TECHNICAL REPORT 2585

Watercare Services Limited

Huia Filter Station

Report On

Geotechnical Risk Assessment

September 2002

GHD
MANAGEMENT
ENGINEERING
ENVIRONMENT

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Appendices

1. Introduction

1.1 Background

GHD Ltd (GHD) was commissioned by Watercare Services Ltd (WSL) to undertake an investigation into the existing treatment plant operations at Huia and Ardmore filter stations and to make recommendations for the upgrade to the plants. In July 2002, GHD produced a report entitled: "Ardmore and Huia Treatment Plant Upgrades, Report on Preliminary Design". That report recommended alterations and upgrades to the existing infrastructure as well as the construction of new water retaining reservoirs and pipelines.

In July 2002, GHD was engaged by WSL to undertake a risk assessment of the proposed alterations and upgrades to the filter stations. This report deals with the geotechnical aspects of the risk assessment for the Huia site.

1.2 Scope of Works

The scope of works of the geotechnical aspects of the risk assessment is as follows:

- Obtain and review existing geotechnical borelog information, reports and drawings for the Huia filter station.
- Undertake a site walkover of the Huia filter stations as well as the proposed pipeline route between the Huia filter station and the Nihotupu reservoir.
- Outline the geotechnical risks and mitigation measures for the construction of the major proposed structures at the filter station site and the pipeline route.
- Recommend further geotechnical investigations as appropriate to assist in the design and construction of the proposed structures.

2. Proposed Upgrade Works

Details of the proposed upgrade to the Huia Filter Station are described in detail in the GHD Ltd report entitled: "Ardmore and Huia Treatment Plant Upgrades, Report on Preliminary Design, July 2002".

The main new proposed infrastructure items for Huia include the following:

- 12.5m dia reinforced concrete sludge thickener, approximately 6m in height (with about 2m below ground level). It was noted that the sludge is to be pumped from the tank therefore the elevation is not considered to be critical).
- 2 X 2m dia superatauant pumpstations, approximately 3m deep located next to the Sludge Thickener tank.
- 170m3 Filter to Waste tank to be constructed beneath the existing Clarifier tanks.
- Pipeline (approximately 400mm dia) between the Huia Filter Station and the Nihotupu Reservoir.

These structures are outlined on the attached Site Layout Plan in Appendix A.

3. Site Description & Observations

3.1 Huia Filter Station

The Huia Filter Station is located to the south of Waima Road in the Waitakere forest, approximately 500m west of the intersection with Scenic Drive. The site has numerous concrete water retaining structures and buildings required for the purification of raw water to drinking water. The site has a gentle slope of approximately 1(v):10(h) in a southern direction and is surrounded by native forests. Several shallow earth bunded lagoons occupy the southern section of the site.

No obvious signs of instability were noticed at the time of the site visit in the immediate proximity of the site. It was clear from the site walkover that fill had been placed within the southern portion of the site to form the lagoons.

Reasonably substantial cracks were noticed in the building to the east of the sand filters. This was assessed as being due to settlement of fill beneath the foundations. No significant cracks that could be attributed to settlement or site movement were noticed in any of the immediately surrounding water retaining structures.

The clarifier tanks are located on the western side of the site. In order to construct the clarifier's base slab the original ground profile has been cut back and a crib retaining wall used to support the cut face. The crib wall is approximately 3m high and has been constructed around the northern half of the clarifiers.

No major threat from land instability to the proposed structures within the site boundary was noticeable. Land instabilities are however relatively common within the general area i.e. the Waitakere forests and further inspections and investigations may be required if the proposed structures are moved from the locations as shown on the layout plan in appendix A.

3.2 Pipeline Route between Huia and Nihotupu

The most suitable location for a proposed pipeline between the Huia and Nihotupu filter stations is along Waima Road. The following observations were made during a site walkover of this route.

The road along this route is generally constructed by cut of the upslope hillside and sideling fill of the downslope side. At approximately the intersection of Manuka Road, Waima Road crosses over an old gully and both sides of the road are built by a fill embankment approximately 2m in height.

