231			5 10 14 N = 24
5.0							
5.5	MUDSTONE, dark grey/blue, moderately to highly weathered, very to extremely weak		90				
6.0	(2.4.08)		90				8 6 7 N = 13
6.5							
7.0			90				

REMARKS:

1. Drilling method: open barrel to a depth of approximately 8.0 m below existing ground surface.
2. Rotary cored (NQ) from 8.0 m to 10.5 m depth.
3. Groundwater level not recorded due to drilling disturbance.
4. Standpipe piezometer (25 mm dia. uPVC) installed on 4 March 2008. Slotted pipe installed between depths of 5.5 m and 2.5 m below the existing ground surface.
Bentonite plug installed between depths of 6.5 m and 5.5 m, and between 2.5 m and 0.5 m.
5. Piezometer was dry on 6.3.08

Fraser Thomas
• CONSULTING ENGINEERS
• RESOURCE MANAGERS
• ENVIRONMENTAL CONSULTANTS
• SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG

SHEET 2 OF 2

BOREHOLE NO. M1

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **28.02.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l X — I	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
7.0	**MUDSTONE, dark grey/blue, moderately to highly weathered, very weak**		95	50 100 150 200	20 40 60 80		20 30 20 For 100 mm
7.5			90				
8.0							
8.5			90				
9.0	**SANDSTONE, dark grey slightly blue, moderately weathered, contains orange limonite staining, weak to very weak**		90				15 25 25 For 130 mm
9.5							
10.0			90				
10.5	**EOB @ 10.5 m TARGET DEPTH**						
11.0							
11.5							
12.0							
12.5							
13.0							
13.5							
14.0							

REMARKS:

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG

SHEET 1 OF 4

BOREHOLE NO. M2

PROJECT. AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 28.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
0.0	[TOPSOIL] SILT, black/brown, friable, dry, contains large amounts of shells						
0.5	CLAY, silty, orange/grey, slightly to moderately plastic, very stiff [WAITEMATA GROUP]		90	x			
1.0	becomes orange/pink		90				
1.5	SILT, clayey, sandy (fine grained), orange/pink, slightly plastic, very stiff to hard			>231			9 11 11 N = 22
2.0	SANDSTONE, light grey/yellow streaked orange, highly to completely weathered, contains orange limonite staining, very weak to extremely weak		80				
2.5			90				
3.0				>231			
3.5	MUDSTONE, light grey/yellow streaked orange, completely weathered, very stiff		90				5 6 4 N = 10
4.0	SANDSTONE, light grey/yellow streaked orange, highly to completely weathered, contains orange limonite staining, very weak to extremely weak		90				
4.5			80				6 3 2 N = 5
5.0							
5.5	MUDSTONE, light grey/yellow streaked orange, completely weathered, very stiff		50				
6.0			80	>231			1 2 2 N = 4
6.5	SANDSTONE, light grey/yellow streaked orange, highly to completely weathered, contains orange limonite staining, very weak to extremely weak		80				
7.0							

REMARKS:

1. Drilling method: open barrel to a depth of approximately 18.0 m below existing ground surface.
2. Rotary cored (NQ) from 18.0 m to 22.5 m depth.
3. Groundwater level not recorded due to drilling disturbance.
4. Standpipe piezometer (25 mm dia. uPVC) installed on 3 March 2008. Slotted pipe installed between depths of 17.5 m and 4.5 m below the existing ground surface.
Bentonite plug installed between depths of 19.5 m and 17.5 m, and between 4.5 m and 2.0 m.
5. Piezometer was dry on 6.3.08 and 1.9.08.

Fraser Thomas
• CONSULTING ENGINEERS
• RESOURCE MANAGERS
• ENVIRONMENTAL CONSULTANTS
• SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG SHEET 2 OF 4 **BOREHOLE NO. M2**

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **28.02.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — ● — I (20, 40, 60, 80)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
7.0	**SANDSTONE, light grey/yellow streaked orange, highly to completely weathered, contains orange limonite staining, very weak to extremely weak**		50				4 9 13 N = 22
7.5			80				
8.0	**becomes extremely weak**						
8.5			95				
9.0							7 8 9 N = 17
9.5			90				
10.0	**MUDSTONE, light grey/yellow streaked orange, completely weathered, very stiff**		80				
10.5			90				3 4 5 N = 9
11.0							
11.5			80				
12.0	**SANDSTONE, light grey/yellow streaked orange, highly to completely weathered, contains orange limonite staining, very weak to extremely weak**		90				7 8 9 N = 17
(7.5.09) ▼ 12.5	**becomes speckled black**						
13.0			90				
13.5	**MUDSTONE, light grey/yellow streaked orange, completely weathered, very stiff**		90				3 5 10 N = 15
14.0							

REMARKS:

Fraser Thomas
- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG SHEET 3 OF 4 **BOREHOLE NO. M2**

PROJECT. **AHUAREKA TRUST NO 2 LTD**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **28.02.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa)	WATER CONTENT (%)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
14.0	**SANDSTONE, grey streaked orange, highly weathered, contains orange limonite staining, very weak to extremely weak**			Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane 50 100 150 200	W_p W_f W_l X — I 20 40 60 80		
14.5	**MUDSTONE, dark grey/blue, highly weathered, very weak to extremely weak**		90				
15.0			90				7 7 9 N = 16
15.5	(22.9.09)						
16.0			80				
16.5	**SANDSTONE, grey streaked orange, highly weathered, contains orange limonite staining, very weak to extremely weak**		80				7 10 17 N = 27
17.0							
17.5	(2.4.08) **becomes weak to very weak**		80				
18.0	**MUDSTONE, dark grey/blue, moderately to highly weathered, weak to very weak**		50				50 For 145 mm
18.5	**SANDSTONE, dark grey, moderately to highly weathered, weak to very weak**						
19.0	**MUDSTONE, dark grey/blue, moderately to highly weathered, weak to very weak**		80				
19.5			80				20 40 10 For 40 mm
20.0							
20.5			80				
21.0							

REMARKS:

Fraser Thomas
- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG SHEET 4 OF 4

BOREHOLE NO. M2

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **28.02.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — ● — I (20, 40, 60, 80)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
21.0	**MUDSTONE, dark grey/blue, moderately to highly weathered, weak to very weak**		90				50 For 110 mm
21.5	**SANDSTONE, dark grey, moderately to highly weathered, weak to very weak**						
22.0	**MUDSTONE, dark grey/blue, moderately to highly weathered, weak to very weak**		90				
22.5	**EOB @ 22.5 m TARGET DEPTH**						
23.0							
23.5							
24.0							
24.5							
25.0							
25.5							
26.0							
26.5							
27.0							
27.5							
28.0							

REMARKS:

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG

SHEET 1 OF 1

BOREHOLE NO. M3

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **29.02.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
0.0	[TOPSOIL] SILT, black/brown, friable, dry						
	CLAY, silty, yellow/orange streaked grey, slightly to moderately plastic, very stiff [WAITEMATA GROUP]		95				
0.5							
1.0			80				
1.5			80	x			3 5 4 N = 9
2.0	MUDSTONE, light grey/white streaked orange/red, highly weathered, contains orange/red limonite staining, very to extremely weak		95				
2.5							
3.0	SANDSTONE, grey streaked orange/red, highly to completely weathered, contains orange/red limonite staining, very to extremely weak		95				4 4 6 N = 10
3.5							
4.0	becomes slightly blue		90				
4.5			90				7 11 13 N = 24
5.0	MUDSTONE, dark grey/blue, moderately to slightly weathered, weak to very weak						
5.5			90				
6.0	EOB @ 6.0 m TARGET DEPTH						50 For 150 mm
6.5							
7.0							

REMARKS:
1. Drilling method: open barrel to a depth of approximately 6.0 m below existing ground surface.
2. Groundwater level not recorded due to drilling disturbance.

Fraser Thomas

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- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG

SHEET 1 OF 1

BOREHOLE NO. M4

PROJECT. AHUAREKA TRUST NO 2 LTD.
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 29.02.08 Logged by J. Ward Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa)	WATER CONTENT (%)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
0.0	[TOPSOIL] SILT, black/brown, friable, dry			Vane readings corrected as per BS 1377. X Shear Vane. ◯ Residual Shear Vane. 50 100 150 200	W_p W_f W_l. X — I. 20 40 60 80		
0.5	CLAY, silty, yellow/orange, slightly to moderately plastic, very stiff [WAITEMATA GROUP]		90	>231			
1.0	SILT, sandy (fine grained) clayey, light grey/white streaked orange, slightly plastic, very stiff to hard		80				
1.5			80	>231			
2.0	SANDSTONE, light grey/white streaked orange/red, highly to completely weathered, contains orange/red limonite staining, very to extremely weak			>231			
2.5			90				
3.0			95				8 13 16 N = 29
3.5							
4.0	MUDSTONE, light grey/white streaked orange/red, highly to extremely weathered, contains orange/red limonite staining, very weak		90				
4.5			90				23 31 19 For 90 mm
5.0							
5.5	SANDSTONE, grey speckled black, slightly to moderately weathered, contains orange limonite staining, moderately strong to weak		90				
6.0	EOB @ 6.0 m TARGET DEPTH						
6.5							
7.0							

REMARKS:
1. Drilling method: open barrel to a depth of approximately 4.5 m below existing ground surface.
2. Rotary cored (NQ) from 4.5 m to 6.0 m depth.
3. Groundwater level not recorded due to drilling disturbance.

Fraser Thomas

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MACHINE BOREHOLE LOG

SHEET 1 OF 2

BOREHOLE NO. M5

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **03.03.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa)	WATER CONTENT (%)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
0.0	**[TOPSOIL] SILT, black/brown, friable, dry**		50				
0.5	**CLAY, silty, yellow/orange, slightly to moderately plastic, very stiff [WAITEMATA GROUP]**			>231			
1.0	**becomes light grey streaked orange**		90				
1.5	**becomes moderately plastic**			x			3 3 3 N = 6
2.0			90				
2.5	**SANDSTONE, light grey/white streaked orange, highly to completely weathered, contains orange limonite staining, very to extremely weak**		90				
3.0			80				3 4 5 N = 9
3.5	**MUDSTONE, light grey/white streaked orange, highly to completely weathered, contains orange limonite staining, very to extremely weak**		90				
4.0							
4.5			80				3 4 5 N = 9
5.0							
5.5			90				
6.0							3 4 6 N = 10
6.5			80				
7.0							

UNDRAINED STRENGTH SHEAR (kPa)
Vane readings corrected as per BS 1377
X Shear Vane
◯ Residual Shear Vane
50 100 150 200

WATER CONTENT (%)
W_p W_f W_l
X I
20 40 60 80

REMARKS:
1. Drilling method: open barrel to a depth of approximately 10.0 m below existing ground surface.
2. Groundwater level not recorded due to drilling disturbance.

Fraser Thomas
- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG SHEET 2 OF 2

BOREHOLE NO. M5

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **03.03.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
7.0	**MUDSTONE, light grey/white streaked orange, highly weathered, contains orange limonite staining, very weak**		80				4 9 11 N = 20
7.5			90				
8.0							
8.5	**MUDSTONE, dark grey/blue, slightly weathered, weak to very weak**		90				
9.0							20 50 For 150 mm
9.5			90				
10.0	**EOB @ 10.0 m TARGET DEPTH**						50 For 150 mm
10.5							
11.0							
11.5							
12.0							
12.5							
13.0							
13.5							
14.0							

REMARKS:

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG

SHEET 1 OF 2

BOREHOLE NO. M6

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **03.03.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
0.0	[TOPSOIL] SILT, black/brown, friable, dry						
	CLAY, silty, yellow/orange, slightly to moderately plastic, very stiff [WAITEMATA GROUP]		90	>231			
1.0	becomes orange/pink speckled white		90	x			
	becomes pink speckled white						
1.5	becomes slightly plastic		90	x			2 3 4 N = 7
2.0							
2.5	becomes pink/red mottled orange/yellow		80				
3.0			90	x			3 3 4 N = 7
(1.9.08) 3.5							
4.0			80				
4.5	becomes white streaked pink/red		70	UTP			2 3 4 N = 7
5.0							
5.5	MUDSTONE, light grey/white streaked orange, highly weathered, contains orange limonite staining, very to extremely weak		80				
6.0 (6.3.08)							
(7.5.06) 6.5			80				6 10 11 N = 21
7.0							

REMARKS:
1. Drilling method: open barrel to a depth of approximately 7.5 m below existing ground surface.
2. Groundwater level not recorded due to drilling disturbance.
3. Standpipe piezometer (25 mm dia. uPVC) installed on 4 March 2008. Slotted pipe installed between depths of 5.5 m and 2.5 m below the existing ground surface.
Bentonite plug installed between depths of 6.5 m and 5.5 m, and between 2.5 m and 0.5 m.
4. Piezometer dry on 2.4.08.

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG

SHEET 2 OF 2

BOREHOLE NO. M6

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **03.03.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l X — I	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
7.0	**MUDSTONE, dark grey/blue, moderately to highly weathered, very to extremely weak**		80				
7.5	**EOB @ 7.5 m TARGET DEPTH**						10 13 13 N = 26
8.0							
8.5							
9.0							
9.5							
10.0							
10.5							
11.0							
11.5							
12.0							
12.5							
13.0							
13.5							
14.0							

50 100 150 200

20 40 60 80

REMARKS:

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG

SHEET 1 OF 4

BOREHOLE NO. M7

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **04.03.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa)	WATER CONTENT (%)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
0.0	[TOPSOIL] SILT, black/brown, friable, dry						
	CLAY, silty, orange/yellow, slightly to moderately plastic, very stiff to hard [WAITEMATA GROUP]		90	>231			
0.5	becomes light grey streaked orange/yellow						
1.0			90	>231			
1.5				>231			
	SILT, clayey, sandy (fine grained), light grey streaked yellow/orange, slightly plastic, very stiff to hard		80				4 5 5 N = 10
2.0							
(22.9.09) 2.5			90				
(6.3.08) 3.0				>231			
	SANDSTONE, light grey/yellow streaked orange, highly to completely weathered, contains orange limonite staining, very weak to extremely weak		90				13 20 15 N = 35
3.5							
4.0			70				
4.5			80				8 10 18 N = 28
5.0							
5.5			90				
6.0	becomes slightly purple		95				5 5 7 N = 12
6.5							
			90				
7.0							

UNDRAINED SHEAR STRENGTH (kPa)
Vane readings corrected as per BS 1377
X Shear Vane
◯ Residual Shear Vane
50 100 150 200

WATER CONTENT (%)
W_p W_f W_l
X ——●—— I
20 40 60 80

REMARKS:

1. Drilling method: open barrel to a depth of approximately 5.0 m below existing ground surface.
2. Rotary cored (NQ) from 5.0 m to 22.5 m depth.
3. Groundwater level not recorded due to drilling disturbance.
4. Two standpipe piezometers (25 mm dia. uPVC) installed on 4 March 2008. Upper standpipe, slotted pipe installed between depths of 5.0 m and 2.0 m below the existing ground surface.
Bentonite plug installed between depths of 5.5 m and 5.0 m, and between 2.0 m and 1.0 m.
Lower standpipe, slotted pipe installed between depths of 22.5 m and 18.5 m below the existing ground surface.
Bentonite plug installed between depths of 18.5 m and 18.0 m.
5. Lower piezometer dry on 6.3.08. Upper and lower piezometer dry on 2.4.08 and 1.9.08.

Fraser Thomas
• CONSULTING ENGINEERS
• RESOURCE MANAGERS
• ENVIRONMENTAL CONSULTANTS
• SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG SHEET 2 OF 4 **BOREHOLE NO. M7**

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **04.03.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
7.0	**SANDSTONE, light grey/yellow streaked orange, moderately to highly weathered, contains orange limonite staining, weak**		90	50 100 150 200	20 40 60 80		17 30 20 For 90 mm
7.5			80				
8.0			90				
8.5							
9.0			80				25 27 23 For 130 mm
9.5							
10.0	**becomes weak to moderately strong**		90				
10.5			80				50 For 110 mm
11.0	**SANDSTONE, light grey, contains orange limonite staining, slightly weathered, weak to moderately strong**		95				
11.5							
12.0	**becomes moderately strong**		90				50 For 90 mm
12.5							
13.0			95				
13.5							
14.0			90				

REMARKS:

Fraser Thomas
- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG SHEET 3 OF 4 **BOREHOLE NO. M7**

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **04.03.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — I (20, 40, 60, 80)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
14.0	**SANDSTONE, light grey, contains orange limonite staining, slightly weathered, moderately strong**		90				
14.5							
15.0	**MUDSTONE, light grey slightly blue, contains orange limonite staining, slightly weathered, weak**		90				
15.5							
16.0	**SANDSTONE, dark grey slightly blue, contains orange limonite staining, slightly weathered, weak to moderately strong**						
16.5	**MUDSTONE, light grey slightly blue, contains orange limonite staining, slightly weathered, weak**		90				50 For 110 mm
17.0							
17.5							
18.0							
▼ (22.9.09)							
18.5	**SANDSTONE, light grey/yellow slightly blue, contains orange limonite staining, moderately weathered, weak to very weak**		90				
19.0							
19.5							
20.0			90				
20.5							
21.0							

REMARKS:

Fraser Thomas
- CONSULTING ENGINEERS
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- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG SHEET 4 OF 4

BOREHOLE NO. M7

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **28.02.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — ● — I (20, 40, 60, 80)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
21.0	**SANDSTONE, light grey/yellow slightly blue, contains orange limonite staining, moderately weathered, weak to very weak**		90				
21.5							
22.0	**SANDSTONE, grey, slightly weathered, moderately strong**		90				
22.5				>231			50 For 75 mm
	EOB @ 22.5 m TARGET DEPTH						
23.0							
23.5							
24.0							
24.5							
25.0							
25.5							
26.0							
26.5							
27.0							
27.5							
28.0							

REMARKS:

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG

SHEET 1 OF 5

BOREHOLE NO. M8

PROJECT. AHUAREKA TRUST NO 2 LTD
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. 60834

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled 17.09.09 Logged by J. Jones Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
0.0	[TOPSOIL] SILT, brown, friable, wet						
0.5	CLAY, silty, light grey mottled orange, moderately plastic, very stiff, moist [WAITEMATA GROUP]		100	x			
1.0	becomes very silty		88	x			
1.5	contains corestones of weak sandstone		100	>222			7 10 15 N = 25
2.0	SILT, very sandy (fine grained), clayey, light brown speckled orange and light grey, non to slightly plastic, very stiff to hard		100				
2.5	becomes light brown/orange mixed light grey, slightly plastic, hard			UTP			
3.0	SANDSTONE, light grey/light brown/yellow streaked orange, highly weathered, contains orange limonite staining, very weak, closely spaced fractures		100	UTP			13 16 22 N = 38
3.5							
4.0	contains occasional clay bands, contains occasional very closely spaced fractures		100				
4.5	SANDSTONE, light grey/light brown/yellow streaked orange, highly weathered, contains orange limonite staining, weak to very weak, closely spaced fractures			UTP			50 For 145 mm
5.0							
5.5			100				
6.0				UTP			50 For 130 mm
6.5	contains occasional clay layers		100				
7.0							

REMARKS:

1. Drilling method: open barrel to a depth of approximately 4.5 m below existing ground surface.
2. Rotary cored (NQ) from 4.5 m to 30.0 m depth.
3. Groundwater level not recorded due to drilling disturbance.
4. Two standpipe piezometer (25 mm dia. uPVC) installed on 18 September 2009. Slotted pipe installed between depths of 1.0 m and 5.0 m and between 21.0 m and 25.0 m below the existing ground surface. Bentonite plugs installed between depths of 0.0 m and 1.0 m and between 20.0 m and 21.0 m
5. Upper piezometer dry on 27.9.09.

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MACHINE BOREHOLE LOG SHEET 2 OF 5 **BOREHOLE NO. M8**

PROJECT. **AHUAREKA TRUST NO 2 LTD**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **17.09.09** Logged by **J. Jones** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — ● — I (20, 40, 60, 80)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
7.0	**SANDSTONE, light grey/light brown/yellow streaked orange, moderately to highly weathered, contains orange limonite staining, weak, closely spaced fractures**		100				50 For 135 mm
7.5							
8.0			87				
8.5							
9.0							50 For 95 mm
9.5			100				
10.0							
	(22.9.09)						
10.5							50 For 125 mm
11.0							
11.5			100				
12.0	**SANDSTONE, grey, highly weathered, very weak, closely spaced fractures**						50 For 96 mm
12.5	very closely spaced fractures, rough undulating fracture surface, infilled with clay (12.4 m to 13.5 m)		100				
13.0							
13.5	**SANDSTONE, dark grey occasionally streaked orange, highly weathered, contains minor orange limonite staining, very weak to extremely weak**						50 For 130 mm
14.0							

REMARKS:

Fraser Thomas
- CONSULTING ENGINEERS
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- ENVIRONMENTAL CONSULTANTS
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MACHINE BOREHOLE LOG SHEET 3 OF 5 **BOREHOLE NO. M8**

PROJECT. **AHUAREKA TRUSTEES LTD**
PROPOSED DEVELOPMENT
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **17.09.09** Logged by **J. Jones** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
14.0	**SANDSTONE, grey occasionally streaked orange, moderately weathered, weak, very closely to closely spaced fractures, rough undulating fracture surfaces, infilled with clay**		67				
14.5	**SANDSTONE, grey, moderately to slightly weathered, weak to moderately strong, closely to moderately widely spaced fractures**						50 For 95 mm
15.0			100				
15.5							
16.0							50 For 45 mm
16.5			100				
17.0							
17.5							50 For 35 mm
18.0	**becomes dark grey/blue**		100				
18.5							
19.0							50 For 40 mm
19.5			93				
20.0	**MUDSTONE, grey, slightly weathered, weak, closely spaced fractures, smooth and rough undulating fracture surfaces**						
20.5	**SANDSTONE, grey, slightly weathered, weak, closely spaced fractures**						
21.0							

REMARKS:

Fraser Thomas
- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG SHEET 4 OF 5 **BOREHOLE NO. M8**

PROJECT. **AHUAREKA TRUST NO 2 LTD**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **18.09.09** Logged by **J. Jones** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l X — ● — I	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
21.0	**SANDSTONE, dark grey, slightly weathered, very weak, very closely spaced fractures**		90				50 For 50 mm
21.5							
22.0	**MUDSTONE, dark grey/blue, slightly weathered, weak, closely to moderately widely spaced fractures**		90				
22.5							50 For 60 mm
23.0							
23.5							
24.0	**SANDSTONE, grey, moderately weathered, very weak to extremely weak, closely spaced fractures**						50 For 50 mm
24.5							
25.0							
25.5							50 For 70 mm
26.0	**SANDSTONE, grey, moderately weathered, weak, closely spaced fractures**						
26.5	**SANDSTONE, grey, moderately to highly weathered, very weak to extremely weak, closely spaced fractures**						
27.0	**at 26.6 m becomes moderately weathered, weak to very weak**						50 For 65 mm
27.5							
28.0							

REMARKS:

Fraser Thomas
- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

MACHINE BOREHOLE LOG SHEET 5 OF 5

BOREHOLE NO. M8

PROJECT. **AHUAREKA TRUST NO 2 LTD**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **18.09.09** Logged by **J. Jones** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — I (20, 40, 60, 80)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
28.0	**SANDSTONE, dark grey, moderately weathered, weak to very weak**		100				
28.5	**MUDSTONE, dark grey/blue, moderately weathered, weak, very closely spaced fractures**						50 For 75 mm
29.0	**SANDSTONE, dark grey, moderately weathered very weak to extremely weak**		100				
29.5	**becomes slightly weathered, weak to moderately strong, closely spaced fractures**						
30.0	**EOB @ 30.0 m TARGET DEPTH**						
30.5							
31.0							
31.5							
32.0							
32.5							
33.0							
33.5							
34.0							
34.5							
35.0							

REMARKS:

Fraser Thomas

- CONSULTING ENGINEERS
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MACHINE BOREHOLE LOG SHEET 1 OF 3 **BOREHOLE NO. M9**

PROJECT. **AHUAREKA TRUST NO 2 LTD**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD
PROJECT NO. **60834**

CO-ORDINATES E N
GROUND LEVEL DATUM
Date Drilled **21.09.09** Logged by **J. Jones** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa)	WATER CONTENT (%)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
0.0	**[PLATFORM FILL] CLAY, silty, brown mottled orange, moderately plastic, very stiff, contains occasional gravels, contains occasional inclusions of topsoil**		100	>222			
0.5	**CLAY, silty, orange mottled light brown/orange, moderately plastic, very stiff, moist [WAITEMATA GROUP]**		86	>222			
1.0			100	x			4 3 4 N = 7
1.5							
2.0	**becomes very silty, slightly sandy (very fine grained), contains occasional fine gravels**		80				
2.5							
3.0	**SILT, very sandy (fine grained), clayey, brown speckled orange and light grey, non to slightly plastic, very stiff to hard, contains numerous fine gravels**			x			4 7 5 N = 12
3.5	**SANDSTONE, light grey/light brown/yellow streaked orange, completely to highly weathered, contains orange limonite staining, very weak to extremely weak, very closely spaced fractures**		80	UTP			
4.0			100				
4.5				UTP			20 19 21 N = 40
5.0			100				
5.5							
6.0	**SANDSTONE, light grey/light brown/yellow streaked orange, highly weathered, contains orange limonite staining, very weak, closely spaced fractures**			UTP			10 13 16 N = 29
6.5			100				
7.0							

UNDRAINED STRENGTH SHEAR (kPa) — Vane readings corrected as per BS 1377; X Shear Vane; ◯ Residual Shear Vane; 50 100 150 200

WATER CONTENT (%) — W_p X W_f I W_l; 20 40 60 80

REMARKS:
1. Drilling method: open barrel to a depth of approximately 4.5 m below existing ground surface.
2. Rotary cored (NQ) from 4.5 m to 18.0 m depth.
3. Groundwater level not recorded due to drilling disturbance.
4. Standpipe piezometer (25 mm dia. uPVC) installed on 22 September 2009. Slotted pipe installed between depths of 13.0 m and 17.0 m below the existing ground surface. Bentonite plugs installed between depths of 12.0 m and 13.0 m

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MACHINE BOREHOLE LOG

SHEET 2 OF 3

BOREHOLE NO. M9

PROJECT. **AHUAREKA TRUST NO 2 LTD**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **21.09.09** Logged by **J. Jones** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — ● — I (20, 40, 60, 80)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
7.0	SANDSTONE, light grey/light brown/yellow streaked orange, highly weathered, contains orange limonite staining, very weak						
7.5	becomes moderately to highly weathered						14, 11, 13 N = 24
8.0			100				
8.5							
9.0	very closely spaced fracture, very weak						17, 17, 12 N = 29
9.5	MUDSTONE light grey/brown streaked orange, completely to highly weathered, extremely weak		73				
	▼ (22.9.09)						
10.0							
10.5	SANDSTONE, light grey/light brown/yellow streaked orange, highly weathered, contains orange limonite staining, very weak, closely to very closely spaced fractures						4, 6, 8 N = 14
11.0	MUDSTONE light grey/brown streaked orange, highly weathered, extremely weak to very weak, very closely spaced fractures		90				
11.5	MUDSTONE light grey, highly weathered, very weak, closely spaced fractures						
12.0							20, 24, 26 For 110 mm
12.5	SANDSTONE, light grey/light brown/yellow streaked orange, highly to completely weathered, contains orange limonite staining, very weak, contains numerous closely spaced fractures		90				
13.0							
13.5	becomes extremely weak						4, 10, 16 N = 26
14.0							

REMARKS:

Fraser Thomas

- CONSULTING ENGINEERS
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MACHINE BOREHOLE LOG SHEET 3 OF 3

BOREHOLE NO. M9

PROJECT. **AHUAREKA TRUST NO 2 LTD**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **22.09.09** Logged by **J. Jones** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	% CORE RECOVERY	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — I (20, 40, 60, 80)	WATER CONTENT (%)	SPT results & (p) pocket penetrometer (kPa)
14.0	**MUDSTONE, dark grey/blue, slightly weathered, weak, closely spaced fractures**						
14.5	**SANDSTONE, dark grey occasionally streaked orange, slightly weathered, weak, closely spaced fractures**		93				
15.0	**MUDSTONE, dark grey/blue, slightly weathered, weak, closely spaced fractures**						50 For 85 mm
15.5	**SANDSTONE grey, moderately weathered, weak, closely spaced fractures**		46				
16.0							
16.5							50 For 75 mm
17.0			100				
17.5							
18.0	**EOB @ 18.0 m TARGET DEPTH**						50 For 65 mm
18.5							
19.0							
19.5							
20.0							
20.5							
21.0							

REMARKS:

Fraser Thomas

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Hand Augered Boreholes

BOREHOLE AND TEST PIT LOGS SYMBOLS AND TERMS

(Based on New Zealand Geomechanics Society "Guidelines for the Field Description of Soils and Rock in Engineering Use" November 1988)

SYMBOLS AND ABBREVIATIONS

RL	Reduced level
EOB	End of borehole
X	Shear vane test result
UTP	Unable to penetrate
⊗	Pocket penetrometer test result
SPT	Standard Penetration Test
N	SPT blows per 300mm penetration
35/90	35 blows per 90mm penetration after seating for SPT
(s)	Inclusive of seating blow count for SPT
▼	Recorded water level
GWL	Groundwater level

W_f	Field water content
W_P	Plastic limit (%)
W_L	Liquid limit (%)
RQD	Rock quality designation
SG	Specific gravity
% F	Percentage fines (<75 micron)
PSD	Particle size distribution
CONS	Consolidation test
COMP	Compaction test
UCS	Unconfined compressive strength
k	Permeability coefficient (m/s)
LS	Linear shrinkage (%)
OC	Organic content (%)

SAMPLE TYPES

Bulk disturbed (arrows denote depth interval)

Small disturbed

"Undisturbed" tube

Block

Standard Penetration Test

SOIL

Symbol	Description
	Clay
	Silt
	Sand
	Gravel
	Boulders and Cobbles
	Organic Material
	Fill

STRENGTH

(a) Cohesive Description	Undrained Shear Strength (kPa)
Very soft	less than 10
Soft	10 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	>200

(b) Non-cohesive Description	SPT "N" Value
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	>50

ROCK

Symbol	Description
	Limestone
	Mudstone
	Sandstone
	Conglomerate
	Breccia
	Volcanic Rock
	Fossiliferous

STRENGTH

Description	Unconfined Compressive Strength (MPa)
Extremely weak	<1
Very weak	1 to 5
Weak	5 to 20
Moderately strong	20 to 50
Strong	50 to 100
Very strong	100 to 250
Extremely strong	>250

WEATHERING

UW	unweathered
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
CW	completely weathered

SPACING OF DISCONTINUITIES

Description	Spacing (mm)
Very widely spaced	>2000
Widely spaced	600 to 2000
Moderately widely spaced	200 to 600
Closely spaced	60 to 200
Very closely spaced	20 to 60
Extremely closely spaced	<20

Notes
1. Composite soil types are signified by combined symbols

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HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H1

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **15.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa)	WATER CONTENT (%)	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
0.5	CLAY, silty, orange, slightly plastic, very stiff [WAITEMATA GROUP]			x			
	becomes slightly to moderately plastic, moist						
1.0	becomes streaked white, highly plastic			x			
	SILT, clayey, orange streaked white, moderately plastic, hard, contains occasional fine gravels of sandstone			>231			
1.5	becomes pink						
2.0	becomes pink mottled brown, slightly plastic			>231			
2.5				>231			
	becomes orange mottled white						
3.0				>231			
	EOB @ 3.0 m TARGET DEPTH						
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

UNDRAINED SHEAR STRENGTH (kPa)
Vane readings corrected as per BS 1377
X Shear Vane
◯ Residual Shear Vane
50 100 150 200

WATER CONTENT (%)
W_p W_f W_l
X ——●—— I
20 40 60 80

REMARKS: 1. Groundwater not encountered on 15.01.08

Fraser Thomas

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HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H2

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **15.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	**CLAY, silty, brown/orange, slightly plastic, very stiff [WAITEMATA GROUP]**			>231			
0.5				>231			
1.0				>231			
1.5				>231			
2.0	**EOB @ 2.0 m TOO HARD TO AUGER**						
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

UNDRAINED STRENGTH: 50 100 150 200

WATER CONTENT: 20 40 60 80

REMARKS: **1. Groundwater not encountered on 15.01.08**

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H3

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **15.01.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	**SILT, brown/grey, friable, dry, very stiff [WAITEMATA GROUP]**						
0.5	**becomes sandy, speckled orange/white**						
1.0							
1.5	**EOB @ 1.4 m TOO HARD TO AUGER**						
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: **1. Groundwater not encountered on 15.01.08**