Numerous minor sideling fill failures were noted along the southern side of Waima Road between the filter station and the Nihotupu Reservoir. None of these had caused any noticeable distress to the road surface except for one near the intersection of Scenic Drive, where some recent patching of the road surface is likely as a result of a slightly larger sideling fill failure. The sideling fill failures are likely as a result of poor compaction and over steep slopes.

An outcrop of sandstone was noted on the northern side of Waima Road, near the intersection with Scenic Drive.

The general impression from the site walkover was that the most stable position for a proposed pipeline would be along the northern side of Waima Road.

Site photographs are attached in Appendix B.

4. Desktop Study

Historical geotechnical information from previous investigations was made available by WSL. The following information was sourced and reviewed:

- Barrett, Fuller & Partners Ltd (BFP) , letter report entitled: "Auckland Regional Authority, Engineering Investigations on Nihotupu and Huia Filter Station Sites, October 1988",
- Department of Scientific and Industrial Research (DSIR), report entitled: "Engineering Geological Report on Investigations – Nihotupu and Huia Filter Station Sites, G.D. Mansergh, NZ Geological Survey, September 1988, Engineering Geology Immediate Report 88/052". (appended to the BFP report)
- Extracts from the Auckland Regional Council contract documents for the construction of the Mag Flow meter, entitled, "Auckland Regional Council, Operations Division – Bulk Water Department, Huia Filter Station Final Water Flowmeter, Contract 1641, March 1990, Specifications and Schedule of Prices".
- Tonkin & Taylor Ltd, letter report, entitled: "Nihotupu Supply Area Improvements, Geotechnical Investigation Report", dated 25 November 1998.
- Numerous WSL drawings showing various upgrades and modifications to the filter station.
- WSL Technical Report No 1942, entitled: "Huia Filter Station, Waima Rd, Titirangi, Borehole Logs & Associated Data". This report included all the available drillhole information.

In addition, the following geological maps were studied:

- New Zealand Geological Survey, Industrial Map Series, Sheet N42/7, Cornwallis, 1:25 000, 1st edition.
- Institute of Geological & Nuclear Sciences Ltd, Geology of the Auckland Urban Area, 1:50 000, 1992.

The DSIR report and the WSL Technical Report No 1942 provided the most useful information pertaining to the current investigation. While the other investigations and information was useful it either did not add to this information or was not directly relevant. These two reports are discussed in more detail below.

4.1 DSIR Report

The scope of the DSIR report was to undertake a reconnaissance survey of the geomorphology of the filter station and surrounding area and to provide an assessment of the stability of the site in the event of an earthquake (with respect to subsidence and earth slip). The key findings of the report can be summarised as follows:

- There is an unbroken rock sequence beneath of the Huia Filter Station site and hence the area south of the bluffs (along Extensive Drive) is not underlain by a massive landslide.
- A mantle between 10m and 14m thick, of clay, silty clay and clayey sand underlie the Huia filter station site. This is underlaid by unweathered bedded gritty sandstone, sandstone and mudstone.
- The potential for large landslides was not great, unless seismically triggered.
- Recent slope failures in weathered material and colluvium were observed both inside and outside of the Huia site adjacent stream, but confined to areas where slopes were greater than 25°. The report noted that these failures did not appear to present a threat to the site at the time however they recommended that geotechnical investigations are undertaken to determine the stability if extensions to the filter station were planned, "particularly to the east of the site".
- Soil creep was noted as being a possibility, "particularly on steeper gradients". Over time this may reduce support to some structures.
- Huia Filter Station was unlikely to be affected by rockfall.
- "Seismically induced failure on the slope between Waima Road and the ponded area below it is less likely to affect the filter station, but such a failure would disrupt the filtered water conduit from Huia Filter Station".
- Huia filter station is afforded some protection from large rock falls from the bluffs by mounds above however localised failures in the weathered material adjacent to the stream could be expected, which could remove lateral support from the foundations.
- No active faults are recognised in the Waitakere area and thus tectonic ground deformation is not considered a significant hazard.
- The report notes that for Auckland the return period for an earthquake intensity of MM 6.0 is 62years (after Smith & Berryman, 1986).
- Materials are unlikely to be susceptible to liquefaction, however the existence of cohesionless soils cannot be ruled out for Huia.
- Low-density soils were not recognised and hence dynamic compaction was considered unlikely.

4.2 WSL Technical Report No 1942

All available historic factual borelog information for the Huia Filter Station is bound together to form the Technical Report no 1942. Copies of relevant borelogs as well as a layout of positions of the borelogs is available in Appendix C.

Based on the borelog information, a summary of the likely founding conditions for the various structures considered under GHD's brief are outlined below:

4.2.1 *Sludge Thickener*

The likely location for the proposed sludge thickener is the southeast of the existing Washwater Recovery Tanks. Cross section 13-13 (from WSL's technical report no 1942) attached in Appendix D, shows the north/south stratigraphy profile through the eastern side of the site. This cross section shows that the colluvium/alluvium layer as well as the weathered sandstone layer increase in thickness towards the south.

An additional cross section of the subsurface stratigraphy has been drawn by GHD for the west/east orientation. This is presented in Appendix E.

The borelogs from this area generally show that the area is underlain by the following:

- ~2m of clay /possible fill.
- ~10m of firm grey sandy clay (possible colluvium/alluvium), underlaid by
- ~4m of weathered sandstone , underlaid by
- Sandstone with inclusions of gravels (likely Cornwallis Formation).

Due to the thickness of the alluvium/colluvium layer it is likely that the tank will be supported on this layer. Other than the descriptions contained within the borelogs (e.g. firm) no soil strength data or densities are available from the borelogs in the immediate vicinity of the proposed sludge thickener tank with similar soil description.

4.2.2 *Filter To Waste Tank*

It is proposed to enclose the lower section of the Clarifiers in order to form an enclosed tank that will form the Filter to Waste tank. The borelogs from this area generally show that the area is underlain by the following:

- ~10m - ~12m of clays/silts & coarse sands overlying
- Alternatively beds of sandstone and mudstone (likely Cornwallis formation).

A 2.7m thick layer of soft organic clay with peat was encountered in borelog 4624 located to the northwest of the Clarifier tanks. No organic clay or peat was recorded in any of the other borelogs at the site. This may either not have been recorded or the layer encountered at B4 4624 may be an isolated pocket.

The borelogs show that consolidation tests were undertaken for the Clarifier tanks but no record of this information was found.

4.3 Geological Maps

The New Zealand Geological Survey, Industrial Map Series, Sheet N42/7, Cornwallis, 1:25 000, 1st edition, describes the subsurface geology as follows:

- Interbedded Sandstone and Mudstone : "Thick to very thick, graded beds of grey, moderately weak, andesite sandstone with dark grey, strong, well rounded to angular granules and pebbles of andesite, interbedded with thin to moderately thick beds of light grey, moderately weak andesite mudstone. Some white weak pebbles of calcareous siltstone. Some cobble and boulder sized fragments from adjacent beds. Very widely spaced joints. Weathered to a residual soil of yellowish brown, soft to stiff, silty clay", of the
- Cornwallis Formation, of the
- Miocene age.

The Institute of Geological & Nuclear Sciences Ltd, Geology of the Auckland Urban Area, 1:50 000, 1992, maps the subsurface geology as follows:

- Volcanogenic flysch : "Grey brown alternating, thick bedded sandstone and thin bedded mudstone, of the
- Cornwallis Formation, of the
- Miocene age.

Our review of the borelog information available for the site, concurs with this description.

4.4 WSL Drawings

Numerous drawings were made available by WSL for the Huia site. Some of the copies were not readable due to the age of the originals. The main findings of this part of the desktop study is summarised below.