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H4

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **15.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
	SILT, clayey, orange, slightly plastic, hard [WAITEMATA GROUP]			>231			
0.5	SILT, sandy, light yellow, friable, hard						
1.0	becomes clayey			>231			
	contains dark brown gravels (medium)						
1.5				>231			
2.0				UTP			
	EOB @ 2.1 m TOO HARD TO AUGER						
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 15.01.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H5

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **15.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
	SILT, clayey, grey/orange, slightly plastic, very stiff [WAITEMATA GROUP]			>231			
0.5	SAND, silty, light grey, friable, hard						
1.0				>231			
1.5	CLAY, silty, orange/light yellow, slightly plastic, very stiff to hard			>231			
2.0	becomes grey, slightly to moderately plastic			x			
2.5	CLAY, orange, highly plastic, contains brown gravels (fine)			x			
	CLAY, silty, grey, highly plastic, very stiff						
3.0				x			
	SILT, sandy (fine grained), slightly plastic, very stiff						
3.5				>231			
	CLAY, silty, grey, highly plastic, very stiff						
4.0	becomes dark grey			x			
				>231			
4.5	EOB @ 4.4 m TOO HARD TO AUGER						
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 15.01.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H6

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **16.01.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown/grey, friable, dry						
0.5	SILT, slightly clayey, brown/yellow, slightly plastic, dry, hard [WAITEMATA GROUP]			x			
1.0	becomes SILT, yellow/grey			>208			
1.5	EOB @ 1.4 m TOO HARD TO AUGER			x			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: **1. Groundwater not encountered on 16.01.08**

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H7

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **22.01.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, grey/brown, friable, dry						
0.5	SILT, slightly clayey, brown/orange, slightly plastic, hard [WAITEMATA GROUP]			>208			
1.0	becomes SILT, yellow/brown slightly grey			>208			
1.5	EOB @ 1.4 m TOO HARD TO AUGER			>208			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 22.01.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H8

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKE VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **16.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry, frequent shells, hard						
0.5	CLAY, silty, orange, slightly plastic, hard [WAITEMATA GROUP]			>231			
	SILT, slightly clayey, white/yellow, slightly plastic, hard						
1.0	CLAY, dark orange/red, slightly plastic, hard			UTP			
	EOB @ 1.0 m TOO HARD TO AUGER						
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 16.01.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H9

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **16.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	**CLAY, silty, yellow/brown, slightly plastic, hard [WAITEMATA GROUP]**						
0.5	**CLAY, silty, orange/yellow, slightly to moderately plastic, hard**			>231			
1.0	**becomes slightly to moderately plastic, very stiff**			x			
	becomes orange						
1.5	**SILT, clayey, pink, moderately plastic, hard**			>231			
2.0	**EOB @ 1.8 m TOO HARD TO AUGER**						
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: **1. Groundwater not encountered on 16.01.08**

Fraser Thomas
• CONSULTING ENGINEERS
• RESOURCE MANAGERS
• ENVIRONMENTAL CONSULTANTS
• SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H10

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **16.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) — Vane readings corrected as per BS 1377; X Shear Vane; ◯ Residual Shear Vane	WATER CONTENT (%) — W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
	SILT, clayey, brown/yellow, slightly plastic, hard [WAITEMATA GROUP]			UTP			
0.5	EOB @ 0.6 m TOO HARD TO AUGER						
1.0							
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 16.01.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H11

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **16.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry, hard						
	SILT, clayey, light brown/yellow, slightly plastic, hard [WAITEMATA GROUP]						
0.5	CLAY, silty, orange/yellow, slightly to moderately plastic, hard			>231			
1.0	becomes orange streaked white/grey			>231			
1.5	becomes pink streaked white/grey			>231			
2.0	EOB @ 2.0 m TOO HARD TO AUGER			x			
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 16.01.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H12

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **17.01.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) — Vane readings corrected as per BS 1377; X Shear Vane; ◯ Residual Shear Vane	WATER CONTENT (%) — W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, frequent shells						
	SILT, light yellow/grey, friable, hard, dry [WAITEMATA GROUP]			UTP			
0.5	EOB @ 0.4 m TOO HARD TO AUGER						
1.0							
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: **1. Groundwater not encountered on 17.01.08**

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H13

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **17.01.08** Logged by **J.Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l (20, 40, 60, 80)	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
	SILT, slightly clayey, yellow/orange, slightly plastic, hard, dry [WAITEMATA GROUP]						
1.0	becomes SILT, sandy, no longer clayey						
1.6	EOB @ 1.6 m TOO HARD TO AUGER						

REMARKS: **1. Groundwater not encountered on 17.01.08**

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H14

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **17.01.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
	SILT, yellow/grey slightly streaked orange, friable, dry [WAITEMATA GROUP]			x			
0.5	becomes sandy (fine grained)						
1.0	becomes slightly clayey			x			
1.5				x			
2.0	becomes grey/yellow			x			
2.5				x			
	CLAY, silty, grey/yellow, slightly plastic, hard			>208			
3.0	becomes orange/yellow streaked light grey						
3.5				>208			
	EOB @ 3.6 m TOO HARD TO AUGER						
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: **1. Groundwater not encountered on 17.01.08**

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H15

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **17.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry, hard						
0.5	SILT, clayey, yellow/orange, slightly plastic, dry, hard [WAITEMATA GROUP]			>231			
1.0	SILT, sandy (fine grained), yellow, friable, hard becomes pink mottled white			UTP			
	EOB @ 1.1 m TOO HARD TO AUGER						
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: **1. Groundwater not encountered on 17.01.08**

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H16

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **17.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH / SHEAR (kPa)	WATER CONTENT (%)	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, dry, friable,						
	SILT, clayey, brown, slightly plastic, dry, very stiff [WAITEMATA GROUP]						
0.5	becomes slightly to moderately plastic						
	CLAY, silty, orange, moderately to highly plastic, very stiff						
1.0							
	SILT, clayey, pink/red, slightly plastic, very stiff						
1.5							
	CLAY, sandy (fine grained), silty, brown, contains frequent dark brown gravels (medium)						
2.0							
2.5	EOB @ 2.6 m TOO HARD TO AUGER						
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

Vane readings corrected as per BS 1377
X Shear Vane
◯ Residual Shear Vane

UNDRAINED STRENGTH / SHEAR (kPa): 50, 100, 150, 200

WATER CONTENT (%): W_p, W_f, W_l; 20, 40, 60, 80

REMARKS: 1. Groundwater not encountered on 17.01.08

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H17

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **17.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	**SILT, yellow/brown, friable dry, hard [WAITEMATA GROUP]**						
	becomes orange/yellow						
0.5				x			
	becomes sandy (fine grained), yellow/grey						
1.0				x			
	SILT, clayey, yellow/grey, slightly plastic, very stiff						
1.5				x			
	becomes CLAY, silty						
2.0				x			
	becomes SILT, sandy (fine grained)						
2.5				x			
	becomes CLAY, silty						
3.0				>231			
	EOB @ 3.0 m TOO HARD TO AUGER						
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: **1. Groundwater not encountered on 17.01.08**

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H18

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **17.01.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	**SILT, brown/yellow, slightly plastic, dry [WAITEMATA GROUP]**						
0.5	**becomes yellow/white mixed orange**			x			
0.7	**EOB @ 0.7 m TOO HARD TO AUGER**						
1.0							
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: **1. Groundwater not encountered on 17.01.08**

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H19

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **17.01.08** Logged by **F. Scheibmair** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH (kPa) — Vane readings corrected as per BS 1377; X Shear Vane; ◯ Residual Shear Vane	WATER CONTENT (%) — W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, brown, friable, dry						
0.5	SILT, clayey, yellow/brown, slightly plastic, very stiff, dry [WAITEMATA GROUP]			>231			
1.0	CLAY, yellow streaked white/grey, highly plastic, moist, very stiff			x			
1.5				x			
2.0	SILT, clayey, orange, slightly to moderately plastic, very stiff			>231			
	becomes pink/white mottled dark brown, contains medium gravels						
2.5	becomes dark pink			x			
3.0				x			
	EOB @ 3.0 m TARGET DEPTH						
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 17.01.08

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HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H20

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **22.01.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, grey/brown, friable, dry						
0.5	SILT, orange/grey/yellow, friable, very stiff [WAITEMATA GROUP]			>208			
	becomes clayey, slightly plastic						
1.0	CLAY, silt, yellow/grey, slightly to moderately plastic, very stiff						
1.5	becomes slightly sandy (fine grained)						
2.0	becomes light grey streaked yellow, moderately plastic						
2.5	becomes yellow/orange, moderately to highly plastic, contains fine orange gravels						
3.0	CLAY, grey streaked orange/pink, moderately to highly plastic, very stiff, moist						
	EOB @ 3.0 m TARGET DEPTH						
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 22.01.08

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HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H21

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **22.01.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane	WATER CONTENT (%) W_p W_f W_l X — ● — I	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, grey, friable, dry						
0.5	SILT, clayey, yellow/orange, slightly plastic, very stiff, dry [WAITEMATA GROUP]			>208			
	becomes yellow/grey						
1.0				>208			
	becomes slightly to moderately plastic						
1.5	CLAY, silty, light grey streaked orange/red, slightly to moderately plastic, very stiff			>208			
2.0	contains occasional orange fine gravels			x			
2.5	becomes sandy, slightly pink			x			
	no longer sandy						
3.0				>208			
	EOB @ 3.0 m TARGET DEPTH						
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

UNDRAINED STRENGTH SHEAR (kPa) scale: 50, 100, 150, 200

WATER CONTENT (%) scale: 20, 40, 60, 80

REMARKS: 1. Groundwater not encountered on 22.01.08

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HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H22

PROJECT. **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **22.01.08** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH SHEAR (kPa) Vane readings corrected as per BS 1377 X Shear Vane ◯ Residual Shear Vane (50, 100, 150, 200)	WATER CONTENT (%) W_p W_f W_l X — ● — I (20, 40, 60, 80)	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, dark grey, friable, dry						
0.5	SILT, clayey, yellow/orange, sightly grey, slightly plastic, very stiff, dry [WAITEMATA GROUP]			x			
1.0	CLAY, silty, yellow/grey slightly orange, slightly to moderately plastic, very stiff			x			
1.5	becomes moderately plastic, moist			x			
2.0	becomes slightly sandy (fine grained), light grey streaked yellow/red			x			
2.5	CLAY, slightly silty, light grey streaked orange, slightly to moderately plastic, very stiff becomes orange/grey, moderately plastic			x			
3.0	CLAY, grey slightly purple, slightly plastic, hard			x			
	EOB @ 3.0 m TARGET DEPTH						
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 22.01.08

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HAND AUGER LOG

SHEET 1 OF 1

BOREHOLE NO. H23

PROJECT. **AHUAREKA TRUSTEES LTD.**
PROPOSED DEVELOPMENT
650 WHITFORD-MARAETAI ROAD

PROJECT NO. **60834**

CO-ORDINATES E N

GROUND LEVEL DATUM

Date Drilled **21.09.09** Logged by **J. Ward** Checked

DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC LOG	SAMPLE TYPE	UNDRAINED STRENGTH / SHEAR (kPa) — Vane readings corrected as per BS 1377; X Shear Vane; ◯ Residual Shear Vane	WATER CONTENT (%) — W_p W_f W_l	WATER CONTENT (%)	TESTING AND COMMENTS
0.0	[TOPSOIL] SILT, black/brown, friable, dry						
0.5	CLAY, silty, yellow/grey streaked red/orange, slightly to moderately plastic, very stiff, dry [WAITEMATA GROUP]						
1.0	becomes moist, streaked red/orange/yellow						
1.5							
2.0	EOB @ 2.0 m TARGET DEPTH						
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							

REMARKS: 1. Groundwater not encountered on 21.09.09

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DYNAMIC CONE PENETROMETER TEST

TEST METHOD : NZS 4402 : 1988, TEST 6.5.2.

Sheet 1 Of 2

Date tested: **15.01.08 16.01.08 17.01.08 22.01.08**

PROJECT NAME: **AHUAREKA TRUST NO 2 LTD.**
AHUAREKA VILLAGE
650 WHITFORD – MARAETAI ROAD

PROJECT No.: **60834**

Tested by: **J. Ward & F. Scheibmair**

Checked by:

TABLE OF BLOWS PER PENETRATION INCREMENT

Test No.	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11
Start Depth (mbgl)	**2.0**	**1.4**	**2.1**	**4.4**	**1.4**	**1.4**	**1.0**	**1.8**	**0.6**	**2.0**
50mm	3	4	9	6	3	4	3	5	10	2
100	4	4	8	7	3	4	5	5	12	2
150	5	1	9	8	4	4	5	5	11	4
200	3	4	12	10	3	5	5	7		3
250	3	3		10	5	6	2	7		4
300	2	2		14	4	12	3	7		4
350	2	2			4	12	3	9		5
400	2	2			5	11	3	12		9
450	2	2			6		3			15
500	2	2			7		3			15
550	2	2			7		3			
600	2	2			7		3			
650	3	2			7		3			
700	2	3			7		3			
750	2	2			6		3			
800	3	3			6		3			
850	4	3			6		3			
900	3	3			6		3			
950	3	3			7		3			
1000	3	4			11		3			
1050	4	4			12		5			
1100	6	4			9		6			
1150	8	5					5			
1200	8	5					6			
1250	7	6					6			
1300	7	5					6			
1350	7	5					7			
1400	7	4					8			
1450	8	4					10			
1500	7	6					8			
1550	8	6								
1600		6								
1650		8								
1700		10								
1750		8								
1800		6								
1850		6								
1900		6								
1950		7								
2000		7								

Remarks: mbgl metres below ground level

R Refusal

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DYNAMIC CONE PENETROMETER TEST

TEST METHOD : NZS 4402 : 1988, TEST 6.5.2.

Sheet 2 Of 2

Date tested: **15.01.08 16.01.08 17.01.08 22.01.08**

PROJECT NAME: **AHUAREKA TRUST NO 2 LTD**
AHUAREKA VILLAGE
650 WHITFORD – MARAETAI ROAD

PROJECT No.: **60834**

Tested by: **J. Ward & F. Scheibmair**

Checked by:

TABLE OF BLOWS PER PENETRATION INCREMENT

Test No.	H12	H13	H14	H15	H16	H17	H18			
Start Depth (mbgl)	0.4	1.6	3.6	1.1	2.6	3.0	0.7			
50mm	9	3	5	2	1	3	4			
100	9	4	6	7	3	3	3			
150	8	4	7	7	3	2	3			
200	6	5	7	7	2	3	5			
250	9	7	9	7	2	2	4			
300	11	9	8	5	1	3	3			
350		10		4	1	3	3			
400		11		5	1	3	3			
450				5	1	2	3			
500				4	2	3	5			
550				5	1	2	5			
600				5	1	2	5			
650				4	2	2	8			
700				4	1	3	8			
750				3	4	3	7			
800				4	3	2	7			
850				6	2	3	8			
900				7	2	5	8			
950				7	3	2	7			
1000				8	5	5	8			
1050				10	6	5	7			
1100				10	8	5	8			
1150					7	5				
1200					7	5				
1250					8	5				
1300					10	4				
1350						5				
1400						7				
1450						7				
1500						8				
1550						8				
1600						7				
1650						6				
1700						6				
1750						6				
1800						6				
1850						6				
1900						6				
1950										
2000										

Remarks: mbgl metres below ground level

R Refusal

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Appendix B

Recommended Fill Specification

RECOMMENDED

FILL SPECIFICATION

The proposed fill materials should be brought to an appropriate water content prior to compaction by either wetting or drying as is necessary, and be spread uniformly in layers of not greater than 150 mm loose thickness, unless the Contractor can demonstrate to the Engineer that compaction to the required standards is achieved with layers of greater thickness. Compacted fill which does not meet the specified requirements shall be excavated, disced and dried or moistened as may be necessary prior to recompaction. Any fill surface which has been steel wheel rolled at the completion of a day's work must be scarified and brought to the appropriate water content prior to continuing filling operations.

Compaction must be carried out using approved equipment. Equipment used in the transportation and spreading of fill will not be permitted as compaction equipment. Compaction plant shall cover the entire area of each layer of fill and give each layer a uniform degree of compactive effort to the procedures agreed with the Engineer and as set out in the contract documents.

COMPACTION STANDARDS

(i) General

Optimum water content, optimum density, field water content and density will be determined by the methods of NZS 4402:1986 and BS 1377:1975, where these are appropriate.

(ii) Engineered Fill

Fill shall be broken up and placed in uniform layers not greater than 150 mm loose thickness. Compaction on each layer of fill materials so placed shall be sufficient to obtain the following minimum standards:

(a) Air Voids Percentage (As defined in NZS 4402:1986)

An average value of not more than 10% and any one test site value of not more than 12%.

The air voids value at any one test site shall be taken as the mean of the results of a minimum of two individual tests made within an area of 0.5 m^2 that has been carefully trimmed to below the compacted surface.

The average value of the air voids shall be taken as the mean of any ten consecutive test site values. If less than ten test sites have been tested, the average air voids value should be taken as the mean of the test site values obtained up to that time.

(b) Undrained Shear Strength (As measured by hand held field vane)

An average value of not less than 120 kPa and any one test site value of not less than 100 kPa.

The test site value of undrained shear strength shall be taken as the mean of six field measurements made within an area of 0.5 m^2 at a single test site and two laboratory measurements, one on each of two "undisturbed" test samples taken from the test site. If no "undisturbed" test samples are taken, the test site value of undrained shear strength shall be taken as the mean of six field measurements.

The average value of the undrained shear strength shall be taken as the mean of ten consecutive test site values. If less than ten test sites have been tested, the average air voids value should be taken as the mean of the test site values obtained up to that time.

In addition to the above criteria, if the variation of the strength values in any one fill area are, in the judgement of the controlling engineer, sufficiently large so as to bring into question the uniformity of the fill materials as placed, the engineer shall reject the fill so affected.

TESTING

(i) General

Testing shall be carried out by the Engineer's Representative as and where required by the Engineer.

(ii) Test Results

Interim IANZ accredited compaction control test results shall be made available to the Engineer and his designated representative, the Contractor and the Local Authority's representative immediately the results come to hand.

Drawings

29626/1 Site Plan

and

29626/2 Cross Section AA

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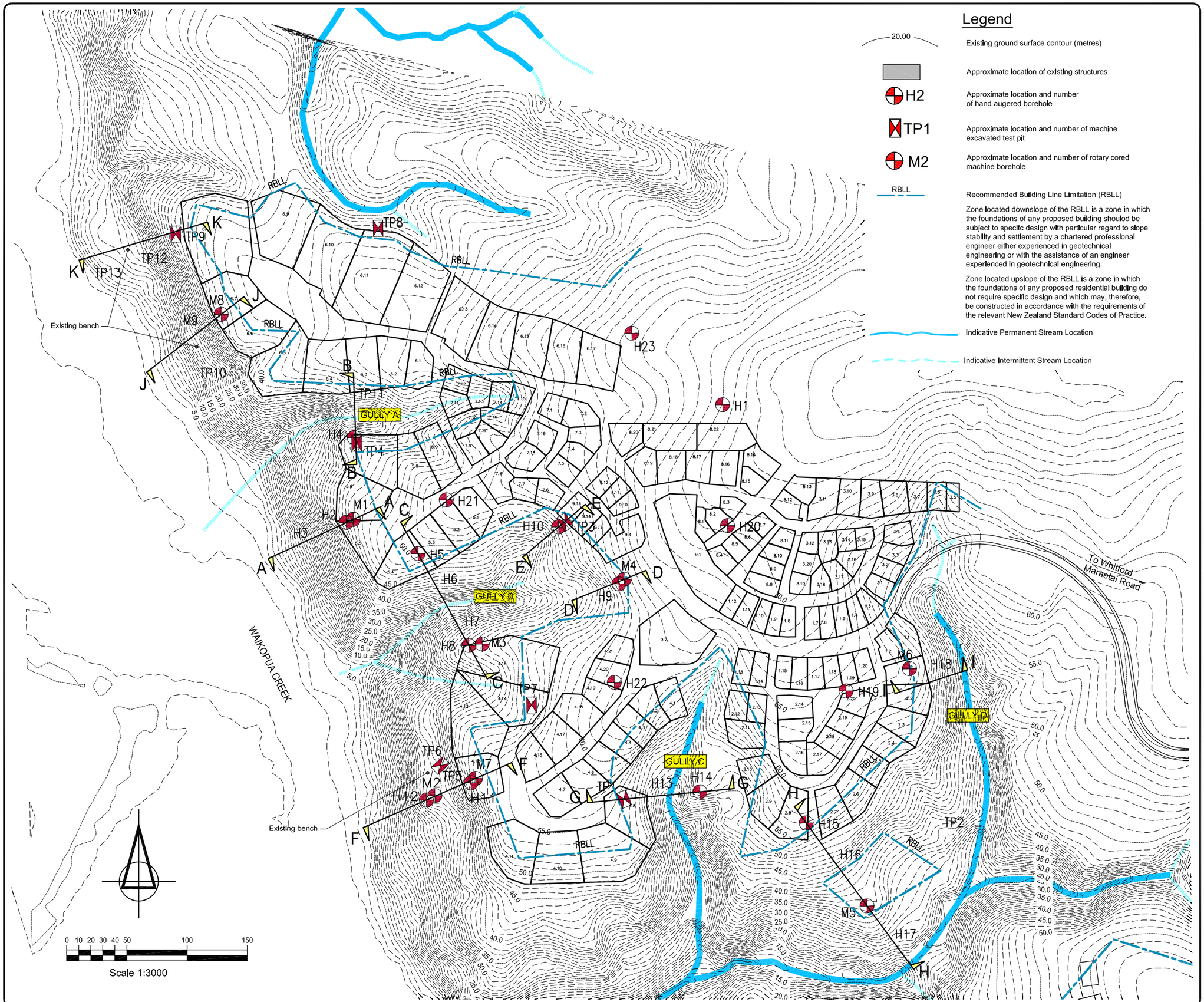

SURVEYED			APPROVED DATE
DESIGNED	MVR	OCT 09	JPMS MARCH 2012
DRAWN	LW	OCT 09	
CAD	AB	OCT 09	
CHECKED			

REVISION	CHANGES	CHECKED	DATE
A	Change in subdivisional scheme & project name	MR	21/03/12
B	Revised lot layout, and stream location update	SF	20/12/12

NOTES

1. The proposed development scheme shown, is adopted from Crosson Clarke Carnachan Architects drawing, dated 21/10/11.
2. The RBLL relates to the ground surface existing at the time of the investigation and will require to be revised where the ground surface is modified by earthworks.

CLIENT

AHUAREKA TRUST No. 2 LTD

PROJECT

AHUAREKA
SPECIAL RURAL SETTLEMENT

TITLE

SITE PLAN

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SCALE 1:3000 (A3)

DRAWING No 60834/1 REVISION B

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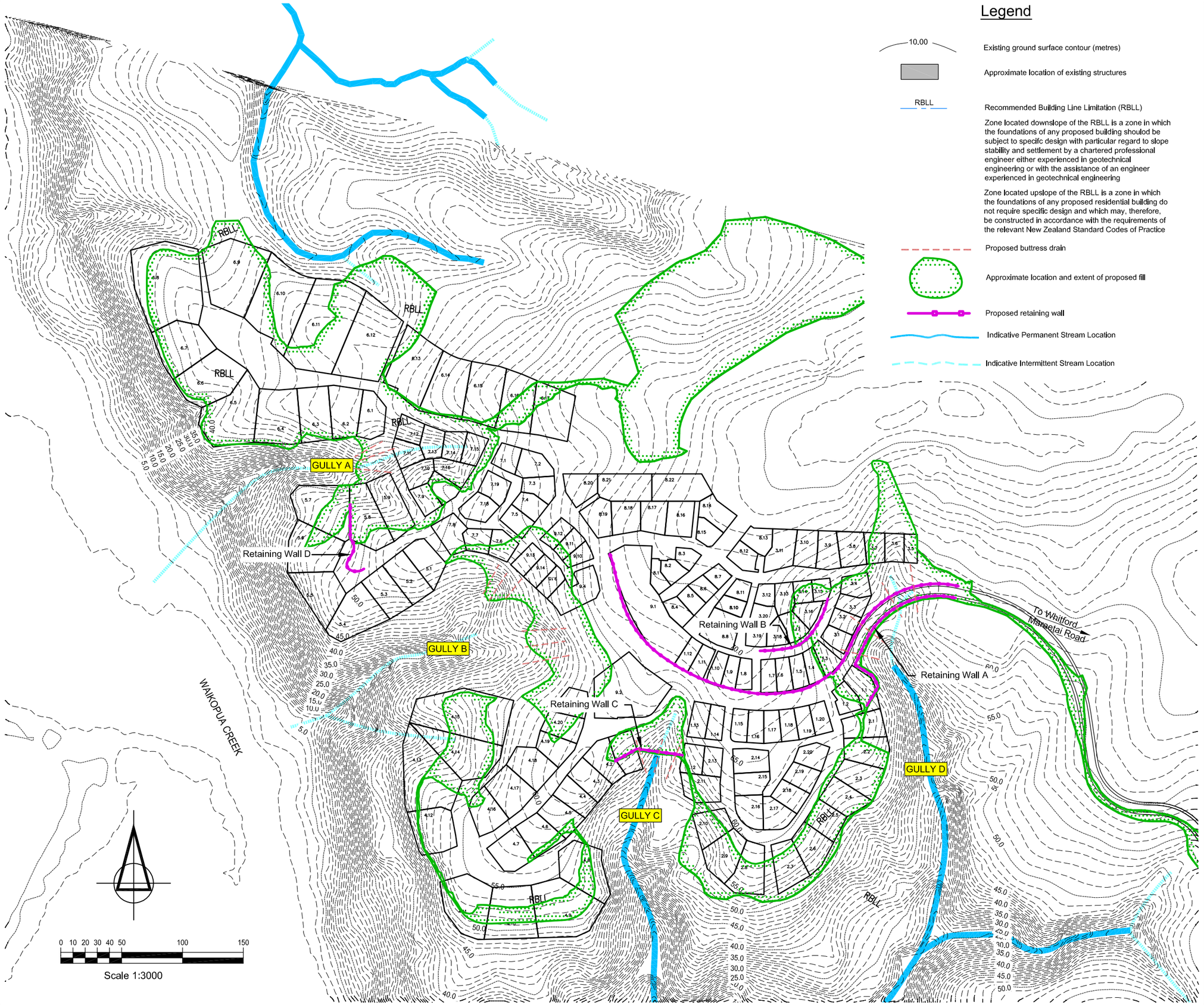

Legend

- 10.00 — Existing ground surface contour (metres)
- Approximate location of existing structures
- RBLL — Recommended Building Line Limitation (RBLL)

Zone located downslope of the RBLL is a zone in which the foundations of any proposed building shoulod be subject to specifc design with particular regard to slope stability and settlement by a chartered professional engineer either experienced in geotechnical engineering or with the assistance of an engineer experienced in geotechnical engineering

Zone located upslope of the RBLL is a zone in which the foundations of any proposed residential building do not require specific design and which may, therefore, be constructed in accordance with the requirements of the relevant New Zealand Standard Codes of Practice

- Proposed buttress drain
- Approximate location and extent of proposed fill
- Proposed retaining wall
- Indicative Permanent Stream Location
- Indicative Intermittent Stream Location

			APPROVED	DATE
SURVEYED			JPMS	
DESIGNED	MVR	OCT 09	MARCH 2012	
DRAWN	LW	OCT 09		
CAD	AB	OCT 09		
CHECKED				

REVISION	CHANGES	CHECKED	DATE
A	Change In subdivision scheme & project name	MR	21/03/12
B	Revised lot layout and stream location update	SF	20/12/12

NOTES

1. The proposed development scheme shown, is adopted from Crosson Clarke Carnachan Architects drawing, dated 21/10/11.
2. The RBLL relates to the ground surface existing at the time of the investigation and will require to be revised where the ground surface is modified by earthworks.

CLIENT

AHUAREKA TRUST No. 2 LTD

PROJECT

AHUAREKA
SPECIAL RURAL SETTLEMENT

TITLE

PLAN SHOWING APPROXIMATE LOCATION AND EXTENT OF PROPOSED FILL

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DRAWING No 60834/2 REVISION B

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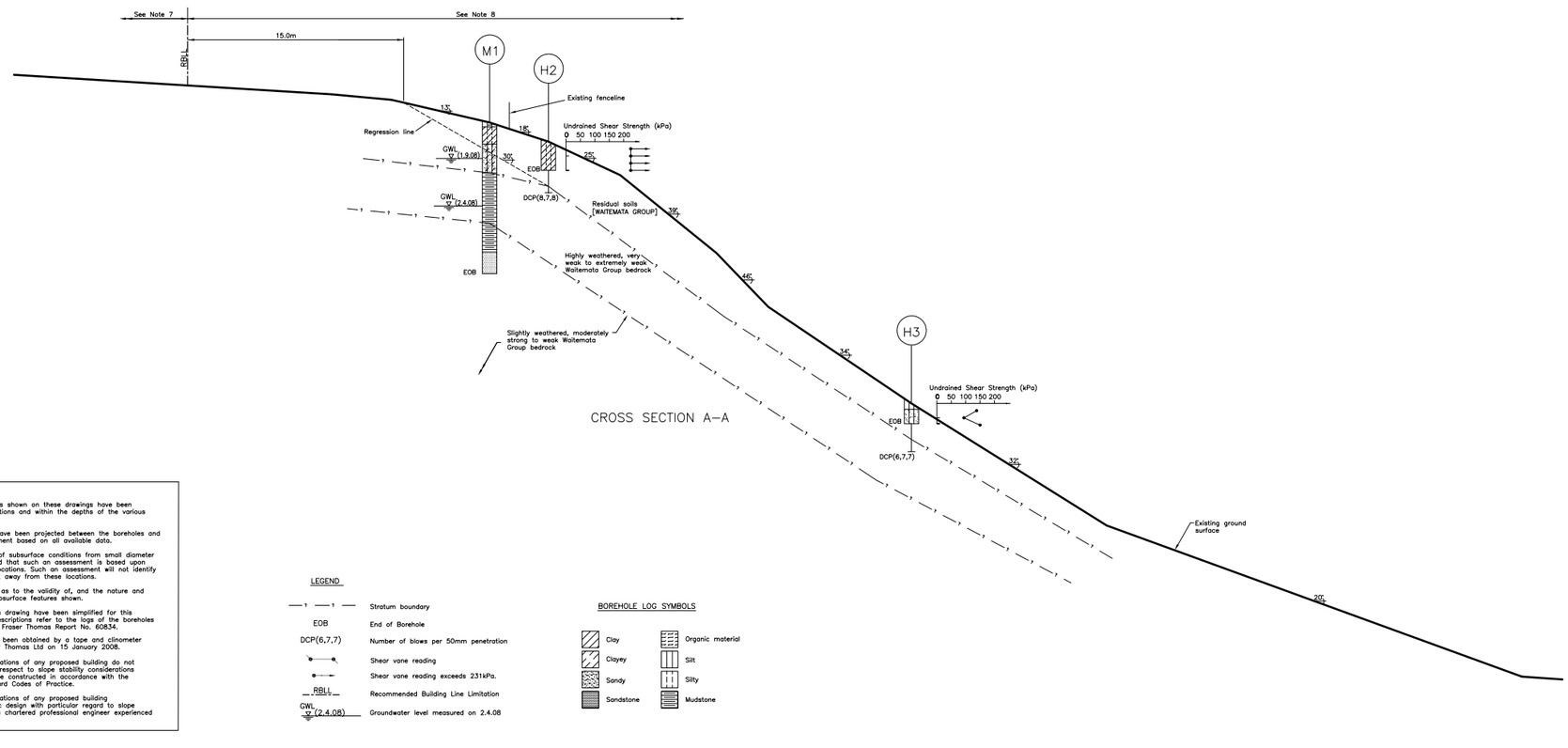

CROSS SECTION A–A

NOTES

1. The subsurface conditions as shown on these drawings have been determined only at the locations and within the depths of the various boreholes shown.
2. The subsurface conditions have been projected between the boreholes and represent a rational assessment based on all available data.
3. In making any assessment of subsurface conditions from small diameter boreholes it should be noted that such an assessment is based upon data obtained at the test locations. Such an assessment will not identify any variation that may exist away from these locations.
4. No guarantee can be given as to the validity of, and the nature and continuity of the various subsurface features shown.
5. The soil descriptions on this drawing have been simplified for this presentation. For detailed descriptions refer to the logs of the boreholes as presented in the related Fraser Thomas Report No. 60834.
6. The slope profile shown has been obtained by a tape and clinometer survey, undertaken by Fraser Thomas Ltd on 15 January 2008.
7. Zone within which the foundations of any proposed building do not require specific design with respect to slope stability considerations and which, therefore, may be constructed in accordance with the relevant New Zealand Standard Codes of Practice.
8. Zone within which the foundations of any proposed building should be subject to specific design with particular regard to slope stability and settlement by a chartered professional engineer experienced in geotechnical engineering.