Early contour drawings of the site from 1968 and 1971 show the likely original landform of the site. These are attached in Appendix E. These contour drawings show that two main streams originally ran, roughly north to south, across the site. These were filled and dammed to create lagoons 1 & 2, which currently exist to the south of the site.

4.4.1 Sludge Thickener Tank

The site proposed for the sludge thickener tank therefore is likely to have the following features:

- varying amounts of fill.
- the original streams are likely still to be the dominant areas for ground water flow.
- organic layers may not have been cleaned out of the inverts of the stream before filling over.

4.4.2 Filter To Waste Tank

WSL drawing no 331371 (refer Appendix G), records the settlement measurements for the Clarifier tanks undertaken post construction. Settlements of between 4mm and 36mm were measured between 1976 and 1986. The largest settlements were recorded along the south-eastern extent of the tank. This would be as expected as the north western sides were cut down to produce the platform level for the tanks i.e. the north western side of the tank would have undergo some degree of preconsolidation compared to the south eastern side of the platform.

5. Geotechnical Issues

5.1 Bearing Capacity

5.1.1 *Proposed Sludge Thickener Site*

There is a clear lack of soil strength parameters from the existing borelogs for the site. The alluvium layer is described as firm. Similar water retaining structures do not show any signs of distress. It is therefore likely that similar foundation types would be suitable for the proposed sludge thickener.

5.1.2 *Filter to Waste Tank Site*

As discussed above it is proposed to construct a filter to waste tank underneath the existing clarifier tanks. The proposed tanks are expected to be approximately 2m in height. The additional loading is therefore expected to be in the order of 20kPa. The existing clarifier tanks are supported on shallow foundations consisting of slabs supported by outer beams. The clarifiers are separated into four separate slab structures. This is likely to limit differential stresses and cracking of the slab caused by differential settlements. From the design drawing the beams are approximately 580mm thick and the slab approximately 200mm thick.

No details on how the beams and floor slab were constructed. If fill was placed under the floor slab, settlement of this material may have resulted in minor voids to have occurred between the bottom of the floor slab and the material below. Additional loading to the floor slab may therefore cause additional stress to be transferred to the slab without sufficient support from the material below. This should therefore be checked during detailed investigations of the site.

Organic clays and peat was encountered in BH 4624, with Cu values (obtained by UCS tests) as low as 7 kPa. None of the other boreholes in the vicinity encountered the organic clay/peat. Additional pockets of peat may be located at other locations in this vicinity however the additional loading proposed will be spread by the clarifier base slab and beams. It would however be prudent to avoid applying additional loading to the north-western side of the clarifiers, where the peat/organic clay was encountered.

The existing design loading applied by the clarifiers needs to be determined and additional subsurface geotechnical investigations undertaken to determine if the underlying soil is capable (with a sufficient factor of safety) of withstanding the additional loading.

5.2 Settlement

5.2.1 *Proposed Sludge Thickener Site*

It is likely that the sludge thickener structure will be excavated to below the level of existing fill/clay layer, identified on the available borelogs, with likely founding onto the recent colluvium/alluvium layer. Depending on the clay and sand content of this material this layer may be subject to immediate and consolidation settlement. The absence of organic rich soils (except for some thin layers of peat found in the western side of the site) negates the risk of long-term creep settlement. In addition, none of the other nearby water retaining structures show any obvious signs of settlement. It is likely therefore that settlements will be within tolerable limits and that piling will not be required.

Further investigations are required in order to be able to quantify the likely settlement magnitude and duration.

5.2.2 *Filter to Waste Tank Site*

From the information available, it is clear that settlement of the clarifiers must have been of concern to the original geotechnical engineers and designers. Additional loadings on the clarifiers are likely therefore to induce further settlements. The question is what it the extent of settlement and is the existing structure capable of withstanding this settlement. The proposed additional loadings as well as the measured settlement are not excessive. It is likely however that due to the sandy nature of the underlying soils that a large proportion of the settlement was induced during construction and may not be recorded by the settlement measurements recorded.