LEGEND

- Stratum boundary
- EOB — End of Borehole
- DCP(6,7,7) — Number of blows per 50mm penetration
- Shear vane reading
- Shear vane reading exceeds 231kPa.
- RBL — Recommended Building Line Limitation
- GWL (2.4.08) — Groundwater level measured on 2.4.08

BOREHOLE LOG SYMBOLS

- Clay
- Clayey
- Sandy
- Sandstone
- Organic material
- Silt
- Silty
- Mudstone

SURVEYED		
DESIGNED	MR	SEP 08
DRAWN	MR	SEP 08
CAD	AB	SEP 08
CHECKED		

APPROVED: JPMS MARCH 2012 — DATE

REVISION	CHANGES	CHECKED	DATE
A	Change in subdivision scheme & project name	MR	21/03/12

NOTES

CLIENT: AHUAREKA TRUST No. 2 LTD

PROJECT: AHUAREKA SPECIAL RURAL SETTLEMENT

TITLE: CROSS SECTION A-A

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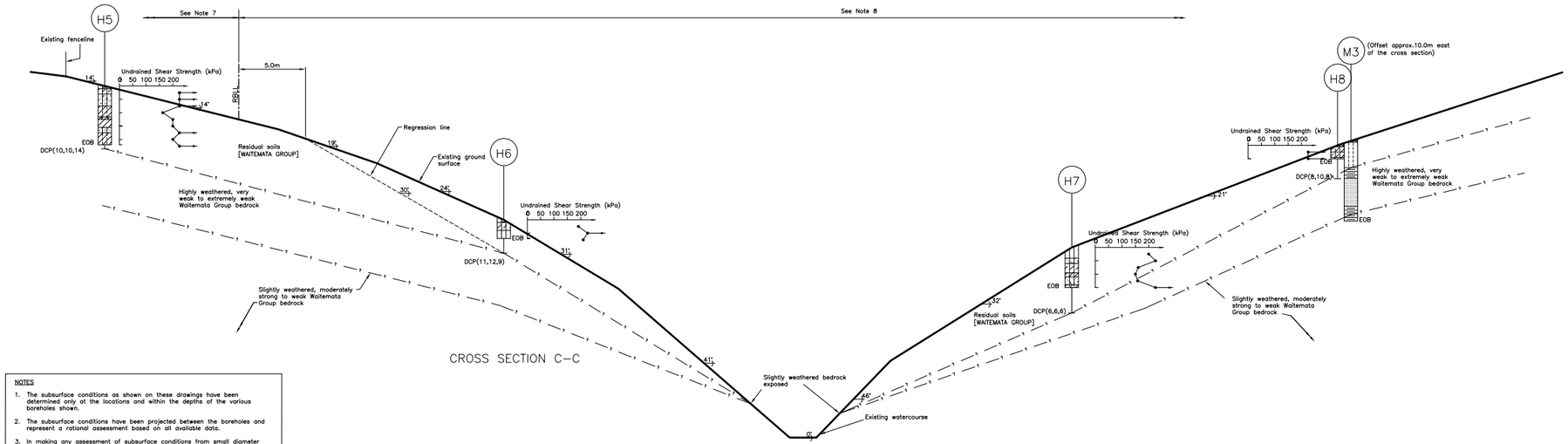

CROSS SECTION C–C

NOTES

1. The subsurface conditions as shown on these drawings have been determined only at the locations and within the depths of the various boreholes shown.
2. The subsurface conditions have been projected between the boreholes and represent a rational assessment based on all available data.
3. In making any assessment of subsurface conditions from small diameter boreholes it should be noted that such an assessment is based upon data obtained at the test locations. Such an assessment will not identify any variation that may exist away from these locations.
4. No guarantee can be given as to the validity of, and the nature and continuity of the various subsurface features shown.
5. The soil descriptions on this drawing have been simplified for this presentation. For detailed descriptions refer to the logs of the boreholes as presented in the related Fraser Thomas Report No. 60834.
6. The slope profile shown has been obtained by a tape and clinometer survey, undertaken by Fraser Thomas Ltd on 15 January 2008.
7. Zone within which the foundations of any proposed building do not require specific design with respect to slope stability considerations and which, therefore, may be constructed in accordance with the relevant New Zealand Standard Codes of Practice.
8. Zone within which the foundations of any proposed building should be subject to specific design with particular regard to slope stability and settlement by a chartered professional engineer experienced in geotechnical engineering.

LEGEND

- Stratum boundary
- EOB — End of Borehole
- DCP(11,12,9) — Number of blows per 50mm penetration
- Shear vane reading
- Shear vane reading exceeds 246kPa.
- RBL — Recommended Building Line Limitation

BOREHOLE LOG SYMBOLS

- Clay
- Clayey
- Sandy
- Sandstone
- Organic material
- Silt
- Silty
- Mudstone

SURVEYED		
DESIGNED	MR	SEP 08
DRAWN	MR	SEP 08
CAD	AB	SEP 08
CHECKED		

APPROVED: JPMS MARCH 2012 — DATE

REVISION	CHANGES	CHECKED	DATE
A	Change in subdivision scheme & project name	MR	21/03/12

NOTES

CLIENT: AHUAREKA TRUST No. 2 LTD

PROJECT: AHUAREKA SPECIAL RURAL SETTLEMENT

TITLE: CROSS SECTION C-C

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DRAWING No: 60834/5 REVISION: A

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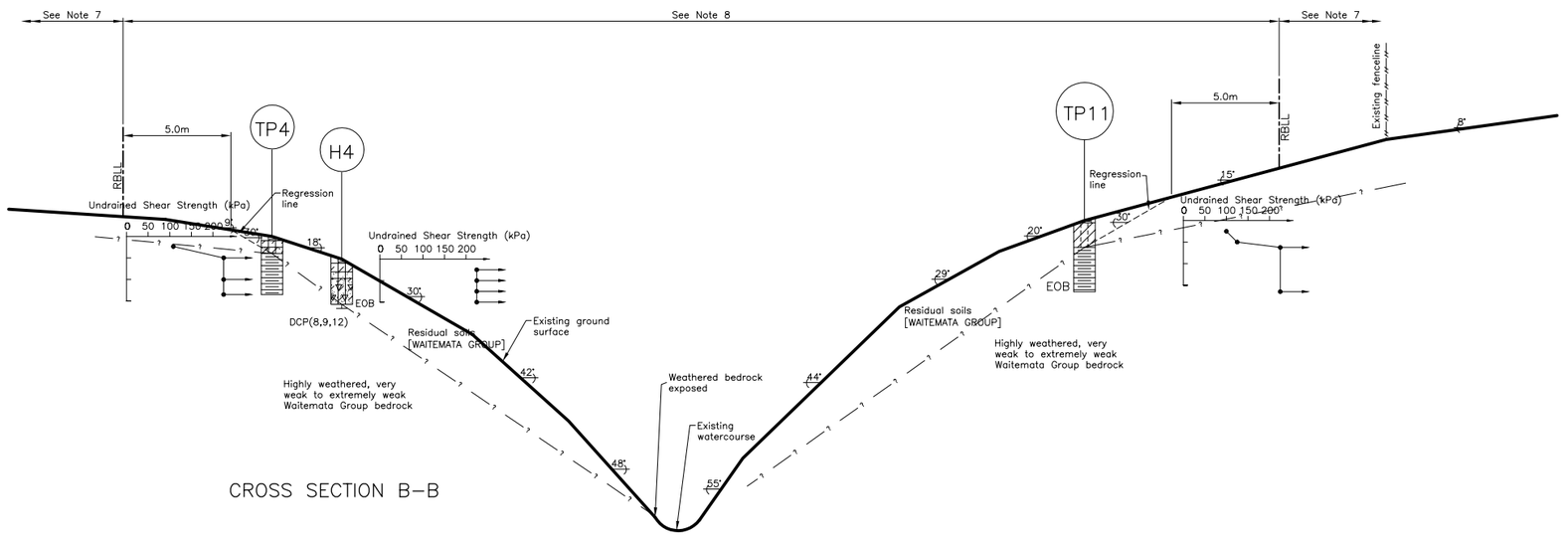

CROSS SECTION B–B

NOTES

1. The subsurface conditions as shown on these drawings have been determined only at the locations and within the depths of the various boreholes shown.
2. The subsurface conditions have been projected between the boreholes and represent a rational assessment based on all available data.
3. In making any assessment of subsurface conditions from small diameter boreholes it should be noted that such an assessment is based upon data obtained at the test locations. Such an assessment will not identify any variation that may exist away from these locations.
4. No guarantee can be given as to the validity of, and the nature and continuity of the various subsurface features shown.
5. The soil descriptions on this drawing have been simplified for this presentation. For detailed descriptions refer to the logs of the boreholes as presented in the related Fraser Thomas Report No. 60834.
6. The slope profile shown has been obtained from a tape and clinometer survey, undertaken by Fraser Thomas Ltd on 21 September 2009.
7. Zone within which the foundations of any proposed building do not require specific design with respect to slope stability considerations and which, therefore, may be constructed in accordance with the relevant New Zealand Standard Codes of Practice.
8. Zone within which the foundations of any proposed building should be subject to specific design with particular regard to slope stability and settlement by a chartered professional engineer experienced in geotechnical engineering.

LEGEND

—?—?—	Stratum boundary
EOB	End of Borehole
DCP(8,9,12)	Number of blows per 50mm penetration
	Shear vane reading
	Shear vane reading exceeds 231kPa.
RBLL	Recommended Building Line Limitation

BOREHOLE LOG SYMBOLS

Clay	Organic material
Clayey	Silt
Sandy	Silty
Sandstone	Siltstone
Gravelly	

SURVEYED			APPROVED DATE
DESIGNED	MR	OCT 09	JPMS
DRAWN	MR	OCT 09	MARCH 2012
CAD	AB	OCT 09	
CHECKED			

REVISION	CHANGES	CHECKED	DATE
A	Change in subdivisional scheme & project name	MR	21/03/12

NOTES

CLIENT
AHUAREKA TRUST No. 2 LTD

PROJECT
AHUAREKA
SPECIAL RURAL SETTLEMENT

TITLE
CROSS SECTION B-B

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

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SCALE 1:200 (A3)

DRAWING No 60834/4 REVISION A

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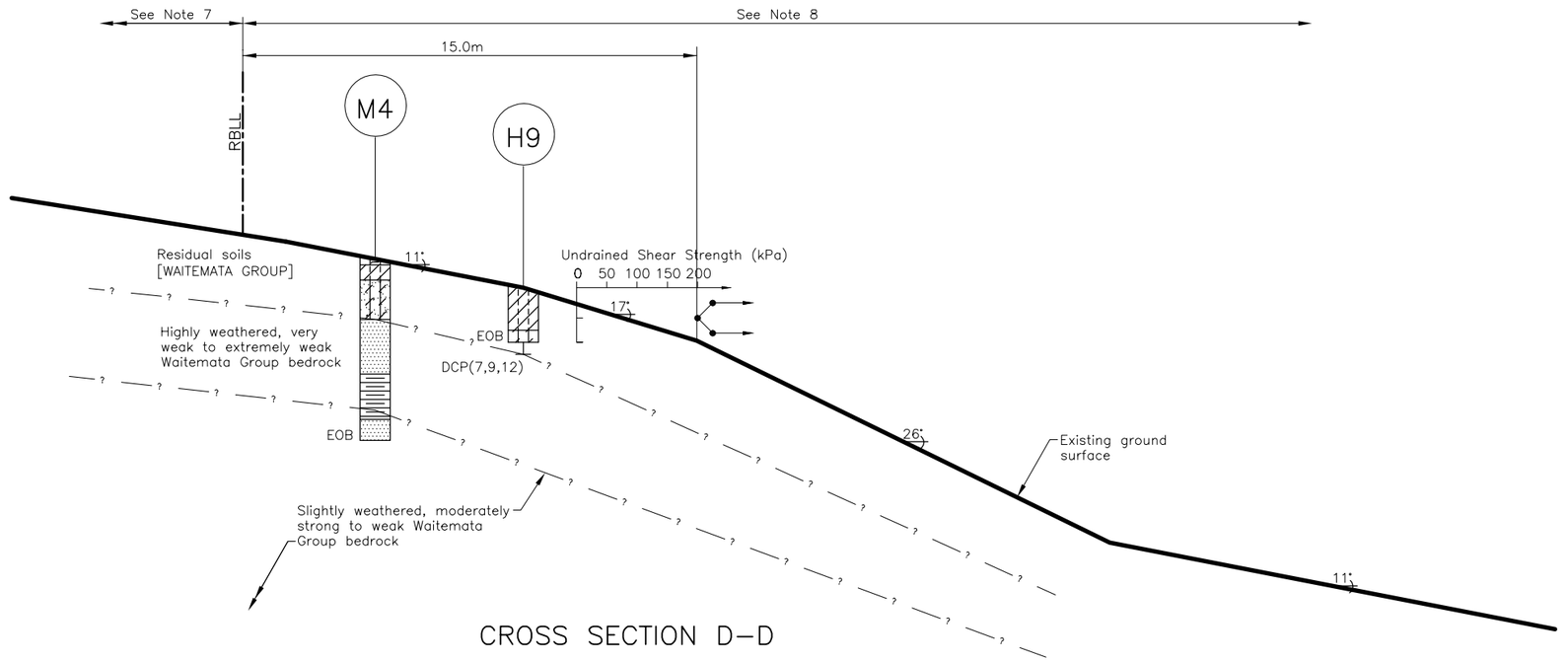

CROSS SECTION D–D

NOTES

1. The subsurface conditions as shown on these drawings have been determined only at the locations and within the depths of the various boreholes shown.
2. The subsurface conditions have been projected between the boreholes and represent a rational assessment based on all available data.
3. In making any assessment of subsurface conditions from small diameter boreholes it should be noted that such an assessment is based upon data obtained at the test locations. Such an assessment will not identify any variation that may exist away from these locations.
4. No guarantee can be given as to the validity of, and the nature and continuity of the various subsurface features shown.
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LEGEND

—?—?—	Stratum boundary
EOB	End of Borehole
DCP(7,9,12)	Number of blows per 50mm penetration
●——●	Shear vane reading
●——→	Shear vane reading exceeds 231kPa.
RBLL	Recommended Building Line Limitation

BOREHOLE LOG SYMBOLS

Clay	Organic material
Clayey	Silt
Sandy	Silty
Sandstone	Mudstone
Gravelly	

SURVEYED			APPROVED DATE
DESIGNED	MR	SEP 08	JPMS
DRAWN	MR	SEP 08	MARCH 2012
CAD	AB	SEP 08	
CHECKED			

REVISION	CHANGES	CHECKED	DATE
A	Change In subdlvlslonal scheme & project name	MR	21/03/12

NOTES

CLIENT
AHUAREKA TRUST No. 2 LTD

PROJECT
AHUAREKA
SPECIAL RURAL SETTLEMENT

TITLE
CROSS SECTION D-D

Fraser Thomas
- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
- SURVEYORS & PLANNERS

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SCALE 1:200 (A3)

DRAWING No 60834/6 REVISION A

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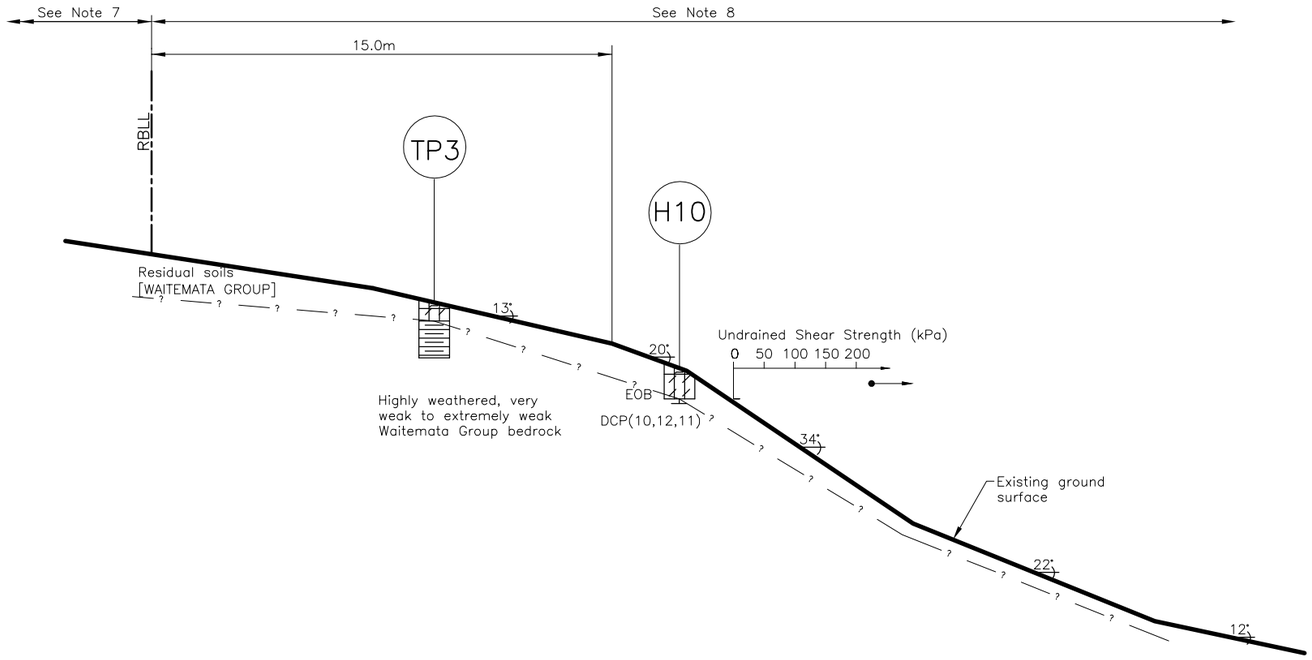

CROSS SECTION E–E

NOTES

1. The subsurface conditions as shown on these drawings have been determined only at the locations and within the depths of the various boreholes shown.
2. The subsurface conditions have been projected between the boreholes and represent a rational assessment based on all available data.
3. In making any assessment of subsurface conditions from small diameter boreholes it should be noted that such an assessment is based upon data obtained at the test locations. Such an assessment will not identify any variation that may exist away from these locations.
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7. Zone within which the foundations of any proposed building do not require specific design with respect to slope stability considerations and which, therefore, may be constructed in accordance with the relevant New Zealand Standard Codes of Practice.
8. Zone within which the foundations of any proposed building should be subject to specific design with particular regard to slope stability and settlement by a chartered professional engineer experienced in geotechnical engineering.

LEGEND

—?—?—	Stratum boundary
EOB	End of Borehole
DCP(7,9,12)	Number of blows per 50mm penetration
	Shear vane reading
	Shear vane reading exceeds 246kPa.
RBLL	Recommended Building Line Limitation

BOREHOLE LOG SYMBOLS

Clay	Organic material
Clayey	Silt
Sandy	Silty
Sandstone	Mudstone
Gravelly	

SURVEYED			APPROVED DATE
DESIGNED	MR	SEP 08	JPMS
DRAWN	MR	SEP 08	MARCH 2012
CAD	AB	SEP 08	
CHECKED			

REVISION	CHANGES	CHECKED	DATE
A	Change In subdlvlslonal scheme & project name	MR	21/03/12

NOTES

CLIENT
AHUAREKA TRUST No. 2 LTD

PROJECT
AHUAREKA
SPECIAL RURAL SETTLEMENT

TITLE
CROSS SECTION E-E

Fraser Thomas
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- RESOURCE MANAGERS
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SCALE 1:200 (A3)

DRAWING No 60834/7 REVISION A

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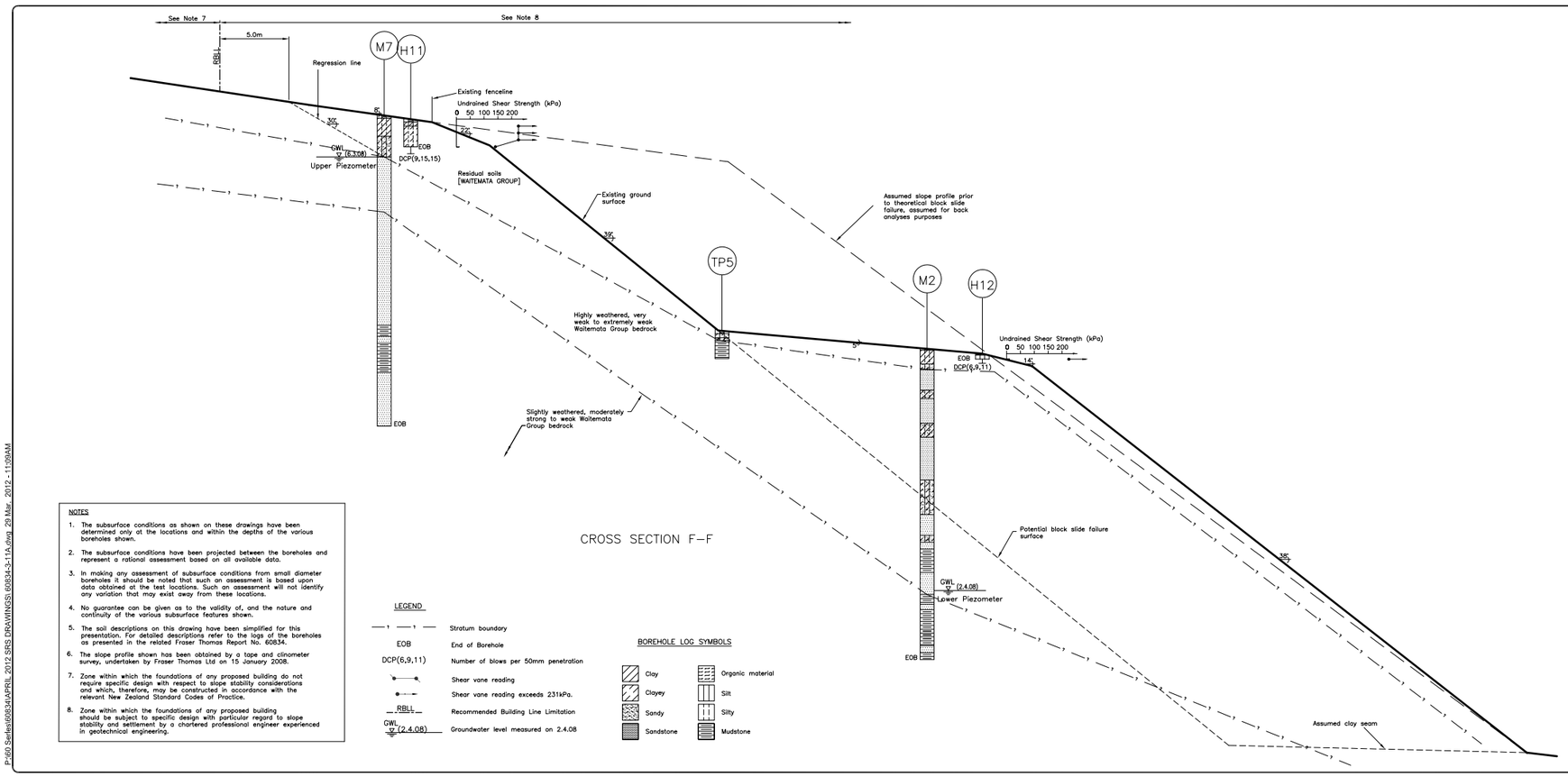

CROSS SECTION F–F

NOTES

1. The subsurface conditions as shown on these drawings have been determined only at the locations and within the depths of the various boreholes shown.
2. The subsurface conditions have been projected between the boreholes and represent a rational assessment based on all available data.
3. In making any assessment of subsurface conditions from small diameter boreholes it should be noted that such an assessment is based upon data obtained at the test locations. Such an assessment will not identify any variation that may exist away from these locations.
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LEGEND

—1—1—	Stratum boundary
EOB	End of Borehole
DCP(6,9,11)	Number of blows per 50mm penetration
	Shear vane reading
	Shear vane reading exceeds 231kPa.
RBLL	Recommended Building Line Limitation
GWL (2.4.08)	Groundwater level measured on 2.4.08

BOREHOLE LOG SYMBOLS

Clay	Organic material
Clayey	Silt
Sandy	Silty
Sandstone	Mudstone

SURVEYED			APPROVED	DATE
DESIGNED	MR	SEP 08	JPMS	
DRAWN	MR	SEP 08	MARCH 2012	
CAD	AB	SEP 08		
CHECKED				

REVISION	CHANGES	CHECKED	DATE
A	Change in subdivisional scheme & project name	MR	21/03/12

NOTES

CLIENT
AHUAREKA TRUST No. 2 LTD

PROJECT
AHUAREKA
SPECIAL RURAL SETTLEMENT

TITLE
CROSS SECTION F-F

Fraser Thomas
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DRAWING No. 60834/8 REVISION A
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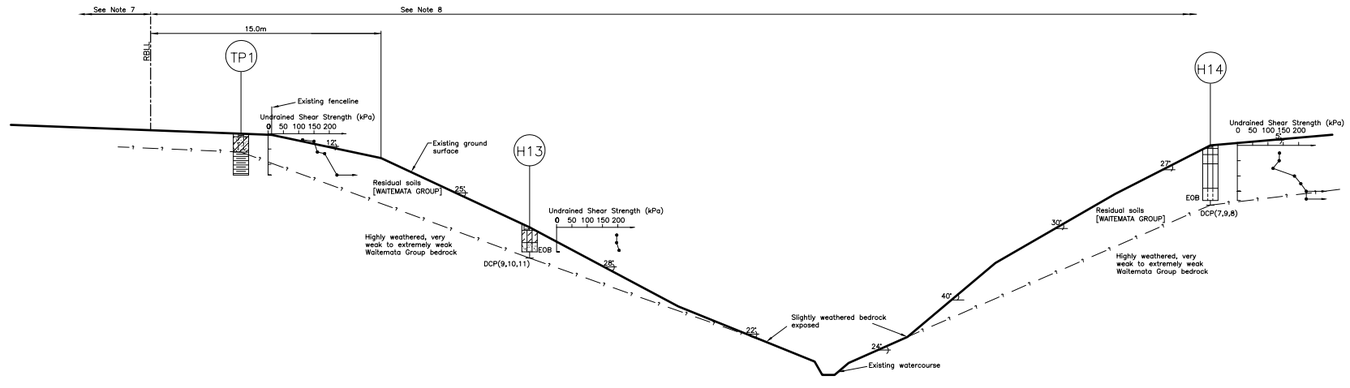

CROSS SECTION G–G

NOTES

1. The subsurface conditions as shown on these drawings have been determined only at the locations and within the depths of the various boreholes shown.
2. The subsurface conditions have been projected between the boreholes and represent a rational assessment based on all available data.
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LEGEND

—1—1—	Stratum boundary
EOB	End of Borehole
DCP(9,10,11)	Number of blows per 50mm penetration
	Shear vane reading
	Shear vane reading exceeds 231kPa.
RBLL	Recommended Building Line Limitation

BOREHOLE LOG SYMBOLS

Clay	Organic material
Clayey	Silt
Sandy	Silty
Sandstone	Mudstone

SURVEYED			APPROVED	DATE
DESIGNED	MR	SEP 08	JPMS	
DRAWN	MR	SEP 08	MARCH 2012	
CAD	AB	SEP 08		
CHECKED				

REVISION	CHANGES	CHECKED	DATE
A	Change in subdivisional scheme & project name	MR	21/03/12

NOTES

CLIENT
AHUAREKA TRUST No. 2 LTD

PROJECT
AHUAREKA
SPECIAL RURAL SETTLEMENT

TITLE
CROSS SECTION G-G

Fraser Thomas
- CONSULTING ENGINEERS
- RESOURCE MANAGERS
- ENVIRONMENTAL CONSULTANTS
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SCALE 1:200 (A3)
DRAWING No. 60834/9 REVISION A
SHEET number of number

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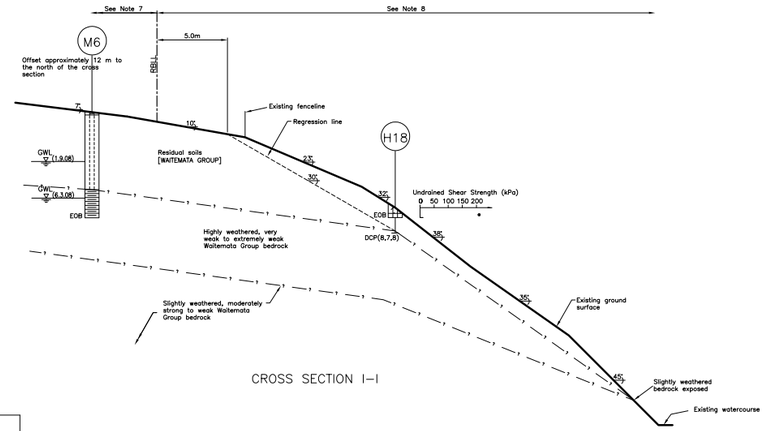

CROSS SECTION I–I

NOTES

1. The subsurface conditions as shown on these drawings have been determined only at the locations and within the depths of the various boreholes shown.
2. The subsurface conditions have been projected between the boreholes and represent a rational assessment based on all available data.
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LEGEND

- Stratum boundary
- EOB — End of Borehole
- DCP(6,7,8) — Number of blows per 50mm penetration
- Shear vane reading
- Shear vane reading exceeds 231kPa.
- RBLL — Recommended Building Line Limitation
- GWL (6.3.08) — Groundwater level measured on 6.3.08

BOREHOLE LOG SYMBOLS

- Clay
- Clayey
- Sandy
- Sandstone
- Gravelly
- Organic material
- Silt
- Silty
- Mudstone

SURVEYED			APPROVED DATE
DESIGNED	MR	SEP 08	JPMS MARCH 2012
DRAWN	MR	SEP 08	
CHK	AB	SEP 08	
CHECKED			

REVISION		CHECKED	DATE
A	Change to subdivisional scheme & project name	MR	21/03/12

NOTES

CLIENT: AHUAREKA TRUST No. 2 LTD

PROJECT: AHUAREKA SPECIAL RURAL SETTLEMENT

TITLE: CROSS SECTION I–I

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
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- SURVEYORS & PLANNERS

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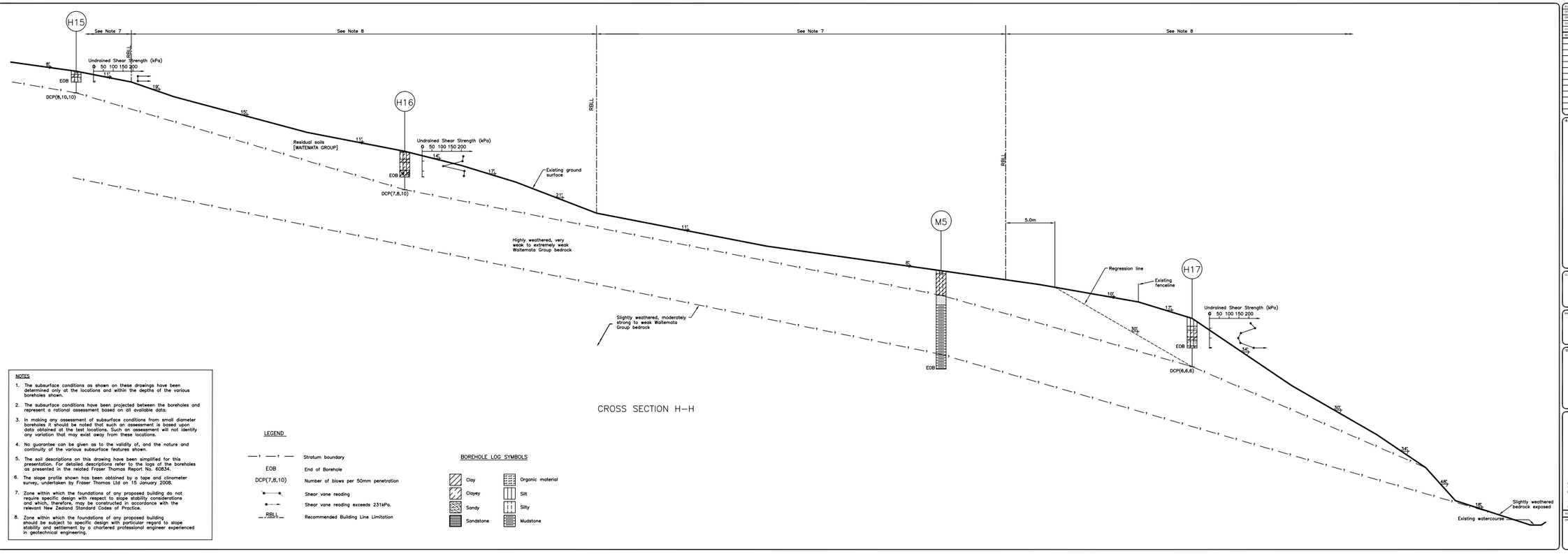
SCALE: 1:200 (A3)

DRAWING No: 60834/11 REVISION: A



CROSS SECTION H–H

NOTES

1. The subsurface conditions as shown on these drawings have been determined only at the locations and within the depths of the various boreholes shown.
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LEGEND

- Stratum boundary
- EOB — End of Borehole
- DCP(7,8,10) — Number of blows per 50mm penetration
- Shear vane reading
- Shear vane reading exceeds 231kPa.
- RBLL — Recommended Building Line Limitation

BOREHOLE LOG SYMBOLS

- Clay
- Clayey
- Sandy
- Sandstone
- Organic material
- Silt
- Silty
- Mudstone

SURVEYED			APPROVED DATE
DESIGNED	MR	SEP 08	JPMS MARCH 2012
DRAWN	MR	SEP 08	
CHK	AB	SEP 08	
CHECKED			

REVISION		CHECKED	DATE
A	Change to subdivisional scheme & project name	MR	21/03/12

NOTES

CLIENT: AHUAREKA TRUST No. 2 LTD

PROJECT: AHUAREKA SPECIAL RURAL SETTLEMENT

TITLE: CROSS SECTION H–H

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
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- SURVEYORS & PLANNERS

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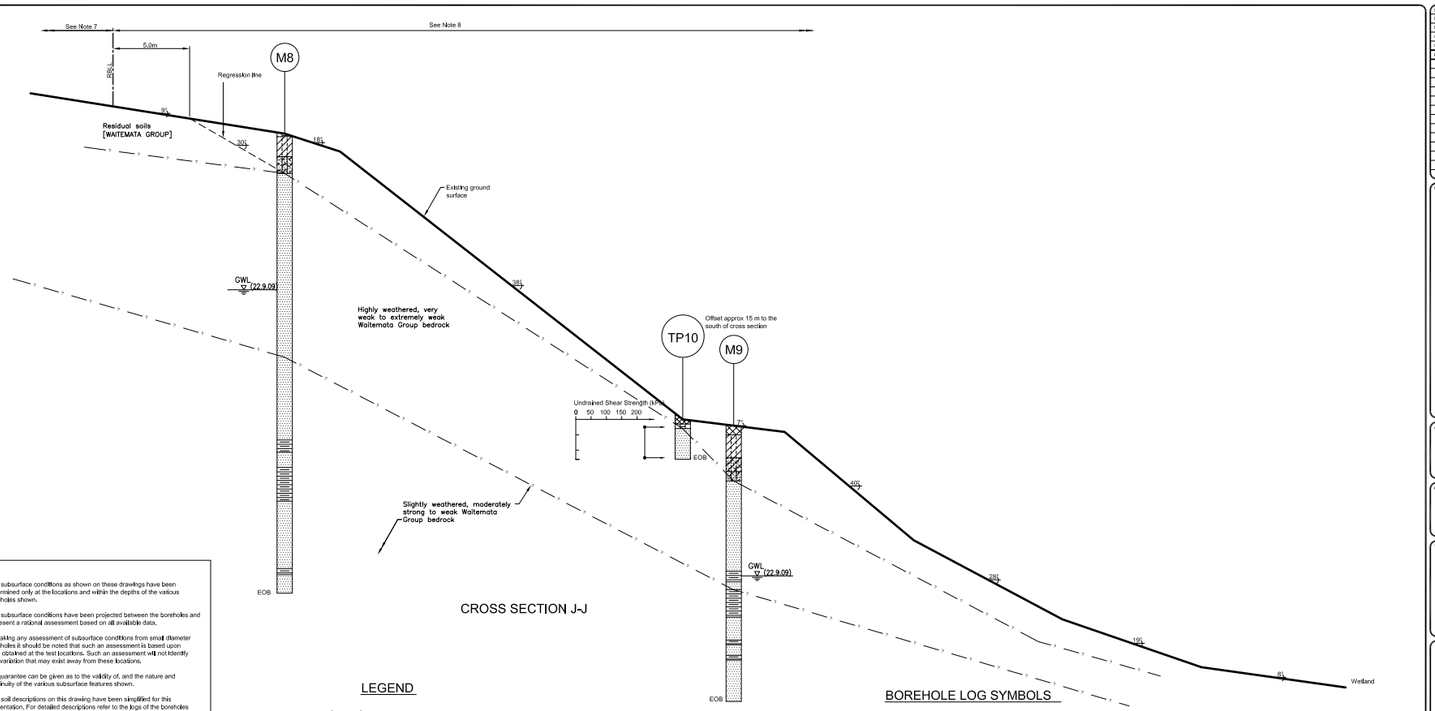
SCALE: 1:200 (A3)

DRAWING No: 60834/10 REVISION: A



NOTES

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LEGEND

- Stratum boundary
- EOB — End of Borehole
- Shear vane reading
- Shear vane reading exceeds 244 kPa.
- RBLL — Recommended Building Line Limitation

BOREHOLE LOG SYMBOLS

- Clay
- Clayey
- Sandy
- Mudstone
- Organic material
- Silt
- Silty
- Sandstone

SURVEYED			APPROVED	DATE
DESIGNED	MR	OCT 09	PRG	
DRAWN	MR	OCT 09	MARCH 2012	
CHK	AB	OCT 09		
CHECKED				

REVISION	DAMAGES	CHECKED	DATE
A	Change in subdivisional scheme & project name	MR	21/03/12

NOTES

CLIENT: AHUAREKA TRUST No. 2 LTD

PROJECT: AHUAREKA SPECIAL RURAL SETTLEMENT

TITLE: CROSS SECTION J-J

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
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SCALE: 1:200 (A3)

DRAWING No: 60834/12 REVISION: A

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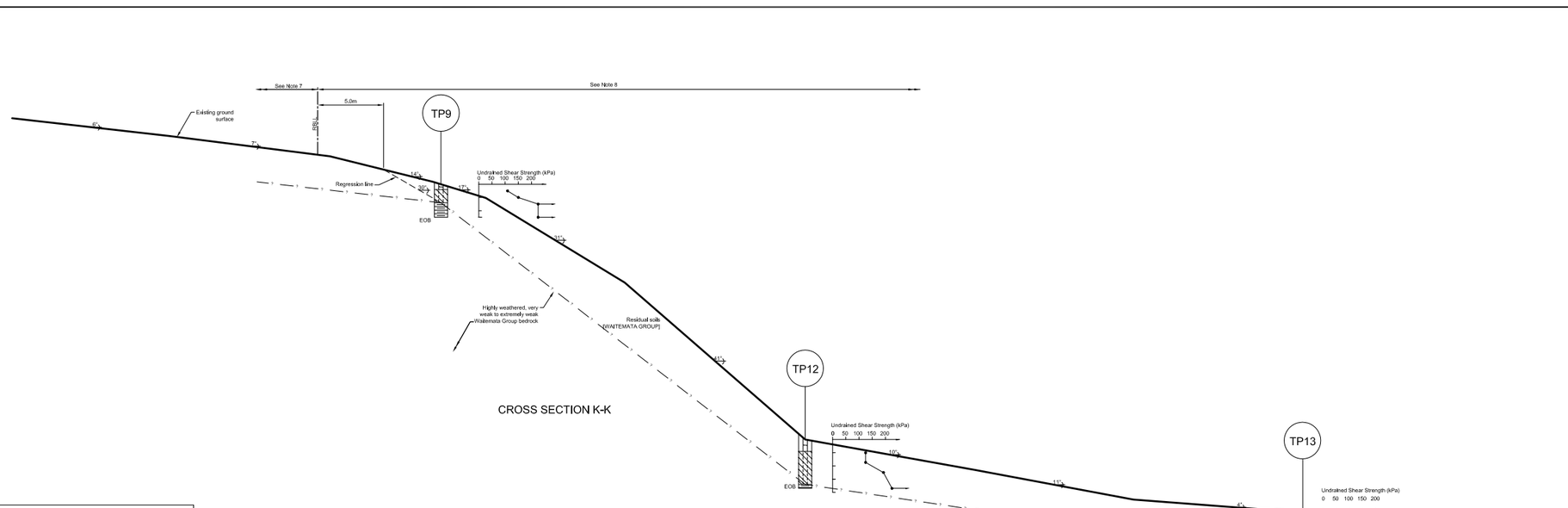

NOTES

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8. Zone within which the foundations of any proposed building should be subject to specific design with particular regard to slope stability and settlement by a chartered professional engineer experienced in geotechnical engineering.

LEGEND

- Stratum boundary
- EOB — End of Borehole
- Shear vane reading
- Shear vane reading exceeds 244 kPa.
- RBLL — Recommended Building Line Limitation

BOREHOLE LOG SYMBOLS

- Clay
- Clayey
- Sandy
- Mudstone
- Organic material
- Silt
- Silty
- Sandstone

SURVEYED			APPROVED	DATE
DESIGNED	MR	SEP 08	JPMS	
DRAWN	MR	SEP 08	MARCH 2012	
CHK	AB	SEP 08		
CHECKED				

REVISION	DAMAGES	CHECKED	DATE
A	Change in subdivisional scheme & project name	MR	21/03/12

NOTES

CLIENT: AHUAREKA TRUST No. 2 LTD

PROJECT: AHUAREKA SPECIAL RURAL SETTLEMENT

TITLE: CROSS SECTION K-K

Fraser Thomas

- CONSULTING ENGINEERS
- RESOURCE MANAGERS
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- SURVEYORS & PLANNERS

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SCALE: 1:200 (A3)

DRAWING No: 60834/13 REVISION: A

SHEET

Pavilion Building (partial records)

LIMITATION

The opinions, recommendations and comments given in this report are subject to the limitations imposed by [illegible] methods of site investigation. As factual evidence has been obtained solely from boreholes which by their nature only provide information about a relatively small volume of subsoils, there may be special conditions pertaining to this site which have not been disclosed by the boreholes and which have not been taken into account in the report. Therefore, it is in the interests of all parties that we be retained to examine the site during foundation construction, so that exposed subsoils can be related to the report assumptions. In all circumstances however, if variations in the subsoils occur from those described or assumed to exist then the matter should be referred back to us immediately.

7

~~Any fill which does not meet the specified requirements shall be excavated, disced and dried or wetted and mixed as necessary and recompacted until it does comply. Any fill surface which has deteriorated through excessive drying or wetting shall be brought to the appropriate water content and recompacted before further fill is placed.~~

~~Under no conditions whatsoever shall the Contractor be permitted to work plastic clay on any portion of the work during rain or wet conditions. If the material already deposited becomes pugged up by an excess of water, no further material shall be deposited until such wet material has dried out or has been completely removed by the Contractor at his own expense and to the satisfaction of the Engineer.~~

1.3.4 COMPACTION REQUIREMENTS FOR ON-SITE ENGINEERED FILLING

Soil placed in fills shall be compacted until the following conditions are satisfied. Either Method A or Method B may be selected by the Engineer based upon the experience with the performance of local soil types.

Method A — Air Voids and Shear Vane (for cohesive soils only)

(a) Air Voids Percentage
(as defined in NZS 4402:1986

General Fill

Maximum value	10%

Within 500 mm of carriageway subgrade

Maximum value	8%

Dam fills including seepage keys and core areas

Maximum value	6%

(b) Undrained Shear Strength
(Measured by insitu vane - [illegible] calibrated)

General fill

Average value not less than	140 kPa
Minimum single value	110 kPa

Within 500 mm of carriage subgrade

Average value not less than	150 kPa
Minimum single value	120 kPa

Dam fills including seepage keys and core areas

Average value not less than	140 kPa
Minimum single value	110 kPa

Note: The average value shall be determined over any ten consecutive tests

fill specification for earthworks on sports pavilion site Formosa International, Beachlands.

Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97
Auger Borehole No. 1 Sheet 1 of 14 Diameter 50 mm

SOIL DESCRIPTION	Depth (m)	Water Level	Shear Vane (kPa)	Soil Sensitivity	Samples - No. Type Depth	Other Tests
FILL: Stiff, slightly plastic, brown slightly clayey silt with numerous gravel inclusions						
NATURAL: Stiff, slightly plastic, orange streaked grey fine sandy slightly clayey SILT	0.5					
			122	5.5		
Stiff, moderately to very plastic, orange streaked grey slightly fine sandy very clayey SILT	1.0		112	3.1		
- becoming very plastic	1.5		116	1.3		
	2.0		118	1.5		
Stiff, very plastic, orange red streaked grey fine sandy very clayey SILT			99	1.8		
- becoming grey streaked orange	2.5		82	2.0		
	3.0		70	1.8		
Firm, very plastic, grey streaked orange very clayey SILT						
- becoming moist	3.5		76	2.7		
Firm, moderately to very plastic, pink, orange streaked grey very fine sandy very clayey SILT, wet - becoming grey streaked orange	4.0	▽	94	2.7		

Continued

Remarks: Groundwater encountered at 3.8 metres

Logged: MJH Checked:

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

Legend: Topsoil, Fill, Clay, Silt, Sand, Gravel, Peat, Rock

Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97
Auger Borehole No. 1 Sheet 2 of 14 Diameter 50 mm

SOIL DESCRIPTION	Depth (m)	Water Level	Shear Vane (kPa)	Soil Sensitivity	Samples - No. Type Depth	Other Tests
Continued Firm, moderately to very plastic, grey streaked orange very fine sandy very clayey SILT, wet						
Stiff, moderately to very plastic, grey streaked orange fine sandy clayey SILT			100	2.5		
	4.5					
Stiff, moderately plastic, grey streaked orange very fine sandy clayey SILT			86	2.3		
	5.0					
Stiff, moderately plastic, dark grey fine sandy slightly clayey SILT			106	2.4		
E.O.B at 5.2 metres						
	5.5					
	6.0					
	6.5					
	7.0					
	7.5					
	8.0					

Remarks: Groundwater encountered at 3.8 metres

Logged: MJH Checked:

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

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Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97
Auger Borehole No. 2 Sheet 3 of 14 Diameter 50 mm

SOIL DESCRIPTION	Depth (m)	Water Level	Shear Vane (kPa)	Soil Sensitivity	Samples - No. Type Depth	Other Tests
TOPSOIL						
NATURAL: Stiff, slightly plastic, orange slightly clayey SILT			100	2.2		
	0.5					
			90	1.9		
Stiff, moderately plastic, orange streaked light grey slightly fine sandy clayey SILT	1.0		120	2.0		
Stiff, very plastic, orange streaked light grey very clayey SILT	1.5		110	1.5		
	2.0		110	1.4		
			90	1.3		
	2.5					
Stiff, moderately plastic, orange, pink streaked light grey slightly fine sandy clayey SILT			90	1.7		
	3.0					
Stiff, slightly to moderately plastic, pink, orange, red streaked light grey fine sandy slightly clayey SILT			89	1.4		
	3.5		84	1.4		
	4.0	▽	88	1.6		

Continued

Remarks: Groundwater encountered at 4.2 metres

Logged: MVR Checked:

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

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Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97
Auger Borehole No. 2 Sheet 4 of 14 Diameter 50 mm

SOIL DESCRIPTION	Depth (m)	Water Level	Shear Vane (kPa)	Soil Sensitivity	Samples - No. Type Depth	Other Tests
Continued Stiff, slightly to moderately plastic, pink, orange, red streaked light grey fine sandy slightly clayey SILT - becoming firm, orange			54	1.4		
	4.5		46	1.4		
	5.0					
- becoming stiff, intermixed with orange streaked dark grey slightly clayey silt			116	1.9		
	5.5		115	1.3		
	6.0		120	1.4		
E.O.B at 6.0 metres						
	6.5					
	7.0					
	7.5					
	8.0					

Remarks: Groundwater encountered at 4.2 metres

Logged: MVR Checked:

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

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Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97
Auger Borehole No. 3 Sheet 5 of 14 Diameter 50 mm

SOIL DESCRIPTION	Depth (m)	Water Level	Shear Vane (kPa)	Soil Sensitivity	Samples - No. Type Depth	Other Tests
TOPSOIL						
NATURAL: Stiff, slightly plastic, orange slightly clayey SILT			140+			
	0.5		140+			
	1.0		140+			
Very stiff, slightly plastic, orange streaked light grey fine sandy slightly clayey SILT	1.5		140+			
	2.0		126	1.4		
Stiff, moderately to very plastic, light grey streaked orange slightly fine sandy clayey SILT						
Stiff, very plastic, orange, pink streaked light grey very clayey SILT			110	1.4		
	2.5		102	1.5		
	3.0		80	1.7		
Stiff, moderately to very plastic, orange, red streaked light grey slightly fine sandy clayey SILT	3.5		80	1.8		
- becoming firm	4.0		74	1.5		

Continued

Remarks: Groundwater not encountered

Logged: MVR Checked:

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

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Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97
Auger Borehole No. 3 Sheet 6 of 14 Diameter 50 mm

SOIL DESCRIPTION	Depth (m)	Water Level	Shear Vane (kPa)	Soil Sensitivity	Samples - No. Type Depth	Other Tests
Continued Firm, moderately to very plastic, orange, red streaked light grey slightly fine sandy clayey SILT - becoming stiff			100	1.4		
	4.5		120	1.5		
	5.0		80	1.9		
- becoming light grey, moist	5.5		130	2.2		
	6.0		136	1.5		
E.O.B at 6.0 metres						
	6.5					
	7.0					
	7.5					
	8.0					

Remarks: Groundwater not encountered

Logged: MVR Checked:

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

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Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97
Auger Borehole No. 4 Sheet 7 of 14 Diameter 50 mm

SOIL DESCRIPTION	Depth (m)	Water Level	Shear Vane (kPa)	Soil Sensitivity	Samples - No. Type Depth	Other Tests
FILL: Firm to stiff, orange, brown silty clay intermixed with topsoil inclusions						
NATURAL: Firm to stiff, moderately plastic, dark orange/brown mottled light orange silty CLAY - becoming very silty			115	2.4		
	0.5					
Firm to stiff, moderately plastic, orange streaked light grey, [illegible] orange slightly sandy clayey SILT			132	2.0		
Stiff, non-plastic to slightly plastic, orange stained light grey slightly clayey sandy SILT - becoming red streaked light grey clayey sandy silt	1.0		116	2.0		
	1.5		140+			
	2.0		140+			
			140+			
	2.5		96	1.7		
	3.0		98	1.3		
Firm, slightly plastic, grey streaked light orange sandy clayey SILT	3.5		74	1.4		
	4.0		57	1.8		

Continued

Remarks: Groundwater encountered at 5.0 metres

Logged: AA-Z Checked:

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

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Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97
Auger Borehole No. 4 Sheet 8 of 14 Diameter 50 mm

SOIL DESCRIPTION	Depth (m)	Water Level	Shear Vane (kPa)	Soil Sensitivity	Samples - No. Type Depth	Other Tests
Continued Firm, slightly plastic, grey streaked light orange sandy clayey SILT			50	1.5		
	4.5					
Stiff, slightly to moderately plastic, orange mottled cream/grey silty CLAY						
Firm to stiff, slightly to moderately plastic, dark grey fine sandy clayey SILT			94	1.5		
Loose, dark grey streaked grey silty SAND, wet	5.0		92	1.2		
E.O.B at 5.2 metres						
	5.5					
	6.0					
	6.5					
	7.0					
	7.5					
	8.0					

Remarks: Groundwater encountered at 5.0 metres

Logged: AA-Z Checked:

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97

Auger Borehole No. 5 — Sheet 9 of 14 — Diameter 50 mm

SOIL DESCRIPTION	Shear Vane (kPa)	Soil Sensitivity
TOPSOIL		
NATURAL: Stiff, moderately plastic, orange streaked light brown clayey SILT	84	2.6
- becoming orange, light brown streaked light grey	115	2.3
Stiff, moderately to very plastic, orange streaked light grey slightly fine sandy clayey SILT; - becoming orange, red streaked light grey	120	1.7
	120	1.3
Stiff, moderately plastic, orange, red streaked light grey slightly fine sandy clayey SILT	140+	
Stiff, moderately to very plastic, orange streaked light grey slightly fine sandy clayey SILT	118	1.1
Stiff, very plastic, orange, brown streaked grey slightly fine sandy very clayey SILT		
Stiff, very plastic, light grey streaked brown slightly silty CLAY	98	1.3
	103	1.2
Stiff, very plastic, red streaked light grey fine sandy very clayey SILT; - becoming firm, light grey streaked pink, moist	78	1.8
Continued		

Remarks: Groundwater not encountered

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97

Auger Borehole No. 5 — Sheet 10 of 14 — Diameter 50 mm

SOIL DESCRIPTION	Shear Vane (kPa)	Soil Sensitivity
Continued		
Firm, very plastic, light grey streaked pink very clayey SILT; - becoming light orange		
Stiff, very plastic, grey streaked orange very clayey SILT	96	1.8
Stiff, very plastic, grey streaked light pink fine sandy very clayey SILT, moist	85	2.0
	90	2.0
Stiff, moderately plastic, orange streaked light grey very sandy slightly clayey SILT, moist		
Stiff, moderately plastic, orange streaked light grey fine sandy clayey SILT	110	2.1
	114	2.3
E.O.B at 6.0 metres		

Remarks: Groundwater not encountered

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97

Auger Borehole No. 6 — Sheet 11 of 14 — Diameter 50 mm

SOIL DESCRIPTION	Shear Vane (kPa)	Soil Sensitivity
TOPSOIL		
FILL: Soft to firm, orange and grey mottled light brown silty clay with organic and fibrous inclusions	70	1.4
NATURAL: Stiff, moderately plastic, orange mottled light brown/light grey silty CLAY, moist	140+	
Stiff, moderately plastic, red and orange streaked light grey clayey SILT, moist	140+	
	140+	
	134	1.6
- with fine sand inclusions	140+	
- becoming orange and red streaked light brown light grey	114	1.5
	102	1.3
Firm to stiff, moderately plastic, grey and red streaked light orange clayey SILT with occasional organic inclusions, moist	100	1.5
- with fine sand inclusions		
Stiff, moderately plastic, orange, brown clayey sandy SILT, moist	140+	
Continued		

Remarks: Groundwater not encountered

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97

Auger Borehole No. 6 — Sheet 12 of 14 — Diameter 50 mm

SOIL DESCRIPTION	Shear Vane (kPa)	Soil Sensitivity
Continued		
Stiff, non-plastic to moderately plastic, red and brown mottled orange clayey sandy SILT, moist		
Firm, moderately plastic, orange/brown clayey sandy SILT intermixed with organic inclusions		
Firm, non-plastic, grey slightly fine sandy slightly clayey SILT with organic inclusions	52	1.2
Loose, brown streaked grey silty SAND, moist; - becoming wet	125	1.7
	140+	
E.O.B at 5.0 metres		

Remarks: Groundwater not encountered

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97

Auger Borehole No. 7 — Sheet 13 of 14 — Diameter 50 mm

SOIL DESCRIPTION	Shear Vane (kPa)	Soil Sensitivity
TOPSOIL		
NATURAL: Stiff, slightly to moderately plastic, orange slightly clayey SILT	95	2.4
	98	2.0
Stiff, moderately plastic, light grey streaked orange slightly fine sandy clayey SILT		
Stiff, very plastic, orange streaked light grey very clayey SILT		
Stiff, moderately to very plastic, orange, pink streaked light grey slightly fine sandy clayey SILT	130	1.9
	140+	
	140+	
	120	1.3
	110	1.4
	100	1.3
E.O.B at 3.2 metres		

Remarks: Groundwater not encountered

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

Client: Mainzeal Property & Construction Limited
Location: Sports Pavilion, Formosa Auckland Country Club, Beachlands
Job Number: 7584 **Date:** 2.4.97

Auger Borehole No. 8 — Sheet 14 of 14 — Diameter 50 mm

SOIL DESCRIPTION	Shear Vane (kPa)	Soil Sensitivity
TOPSOIL		
NATURAL: Stiff, slightly plastic, orange slightly clayey SILT	108	2.8
	98	2.5
	140+	
Stiff, moderately plastic, light grey streaked orange clayey SILT		
Stiff, moderately plastic, light grey streaked orange slightly fine sandy clayey SILT	140+	
	120	1.4
Stiff, very plastic, orange, pink, red streaked light grey slightly fine sandy very clayey SILT	138	1.4
	102	1.5
Stiff, very plastic, orange streaked light grey silty CLAY	100	1.6
E.O.B at 3.2 metres		

Remarks: Groundwater not encountered

FOUNDATION ENGINEERING — Foundation Engineering Limited, Johns Lane, Pakuranga, Auckland

PRODUCER STATEMENT - PS1 - DESIGN

(Guidance notes on the use of this form are printed on the reverse side)

ISSUED BY: Thorburn Consultants Ltd

TO: Formosa Auckland Country Club

TO BE SUPPLIED TO:

IN RESPECT OF: proposed concrete swimming pool

AT: Jack Lachlan Drive, Beachlands, Manukau City

LOT 4 & 5 DP 125200 SO

Thorburn Consultants Ltd has been engaged by Cascade Pools Paparoa to provide structural design services in respect of the requirements of Clause(s) B1/VM1 of the Building Regulations 1992 for [X] All [ ] Part only as specified of the building work. The design has been prepared in accordance with NZS 3106 (respectively) of the approved documents issued by the Building Industry Authority and the work is described on Thorburn Consultants Ltd drawings titled proposed pool for Formosa Auckland Country Club and numbered P21-118, P1 and the specification and other documents according to which the building is proposed to be constructed.

As an independent design professional, covered by a current policy of Professional Indemnity Insurance to a minimum value of $200,000, I BELIEVE ON REASONABLE GROUNDS that subject to:

(i) the site verification of the following design assumptions that the founding soils are original ground with a minimum safe bearing pressure of 100 kPa

and (ii) all proprietary products meeting the performance specification requirements,

the drawings, specifications, and other documents according to which the building is proposed to be constructed comply with the relevant provisions of the building code.

MIPENZ

Date: 30 April 1997

ERB/AERB Reg No. 4441

Member ACENZ [X] IPENZ [X] NZIA [ ]

RECEIVED CPU 07 MAY 1997

RECEIVED M.C. 07 MAY 1997

This form to accompany Form 3 of the Building Regulations 1992 for the application of a Building Consent.

October 94

MANUKAU CONSULTANTS — BCN-020

BUILDING CONSENT APPLICATION

TO: CE/BO

JOB DESC: Gr. foundation for golf club

APPLICANT: Stuart Charlton

BLD/REF: 97 1629

CALCS BY: George Butler

ST. REF: 782 Whitford Maraetai - 9347/782

COMMENTS: all foundation structures up to slab level + swimming pool.

FOUNDATION AND/OR SITE REQUIREMENTS

ENDORSEMENT: SUPERVISION
SUPERVISION IS REQUIRED BY REGISTERED ENGINEER (SEE SUPERVISION CERTIFICATE)

Structurally checked by: Date:

Butler Cargo Engineers

1.9 BURVEYING AND SETTING OUT

The Contractor shall be responsible for the correct setting out of the work and he shall employ a registered surveyor for this. The setting out shall be done from the survey pegs and from information supplied on the drawings or from such further pegs or drawings that may be supplied as the works proceeds.

The Contractor will take care at all times to preserve legal survey marks and should they become disturbed shall reinstate them at their own expense.

1.10 SURFACE STRIPPING

This shall include the removal of all obstacles, fences, stone walls, concrete, trees, vegetation, turf or other matter within the area of operation. Remove material and cart and deposit from site.

1.11 TOPSOIL

Remove and cart away topsoil in affected areas.

1.12 BULK EXCAVATION AND FILLING

The subgrade shall be bulk excavated or filled as necessary to enable the finished levels to be achieved.

The Contractor shall dig such trenches and provide such other facilities as may be required to ensure that stormwater will quickly drain off the subgrade. These must be constructed so as not to flood or damage any property whatsoever and shall be filled in or removed on completion of the work.

The control of silt from development works may be subject to water right in terms of Section 88 of the Resource Management Act 1991. The Contractor is to ensure that this is complied with. During the construction period measures shall be taken to prevent fill material from being eroded and re-deposited at lower levels where it might cause damage to property, malfunction of drainage systems, public nuisance or danger.

During the construction period, measures shall be taken to prevent excessive water logging of surface materials yet to be excavated or compacted, or both.

Without prejudice to the conditions of any water right the following practices should be adopted:

The surfaces of fills and cuts should be graded to prevent ponding.

The upper surfaces of fill should be compacted with rubber tyred or smooth wheeled plant when rain is impending, or when the site is to be left unattended.

The compacted battered surfaces of fills should be compacted with sheepsfoot or similar non-smooth compaction plant to reduce run off velocities.

Surface water should be prevented from discharging over batter faces by drains or ditches formed to intercept surface runoff and to discharge via stable channels or pipes preferably into stable water courses or piped stormwater systems as approved by the Local Authority.

Silt traps of adequate capacity should be constructed to pond runoff and precipitate silt so that it is prevented from being washed down to where it could cause damage.

All surplus excavated material shall be removed from site as directed.

After bulk excavation is completed in any given area, the Engineer is to be notified so that an inspection can be made. If any unsuitable material is encountered at subgrade level it shall be removed by the Contractor on receiving written instructions.

FORMOSA SPORTS CENTRE

Butler Cargo Engineers

Some areas will require building up to subgrade level. Prior to placing fill, the sub base must be inspected and approved by the Engineer. Fill shall be approved imported hardfill.

Fill material shall be spread in layers not exceeding 200mm depth (loose) and compacted by at least 6 passes of an 8 tonne roller or equivalent. Compaction shall be carried out at optimum moisture content to achieve 95% relative standard compaction in accordance with NZS 4402:1986.

1.13 TRIMMING OF SUBGRADE

When bulk earthworks have been completed the subgrade, paths and berms shall be trimmed true to level, grade and cross section.

The subgrade shall be brought to a firm smooth and uniform finish by rolling the entire area, in conjunction with grading and blading or hand trimming to fill any depressions which may develop.

Any yielding or unsatisfactory materials which becomes evident during rolling shall be removed and replaced with suitable materials at the Contractor's expense.

The surface of any section of the subgrade shall conform to grades and typical cross section and there shall be no point in the general surface that will vary more than 20mm. Each section of the subgrade shall be approved and passed by the Engineer before any metalling is done on that section.

1.14 BUILDING EXCAVATIONS

Excavate generally as required for foundations, walls and floors. Bottoms of trenches shall be trimmed level and loosening of underlying material shall be avoided.

Any soft areas shall be reported to the Engineer.

Allow for boxing on all sides of foundations except that where approved by the Engineer, boxing may be omitted provided the foundations are widened 25mm each side to provide additional cover.

After inspection by the Engineer place 25mm thickness of 10 MPa site concrete in all foundations.

1.15 SHORING AND SUPPORT OF EXCAVATIONS

Provide any underpinning or temporary support of adjacent properties, roads, paths etc as may be necessary to ensure that construction does not affect these existing works.

Provide and maintain all shoring and strutting which may be required to support trenches, banks, ditches, retaining walls etc. The support systems shall be such as to prevent any movement of the supported ground, and shall ensure the safety of the workmen.

Remove all shoring, strutting, planking etc when no longer required. No timbering shall be left in the ground.

1.16 MAINTENANCE OF EXCAVATIONS

Provision shall be made for draining water from foundations and sumps shall be provided clear of the foundations where necessary so that water can be pumped away.

Excavations shall be maintained and kept free of water and the contractor shall pump or drain water away as necessary. Excavations shall be dry before placing concrete or hardfill, and any areas damaged by water shall be additionally excavated and made good at the Contractor's expense.

1.17 EXCESS EXCAVATION

Any excess excavation under foundations shall be made good with a nominal 1:8 mix concrete.

FORMOSA SPORTS CENTRE

1.18 BUILDING PLATFORMS

Allow to supply and compact 125mm of approved hardfill.

Platforms are then to be blinded off with 25mm thickness of sand or approved scoria tuff and rolled to provide a hard level surface. Finished levels to be within ± 5mm from specified levels. Use water during compaction as necessary.