Due to the higher in-situ stesses, loading along the northern side of the tank and the lower measured settlements in this area, it would be preferable to locate the proposed tank along this side of the clarifiers. This will limit the total settlements and also rebalance the differential settlements that have already occurred. It would also be prudent to avoid the western side of the clarifiers where previous pockets of peat have been encountered.

If possible the existing settlement markers should be relevelled to determine if any ongoing settlement has occurred since the last recorded measurement in 1986. This information can be used to predict future settlements from additional loadings.

5.3 Stability

5.3.1 *Proposed Sludge Thickener Site*

No obvious signs of large-scale instability were noted near the proposed site for the sludge thickener. Soil creep is likely on slopes steeper than ~ 25°. All structural design should ignore passive lateral support provided by the surrounding downslope soil

The DSIR report noted instabilities within the stream to the east of the site although they did not, at that time, pose any direct threat to the filter station. They recommended however that geotechnical investigations be undertaken to determine the influence of the instabilities if development was anticipated to the east of the site. We believe that the proposed site for the sludge thickener, although on the eastern side of the site it is sufficiently far away not to be threatened by these instabilities. Further investigations for stability purposes are not deemed warranted at this stage.

5.3.2 *Filter to Waste Tank Site*

The additional loading from the proposed filter to waste tanks are not expected to cause any stability concerns.

5.3.3 *Pipeline Route between Huia and Nihotupu*

The most stable location for the proposed new pipeline between the Huia and Nihotupu Filter stations is along the northern side of the Waima Road. Some excavation into sandstone can be expected towards the eastern extent of this route. Detailed subsurface investigations of the proposed pipeline are warranted to reduce the contractual risks.

A check of existing services in this location is also required in order to confirm the route as suitable.

5.4 Liquefaction

5.4.1 *All Structures*

The DSIR report noted that "the materials are unlikely to be susceptible to liquefaction, however the existence of cohesionless soils cannot be ruled out for Huia". This needs to be confirmed by further geotechnical investigations.

5.5 Groundwater

5.5.1 *Proposed Sludge Thickener Site*

Due to the nearby lagoons, the groundwater level (GWL) is expected to be within 1-2m of the surface at this location. This will need to be considered in the uplift calculations of the tank as well as in the construction methodology of the tank.

5.5.2 *Filter to Waste Tank Site*

The GWL at this location is expected to be at a greater depth than at the proposed sludge thickener site. As the filter to waste tank is proposed to be constructed above ground level, GWL is not of concern for construction purposes. GWL is however of interest for assessment of settlements and liquefaction potential. GWL levels should therefore be measured during detailed subsurface investigations.

6. Conclusions

Based on the findings of this investigation the following conclusions are drawn:

6.1 Proposed Sludge Thickener

1. The proposed sludge thickener tank is likely to be supported on the underlying alluvium/colluvium layer, which extends to approximately 12m below the proposed site.
2. It is expected that adequate bearing capacity soil will be found to allow the tank to be supported on shallow foundations, however no soil strength parameters are available. Allowable bearing capacities will need to be determined through appropriate strength testing during detailed subsurface geotechnical investigations.
3. Settlement of the clayey sands needs to be considered further. Further detailed investigations and testing is required in order to allow the likely magnitude and duration of settlement to be determined.
4. Liquefaction is unlikely to be a major issue however detailed investigations at the proposed site is required in order to assess the liquefaction potential.
5. Groundwater measurements are required to allow uplift calculations for the proposed tank to be undertaken.

6.2 Proposed Filter Waste to Tank

6. Bearing capacity of the underlying soils are not expected to be of concern for the additional loading imposed by the proposed waste water tanks. Further subsurface investigations are required to confirm this.
7. Settlement is a previous concern for the site, however based on the proposed loadings, the settlement measurements undertaken, settlement is not expected to be of concern for the proposed construction of the filter to waste tanks. Additional subsurface investigations should however be undertaken to allow likely settlements to be estimated.
8. The nature of the material directly beneath the existing clarifier floor slab needs to be checked. This can be achieved by coring through the slab and testing of the material beneath.
9. Settlements are likely to be minimised by locating the proposed wastewater tanks on the north-eastern side of the clarifiers.
10. Stability of the clarifiers is unlikely to be affected by the proposed construction of the wastewater tanks.