Lay Moistop 150 grey side up over all the basecourse and turned up at the perimeter, lapped 150mm and sealed using 48mm wide PVC pressure sensitive tape. Seal all slits for services.

Hardfill under slabs shall generally be gravel or crushed stone well graded and all passing a 45mm sieve compacted to 95% relative standard compaction determined in accordance with NZS 4402:1986 Part 2P - Test 14.

When free draining hardfill is specified this shall be gravel or crushed stone complying with the following grading requirements when sieved as specified in NZS 3111.

Sieve Size	Percentage Passing (by weight)
40	100
5	5

1.19 BASECOURSE

Basecourse shall be laid to the following consolidated depths;

Carparking

Sub base metal - approved GAP65	150mm
Basecourse metal - NRB M/4	100mm

Heavy Duty

Sub base metal - approved GAP65	200mm
Basecourse metal - NRB M/4	100mm

Before laying basecourse ensure that junctions with kerbs and other finishes are cut and cleaned to give full depth.

All metal to be approved by the Engineer.

The sub basecourse shall be placed in layers not exceeding 150mm loose depth and each layer shall be thoroughly compacted by approved mechanical means.

The basecourse material shall be thoroughly mixed to the proper grading and balance in a comparatively dry state. When the mixing is complete, water shall be added in small increments. As water is added the whole of the material shall be turned and bladed from side to side. When the optimum moisture content has been achieved the aggregate shall be spread into its final position and compaction commenced immediately in order to obtain maximum density before moisture is lost by evaporation.

Compaction shall be achieved by several passes of an approved iron tyred roller or pneumatic tyred compaction roller. During the process of compaction the basecourse shall be kept true to line and grade by blading continuously with a single unit long base power grader. A three wheeled roller weighing not less than 8 tonne shall be used for final compaction.

Construction shall be in accordance with NRB B/2 1985.

The surface finish shall have smooth transitions between gradients, regular falls to drainage points and no sudden changes in level at corners, manholes, cesspits etc.

There shall be no point in the general surface that will vary more than 12mm when measured under a 3m straight edge.

1.20 TESTING

The Contractor shall arrange for and pay for 5 standard compaction tests in accordance with NZS 4402:1986 Part 2P at locations directed by the Engineer. Tests shall be carried out by an independent suitably qualified laboratory. Results shall be forwarded directly to the Engineer.

Before metalling, and on completion of metalling, if required by the Engineer CBR tests shall be taken in accordance with NZS 4402 Test 15C. No more than 5% of the tests shall be less than the minimum allowable CBR and no single test shall be less than 75% of the minimum allowable.

CBR test minimum	Top of subgrade	Top of subbase
Carparks areas	7	15
Lower grade pavement	15	30
Premium pavement	20	40

1.21 SURFACING

Following the approval of the compacted basecourse the surface shall be broomed off and sprayed with an approved non leaching residual type universal weed killer in accordance with the manufacturer's recommendations.

The area shall be penetrated with 65% emulsion diluted with equal parts of water, the rate of application being varied according to the texture of the surface. Where an open texture is present the rate shall be increased to provide adequate binding. Overall, the rate shall be such as to provide a tight fully primed surface ready for paving.

After setting up the primed surface the area shall be paved with asphaltic concrete to the following depths;

Carparking areas and roading	25mm
Heavy Duty	40mm

The materials shall be as for Mix No 10 of the NRB specification M/10 (June 1975). The bituminous binder content shall be 7% by weight.

The method of construction of the paving shall comply as far as site conditions allow with NRB P/9 (June 1975). Joints in the surfacing shall be stepped from joints in the basecourse.

Allow for painting of carparking spaces etc as per architectural layouts. The paint shall comply with NRB Specification M/7.

1.22 KERBING AND CHANNELLING

Unless specified or approved otherwise, kerbing shall be precast concrete with 75mm deep 10 MPa concrete bedding and full haunching. The bedding shall be founded on firm natural ground or on well compacted fill with sufficient width beyond the edge of the pavement to provide adequate support to the kerbing.

Construction and dimensions shall comply with NZS 4404:1981, Fig 5.

1.23 BACKFILL AROUND FOUNDATIONS

Hardfill around foundations shall be gravel or crushed stone well graded and all passing a 45mm sieve compacted to 95% relative standard compaction determined in accordance with NZS 4402:1986, Part 2 - Test 14.

1.24 BACKFILL BEHIND RETAINING WALLS

Backfill behind retaining walls shall be gravel or crushed stone complying with the following grading requirements when sieved as specified in NZS 3111.

Sieve Size	Percentage Passing (by weight)
50mm	100
14mm	0

1.25 INSPECTIONS

The Contractor shall advise the Engineer at the following stages so that he may arrange an inspection:

Prior to the removal of unsuitable material below subgrade level.

Prior to placing imported hardfill.

Prior to placing sub base metal

When brooming will be finished so that he can arrange a final inspection of the subgrade before tack coat is applied. This inspection is to ensure the correct depth of hotmix has been allowed for and all loose material has been removed particularly adjacent to kerbs, channels, cesspits etc. When asphalt is to be laid.

1.26 GRASS BERMS

On completion of all other works, the berms shall be spread with first quality topsoil and compacted to a depth of 100mm. The topsoil shall be graded to kerb top and footpath edges, and shall be finished 15mm high to allow for settlement except on the low side of the footpath where the topsoil shall be finished flush to prevent water ponding.

After topsoiling, the berms shall be sown with a seed mixture containing equal parts by weight of perennial rye grass and white clover.

The mixture shall be sown at a rate of 1 kg to 60 sq m area. Grassed areas shall be maintained free of excessive weed growth and shall be kept mown throughout the maintenance period.

1.27 MAINTENANCE

The Contractor shall maintain the whole of the works in a satisfactory condition and to the standards of construction and finish laid down in the specifications for the period set down in the Special Conditions of Contract. Similarly, the Contractor shall indemnify the Principal against any claim arising out of the Contract as required by the Special Conditions of Contract.

In addition to any other work which may be required by the Engineer prior to final acceptance, at the completion of the maintenance period the Contractor shall have the following works carried out:

Carriageways swept.

Cesspits cleaned.

Mow all grass on berms.

1.28 GENERAL

The whole of the works shall be carried out to the satisfaction of the Engineer. All materials used shall be the best of their respective kinds and the use of faulty materials will not be tolerated. Any defective material or work shall, at the discretion of the Engineer, be made good at the expense of the contractor.

1.29 COMPLETION

At the conclusion of all works of the contract, a complete inspection of the site and surrounding areas will be carried out by the Engineer to ensure that all works have been left tidy to the satisfaction of all parties including adjoining property owners. The contract will not be considered as concluded until this has been done.

2. REINFORCEMENT

2.1 PRELIMINARY

This section of the works shall be carried out in strict accordance with the drawings and specification and reference is to be made to all Special and General clauses of this specification.

2.2 SCOPE OF WORK

This section of the contract consists of the supply, bending and placing of all reinforcement in concrete and blockwork.

2.3 REFERENCE STANDARDS

All materials and workmanship shall comply with the following standards:

New Zealand Building Code - Clause B1 - Structure

NZS 3109:1987	Concrete Construction
NZS 3402:1989	Steel Bars for the Reinforcement of Concrete
NZS 3421:1975	Hard Drawn Mild Steel Wire for Concrete Reinforcement
NZS 3422:1975	Welded Fabric Drawn Steel Wire for Concrete Reinforcement
NZS 4702:1982	Metal Arc Welding of Grade 275 Reinforcing Bar

These Standards form part of this specification. A copy of NZS 3109 shall be kept on site at all times.

2.4 MATERIALS

Reinforcement shall be provided as shown in the drawings, to the requirements of the following standard specifications:

Plain steel bars and welded mesh;

For 300 MPa steel yield strength deformed bars;
to NZS 3402:1989, shown as D10 (for 10mm diameter).

For 430 MPa steel yield strength deformed bars;
to NZS 3402:1989, shown as D20HT or DH20 (for 20mm diameter).

2.5 BENDING

Reinforcement shall be bent cold to the shapes and dimensions indicated on the drawings. Stirrups shall be bent to the diameter of the rods they enclose. Details of standard bends are shown in Fig 7 NZS 3109:1987.

2.6 CLEANING

At the time of concreting, reinforcement shall be free from loose flaky rust and millscale, loose concrete, laitance, mud, oil and or other coatings which adversely affect bonding capacity.

2.7 SPLICES IN REINFORCEMENT

Splice lap lengths for deform steel shall be not less than the following:

Bar Size	300 Mpa	430 Mpa
D10	240	340
D12	290	420
D16	380	560
D20	480	660
D24	680	960
D28	940	1350
D32	1220	1750

2.8 PLACING AND FASTENING

All reinforcement shall be accurately placed and securely held to ensure no displacement during pouring. Soft black wire of between 14 and 18 s.w.g. shall be used to join the rods.

Tolerances shall be as follows:

Bar Spacings

i. Spacing of main bars in beams and columns ± 10mm.
ii. Distances between layers of main steel ± 6mm.
iii. Distances between bars along the face of walls or slabs ± 20mm.
iv. Spacing of stirrups or ties in beams and columns ± 20mm.

Tolerances on Cover

i. Slabs and wall	+ 10mm,	-0mm
ii. Beams and column	+ 11mm,	-0mm
iii. At ends of members	+ 25mm,	-0mm.

Members	Poured against natural ground	Exposed to weather or in contact with ground	Not exposed to weather or in contact with ground
Foundations	75mm	50mm	
Beams and columns		40mm	30mm
Walls and slabs		35mm	25mm

2.9 BLOCKWORK WALLS

Supply and fix reinforcement in blockwork walls as detailed. In general vertical reinforcement shall be placed in advance of the blocks and horizontal reinforcement shall be fixed as laying proceeds.

2.10 SUPERVISION

The reinforcing steelworker shall be represented on site by a competent leading hand while steel is being placed.

The Engineer shall be informed when reinforcement is being fixed so that an inspection can be made.

During pouring, the reinforcing steelwork subcontractor shall be on call to correct any damage or displacement of reinforcing.

3. CONCRETOR

3.1 PRELIMINARY

This section of the works shall be carried out in strict accordance with the drawings and specification and reference is to be made to all Special and General clauses of this specification.

3.2 SCOPE OF WORK

This section of the works consists of the manufacture, handling, placement, finishing and forming of concrete work.

All materials and workmanship shall comply with NZS 3109 : 1987, including all current amendments.

3.3 REFERENCE STANDARDS

All materials and workmanship shall comply with the following Standards:

New Zealand Building Code - Clause B1 - Structure

NZS 3104:1991	Concrete Production - High Grade and Special Grade
NZS 3109:1987	Concrete Construction
NZS 3112:1986	Methods of Test for Concrete
NZS 3114:1987	Concrete Surface Finishes
NZS 3121:1986	Water and Aggregate for Concrete
NZS 3122:1990	Portland Cement

These Standards form part of this specification. A copy of NZS 3109 should be kept on site at all times.

3.4 MATERIALS

Cement shall comply with NZS 3122:1990 "Portland Cement". The brand and type of cement is subject to approval by the Engineer.

Aggregates shall comply with NZS 3121:1986. The maximum size of aggregate shall be 19mm nominal. The aggregate type is subject to approval by the Engineer.

Water shall comply with NZS 3121:1986.

3.5 CONCRETE

Site concrete and concrete required to make good excavations shall be 10 MPa at 28 days or better. All other concrete shall be Special Grade as defined in NZS 3104:1991.

The specified strength of concrete shall be as follows:

REFER TO THE DRAWINGS COVER SHEET FOR SPECIFIED STRENGTH OF CONCRETE.

The slump shall be as specified in NZS 3109 - Table 6.

3.6 READY MIXED CONCRETE

Concrete shall be mixed at a central mixing plant and transported to the site in an agitator of revolving drum type. The interval between batching the concrete at the plant and discharge mixing shall be in accordance with the requirements of NZS 3104:1991 - "Concrete Production High Grade and Special Grade".

3.7 TESTS

Tests will be required during construction as specified in NZS 3109 : 1987. The costs of such tests and incidental charges shall be borne by the Contractor, who must provide all necessary moulds.

The slump shall not exceed that shown in Table 6 of NZS 3109 for the particular situation and placing procedure.

3.8 TESTS ON COMPLETED WORK

Any concrete which is not placed in accordance with the specification or which is judged by the Engineer to be defective in any way, may be subjected to further testing or load testing.

Should any structural unit fail under load test or if test loading is not practical, the concrete shall be removed and replaced within the limits defined by the Engineer and replaced to his satisfaction. The costs of such loading tests, additional testing or removal of defective work and replacement, shall be borne by the Contractor.

3.9 COMPACTION

Compaction of concrete shall be carried out by the use of power driven vibrators of suitable size and frequency for the section being placed. Vibration shall not be used to produce lateral motion of concrete which in any case shall not exceed a distance of 750mm.

Care shall be observed to ensure that zones of vibration overlap and no portions are missed, and that the concrete is thoroughly compacted with the required surface finish. Vertical drop shall not exceed 1.5m without approval.

3.10 HANDLING AND PLACING

Before concrete pouring commences, the Contractor shall submit for approval by the Engineer, his proposed handling and placing methods, sequence and timing of pours and location of construction joints.

The foreman shall be responsible for ensuring that the reinforcement specified is not displaced during concreting.

Concrete shall be placed with the aid of approved high frequency immersion type vibrators of pattern and size suitable for the section being poured and with frequencies under load ranging between 4000 and 8000 cycles per minute.

3.11 CONSTRUCTION JOINTS

Concrete shall be deposited continuously between predetermined joints as shown on the drawings. Where joints are not shown on the drawings, these may be introduced at positions agreed with the Engineer. Joints shall be finished perpendicular to the finished faces. Immediately before placing fresh concrete, joints shall be scabbled to removed laitance.

3.12 SAWCUT JOINTS

Sawcuts shall be located to the approval of the Engineer. Where sawcuts are used they shall be done within one day of casting or after concrete has cured sufficiently to prevent fretting of edges. Depth of sawcuts shall be 1/3 of the floor thickness.

Where slabs are to have floor coverings applied, sawcuts shall be filled with a neat grout mixture, finished flush with the surface.

3.13 CURING

The concrete shall be protected during the first stage of hardening from the harmful effects of sunshine, drying winds, cold rain or running water.

The concrete shall either be covered with a layer of sacking or similar absorbent material or layer of sand and kept continuously sprinkled for seven days. From 8-14 days after pouring, concrete shall be kept damp by occasional hosing.

The use of curing membrane may be approved if weather conditions are suitable.

Traffic or loading shall not be allowed on the concrete until the concrete is sufficiently matured and the Engineer's approval given. In no case shall traffic or loading be of such magnitude as to cause deflection or other movement in the formwork or damage to the concrete members.

3.14 TOLERANCES

Tolerances shall be as specified in NZS 3109 : 1987.

In addition to the above, no hollow in the surface of a floor slab shall be more than 3.00mm away from the edge of a 3m straight edge used in any direction touching at least two points of the surface with one end on the highest point of the area.

3.15 CONCRETE SURFACE FINISHES

All concrete surface finishes shall conform to NZS 3114 : 1987. Unless noted otherwise formed concrete surface finishes shall be Class F5, where the concrete is to be painted or exposed, and Class F2 elsewhere.

Concrete floor slabs shall be finished to Class U3, foot paths, driveways and roads shall then be finished to Class U5.

All trowelling ridges shall be removed while green or by subsequent light grinding. Slabs not fulfilling the standard of finish required shall be ground smooth or otherwise treated to the satisfaction of the Engineer.

3.16 SEATING UNDER STRUCTURAL STEELWORK

Dry pack mortar shall be used for filling all bearing area between steel base plates and concrete. The mix shall consist of 1 part cement to 2 parts dry sand by weight, with a water/cement ratio not exceeding 0.35. Dry packing shall have been completed before the steel is loaded.

Allow to cast in holding down bolts in all new concrete work. Use templates supplied by Structural Steelworker where fixings are to baseplates etc.

3.17 PRECAST FLOOR UNITS

Precast floor units shall be designed by the manufacturer to support the loads specified on the drawings and to achieve the specified fire rating. The manufacturer shall supply calculations and drawings of the precast flooring to Buller George Engineers Ltd and to the local authority for checking.

The manufacturer shall indicate on his drawings the propping requirements of floors and beams.

Precast units shall be manufactured from concrete having minimum crushing strength of 30 MPa at 28 days.

Units shall be manufactured to the following tolerances:

Maximum precamber at delivery to site SPAN/300
Other deviations, refer NZS 3109:1987, Table 4,
Differential camber between adjacent units of same design 7mm per 3m but no greater than 12mm
Squareness of end ± 6mm

Units shall be stacked on timber dunnage placed under design bearing points on units, and when stacked in tiers the dunnage shall be placed in vertical lines.

Stacking of units shall be carried out on an area capable of withstanding the bearing pressures involved and in such a way that damage to units, lifting hooks and to other embedded fixtures and other units shall not occur.

The design of the precast flooring and propping requirements must be certified by a registered engineer to ensure that the system adopted can safely carry the imposed loads.

Topping thickness is 65mm unless otherwise specified on the drawings and beams and floors are to be poured in one operation.

3.18 FLOOR SLABS WITHOUT SURFACE COVERING

Subgrade preparation, sand blinding and Dampcourse shall be constructed in accordance with the Siteworks section of this specification (refer 1.18 Building Platforms).

The slab shall be 150mm thick, minimum 30 Mpa reinforced with 665 mesh or equivalent.

Concrete shall be placed directly from the truck. PUMPING IS NOT PERMITTED.

Concrete mix shall include a high proportion of coarse aggregate including 19mm aggregate. Concrete shall be batched to a target slump of 40mm. To enable the concrete to be effectively placed and compacted superplasticer shall be used to raise the workability. The mix proportion of fine aggregate shall allow the concrete to be cohesive at the higher slump level.

An indicative mix design:

TOTAL COARSE AGGREGATE	1100 KG/M3	(700 OF 19) (400 OF 10)
TOTAL FINE AGGREGATE	600 KG/M3	
CEMENT CONTENT	300 KG/M3	
WATER	170 KG/M3	
SIKAMENT 1000N	APPROPRIATE DOSAGE 2 L/M3	
AIR ENTRAINMENT, WATER REDUCING ADMIXTURE	USUAL DOSAGES	

Proposed mix design shall be submitted to Buller George Engineers for review.

4. CONCRETE MASONRY

4.1 PRELIMINARY

This section of the works shall be carried out in strict accordance with the drawings and specification and reference is to be made to all Special and General clauses of this specification.

4.2 SCOPE OF WORK

This section of the works consists of the manufacture, supply laying, reinforcement and grouting of masonry walls.

4.3 REFERENCE STANDARDS

All materials and workmanship shall comply with the following Standards:

New Zealand Building Code - Clause B1 - Structure	
NZS 3104:1991	Specification for concrete production - high grade and special Grade.
NZS 3105:1986	Specification for concrete mixers (batch type and truck type)
NZS 3109:1987	Specification for concrete construction
NZS 4210:1989	Masonry construction, Materials and Workmanship

These Standards form part of this specification. A copy of NZS 4210:1989 shall be kept on site at all times.

4.4 GRADE B MASONRY

All masonry shall be Grade B masonry unless stated otherwise and shall be subject to construction observation during construction by the Engineer. In addition all masonry shall be subjected to construction supervision at all critical stages by a Registered Mason.

The Registered Mason shall provide written certification that the observation has been carried out and that the masonry has been constructed in accordance with the drawings and specification.

The Registered Mason shall complete any certificates or forms required by the Local Authority to confirm his role in providing construction supervision.

4.5 GROUTING OF CELLS

All masonry shall be constructed using open ended blocks and all cells shall be grouted.

4.6 MATERIALS

4.6.1 Masonry Units

Masonry units shall be Class A open ended concrete masonry units manufactured by a licensed manufacturer in accordance with NZS 3102:1983.

4.6.2 Mortar

Mortar shall be composed of Portland cement, sand, water and an admixture all in accordance with NZS 4210P:1989, and as follows:

	Proportions	Compressive Strength
for all reinforced masonry and work under ground	1 cement : 3-4.5 sand	12.5 MPa
for all other work	1 cement : 4-6 sand	6.5 MPa

4.6.3 Grout

Grout shall be coarse grout composed of Portland cement, sand, 4.75 to 13.2mm aggregate and water, and may contain admixture. The sand used in grout shall comply with NZS 3121, mortar sand shall not be used.

Grout shall be mixed off the site, ie ready mixed and comply with the relevant provisions of NZS 3104.

Grout may only be mixed on the site with the approval of the Engineer, and in such cases shall be done with a power driven batch mixer complying with the provision of NZS 3105, and mixed in accordance with NZS 4210P:1989.

Grout strength shall be 17.5 MPa.

4.6.4 Reinforcement

All reinforcement shall be detailed, bent and placed in accordance with NZS 3109:1987. Section 8, and must comply with the Reinforcement section of this specification

4.7 TESTS

Within two days of starting of masonry works on site a compressive strength test for mortar and grout shall be carried out in accordance with NZS 4210:1989, Appendix 2.A.

The test results shall be certified by a registered engineer or recognised authority and the results shall be submitted to the Engineer.

Additional tests shall be made whenever any change in materials or job conditions occur or whenever, in the opinion of the Engineer, tests are necessary to determine the quality of the materials.

4.8 WORKMANSHIP

A Registered Mason shall be employed upon these works and the standard of laying shall be consistent from start to finish and in accordance with the best modern methods.

4.9 CONSTRUCTION

4.9.1 General

Concrete masonry units shall be protected from the weather before they are laid and shall be laid dry to ensure that the moisture content does not increase above that specified in NZS 3102.

Masonry units shall be adjusted into final position while the mortar is sufficiently plastic to ensure a true bond free from cracks and cavities. Any patching or pointing necessary to fill the joints shall be evenly tooled to a concave surface. The bottoms of cavities and cells are to be kept free of mortar droppings.

Great care shall be taken to prevent dropping and mortar smears. Should any occur, the masonry shall be thoroughly washed down before it sets. Joints below ground to be struck flush.

4.9.2 Reinforced walls

Any mortar protruding from the joints is to be removed and cells cleaned out before placing the concrete. The grout shall be placed in lifts not exceeding 1200mm and shall be thoroughly rodded until no further settlement occurs.

4.9.3 Control joints

Control joints shall be constructed in accordance with Fig 2.10.1 (b) TYPICAL CONTROL JOINT in NZS 4210:1989.

5. GLUE LAMINATED TIMBER

5.1 PRELIMINARY

This section of the works shall be carried out in strict accordance with the drawings and specification and reference is to be made to all Special and General clauses of this specification.

5.2 SCOPE OF WORK

Supply and erect glue laminated roof rafters and eaves beams at locations and sizes shown on the drawings.

5.3 REFERENCE STANDARDS

All materials and workmanship shall comply with the following standards:

NZS 3603:1993	Timber Design
NZS 3606	Manufacture of Glue Laminated Timber

5.4 SPECIFICATION

a) Length, depth, width - refer to drawings.
b) Camber - 5mm per 3m.
c) Laminations 45mm Radiata Pine or Douglas Fir.
d) End joints - refer drawings.
e) Exposure category B (occasionally damp).
f) Treatment H3.
g) Surface finish - Premium.
h) Moisture content - 18%

FIRE DESIGN REPORT

RECEIVED 07 APR 1997

Based on BIA C1/AS1, C2/AS1, C3/AS1 and C4/AS1

The following report summarises the main fire safety features of the project and is based on the attached calculation spreadsheets. Territorial Authority approval must be obtained before any action is taken on the basis of this report.

PROJECT 416	FORMOSA AUCKLAND COUNTRY CLUB - New Sports Centre 782 Whitford Maraetai Road, Beachlands (access from 110 Jack Lachlan Drive)
ITEMS DEALT WITH	Purpose Groups, occupant density, activity Alarm type and life safety features Firecell size and fire resistance ratings Means of escape and construction of escape routes Fire spread outside and within Firecell

SUMMARY

BUILDING SIZE	Level 1		1932.5 m²	
PURPOSE GROUP	Primary purpose group CL, fire hazard category 1.			
OCCUPANCY	Level 1		175	
LIFE SAFETY FEATURES	None			
FRRS		Stability	Integrity	Insulation
	Primary Elements	0	0	0
	Secondary Elements	0	0	0
	Combined Elements	0	0	0
FIRECELL	Building is treated as one firecell			
MEANS OF ESCAPE			No./Provided	Width
	Level 1		4	6200 mm
	Length: No open path exceeds 45m. No protected paths provided. No dead end open path exceeds 18m			
FIRE SPREAD	Ceilings walls floors	No requirement		
FIRE FIGHTING	Fire service vehicle to within 18m of building			

CALCULATIONS

Basic Information Appendices A, B and C NZBC

FLOOR AREAS AND OCCUPANT LOADING				
		Area	Activity	No. Design Occupancy (Refer Appendix 1)
	Level 1	1932.5m²	CL	175
PURPOSE GROUP - Table A1 Appendix A				
It is proposed to treat the building as primary purpose group CL and Fire Hazard Category 1.				
FIRE SAFETY PRECAUTIONS (Life Safety) (3) - Appendix B Table B1/1				
Firecell	Floor	F Value	Alarm	Other Features
	Total occupant load	F-0	Type 2a	15sd
Note: Alarms and emergency lighting required only in cinemas and theatres and any associated corridors and passageways. Therefore not required in this instance.				
EXTERNAL WALL RATING				
	Building is > 12.5m to a relevant boundary.			

FIRE RESISTANCE RATINGS - C3/AS1 Paragraph 3.3				
		Stability	Integrity	Insulation
	Primary Elements	0	0	0
	Secondary Elements	0	0	0
	Combined Elements	0	0	0
NUMBER OF ESCAPE ROUTES - C2/AS1 Paragraph 2.2				
		Design Occupancy	No. Required	No. Provided
	Lower Floor	175	2	4
WIDTH OF ESCAPE ROUTES (Based On Occupant Load)				
		Design Occupancy	Width Required (Based on Occ.)	
	Lower Floor	175	Horiz 175 x 7 = 1225mm	
	Width provided	6200mm		
LENGTH OF ESCAPE ROUTES C2/AS1 Table 1				
	Maximum length CL	Dead end open path = 18 m Total open path = 45 m		

ESCAPE SCENARIOS		
Escape from the building has been investigated Refer Appendix 2		
Escape Route No. (origin/final exit)	Dead End Open Length	Total Open Path Length
A1	18m	30m
A2	16m	41m
B1	-	40.6m
B2	-	26.5m
C1	13m	37.8m
C2	13m	40m
D1	-	33m
D2	-	30.5m
D3	-	34m
D4	-	45m
E4 (Exit 3 obstructed)	-	28m

FIRE SPREAD BEYOND FIRECELL		
	External Finishes	No requirement
FIRE SPREAD WITHIN FIRECELL C3/AS1 Table 4		
Surface Finishes	Walls and Ceilings	All spaces SFI not > 2 SDI not > 5
	Suspended Flexible Fabrics	FI not > 12
Note: Does not apply where occupancy is less than 250, there are two or more exitways and difference in floor level between firecell and final exit is no greater than 600mm.		
EGRESS		
	Doors	Doors in exitways to have vision panels
	Signs	NZBC F8
FIRE FIGHTING		
	Fire Service Vehicle to within 18m of building - 25 tonnes, 6.2 tonne load.	

APPENDIX 1

AREA AND OCCUPANCY CALCULATIONS			
Space	Area	Designated Occupancy from Appendix A, Table A2	Proposed Design Occupancy
01 Entrance	-	-	-
02 Foyer	55m²	55	19 (note 1)
03 Walkway	165m²	-	-
04 Store	9m²	-	-
05 Squash Court	71m²	-	2
06 Gallery	110m²	110	95
07 Tennis Hall	1010m²	-	8
08 Pool Hall	295m²	-	20
09 Plant Room	5m²	-	-
10 Cleaner	2m²	-	-
11 Male Change	46m²	-	10 (note 2)
12 Female Change	46m²	-	10 (note 2)
13 Locker	incl.	-	-
14 Locker	incl.	-	-
15 Duct	4.5m²	-	-
16 Fitness Room	112m²	-	11 (note 3)
TOTALS	1932.5m²	165	175

NOTES

Note 1 The design occupancy is based on the actual number of seats determined from furniture layouts.

Note 2 The design occupancy in the change rooms makes allowance for the periods when "change over" occurs e.g. players coming off the tennis courts to change whilst a new group of players commences play.

Note 3 The design occupancy is assumed from potential equipment layouts.

CALCULATIONS W.I. 6.8

Buller George Engineers Structural & Civil Consultants

Project: Sports Pavilion Ref: 8310
By: SFG Page: 1 Date: 24/2/97

DESCRIPTION

A new building comprising 2 covered tennis courts, squash courts and a swimming pool.

LOADS

Roof dead 0.5 kPa
live 0.25 kPa

Wind $(0.91 \times 0.97 \times 45)^2 \times 0.6 = 0.9$ kPa.

20 Eden St, Newmarket, P.O. Box 99 594 Newmarket, Auckland, NZ. Phone (09) 529 2529. Facsimile (09) 529 0390
Directors: M. John Buller, NZCE CEI, MIPENZ. Stuart F. George, BE(Hons), ME, MIPENZ. Associates: Dan W. Houghton. John J. Orchard.

CALCULATIONS W.I. 6.8

Buller George Engineers Structural & Civil Consultants

Project: Sports Pavilion Ref: 8310
By: SFG Page: 2 Date: 24/2/97

ARCHED FRAME OVER TENNIS

Span 38.6
width 15

$M^* = 1.6 \times 0.15 \times 38.6^2 / 16$
$= 1400$ kN-m

800 PFC 152.

PURLINS

Span 14.5
Spacing 1.4 } DHS 300/15 lapped

WIND COLUMN

Spacing 7.6
Span 11.0

$M^* = 0.9 \times 1.2 \times 7.6 \times 11.0^2 / 8$
$= 114$

310UB40

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CALCULATIONS

W.I. 6.8

Buller George Engineers — Structural & Civil Consultants

Project: Sports Pavilion | Ref: 8310 | By: SG | Page: 3 | Date: 20/8/97

Timber Purlins over Pool

Span 13.2, Spacing 5.6

$M^* = 1.0 \times 13.2^2 \times 5.6 / 12$
$= 79$ kNm

allowable thing = 0.8 × 0.8 × 24.5 × 1.33 = 21 kNm

Use 540 × 90 Glulam

20 Eden St, Newmarket, P.O. Box 99 594 Newmarket, Auckland, NZ. Phone (09) 529 2529. Facsimile (09) 529 0390
Directors: M. John Buller, NZCE CEI, MIPENZ. Stuart F. George, BE(Hons), ME, MIPENZ. Associates: Dan W. Houghton. John J. Orchard.

CALCULATIONS

W.I. 6.8

Buller George Engineers — Structural & Civil Consultants

Project: Sports Pavilion | Ref: 8316 | By: SG | Page: 4 | Date: 10/4/97

Foundations.

Pad under portal

$N^* = 1.45 \times 15 \times 20$
$= 300$ kN

Adopt 2000 × 2000 × 400 Pad

Pad under Plate Girder etc

$N^* = 7 \times 5 \times 1$
$= 35$ kN

Adopt 900 × 900 × 300 Pad

Strip footing Grid F + H

$N^* = 5m \times 150$ kN/m + 5m ...
$= 5 \times 3.8 \times 1.4 + 5 \times 1$
$= 30$

Adopt 350 wide footing

20 Eden St, Newmarket, P.O. Box 99 594 Newmarket, Auckland, NZ. Phone (09) 529 2529. Facsimile (09) 529 0390
Directors: M. John Buller, NZCE CEI, MIPENZ. Stuart F. George, BE(Hons), ME, MIPENZ. Associates: Dan W. Houghton. John J. Orchard.

CALCULATIONS

W.I. 6.8

Buller George Engineers — Structural & Civil Consultants

Project: Sports Pavilion | Ref: 8310 | By: SG | Page: 5 | Date: 10/4/97

Tie Beam to Footing

T = 1400 kNm / 3.5
= 400 kN

$A_s = 400 \times 10^3 / 0.9 \times 300$
$= 1480 \text{ mm}^2$

20 Eden St, Newmarket, P.O. Box 99 594 Newmarket, Auckland, NZ. Phone (09) 529 2529. Facsimile (09) 529 0390
Directors: M. John Buller, NZCE CEI, MIPENZ. Stuart F. George, BE(Hons), ME, MIPENZ. Associates: Dan W. Houghton. John J. Orchard.

```
Program   FOOTING
Version   3.02 AUGUST 1996                  BULLER GEORGE ENGINEERS LTD
Author    Stuart George                                  20 EDEN ST.
                                                  NEWMARKET,AUCKLAND
Date      04-10-1997   08:59:04

FOOTING NAME : PAD UNDER TENNIS PORTAL

Design Variables
----------------

ULT AXIAL LOAD (kN)   PU =   300                        X-Dir       Y-Dir
ULT MOMENT   (kN-m)   MU =     0
ULT BEARING  (kPa)    QU =   153   COLUMN SIZE (mm)  CX =  600  CY =  250
SHAPE                  S = User Spec.

Footing Details
---------------

FOOTING DEPTH  (mm)  D =   400   FOOTING SIZE (mm)  FX =  2000  FY =  2000
CONCRETE GRADE (MPa) FC =   25   REO. AREA   (mm2)  AX =  1224  AY =  1232
REO. GRADE     (MPa) FS =  275

Supplementary Output
--------------------

ACTUAL BEARING  (kPa)            75   MAX. HOOKED BAR        32       32
PUNCHING STRESS (max 1.04)     0.25   MAX. STRAIGHT BAR      20       24
ONE WAY STRESS  (max 0.35)     0.17   REO. RATIO         0.0020   0.0023
REO. WEIGHT     (kg/m3)          29
OVERTURNING FOS            INFINITY

Reinforcement Options
---------------------

eg 10D20 (375) = 10 number 28 diameter 375 spacing

X-Direction     Y-Direction

12D 12 ( 183)    13D 12 ( 163)
 7D 16 ( 300)     7D 16 ( 300)
```

```
Program   FOOTING
Version   3.02 AUGUST 1996                  BULLER GEORGE ENGINEERS LTD
Author    Stuart George                                  20 EDEN ST.
                                                  NEWMARKET,AUCKLAND
Date      04-10-1997   09:01:10

FOOTING NAME : MISC 900 X 900 PADS

Design Variables
----------------

ULT AXIAL LOAD (kN)   PU =    40                        X-Dir       Y-Dir
ULT MOMENT   (kN-m)   MU =     0
ULT BEARING  (kPa)    QU =   150   COLUMN SIZE (mm)  CX =  100  CY =  100
SHAPE                  S = User Spec.

Footing Details
---------------

FOOTING DEPTH  (mm)  D =   300   FOOTING SIZE (mm)  FX =   900  FY =   900
CONCRETE GRADE (MPa) FC =   25   REO. AREA   (mm2)  AX =   382  AY =   335
REO. GRADE     (MPa) FS =  275

Supplementary Output
--------------------

ACTUAL BEARING  (kPa)            49   MAX. HOOKED BAR        20       20
PUNCHING STRESS (max 1.24)     0.13   MAX. STRAIGHT BAR      12       12
ONE WAY STRESS  (max 0.34)     0.06   REO. RATIO         0.0020   0.0020
REO. WEIGHT     (kg/m3)          75
OVERTURNING FOS            INFINITY

Reinforcement Options
---------------------

eg 10D28 (375) = 10 number 28 diameter 375 spacing

X-Direction     Y-Direction
```

CALCULATIONS

W.I. 6.8

Buller George Engineers — Structural & Civil Consultants

Project: Bowling Range Shelter | Ref: | By: SG | Page: 1 | Date: 26/8/97

Description.

A simple 'lean to type' cantilevering structure in an exposed environment

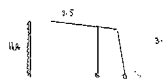
Loads

Cat 2, Sm, Auckland

$V_z = 0.91 \times 0.93 \times 45$
$= 38.1$
$q = 0.6 \times (38.1)^2$
$= 0.87$ kPa

design for 1 kPa

Frame



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CALCULATIONS

W.I. 6.8

Buller George Engineers — Structural & Civil Consultants

Project: Bowling Range Shelter | Ref: | By: SG | Page: 2 | Date: 26/8/97

Cantilever

$M^* = 3.4 \times 3.5^2 / 2$
$= 21$ kNm

Columns

V = 3.4 × 3.6
= 12.2
$M^* = 12.2 \times 2.6 / 2$
= 16 kNm
$N^* = 3.4 \times 3.6^2 / 2 \times 1.6$
= 14 kN

200 UB 25

Concrete ... 300 × 300 ...

= 37 kNm

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CALCULATIONS

W.I. 6.8

Buller George Engineers — Structural & Civil Consultants

Project: Bowling Range Shelter | Ref: | By: SG | Page: 3 | Date: 26/8/97

Purlins

Span 3.6, width 2.3

$M^* = 2.3 \times 3.4^2 / 8$
$= 3.3$

100 TFC

Member at top of Rear Wall

$M^* = 1.3 \times 3.4^2 / 8$
$= 1.9$

Adopt 75 × 75 × 5 EA

Rafters

Span 2.6, Cantilever 1.0

150 × 50 @ 600
50 × 40 @ 600 ...

20 Eden St, Newmarket, P.O. Box 99 594 Newmarket, Auckland, NZ. Phone (09) 529 2529. Facsimile (09) 529 0390
Directors: M. John Buller, NZCE CEI, MIPENZ. Stuart F. George, BE(Hons), ME, MIPENZ. Associates: Dan W. Houghton. John J. Orchard.

THORBURN consultants limited

STRUCTURAL DESIGN CALCULATIONS

FOR A

SPRAYED CONCRETE SWIMMING POOL

JOB NO ... P2/118 ... DATE ... APR 97 ...

MINIMUM CODE REQUIREMENTS (NZS 3106)

Minimum reinforcement each way	0.25% deformed bar 0.2% mesh
Maximum spacing of rebars	2.5 x thickness of element
Minimum thickness of elements	100mm
Maximum steel stresses	110MPa deformed bar 120MPa mesh
Concrete strength	25MPa
Maximum compressive stress in concrete	0.45 x 25 = 11.25MPa

RECEIVED
- 2 MAY 1997

DESIGN CRITERIA

1. **Summer Conditions:** Pool full to flood level, backfill shrunk away from full vertical height of wall.
2. **Winter Conditions:** Pool empty - wall submitted to full soil pressure.
3. Adequate drainage to pool exterior plus hydrostatic relief valve so as to ensure against any external hydraulic head or flotation.

THORBURN CONSULTANTS LIMITED

1. POOL FULL CONDITION

Maximum depth to flood level from top of radius = 1.000

$BM = \frac{9.81 \times 1^3}{6} = 1.635$ kNm/m

with d = 55mm

Initially Ast required $= \frac{1.635}{110 \times .87 \times .055}$
$= 310 \text{mm}^2/\text{m}$

Try D10 @ 250

Let n = modular ratio $= \frac{E_s}{E_c} = 8.5$

Let p = steel ratio $= \frac{A}{bd} = \frac{314}{1000 \times d}$

$k = \sqrt{(np)^2 + 2np} - np$

$j = 1 - \frac{k}{3}$

BM = 1.635kNm/m

d = 55mm
p = 0.0057

k = 0.2666
j = 0.9111

$f_m = \frac{2M}{jkbd^2}$ $f_m = \frac{2 \times 1.635 \times 10^6}{0.2666 \times 0.9111 \times 1000 \times 55^2}$
= 4.45mPa OK

$f_s = \frac{M}{jdA_s}$ $f_s = \frac{1.635 \times 10^6}{j \times 0.055 \times 314}$
= 103.91MPa OK

```
Program    FOOTING                              BULLER GEORGE ENGINEERS LTD
Version    3.02 AUGUST 1996                              20 EDEN ST.
Author     Stuart George                          NEWMARKET,AUCKLAND

Date       04-30-1997   08:59:04

FOOTING NAME : PAD UNDER TENNIS PORTAL

Design Variables
----------------

ULT AXIAL LOAD (kN)   PU =    300                     X-Dir      Y-Dir
ULT MOMENT    (kN-m)  MU =      0
ULT BEARING   (kPa)   QU =    150   COLUMN SIZE (mm) CX =  800  CY =  250
SHAPE                  S  = User Spec.

Footing Details
---------------

FOOTING DEPTH  (mm)  D  =   400   FOOTING SIZE (mm) FX = 2000 FY = 2000
CONCRETE GRADE (MPa) FC =    25   REQ. AREA   (mm2) AX = 2224 AY = 1232
REO. GRADE     (MPa) FS =   275

Supplementary Output
--------------------

ACTUAL BEARING  (kPa)          75   MAX. HOOKED BAR        32        32
PUNCHING STRESS (max 1.04)   0.28   MAX. STRAIGHT BAR      20        14
ONE WAY STRESS  (max 0.35)   0.17   REQ. RATIO         0.0020    0.0023
REO. WEIGHT     (kg/m3)        23
OVERTURNING FOS          INFINITY

Reinforcement Options
---------------------

eg 10D28 (375) = 10 number 28 diameter 375 spacing

X-Direction     Y-Direction

 12D 12 ( 163)     12D 12 ( 163)
  7D 16 ( 300)      7D 16 ( 300)
```

```
Program    FOOTING                              BULLER GEORGE ENGINEERS LTD
Version    3.02 AUGUST 1996                              20 EDEN ST.
Author     Stuart George                          NEWMARKET,AUCKLAND

Date       04-30-1997   09:01:10

FOOTING NAME : MISC 900 X 900 PADS

Design Variables
----------------

ULT AXIAL LOAD (kN)   PU =     40                     X-Dir      Y-Dir
ULT MOMENT    (kN-m)  MU =      0
ULT BEARING   (kPa)   QU =    150   COLUMN SIZE (mm) CX =  100  CY =  100
SHAPE                  S  = User Spec.

Footing Details
---------------

FOOTING DEPTH  (mm)  D  =   300   FOOTING SIZE (mm) FX =  900 FY =  900
CONCRETE GRADE (MPa) FC =    25   REQ. AREA   (mm2) AX =  382 AY =  335
REO. GRADE     (MPa) FS =   275

Supplementary Output
--------------------

ACTUAL BEARING  (kPa)          49   MAX. HOOKED BAR        20        20
PUNCHING STRESS (max 1.24)   0.13   MAX. STRAIGHT BAR      12        12
ONE WAY STRESS  (max 0.34)   0.06   REQ. RATIO         0.0020    0.0020
REO. WEIGHT     (kg/m3)        25
OVERTURNING FOS          INFINITY

Reinforcement Options
---------------------

eg 10D28 (375) = 10 number 28 diameter 375 spacing

X-Direction     Y-Direction
```

W.I.6.8

CALCULATIONS

Buller George Engineers

Project: [illegible] By: SG Page: 1 Date: [illegible]/97

DESCRIPTION

A simple 'lean to type' cantilevering structure in an exposed environment.

LOADS

[illegible]

W.I.6.8

CALCULATIONS

Buller George Engineers

Project: [illegible] By: SG Page: 2 Date: [illegible]/97

[illegible]

W.I.6.8

CALCULATIONS

Buller George Engineers

Project: [illegible] By: SG Page: 3 Date: [illegible]/97

[illegible]

W.I.6.8

CALCULATIONS

Buller George Engineers

Project: [illegible] Ref: 8310 By: SG Page: 1 Date: 30/4/97

Foundation Contract – Additional Information

Keep Please

Item 3

[illegible]

W.I.6.8

CALCULATIONS

Buller George Engineers

Project: [illegible] Ref: 8310 By: SG Page: 2 Date: 1/5/97

Item 4

Item 5

[illegible]

W.I.6.8

CALCULATIONS

Buller George Engineers

Project: [illegible] Ref: 8310 By: SG Page: 3 Date: 1/5/97

[illegible]

W.I.6.8

CALCULATIONS

Buller George Engineers

Project: [illegible] Ref: 8310 By: SG Page: 4 Date: 1/5/97

Item 6

Item 7

[illegible]

BCN-039

MANUKAU City Council

To: Date: ______

Senior Building Inspector
MANUKAU CITY COUNCIL

CT/80

SUPERVISION/OBSERVATION BY A REGISTERED ENGINEER

I, ____________________ being owner, hereby certify that I have engaged ____________________ a Registered Engineer to be responsible for the observation/supervision (delete one) of the construction of the work shown on drawings numbered ______ pertaining to the construction of [illegible] at (address) 782 [illegible] Road [illegible]

Observation and supervision shall be defined in the Institution of Professional Engineers of New Zealand Document *Conditions of Engagement for Consulting Engineers*)

The following items of work will be supervised/observed during construction:

1) ensure the design recommendations stated in geotech report (ref. 7586) are adhered to.
2) [illegible]

Signed: ____________ (Owner) ____________ (Registered Engineer)

IN YOUR REPLY PLEASE QUOTE
TH Nos:

IF CALLING PLEASE ASK FOR
Central Processing Unit

2. **POOL EMPTY CONDITION**

BM = $\frac{4.8 \times 1.2^2}{8}$ = 1.38kNm/M

d = 45mm

p = 0.007

n = 8.5

k = 0.2906

j = 0.9031

fm = 5.19MPa OK

fs = 108.14MPa OK

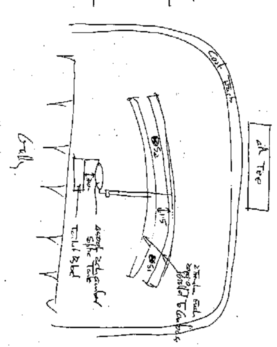
3. **FLOOR SLAB**

Thickness 100mm

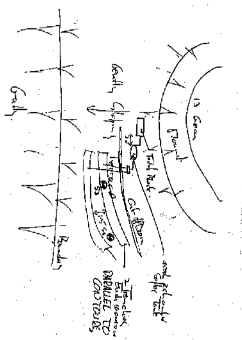
Minimum Ast at .25% = 250mm²/m

D10 at 250 bar OK

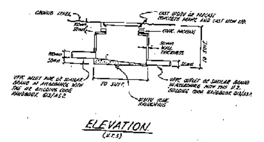
CHAMBERS CONSULTANTS LTD



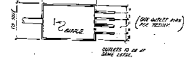
CHAMBERS CONSULTANTS LTD



CHAMBERS CONSULTANTS LTD CONSULTING ENGINEERS

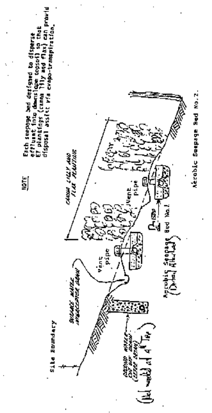


ELEVATION (N.T.S)



PLAN (N.T.S)

DISTRIBUTION BOX DETAIL



CHAMBERS CONSULTANTS LTD

CLIENT:

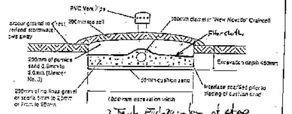
ADDRESS:

PROJECT:

EVAPO-TRANSPIRATION/AEROBIC SEEPAGE BEDS

TYPICAL DETAILS ONLY NOT FOR DESIGN

Ref: Figs A28, A29 ARWB Technical Publication No 58



TYPICAL BED CROSS - SECTION

NOTE:

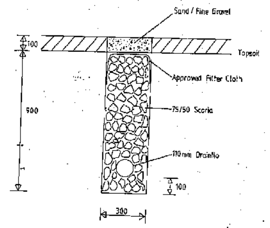
Aerobic Seepage Beds function without the need for heavy overplanting. For Evapo-Transpiration Seepage beds the ground surface should be heavily planted. The following is a selection of plants and evergreens given in Appendix F of TP58, to which reference should be made for varieties of trees and/or grasses if also desired.

Canna, 1B	Flax (Phormium tenax), 2A
Taro, 1C	Buddleia, 2-3A
Aralias, 1-2B	Agapanthus, 1B
Rhubarb, 1A	Kaka Beak (Clianthus), 1-3A
Arum Lily, 1A	Swan Plant, 2-3A
Rock Lily (Arthropodium), 1B	Gunneras (larger varieties), 1-2A
Hapora, 2A	Geraniums (large range), 1A
Fushia, 2A	Poroporo (Solanum aviculare), 2B
Philodendrons (large range), 1C	Begonias (large range of species), 1C,
	are very useful as an underplant in sheltered places.

KEY:

HEIGHT	DURABILITY
1. Around 1m or lower	A. Very hardy
2. Around 2m	B. Hardy
3. Around 3m	C. Soft

CHAMBERS CONSULTANTS LTD CONSULTING ENGINEERS



STANDARD CUTOFF DRAIN DETAIL NTS

CALCULATIONS W.I. 6.8

Buller George Engineers STRUCTURAL & CIVIL CONSULTANTS

Project: Sports Pavilion Ref: 8310

By: SG Page: 1 Date:

DESCRIPTION

A new building comprising 2 covered tennis courts, squash courts and a swimming pool.

Loads

roof dead 0.5 kPa

live 0.25 kPa

wind ... = 0.9 kPa high

CALCULATIONS W.I. 6.8

Buller George Engineers STRUCTURAL & CIVIL CONSULTANTS

Project: Sports Pavilion Ref: 8310

By: SG Page: 4 Date: 10/4/97

FOUNDATIONS

$N^* = 35$ kN

$= 300$ kN

$N^* = 7 \times 5 \times 1$

$= 35$ kN

$N^* = 30$

CALCULATIONS W.I. 6.8

Buller George Engineers STRUCTURAL & CIVIL CONSULTANTS

Project: Sports Pavilion Ref: 8310

By: SG Page: 5 Date: 10/4/97

$T = 1400 / 3.5$

$= 400$ kN

$= 1480$ mm²

NZGD various nearby borehole logs

Consent [illegible]

LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

PATTLE DELAMORE PARTNERS LTD

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 1 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	STRENGTH	FRACTURE SPACING (cm)	GRAPHIC LOG	DEPTH (m)	RL (m)	CORE LOSS (%)	DRILLING DEPTH / DATE	WATER LEVEL GAIN / LOSS	CORE BOX No.	INSTALLATION
	Sandy CLAY, dark brown, homogeneous. Weak, soft, moist, non-plastic - sands are loosely packed, moist, poorly (uniformly) graded (~1mm), moderately weathered, subangular (TOPSOIL)				0.0	19					Raised Toby Box
	CLAY, light orangey brown, homogeneous. Weak, firm, dry, non-plastic.				1.0	18					
					2.0	17					
					3.0	16					
					4.0	15					
	SAND, dark brown, homogeneous. Moderately strong, tightly packed, moist, poorly (uniformly) graded (~1mm), moderately weathered, subangular				5.0	14					
					6.0	13					
	Unweathered, greenish grey, interbedded, alternating SANDSTONE/MUDSTONE (changes in drilling speed / hardness indicate interbedded nature of material). Weak, WAITEMATA GROUP.				7.0	12					
					8.0	11					
					9.0	10					
					10.0	9					
					11.0	8					
					12.0	7					
					13.0	6					
					14.0	5					
					15.0	4					
					16.0	3					
					17.0	2					
					18.0	1					
					19.0	0					

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

KEY
Groundwater Level
Water Gain
Water Loss

STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:

Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

BH_TT70613 BH_68270

SOURCE: NZGD

LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

PATTLE DELAMORE PARTNERS LTD

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 2 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	STRENGTH	FRACTURE SPACING (cm)	GRAPHIC LOG	DEPTH (m)	RL (m)	CORE LOSS (%)	DRILLING DEPTH / DATE	WATER LEVEL GAIN / LOSS	CORE BOX No.	INSTALLATION
					20.0	0					
					21.0	-1					
					22.0	-2					
					23.0	-3					
					24.0	-4					
					25.0	-5					
					26.0	-6					
					27.0	-7					
					28.0	-8					
					29.0	-9					
	Sandy GRAVEL, dark grey brown, lensoidal. Tightly packed, moist - wet, unweathered, subangular (original size unclear).				30.0	-10					
					31.0	-11					
					32.0	-12					
					33.0	-13					
					34.0	-14					
	Unweathered, greenish grey, interbedded, alternating SANDSTONE/MUDSTONE (changes in drilling speed / hardness indicate interbedded nature of material). Weak, WAITEMATA GROUP.				35.0	-15					
					36.0	-16					
					37.0	-17					
					38.0	-18					
					39.0	-19					

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

KEY
Groundwater Level
Water Gain
Water Loss

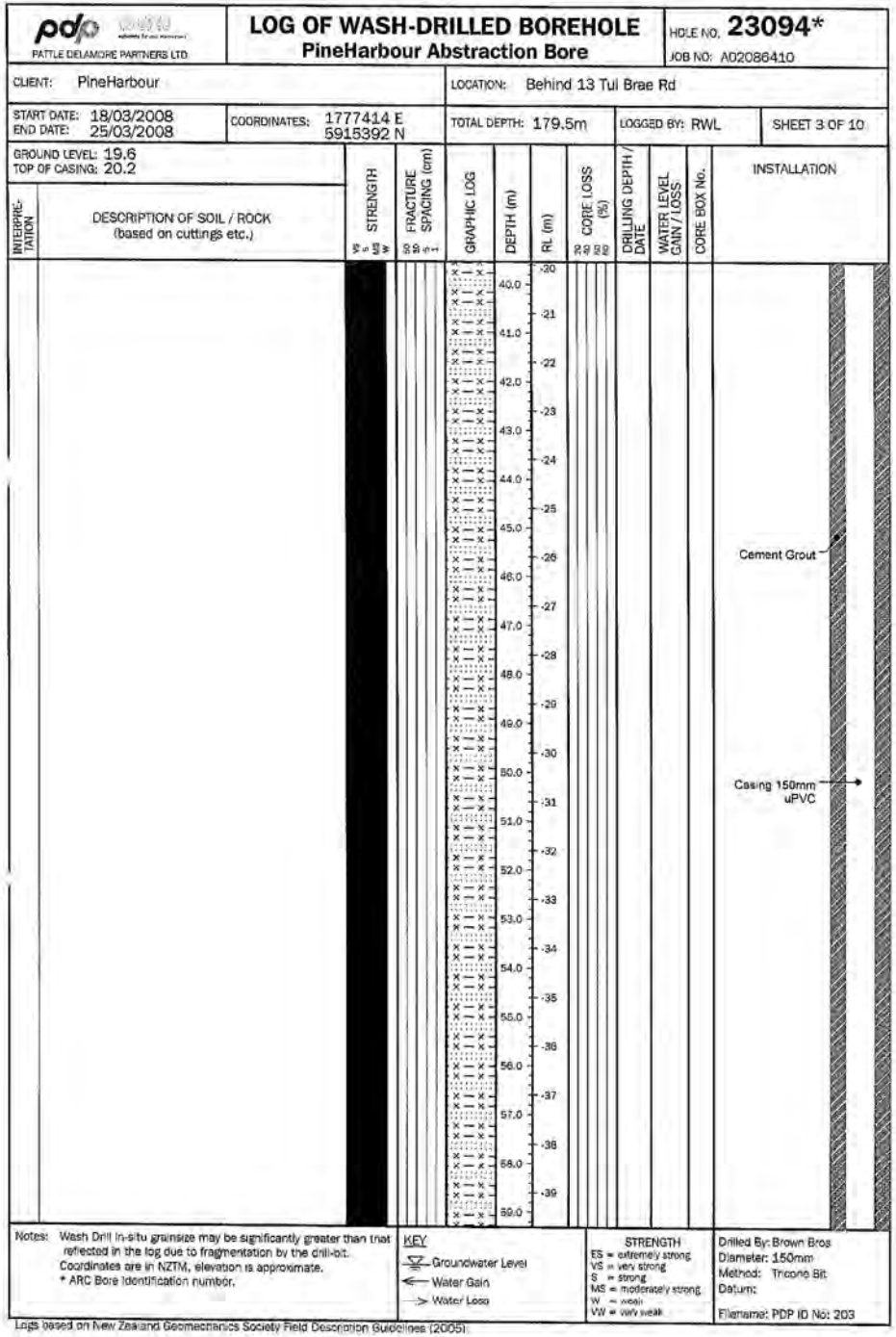
STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:

Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

BH_TT70613 BH_68270



LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

PATTLE DELAMORE PARTNERS LTD

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 3 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRETATION | DESCRIPTION OF SOIL / ROCK (based on cuttings etc.) | STRENGTH (VS = VS, MS, W) | FRACTURE SPACING (cm) | GRAPHIC LOG | DEPTH (m) | RL (m) | CORE LOSS (%) | DRILLING DEPTH / DATE | WATER LEVEL GAIN / LOSS | CORE BOX No. | INSTALLATION

INSTALLATION: Cement Grout; Casing 150mm uPVC

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

KEY
Groundwater Level
Water Gain
Water Loss

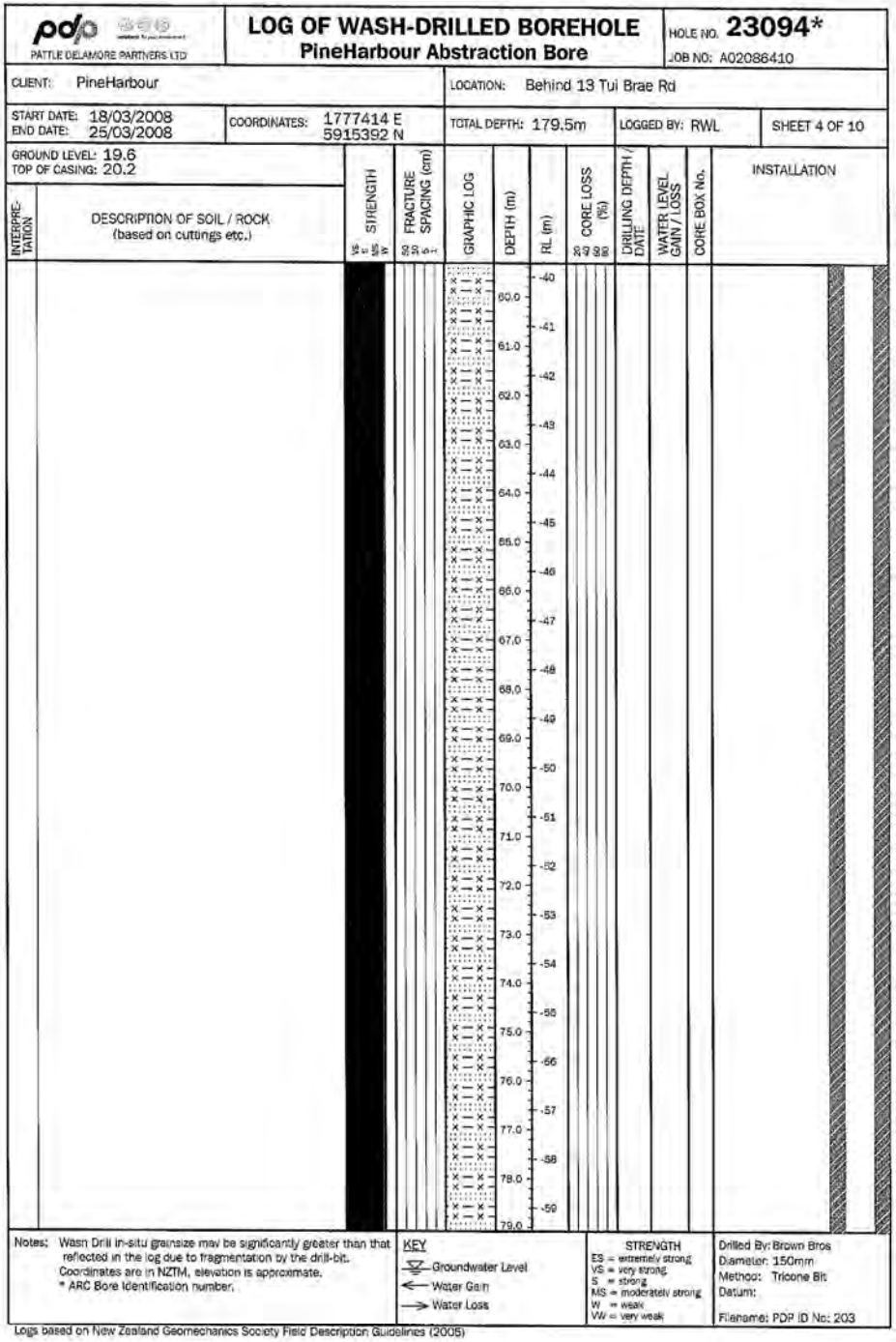
STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:
Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

BH_TT70613 BH_68270

SOURCE: NZGD



LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

PATTLE DELAMORE PARTNERS LTD

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 4 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRETATION | DESCRIPTION OF SOIL / ROCK (based on cuttings etc.) | STRENGTH (VS = VS, MS, W) | FRACTURE SPACING (cm) | GRAPHIC LOG | DEPTH (m) | RL (m) | CORE LOSS (%) | DRILLING DEPTH / DATE | WATER LEVEL GAIN / LOSS | CORE BOX No. | INSTALLATION

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

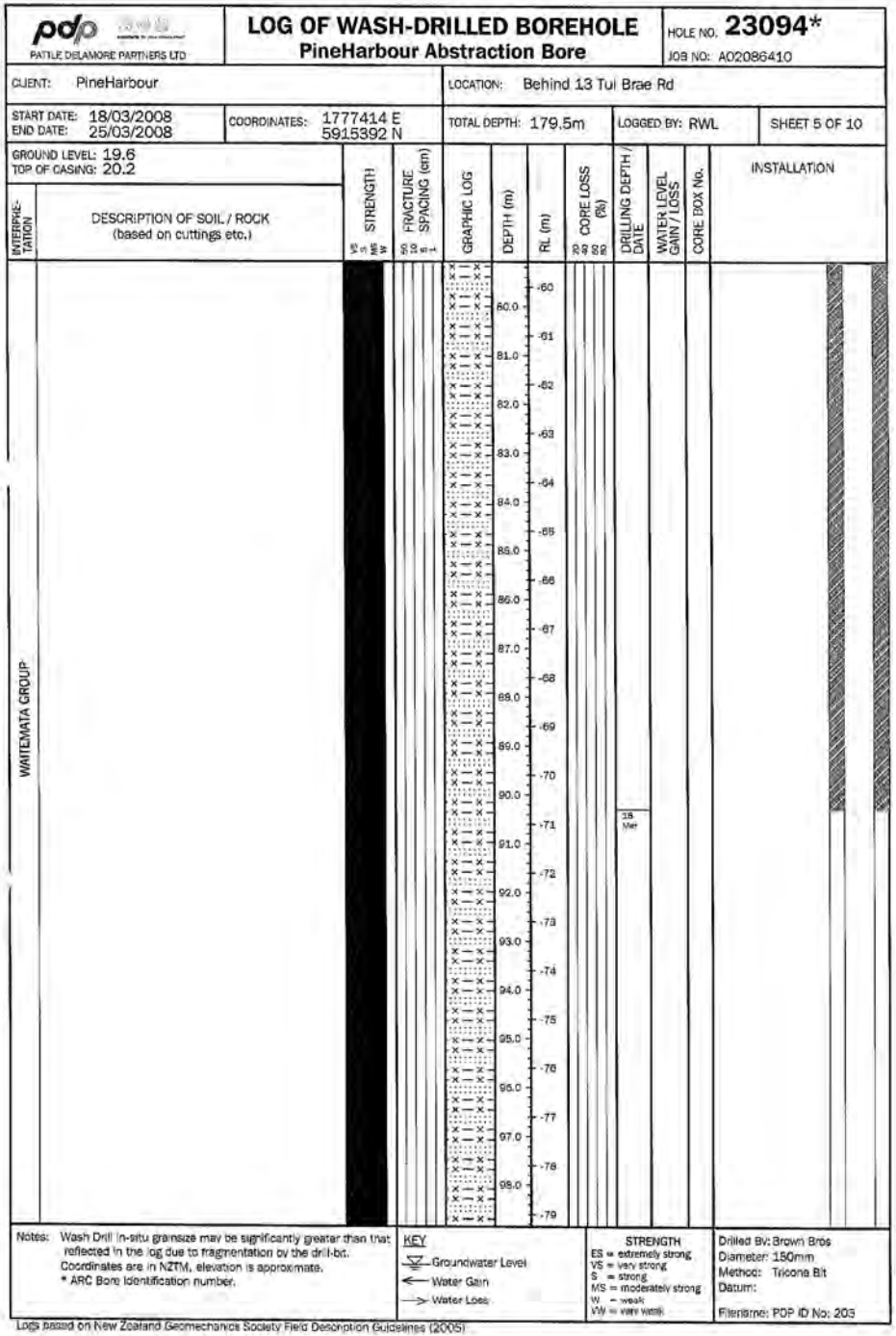
KEY
Groundwater Level
Water Gain
Water Loss

STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:
Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