6.3 General

11. Liquefaction is unlikely to affect the site. This should be further assessed during detailed investigations.
12. GWL measurements are required during subsurface investigations.

7. Recommendations

Based on the findings of this investigation it is recommended that detailed geotechnical subsurface investigations are undertaken at the clarifier site, the sludge thickener as well as along the proposed pipeline route in order to determine the following:

7.1 Sludge Thickener

- Thickness of overlying fill and soft clay material.
- Allowable bearing capacity of the subsurface material.
- Settlement characteristics of the underlying alluvium material.
- Potential for liquefaction.
- Groundwater level.

It is recommended that two triple tube drillholes be undertaken to a minimum depth of 15m, with a minimum of 2m into the sandstone. SPT's should be undertaken at 1.5m intervals and undisturbed samples recovered for consolidation test below the proposed foundation level.

7.2 Proposed Filter to Waste Tank

- Allowable bearing capacity of the subsurface material.
- Settlement characteristics of the underlying alluvium material.
- Potential for liquefaction.
- Groundwater level.

It is recommended that two triple tube drillholes be undertaken to a minimum depth of 15m with a minimum of 2m into sandstone, immediately adjacent to the clarifiers. SPT's should be undertaken at 1.5m intervals and undisturbed samples recovered for consolidation tests.

In addition two cored holes should be made through the existing clarifier floor slab and strength and density tests undertaken of the material directly beneath. These holes should be extended by hand auger until refusal if possible.

The settlement markers on the clarifiers should also be relevelled

7.3 Pipeline Route between Huia and Nihotupu

- The proposed pipeline should be located along the northern side of Waima Road (subject to a check of existing services).
- Detailed geotechnical investigations of the pipeline route should be undertaken to identify construction limitations and constraints.

It is recommended that test pits be excavated at 100m intervals along the northern side of the road with scala penetrometers and shear strength tests undertaken at regular depth intervals.

The estimated costs for the proposed geotechnical site investigations and geotechnical reporting for these three structures is in the order of $30K - $40K. A detailed proposed and cost estimate can be supplied if required.

8. Scope & Limits of Geotechnical Appraisal

This report presents the results of a geotechnical appraisal prepared for the purpose of this commission. The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent geotechnical engineer before being used for any other purpose. GHD Limited (GHD) accepts no responsibility for other use of the data.

The advice tendered in this report is based on a geotechnical appraisal of the site based on available geotechnical information of the area and a site walkover. No subsurface investigations have been conducted as part of this commission.

Where subsurface investigation logs, cone tests, laboratory tests, geophysical tests and similar work have been recorded and performed by others as part of a separate commission, the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