BH_TT70613 BH_68270



PATTLE DELAMORE PARTNERS LTD

LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 5 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRE-TATION | DESCRIPTION OF SOIL / ROCK (based on cuttings etc.) | STRENGTH (ES VS S MS W) | FRACTURE SPACING (cm) (50 10 5 1) | GRAPHIC LOG | DEPTH (m) | RL (m) | CORE LOSS (%) (20 40 60) | DRILLING DEPTH / DATE | WATER LEVEL GAIN / LOSS | CORE BOX No. | INSTALLATION

WAITEMATA GROUP

DEPTH (m): 60.0, 81.0, 82.0, 83.0, 84.0, 85.0, 86.0, 87.0, 88.0, 89.0, 90.0, 91.0, 92.0, 93.0, 94.0, 95.0, 96.0, 97.0, 98.0
RL (m): -60, -61, -62, -63, -64, -65, -66, -67, -68, -69, -70, -71, -72, -73, -74, -75, -76, -77, -78, -79
DRILLING DEPTH / DATE: 18 Mar

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

KEY
Groundwater Level
Water Gain
Water Loss

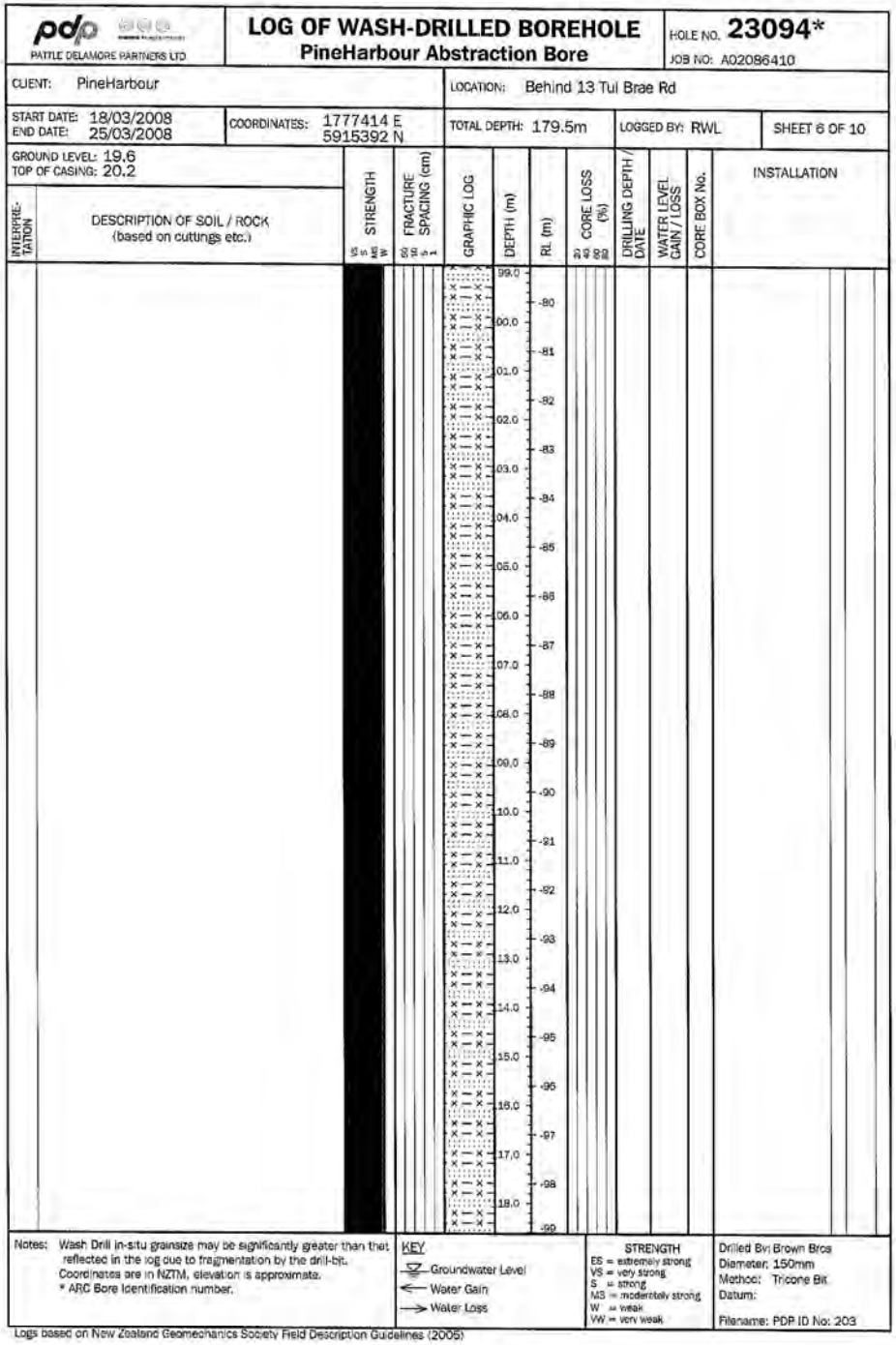
STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:

Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

SOURCE: NZGD



PATTLE DELAMORE PARTNERS LTD

LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 6 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRE-TATION | DESCRIPTION OF SOIL / ROCK (based on cuttings etc.) | STRENGTH (ES VS S MS W) | FRACTURE SPACING (cm) (50 10 5 1) | GRAPHIC LOG | DEPTH (m) | RL (m) | CORE LOSS (%) (20 40 60) | DRILLING DEPTH / DATE | WATER LEVEL GAIN / LOSS | CORE BOX No. | INSTALLATION

DEPTH (m): 99.0, 00.0, 01.0, 02.0, 03.0, 04.0, 05.0, 06.0, 07.0, 08.0, 09.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0
RL (m): -90, -91, -92, -93, -94, -95, -96, -97, -98, -99

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

KEY
Groundwater Level
Water Gain
Water Loss

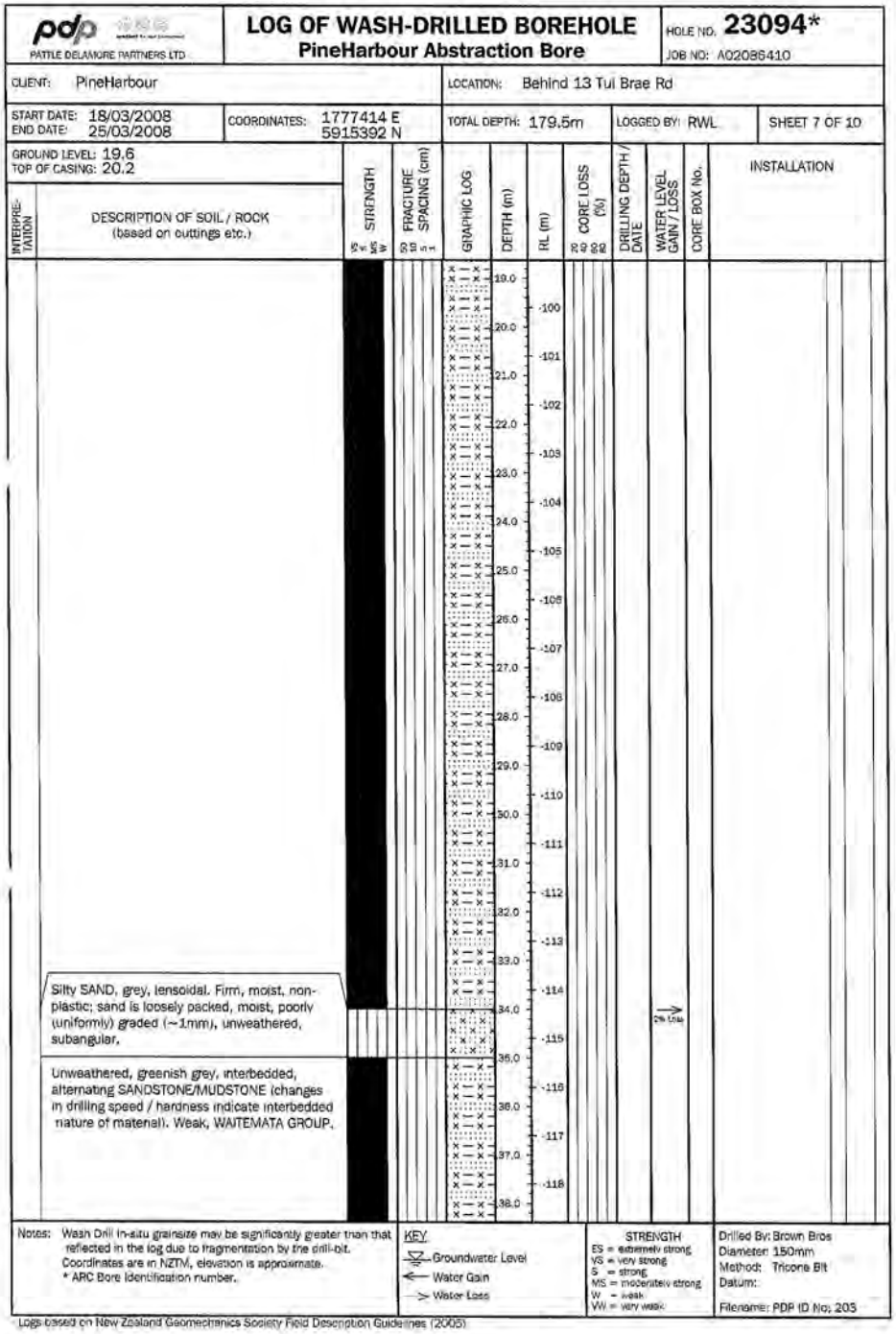
STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:

Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

BH_TT70613 BH_68270



PATTLE DELAMORE PARTNERS LTD

LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 7 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	STRENGTH VS S MS W	FRACTURE SPACING (cm) 60 20 6 2	GRAPHIC LOG	DEPTH (m)	RL (m)	CORE LOSS (%) 20 60 80	DRILLING DEPTH / DATE	WATER LEVEL GAIN / LOSS	CORE BOX No.	INSTALLATION
	Silty SAND, grey, lensoidal. Firm, moist, non-plastic; sand is loosely packed, moist, poorly (uniformly) graded (~1mm), unweathered, subangular.				19.0 – 34.0	-100 – -115			2% Loss		
	Unweathered, greenish grey, interbedded, alternating SANDSTONE/MUDSTONE (changes in drilling speed / hardness indicate interbedded nature of material). Weak, WAITEMATA GROUP.				34.0 – 38.0	-115 – -118					

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

KEY
Groundwater Level
Water Gain
Water Loss

STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

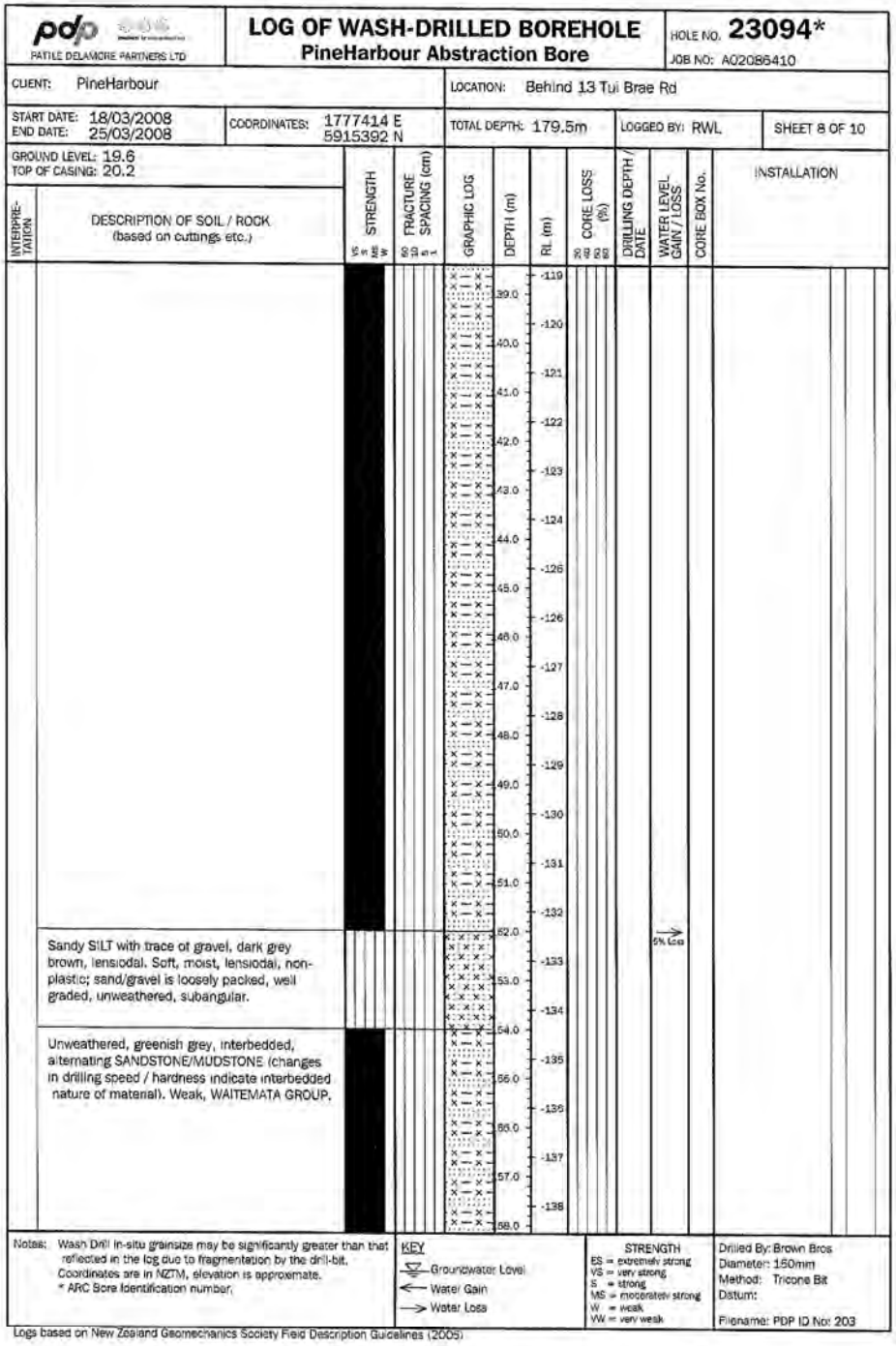
Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:

Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

BH_TT70613 BH_68270

SOURCE: NZGD



PATTLE DELAMORE PARTNERS LTD

LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 8 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	STRENGTH VS S MS W	FRACTURE SPACING (cm) 60 20 6 2	GRAPHIC LOG	DEPTH (m)	RL (m)	CORE LOSS (%) 20 60 80	DRILLING DEPTH / DATE	WATER LEVEL GAIN / LOSS	CORE BOX No.	INSTALLATION
	Sandy SILT with trace of gravel, dark grey brown, lensiodal. Soft, moist, lensiodal, non-plastic; sand/gravel is loosely packed, well graded, unweathered, subangular.				39.0 – 54.0	-119 – -134			5% Loss		
	Unweathered, greenish grey, interbedded, alternating SANDSTONE/MUDSTONE (changes in drilling speed / hardness indicate interbedded nature of material). Weak, WAITEMATA GROUP.				54.0 – 58.0	-134 – -138					

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

KEY
Groundwater Level
Water Gain
Water Loss

STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:

Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

BH_TT70613 BH_68270

PATTLE DELAMORE PARTNERS LTD

LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 9 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	STRENGTH	FRACTURE SPACING (cm)	GRAPHIC LOG	DEPTH (m)	RL (m)	CORE LOSS (%)	DRILLING DEPTH / DATE	WATER LEVEL GAIN / LOSS	CORE BOX No.	INSTALLATION
		ES VS S MS W VW	60 30 10 3		59.0	-139	20 40 60 80				
					60.0	-140					
					61.0	-141					
					62.0	-142					
					63.0	-143					
					64.0	-144					
					65.0	-145					
	Unweathered, greenish grey, SANDSTONE CONGLOMERATE. Very strong, BASAL WAITEMATA GROUP CONGLOMERATE, grains of quartz, plagioclase, and feldspar.				66.0	-146			10% Loss		
					67.0	-147					
					68.0	-148					
					69.0	-149					
					70.0	-150					
	Unweathered, grey, indurated, GREYWACKE. Very strong, GREYWACKE.				71.0	-151		20 Mar	25% Loss		
					72.0	-152					
					73.0	-153					
					74.0	-154					
					75.0	-155					
					76.0	-156					
					77.0	-157					
						-158					

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

KEY
Groundwater Level
Water Gain
Water Loss

STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:

Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

SOURCE: NZGD

PATTLE DELAMORE PARTNERS LTD

LOG OF WASH-DRILLED BOREHOLE
PineHarbour Abstraction Bore

HOLE NO. 23094*
JOB NO: A02086410

CLIENT: PineHarbour
LOCATION: Behind 13 Tui Brae Rd

START DATE: 18/03/2008
END DATE: 25/03/2008
COORDINATES: 1777414 E 5915392 N
TOTAL DEPTH: 179.5m
LOGGED BY: RWL
SHEET 10 OF 10

GROUND LEVEL: 19.6
TOP OF CASING: 20.2

INTERPRETATION	DESCRIPTION OF SOIL / ROCK (based on cuttings etc.)	STRENGTH	FRACTURE SPACING (cm)	GRAPHIC LOG	DEPTH (m)	RL (m)	CORE LOSS (%)	DRILLING DEPTH / DATE	WATER LEVEL GAIN / LOSS	CORE BOX No.	INSTALLATION
		ES VS S MS W VW	60 30 10 3		79.0	-159	20 40 60 80	20 Mar			
					79.0						

END OF BOREHOLE AT 179.5m

Notes: Wash Drill in-situ grainsize may be significantly greater than that reflected in the log due to fragmentation by the drill-bit.
Coordinates are in NZTM, elevation is approximate.
* ARC Bore Identification number.

KEY
Groundwater Level
Water Gain
Water Loss

STRENGTH
ES = extremely strong
VS = very strong
S = strong
MS = moderately strong
W = weak
VW = very weak

Drilled By: Brown Bros
Diameter: 150mm
Method: Tricone Bit
Datum:

Filename: PDP ID No: 203

Logs based on New Zealand Geomechanics Society Field Description Guidelines (2005)

BH_68270
BH_TT70613

KIWI WELLDRILLERS N.Z. LTD

ISO 9002 CERTIFIED

MEMBER: NZ. DRILLERS FED

Ph. 0800 822 822

BRANCHES:
Drilling from
Waikato to
the Far North

PO BOX 400, OREWA 0946
E-Mail: info@kiwiwelldrillers.co.nz

BORE LOG FORM

Client MIKE WOOD
Address KAWAIRAHI DRIVE
BEACHLANDS. Ph 021 954 979
Grid Reference No.. 1778513 5914888
Consent No 45915 Bore I.D. 29447

Driller JORDAN BROWN
Drilling Method ROT.- MUD
Date of Finishing 28.1.2015
Purpose of Bore DOMESTIC

BORE LOG

Depth from Surface Top	Bottom	Description of Ground Passed Through
0.0	1.0	ORANGE/BROWN CLAY
1.0	5.0	ORANGE WHITE CLAY
5.0	10.0	MARINE MUDSTONE SOFT
10.0	23.0	MUDSTONE
23.0	24.0	MUDSTONE WITH COAL BANDS
24.0	35.0	MUDSTONE
35.0	36.0	MUDSTONE WITH COAL BANDS
36.0	45.0	SANDSTONE MUDSTONE
45.0	50.0	SANDSTONE MUDSTONE WITH GRAVELS
50.0	56.0	SANDSTONE SOFT
56.0	57.0	GREYWACKE

WELL CONSTRUCTION

All measurements from the top of the casing

Depth of bore (M) 57.00 m
Depth of casing (M) 40.00 m
Diameter of Casing PVC 104 (mm)
Screens:
From m to m
Slot size and type
Grouting 14 Bags

Pump Tests:

Method of development AIR INDUCTION
Static water level 15.30 m
Duration of test 3 HOURS
Max 10500 ltrs p/hr
Test discharge (m^3/hr) 10.5
Drawdown level 25.00 m
PUMP DEPTH 40.00 m
PUMP VOLUME up to 5000 ltrs p/hr

Type pump to suit construction of bore for client

80mm SUBMERSIBLE PUMP SET **SQE 5-35**
AT 40.00 m. FOR 5000 lph
Water Quality Basic on site taste test

REMARKS

Resin water sample test taken to establish correct Water Softener unit
20% CIRCULATION LOSS FROM 31.00 TO 40.00m THEN CASED. 50% CIRCULATION LOSS FROM 40.00 TO 48.00 THEN 100% CIRCULATION LOSS FROM 48.00 TO 57.00m

This well has been drilled in accordance with **New Zealand Standard 4411:2001** Environmental Standard for Drilling of Soil and Rock.

DRILLFORCE
THE DRILLING SPECIALISTS

Drill Force New Zealand Ltd
PO Box 72 335, Papakura 2244,
Stevenson Laboratory, Cnr Fitzgerald and Quarry Roads, Drury, Auckland
www.drillforce.co.nz

Ph: 09 294 9038
Fax: 09 294 9058

BORE LOG FORM

Permit #	P47861
Finish date	6/10/15
Client	Beachlands Pastoral Ltd
Details	680 Whitford-Maraetai Rd
	Beachlands
Bore ID	29901
Grid ref	1778381mE 5913709mN
Driller	Kiel Peterson
Method	Rotary Mud
Purpose	Water

Well Construction Detail

Depth of bore	206m
Depth of casing	91.66m
ID of casing	100mm

Casing grouting details

Fully grouted casing with 50 bags of cement.

Method of development

Method	Air
S.W.L	52.7m
Start pressure	70 PSI
Run pressure	35 PSI
Flow rate	2.4 cubes per hour
Air line @	91m

Bore Log

0	-	.200	Top Soil
.200	-	5	Yellow / brown clays
5	-	7.8	Brown / white clays
7.8	-	12	Yellow sandy silts
12	-	14.7	Grey silts
14.7	-	39	Sandstone
39	-	78	Mudstone
78	-	172	Sandstone with mudstone bands
172	-	180.9	Shell rock mixed with sandstone gravels
180.9	-	197	Hard shell rock
197	-	206	Grey wakey

Comments

We recommend installing the pump on 14 lengths of pipe around 91m and pumping maximum flow of 2 cubes per hours.

Legend and/or Notes:

Hand Auger Borehole

client: CLC CONSULTING GROUP
project: S/W UPGRADE THIRD VIEW AVENUE, BEACHLANDS
title: BOREHOLE LOCALITY PLAN
project no: J 00050
figure no: 01
drawn: MC
approved: MC
date: 07.04.15
scale: 1:500
original size: A3

LANDER geotechnical

Horizontal Scale (metres) 0 10.0 20.0 30.0
Vertical Scale (metres) 0 10.0 20.0 30.0

revision	description	drawn	approved	date

BASEPLAN SOURCE: AS SUPPLIED BY AUCKLAND COUNCIL

Client : CLC CONSULTING GROUP
Project Location : THIRD VIEW AVENUE, BEACHLANDS
Job Number: J00050

Auger Borehole No. 1
Sheet 1 of 4

Vane Head: 307 | Logged By: TT | Processor: MC | Date: 02.04.15

Borehole Location: mN | mE | Ground R.L.
Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
silty CLAY, brown/ orange mottled orange. Hard, dry, medium plasticity [TAURANGA GROUP]	0.5		229 +		
becoming brown streaked grey					
becoming grey, moist, high plasticity	1.0		UTP		
becoming dark brown/ grey, very stiff, moderately sensitive	1.5		186/ 87	2.1	Approx: Invert level Pipeline
becoming black					
organic CLAY, black. Stiff, moist, high plasticity, moderately sensitive	2.0		74/ 28	2.6	
with fibrous wood inclusions					
sandy SILT, grey. Hard, moist, low plasticity	2.5		UTP		
SILT, white/ grey. Hard, moist, low plasticity	3.0		UTP		
becoming wet, very difficult to retain sample due to dilatency	3.5	▽	UTP		
	4.0		UTP		
CLAY, brown. Stiff, wet, high plasticity moderately sensitive	4.5		87/ 26	3.3	
becoming blue/ grey					
becoming very stiff	5.0		111/ 51	2.2	
E.O.B. at 5.0m. Target Depth.	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater encountered 3.6m
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm
Checked:

Topsoil, Fill, Clay, Silt, Sand, Gravel, Organic, Pumice, Sandstone, Siltstone, Limestone, Volcanic, Pholoric, No Core

Client : CLC CONSULTING GROUP
Project Location : THIRD VIEW AVENUE, BEACHLANDS
Job Number: J00050

Auger Borehole No. 2
Sheet 2 of 4

Vane Head: 1750 | Logged By: MC | Processor: MC | Date: 02.04.15

Borehole Location: mN | mE | Ground R.L.
Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
silty CLAY, yellow/ brown streaked grey. Hard, dry, high plasticity [TAURANGA GROUP]					
becoming moist at 0.5m	0.5		186 +		
becoming slightly silty CLAY, brown mottled grey/ brown, moist					
becoming brown, very stiff, moderately sensitive	1.0		133/ 44	3.0	
becoming yellow/ brown					
slightly clayey SAND, white/ grey. Very stiff, moist, low plasticity, extra sensitive	1.5		178/ 13	13.7	
SAND, white/ grey. Hard, moist, non-plastic					Approx. Invert level pipeline
becoming wet	2.0		UTP		
SILT, white. Hard, wet, non-plastic					
becoming very difficult to retain sample due to dilatency	2.5		UTP		
becoming brown, damp	3.0	▽	UTP		
slightly silty CLAY, grey/ brown. Stiff, moist, high plasticity, moderately sensitive					
becoming grey, stiff	3.5		60/ 17	3.5	
becoming blue/ grey	4.0		60/ 24	3.3	
becoming silty CLAY, damp, medium plasticity					
slightly clayey SILT, grey. Very stiff, moist, low plasticity, moderately sensitive	4.5		119/ 48	2.5	
silty CLAY, grey. Stiff, moist, high plasticity, moderately sensitive	5.0		60/ 27	2.2	
E.O.B. at 5.0m. Target Depth.					
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater encountered 2.1m
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm
Checked:

Topsoil | Fill | Clay | Silt | Sand | Gravel | Organic | Pumice | Sandstone | Siltstone | Limestone | Volcanic | Plutonic | No Core

Client : CLC CONSULTING GROUP
Project Location : THIRD VIEW AVENUE, BEACHLANDS
Job Number: J00050

Auger Borehole No. 3
Sheet 3 of 4

Vane Head: 307 | Logged By: TT | Processor: MC | Date: 02.04.15

Borehole Location: mN | mE | Ground R.L.
Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
silty CLAY, grey mottled orange. Hard, dry, high plasticity [TAURANGA GROUP]					
becoming grey	0.5		229 +		
becoming very stiff, moderately sensitive, with minor limonite inclusions	1.0		175/ 62	2.8	
becoming moist					
becoming hard	1.5		229 +		Approx. Design Invert Level
slightly clayey SILT, grey/ white. Hard, damp, medium plasticity with minor yellow weakly cemented clast inclusions	2.0		UTP		
becoming yellow/ brown	2.5		UTP		
becoming brown					
CLAY, dark brown with organic staining. Very stiff, moist, high plasticity	3.0		111/ 51	2.2	
CLAY, grey/ cream. Very stiff, moist, high plasticity, moderately sensitive, with minor limonite inclusions	3.5		120/ 51	2.4	
silty CLAY, yellow/ brown. Very stiff, moist, high plasticity, moderately sensitive	4.0		139/ 48	2.9	
CLAY, grey. Very stiff, moist, high plasticity, insensitive, with minor limonite inclusions	4.5		103/ 58	1.8	
becoming stiff					
E.O.B. at 5.0m. Target Depth.	5.0		64/ 39	1.6	
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm
Checked:

Topsoil | Fill | Clay | Silt | Sand | Gravel | Organic | Pumice | Sandstone | Siltstone | Limestone | Volcanic | Plutonic | No Core

Client : CLC CONSULTING GROUP
Project Location : THIRD VIEW AVENUE, BEACHLANDS
Job Number: J00050

Auger Borehole No. 4

Sheet 4 of 4

Vane Head: 1750 | Logged By: MC | Processor: MC | Date: 02.04.15

Borehole Location: mN | mE | Ground R.L. | Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL				
slightly silty CLAY with some fine gravel, black/ white/ brown/ orange. Hard, moist, high plasticity [FILL]	0.5	UTP		Approx. Design Invert Level.
silty CLAY, grey. Hard, moist, medium plasticity [TAURANGA GROUP] becoming yellow/ brown mottled grey, with small white weakly cemented clast inclusions becoming slightly silty CLAY, grey/ brown, moist, high plasticity	1.0	186 +		
becoming yellow/ brown mottled grey/ brown with major limonite stains for 0.3m	1.5	141/ 53	2.7	
becoming grey/ brown				
becoming silty CLAY, medium plasticity 100mm lens of sandy CLAY, grey	2.0	117/ 33	3.5	
becoming stiff becoming slightly silty CLAY, high plasticity	2.5	93/ 31	3.0	
becoming wet	3.0	64/ 27	2.4	
sandy CLAY, yellow/ brown. Very stiff, wet, medium plasticity	3.5	119/ 31	3.8	
clayey SAND, brown/ orange streaked yellow/ brown. Very dense, moist, low plasticity E.O.B. at 4.0m. Too hard to auger further. D.C.P. Test in base of borehole.	4.0	UTP		D.C.P TEST 20 blows for 0mm penetration (effective refusal)
	4.5			
	5.0			
	5.5			
	6.0			

05/12/18

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm
Checked:

Topsoil, Fill, Clay, Silt, Sand, Gravel, Organic, Pumice, Sandstone, Siltstone, Limestone, Volcanic, Plutonic, No Core

coffey
A TETRA TECH COMPANY

Engineering Log - Hand Auger

Borehole ID. **HA01**
sheet: 1 of 1
project no. **AKLGE222037**

client: ***Ignite Partners Ltd.***
principal:
project: ***Beachlands School***
location: ***Refer to Site Plan***

date started: ***05 Dec 2018***
date completed: ***05 Dec 2018***
logged by: ***AC/WW***
checked by: ***JCF***

position: E: 1778175; N: 5916104 (NZGD2000) | surface elevation: Not Specified | angle from horizontal: 90°
drill model: Hand Auger | drilling fluid: | hole diameter : 50 mm | vane id.: 1466

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	vane shear ⊖ remoulded ⊕ peak (kPa)	structure and additional observations
HA					0.0			**TOPSOIL: Clayey SILT**: low plasticity, dark brown, with trace fine grained sand, with trace rootlets.	M	VSt		**TOPSOIL**
							ML	**Clayey SILT**: low plasticity, orange brown, with trace black inclusions (<5mm), sensitive.			VS 131/ 27 kPa	**PUKETOA FORMATION SOIL**
											VS 167/ 67 kPa	
					1.0		CL	**Silty CLAY**: low plasticity, orange brown mottled grey pale brown, moderately sensitive. 1.3 m: becoming pale brown streaked orange and grey			VS 187 kPa	
											VS 187 kPa	
					2.0		ML	**Clayey SILT**: low plasticity, pale grey mottled orange red and brown, with minor fine to coarse grained pumiceous sand, moderately sensitive.			VS 182/ 48 kPa	
											VS 109/ 40 kPa	
					3.0		CI	**Silty CLAY**: medium plasticity, pale grey streaked orange red and brown, with trace fine grained pumiceous sand, moderately sensitive. 3.2 m: becoming pale grey mottled black-brown			VS 147/ 53 kPa	
											VS 100/ 43 kPa	
							OH	**ORGANIC CLAY**: medium plasticity, black, with organic odour.	M to W		VS 148/ 53 kPa	
					4.0						VS 100/ 33 kPa	
											VS 108/ 32 kPa	
											VS 187 kPa	
					5.0			Hand Auger HA01 terminated at 5.0 m Target depth				

CDF_0_9_06_LIBRARY.GLB rev.4R Log COF BOREHOLE NON CORED 222037 - BEACHLANDS SCHOOL.GPJ <<DrawingFile>> 11/12/2018 07:47

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger
* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
S saturated
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

DRILLED: 08/12/2017 FILE: 47931

HAND AUGER NO.: HA 01

SHEET 1 OF 1

PROJECT: ECE Development CLIENT: Signature Building Ltd - AKL

LOGGED	PROCESSED	CHECKED
SG	CT	IH

ADDRESS: 17a Bell Road, Beachlands

BH LOCATION: COORDS: RL GROUND: SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION (Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments)	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) ○Residual ●Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
	TOPSOIL	TS				
	Very stiff, yellow, SILT, dry, friable, trace topsoil intrusion (Puketoka Formation)					
	yellow trace pale grey			Unable To Penetrate	-	
	pale grey and orange, moist, non friable					
1				Peak Exceeded	-	
	pale grey streaked orange trace white					
	brown grey and black					
	light pinkish brown, trace pumice speckles				2.9	
2	some speckles of black, trace peat				2.3	
	white trace orange, trace brown, slightly pumiceous, trace sand					
	very moist, trace to some pumice nodules, occasional small pockets of orange sand				3.3	
	black, brown, orange and white, peaty					
	white, trace orange					
3					3.2	
	End of Hand Auger (Target Depth Achieved)					
4						

EOH @ 4.20 m

NOTES:
No groundwater encountered during drilling

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HAND AUGER NO.: HA 02

SHEET 1 OF 1

PROJECT: ECE Development CLIENT: Signature Building Ltd - AKL

LOGGED	PROCESSED	CHECKED
SG	CT	IH

ADDRESS: 17a Bell Road, Beachlands

BH LOCATION: COORDS: RL GROUND: SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION (Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments)	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) ○Residual ●Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
	TOPSOIL	TS				
	Very stiff, pale grey brown, trace orange, SILT, moist, friable (Puketoka Formation)					
	non friable, pale grey brown				2.7	
1				Peak Exceeded	-	
	occasional brown streaks			Peak Exceeded	-	
	Very stiff, brown grey and black, trace pink, clayey SILT, trace peat (Puketoka Formation)					
2	End of Hand Auger (Target Depth Achieved)			Peak Exceeded	-	
3						

EOH @ 3.30 m

NOTES:
No groundwater encountered during drilling

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HAND AUGER NO.: HA 03

SHEET 1 OF 1

PROJECT: ECE Development CLIENT: Signature Building Ltd - AKL

LOGGED	PROCESSED	CHECKED
SG	CT	IH

ADDRESS: 17a Bell Road, Beachlands

BH LOCATION: COORDS: RL GROUND: SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION (Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments)	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) Residual / Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
	TOPSOIL	TS T				
	Very stiff, pale grey and orange, SILT, friable, moist (Puketoka Formation)					
	non friable			Unable To Penetrate	-	
1	friable, pale grey streaked orange					
				Peak Exceeded	-	
	Very stiff, brown grey and black, clayey SILT, trace peat (Puketoka Formation)				1.6	
	white trace orange					
2	slightly peaty, brown black trace pink				2.4	
	Stiff, black, clayey PEAT (Puketoka Formation)					
	white trace black and brown					
	'Medium dense', brow grey, silty SAND, moist (Puketoka Formation)			Peak Exceeded	-	
	moist to very moist, slighly pumiceous					
	End of Hand Auger (Target Depth Achieved)					
3						
4						

EOH @ 4.50 m

NOTES:
No groundwater encountered during drilling

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HAND AUGER NO.: HA 04

SHEET 1 OF 1

PROJECT: ECE Development CLIENT: Signature Building Ltd - AKL

LOGGED	PROCESSED	CHECKED
SG	CT	IH

ADDRESS: 17a Bell Road, Beachlands

BH LOCATION: COORDS: RL GROUND: SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION (Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments)	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) Residual / Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
	TOPSOIL	TS T				
	Very stiff, pale grey brown, SILT, slightly moist, friable (Puketoka Formation)					
	pale grey orange, non friable				4.1	
1	slightly friable in places				2.2	
	trace brown grey, non friable				2.1	
	occasional thin (approximately 20mm layers) of black					
	brown light grey and orange, trace white					
	trace peat					
2	white trace and orange				2.4	
	End of Hand Auger (Target Depth Achieved)					
3						

EOH @ 3.35 m

NOTES:
No groundwater encountered during drilling
Peat noted on Scala Penetrometer

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HAND AUGER NO.: HA 05

SHEET 1 OF 1

PROJECT: ECE Development CLIENT: Signature Building Ltd - AKL

LOGGED	PROCESSED	CHECKED
SG	CT	IH

ADDRESS: 17a Bell Road, Beachlands

BH LOCATION: COORDS: RL GROUND: SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION (Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments)	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) ○Residual ●Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
0	TOPSOIL	TS				
	Very stiff, yellowish orange brown, SILT, trace sand, friable, dry (Puketoka Formation)					
	tree rootlet (approximately 6mm diameter)			Unable To Penetrate	-	
	pale grey orange, non friable, moist					
1	slightly friable			Unable To Penetrate	-	
				Peak Exceeded	-	
	white, pumiceous, slightly friable					
2	light brown grey, speckles of black				2.5	
	white trace orange, moist, non friable					
	occasional orange speckles, pumiceous				3.5	
	friable					
3	slightly sandy				9.4	
	End of Hand Auger (Target Depth Achieved)					
4						

EOH @ 4.30 m

NOTES:
No groundwater encountered during drilling
No peat on Scala Penetrometer

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HAND AUGER NO.: HA 06

SHEET 1 OF 1

PROJECT: ECE Development CLIENT: Signature Building Ltd - AKL

LOGGED	PROCESSED	CHECKED
SG	CT	IH

ADDRESS: 17a Bell Road, Beachlands

BH LOCATION: COORDS: RL GROUND: SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION (Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments)	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) ○Residual ●Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
0	TOPSOIL and hardfill					
	TOPSOIL	TS				
	Very stiff, yellow brown orange, SILT, moist, friable (Puketoka Formation)				3.2	
	pale grey orange, trace brown, moist			Peak Exceeded	-	
1						
	pale grey white, non friable			Peak Exceeded	-	
	pale grey trace orange trace white					
2					2.1	
	End of Hand Auger (Target Depth Achieved)					
3						

EOH @ 3.70 m

NOTES:
No groundwater encountered during drilling

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HAND AUGER NO.: HA 07

SHEET 1 OF 1

PROJECT: ECE Development CLIENT: Signature Building Ltd - AKL

LOGGED	PROCESSED	CHECKED
SG	CT	IH

ADDRESS: 17a Bell Road, Beachlands

BH LOCATION: COORDS: RL GROUND: SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION — Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) ○Residual ●Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
	TOPSOIL	TS				
	Very stiff, pale grey white, SILT, friable, dry (Puketoka Formation)					
	tree rootlet (approximately 5mm diameter)				7.0	
	non friable, moist, pale grey trace orange					
1	pale grey light brown				3.8	
	End of Hand Auger (Target Depth Achieved)	EOH @ 1.10 m				

NOTES:
No groundwater encountered during drilling

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DRILLED: 08/12/2017 FILE: 47931

HAND AUGER NO.: HA 08

SHEET 1 OF 1

PROJECT: ECE Development CLIENT: Signature Building Ltd - AKL

LOGGED	PROCESSED	CHECKED
SG	CT	IH

ADDRESS: 17a Bell Road, Beachlands

BH LOCATION: COORDS: RL GROUND: SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION — Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) ○Residual ●Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
	TOPSOIL, gravely	TS				
	FILL, hardfill gravel with silt, friable on auger					
	Very stiff, pale grey trace orange, SILT, slightly moist, non friable (Puketoka Formation)			Unable To Penetrate	-	
	slightly friable, pale grey brown streaked orange					
1				Peak Exceeded	-	
	End of Hand Auger (Target Depth Achieved)	EOH @ 1.10 m				

NOTES:
No groundwater encountered during drilling

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Water Allocation team
Natural Resources & Specialist Input Unit

Auckland Council
Te Kaunihera o Tāmaki Makaurau

BORE RECORD

Bore ID	29259
Adviser	N. o'HAZARD

Bore details

Status	(Drilled)		Land use note	
Environment	Land			
Land use	GEOTECH			
Purpose (circle one)	(Investigation)	Abstraction permitted	Abstraction consented	Other
Bore use				
Description	Drilled pre 1987 for			(owner name)
	By ~~driller unknown~~ or by (driller name) DCN Drilling			
	Drilled as suite of holes under consent number			
	Source location from permit no: 42858			

SOURCE: NZGD

Location NZTM coordinates							
Seq no	Easting	Northing	Location type	Collection method	Date collected	Accuracy rating	
1	1778563	5914968	Point	(GPS) / (Map)	8/4/2014	5	(m)

If more than one bore, list others on an attachment in format above

Aquifer/ALW zone

Main aquifer	Alluvium	Geothermal	Greywacke	Kaawa	Limestone
	Other	Sand	Volcanic	(Waitemata)	
Aquifer	Whitford Beachlands				
Sub aquifer	Beachlands				
Sub-aquifer 2					
GW reporting area	Auckland - Manukau				
ALW Plan zone (high use):	—		TLA area	Manukau	

Property details (relationships/property)

Site name (owner)	New Avenues		
Site description			
Street address	49 Jade Ladlan Drive	Suburb	Beachlands
Legal description		C/T	

Survey data (bore attributes)

Bore log	(Yes) / No	Total depth (btoc)	10.0 (m)	Date drilled (finished)	7/6/2013
Static water level (SWL) (btoc)		2.5 (m)		SWL date measured	11/2013
Ground elevation (RL)		21.5		Elevation accuracy	(GIS) / GPS / Survey

Bore			Casing				Screen		
From (m)	To (m)	Dia (m)	From (m)	To (m)	Type PVC / Steel	Dia (m)	From (m)	To (m)	Type PVC / Steel

Comments	Please attach bore log and location map
Date entered in database	*Administrator: Scan this form and attachments in colour and save using the prescribed file naming protocol.*

BH_TT71997

SOURCE: NZGD

Geology

0 – 4.4 Clay + silts

4.4 – 5.9 CLAY + SAND, Residual Waitemata Group Soils

5.9 – 10.0 Grey, moderately weathered Waitemata Gp sandstone

BH_TT71997

Borehole No. MH1

Page 1 of 1

Datum:
Elevation: 0.0
Location: -

Drilled By: DCN
Orientation: Vertical
Equipment: Track Mounted Rig

Date Started: 07/06/2013
Date Finished: 07/06/2013

Core Data			Field Tests							
TCR %	RQD %	Frac-Space (mm) Max / Min / Avg	SPT	Vane Shear Strength (kPa)	Ground Water	Drilling Method	Test Sample	RL (m)	Depth (m)	Description of strata	Geologic Unit	Graphic Log
60						Open Barrel		0.0	0	Topsoil	TS	
100				114/25						Silty CLAY. Brown, stiff, moist, moderate to high plasticity. [WAITEMATA GROUP SOILS]		
								-1.0	1	Clayey SILT with some fine grained sand. Dark brown, stiff, moist, moderate plasticity.		
100				154/104						Silty CLAY. Yellow/light grey, stiff to very stiff, moist, moderate plasticity. Between 1.0m and 3.2m; becomes light grey mottled orange, high plasticity. Fine grained, light grey sandy laminations in part.		
								-3.0	2			
100				101/50							WAITEMATA GROUP SOILS	
					▽ 2.5 May 2013							
100				101/40				-3.9	3	Sandy SILT with some clay. Grey speckled orange, very stiff, moist, moderate plasticity.		
100				201/0				-4.9	4			
										Silty sandy CLAY. Grey, stiff to hard, moist, moderate plasticity. [WAITEMATA GROUP SANDSTONE TRANSITITION] Completely weathered, very low strength.	TRANSITION	
100								-5.8	5	Clayey silty fine to medium grained SAND. Grey, hard, moist, moderately plastic. [WAITEMATA GROUP SANDSTONE]. Completely weathered, very low strength.		
100	100		50/150mm				D	-6.0	6	Moderately weathered, grey, fine to medium grained WAITEMATA GROUP SANDSTONE, very weak.		
100	100											
								-7.0	7		WAITEMATA GROUP SANDSTONE	
100	100		50/220mm			Triple Tube						
								-8.0	8	At 8.2m; sub-vertical fracture, undulating, rough, unsure spacing, no staining. At 8.4m; steeply inclined fracture, undulating, smooth, 1m spacing.		
100	100											
			52/225mm					-9.0	9			
100	100											
										At 9.74; 45 degree joint, planar, rough.		
								-10		EOB at 10.00 m		

Soil/Rock descriptions are in accordance with the following current NZ Geomechanics Society Guidelines:
Guidelines for the Field Description of Soils and Rocks in Engineering Use
Guidelines for Hand Held Shear Vane Test

Observations:
Shear vane used is GEO1428, correction factor of 1.68

Logged: AS
Checked: PH

Project: New subdivision
Job Number: 7169

Client: Beachlands Avenues Ltd
Sheet:

6 Omega St, Albany, Auckland
PO Box 302 361 NHMC
Tel: 09 478 6655
Fax: 09 478 6169
Email: kga@kga.co.nz
KGA GEOTECHNICAL

BOREHOLE LOG PZ 1

Sheet 1 of 5

Job no: 09710
Job Name: Proposed Beachlands Subdivision Beachlands
Borehole Coordinates: 1779220.59 mE 5915282.85 mN
Borehole Location: See site plan
Surface Elevation [m]: 39.50 Datum: [NZTM]
Surface Conditions: Slight slope, grassed

PA

Geol. Unit	Soil / Rock description in accordance with the NZ Geotechnical Society Inc Publication "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005 — Soil / Rock Description	Graphic Log	Depth (m)	Reduced Level (m)	Drilling Method	SAMPLE DATA: Sample Condition	SAMPLE DATA: Sample Type	SAMPLE DATA: Sample recovery (%)	FIELD TESTS: Factored Shear Strength (kPa) Peak Value / Remolded Vane	FIELD TESTS: Groundwater	FIELD TESTS: SPT	LABORATORY TESTS: Water content (%)	LABORATORY TESTS: Dry Density(kg / m³)	LABORATORY TESTS: Other Tests
	TOPSOIL [Brown SILT, trace clay, stiff, dry to moist, non plastic]													
ALLUVIAL DEPOSITS	Yellow, orange, light grey mottled silty CLAY, very stiff, moist, highly plastic		1	39	WASH DRILLED				UTP UTP					
WEATHERED WAITEMATA GROUP SOILS	Grey, streaked orange fine sandy SILT, some clay, very stiff, moist, slightly plastic		3	36										
	Grey silty SAND, minor clay, hard, wet, slightly to moderately plastic; alternating with Some clayey SILT, very stiff, wet, moderately plastic		7	32	TRIPLE TUBE	Excellent								
WAITEMATA GROUP ROCKS	Grey extremely weak to very weak fine SANDSTONE Very weak, minor hard clayey Silt layers		8 9 10	31 30										

Log of Borehole PZ 1 is continued on sheet 2

Date started: 25 March 2010
Date finished: 25 March 2010
Driller: RCN Drilling
Type of Rig: Track mounted
Shear Vane No: 1050
Logged by: PG. Checked by:
Shear Vane Calib Factor: 1.873.
Date of last calibration: 8 October 2009.

Observations:

Filename: 09710 pz 1-2.dwg

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BOREHOLE LOG PZ 1

Sheet 2 of 5

Job no: 09710 | Job Name: Proposed Beachlands Subdivision Beachlands

Borehole Coordinates: 1779220.59 mE 5915282.85 mN

Borehole Location: See site plan

Surface Elevation: 39.50 Datum: [NZTM]

Surface Conditions: Slight slope, grassed

Geol. Unit	Soil / Rock description in accordance with the NZ Geotechnical Society Inc Publication "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005 — Soil / Rock Description	Depth (m)	Reduced Level (m)	Drilling Method	Sample Condition	Sample Type	Sample recovery (%)	Factored Shear Strength (kPa) Peak Vane/ Remolded Vane	Groundwater	SPT	Water content (%)	Dry Density(kg / m³)	Other Tests
WAITEMATA GROUP ROCKS	Grey very weak fine SANDSTONE, minor hard clayey Silt layer, trace hard silty Clay layers	11	29	TRIPLE TUBE	Excellent								
	Very weak to weak	12	28										
	Dark grey for 10mm Very weak	13	27										
	Grey, speckled black	14	26										
	Very weak to weak	15	25										
	Weak	16	24										
	Grey, speckled black for 60mm	17	23										
	Very weak for 100mm	18	22										
	weak	19	21										
		20	20										

Log of Borehole PZ 1 is continued on sheet 3

Date started: 26 March 2010
Date finished: 26 March 2010
Driller: DCN Drilling
Type of Rig: Track mounted
Shear Vane No: 1050
Logged by: PG Checked by:
Shear Vane Calib Factor: 1.873
Date of last calibration: 8 October 2009

Observations:

Filename: 09710 pz 1-2.dwg

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SOURCE: NZGD

BOREHOLE LOG PZ 1

Sheet 3 of 5

Job no: 09710 | Job Name: Proposed Beachlands Subdivision Beachlands

Borehole Coordinates: 1779220.59 mE 5915282.85 mN

Borehole Location: See site plan

Surface Elevation: 39.50 Datum: [NZTM]

Surface Conditions: Slight slope, grassed

Geol. Unit	Soil / Rock description in accordance with the NZ Geotechnical Society Inc Publication "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005 — Soil / Rock Description	Depth (m)	Reduced Level (m)	Drilling Method	Sample Condition	Sample Type	Sample recovery (%)	Factored Shear Strength (kPa) Peak Vane/ Remolded Vane	Groundwater	SPT	Water content (%)	Dry Density(kg / m³)	Other Tests
WAITEMATA GROUP ROCKS	Grey, speckled black, white weak fine SANDSTONE	21	19	TRIPLE TUBE	Excellent								
	Very weak	22	18										
	Very weak to weak Streaked black, dark grey	23	17										
	Brown organic stained silty CLAY, very stiff, moist, highly plastic	24	16										
	2mm Horiz Coal seam Weak	25	15										
	Smooth dipping fracture, 30° 4mm wide fault, dipping 80°	26	14										
	fracture dipping 40°	27	13										
	fracture dipping 60°, intersects @90° to 2nd fracture dipping 60°	28	12										
	Fracture dipping 70°, Sandstone fine to medium grained	29	11										
	Dark grey, speckled black, white Trace coal fragments Fine sandstone	30	10										
	Light grey, streaked and mottled brown												
	Light grey												

Log of Borehole PZ 1 is continued on sheet 4

Date started: 26 March 2010
Date finished: 26 March 2010
Driller: DCN Drilling
Type of Rig: Track mounted
Shear Vane No: 1050
Logged by: PG Checked by:
Shear Vane Calib Factor: 1.873
Date of last calibration: 8 October 2009

Observations:

Filename: 09710 pz 1-2.dwg

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BOREHOLE LOG PZ 1

Sheet 4 of 5

Job no: 09710 | Job Name: Proposed Beachlands Subdivision Beachlands

Borehole Coordinates: 1779220.59 mE 5915282.85 mN

Borehole Location: See site plan

Surface Elevation: 39.50 Datum: [NZTM]

Surface Conditions: Slight slope, grassed

Geol. Unit	Soil / Rock description in accordance with the NZ Geotechnical Society Inc Publication "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005 — Soil / Rock Description	Depth (m)	Reduced Level (m)	Drilling Method	Sample Condition	Sample Type	% Sample recovery (%)
WAITEMATA GROUP ROCKS	Light grey fine SANDSTONE	0	39	TRIPLE TUBE	Excellent		
	Light grey, speckled, streaked light grey, brown, black	1	38				
	Light grey	2	37				
	Fracture dipping 70°	3	36				
	Fractures dipping 70°, spaced 10mm for 200mm	4	35				
	Minor plant fragments	5	34				
	No plant fragments	6	33				
	Trace plant fragments for 40mm	7	32				
	No plant fragments	8	31				
	Fracture dipping 60°	9	30				
	fracture dipping 60°	10	29				
	Fracture dipping 90 and 65°	11	28				
	Trace to minor coal fragments	12	27				
	No coal fragments	13	26				
	Fracture dipping 45°	14	25				
	Fracture dipping 45°	15	24				
	Fracture dipping 45°	16	23				

Factored Shear Strength (kPa) Peak Vane/ Remoulded Vane	Groundwater	SPT	Water content (%)	Dry Density (kg / m³)	Other Tests

Log of Borehole PZ 1 is continued on sheet 5

Date started: 28 March 2010
Date finished: 28 March 2010
Driller: DCN Drilling
Type of Rig: Track mounted
Shear Vane No: 1050
Logged by: DG Checked by:
Shear Vane Calib Factor: 1.873
Date of last calibration: 8 October 2009

Observations:

Filename: 09710 pz 1-2.dwg

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BH_TT71260 BH_68917

SOURCE: NZGD

BOREHOLE LOG PZ 1

Sheet 5 of 5

Job no: 09710 | Job Name: Proposed Beachlands Subdivision Beachlands

Borehole Coordinates: 1779220.59 mE 5915282.85 mN

Borehole Location: See site plan

Surface Elevation: 39.50 Datum: [NZTM]

Surface Conditions: Slight slope, grassed

Geol. Unit	Soil / Rock description in accordance with the NZ Geotechnical Society Inc Publication "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005 — Soil / Rock Description	Depth (m)	Reduced Level (m)	Drilling Method	Sample Condition	Sample Type	% Sample recovery (%)
WAITEMATA GROUP ROCKS	Grey fine SANDSTONE, weak	0	39	TRIPLE TUBE	Excellent		
	Green, grey	1	38				
		2	37				
BASAL WAITEMATA GROUP	Coarse SANDSTONE, trace fine gravel [to 3 mmØ], very weak to weak	3	36				
WAIPAPA GROUP	Dark grey SILTSTONE, closely fractured, moderately strong	4	35				
		5	34				
	Very closely fractured	6	33		Ok		
	Subhorizontal 3mm thick quartz vein	7	32				
		8	31				
		9	30				
		10	29				
		11	28				
		12	27				
		13	26				
		14	25				
		15	24				
		16	23				
	EOB. 46.0 metres (target depth)	17	22				

Factored Shear Strength (kPa) Peak Vane/ Remoulded Vane	Groundwater	SPT	Water content (%)	Dry Density (kg / m³)	Other Tests
		Minor Core loss due to fracturing			
		Core loss due heavy fracturing			

Date started: 28 March 2010
Date finished: 28 March 2010
Driller: DCN Drilling
Type of Rig: Track mounted
Shear Vane No: 1050
Logged by: DG Checked by:
Shear Vane Calib Factor: 1.873
Date of last calibration: 8 October 2009

Observations:

Water loss In Borehole @ 45.0m [minor]

Filename: 09710 pz 1-2.dwg

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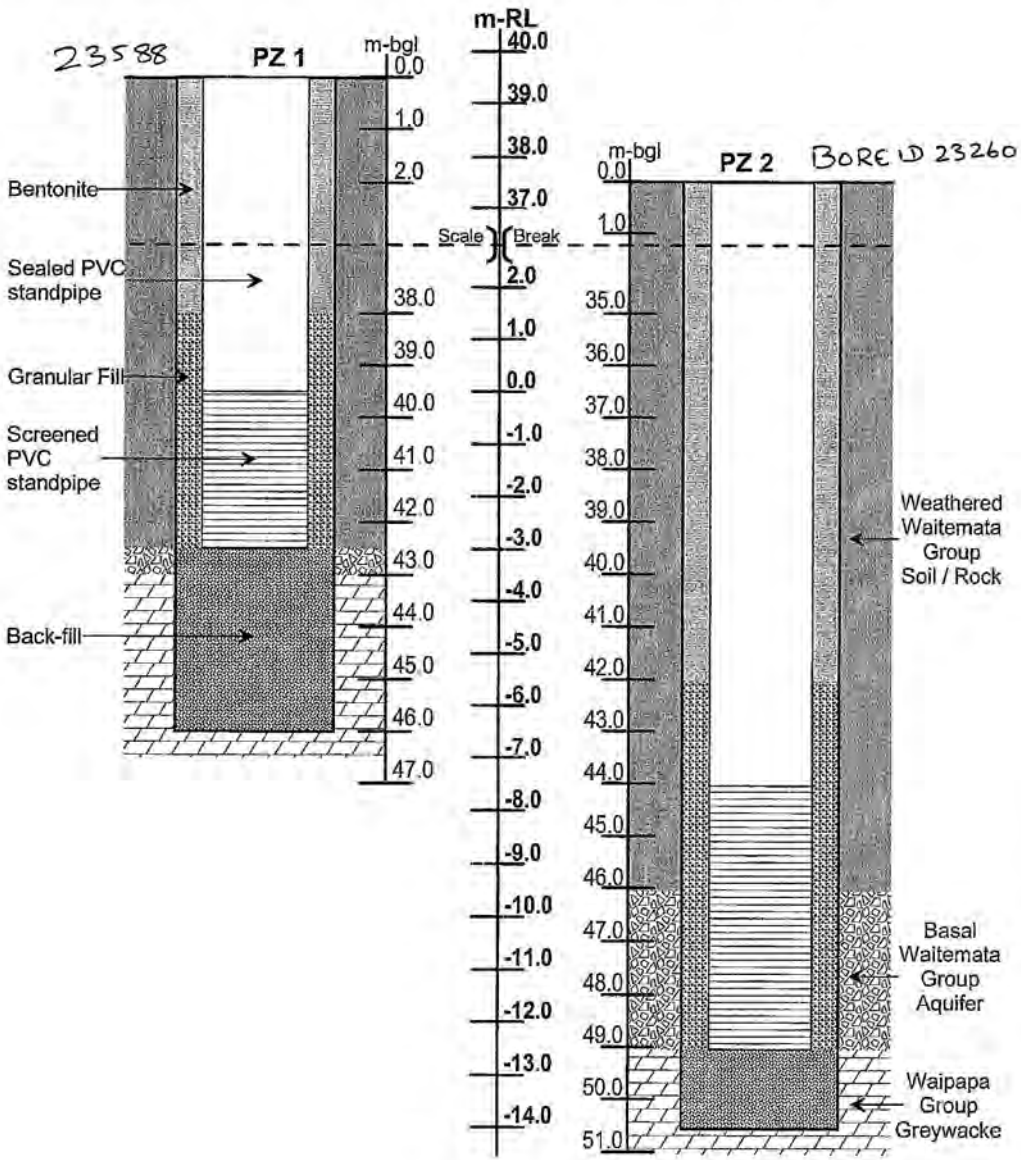
09710 - Potable Water Supply Investigation
Beachlands Village Business Centre
129 Beachlands Road, Beachlands

09710/7 : Beachlands. Schematic Piezometer Construction



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Drawing No. 09710/7
Draughted: May 2010
By: SB

BH_TT71260

BH_68917

BOREHOLE LOG PZ 2

Sheet 1 of 1

Job no: 09710	Job Name: Proposed Beachlands Subdivision Beachlands
Borehole Coordinates:	1779086.58 mE 5915264.33 mN
Borehole Location:	See site plan
Surface Elevation:	37.50 Datum: [NZTM]
Surface Conditions:	Slight slope, grassed

Geol. Unit	Soil / Rock Description	Depth (m)	Reduced Level (m)	Drilling Method	Sample Condition	Sample Type	Sample recovery (%)	Groundwater	Water content (%)	Other Tests
	Borehole log PZ2 wash-drilled from surface to 45.0m (0-45m)	0		Wash drilled	None					
WAITEMATA GROUP	Dark grey moderately weathered SANDSTONE, trace carbonaceous organic fragments to 30 mm dia, very weak to weak, well graded fine sand water loss	45	-8	TRIPLE TUBE	Good					
BASAL WAITEMATA GROUP	Dark greenish grey slightly weathered to fresh GREYWACKE, inclusions [Indurated Sandstone], strong to very strong, closely / very closely spaced undulating fractures [smooth] CONGLOMERATE, light green / grey medium to coarse sand, weak, poorly graded, trace to minor clay, matrix medium dense, minor fine greywacke gravel Overall layer mainly boulder-like [<60%]	47	-10	TRIPLE TUBE	Ok					
	Matrix Conglomerate, light green/grey, highly weathered, very weak to weak, strong greywacke inclusions [10mm dia], poorly - gap graded, minor sand to fine / med gravel, some silt and clay 49.7 Strong - very strong greywacke incl <45mm dia, some strong Sandstone incl <25mm dia [minor]	49	-12	TRIPLE TUBE	Poor					
WAIPAPA GROUP	Dark greenish grey unweathered GREYWACKE, Strong to very strong, closely spaced fractures, closed to gapped aperture, subhorizontal to subvertical, undulating [rough to smooth] Minor silt-filling of fractures @ 50.8m	50	-13	TRIPLE TUBE	Ok					
		51	-14	TRIPLE TUBE	Good					
	E.O.B. 51.5 metres (target depth)	52								

Date started:	30 March 2010
Date finished:	30 March 2010
Driller:	DCN Drilling
Type of Rig:	Track mounted
Shear Vane No:	NA
Logged by:	SB Checked by:
Shear Vane Calib Factor:	
Date of last calibration:	

Observations:

Filename: 09710 pz 1-2.dwg

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09710 - Potable Water Supply Investigation
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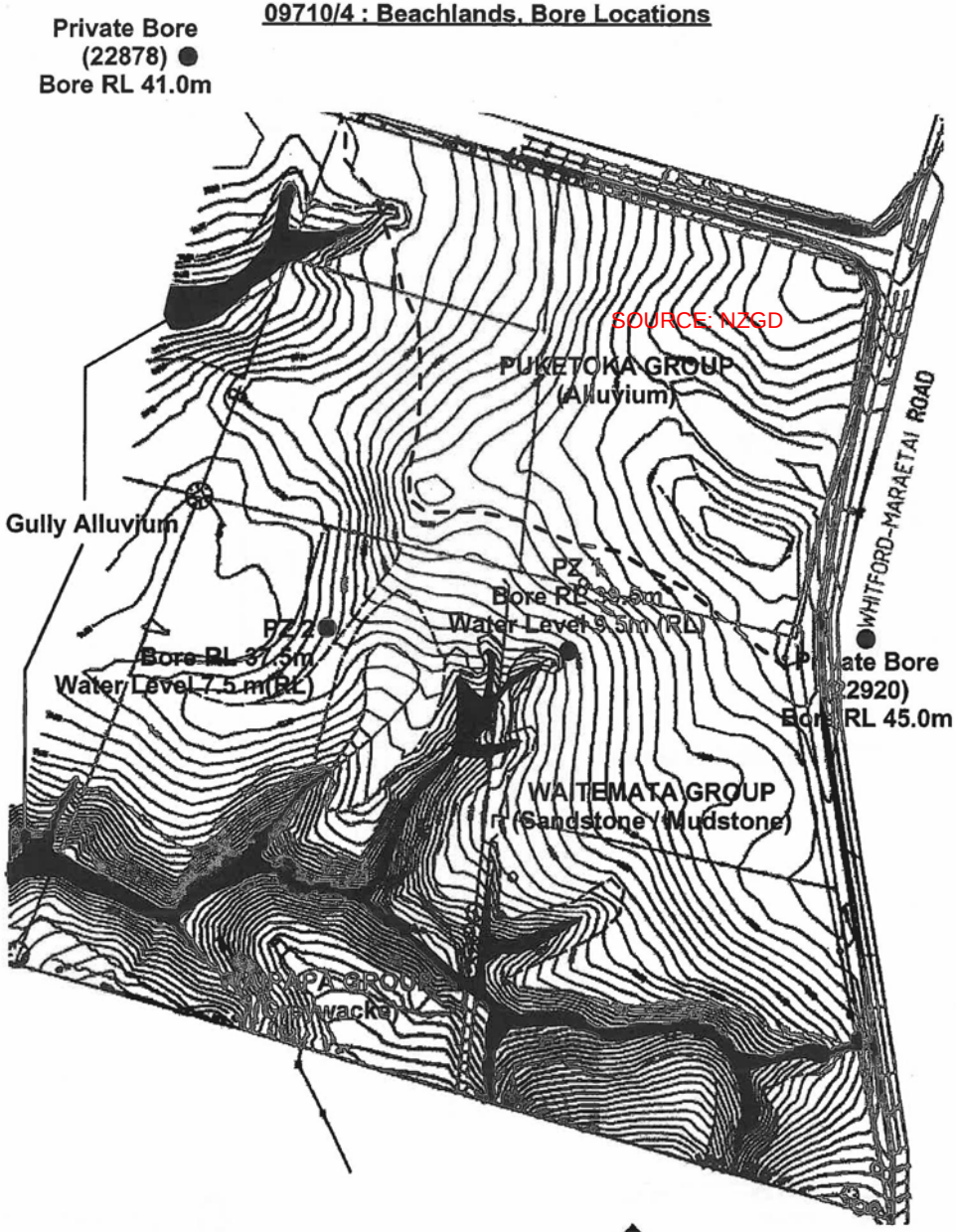
129 Beachlands Road, Beachlands

09710/4 : Beachlands, Bore Locations



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Draughted: April 2010
By: SB

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