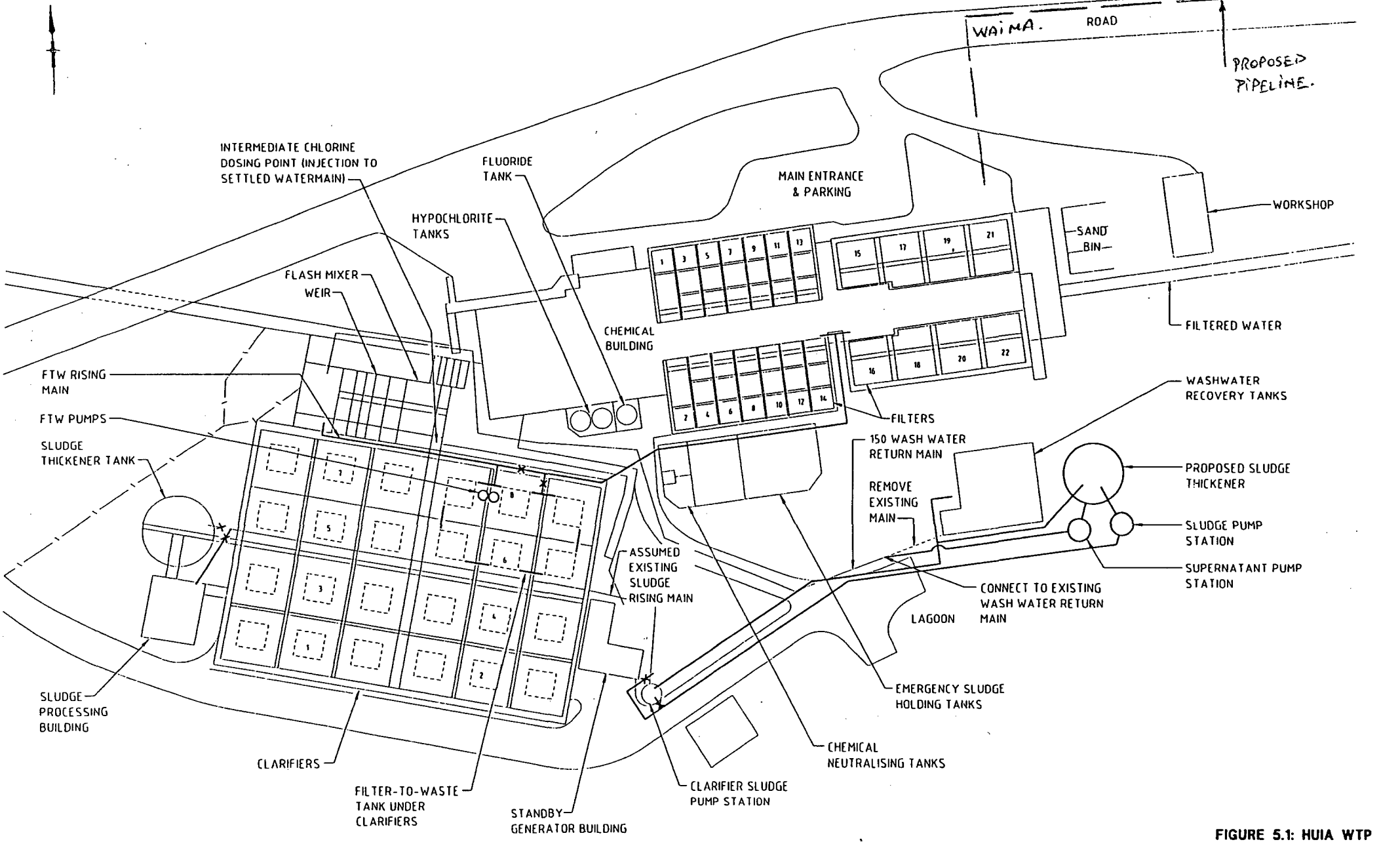
It is emphasised that geotechnical conditions may vary substantially across the site from where observations have been made. Subsurface conditions, including groundwater levels can change in a limited distance or time. In evaluation of this report, cognisance should be taken of the limitations of this type of investigation.

The geotechnical appraisal made in this report should be substantiated by a detailed subsurface investigation, including drilling, sampling, testing and monitoring of subsurface conditions.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances that arise from the issue of the report, which have been modified in any way as outlined above.

Appendix A

Site Layout Plan



SITE PLAN.

FIGURE 5.1: HUIA WTP WASHWATER HANDLING & FILTER-TO-WASTE SYSTEMS

0745w10.dwg

NOT TO SCALE

Appendix B

Site Photos

Huia Filter Station Risk Assessment
Site Photographs
GHD Ltd - August 2002

Proposed Location for Sludge Thickener, adjacent to existing Wash Water Tanks

Proposed Location for Filter to Waste Tank below existing Clarifiers

Huia Filter Station Risk Assessment
Site Photographs
GHD Ltd - August 2002

Existing Lagoons south of Proposed Location for Sludge Thickener

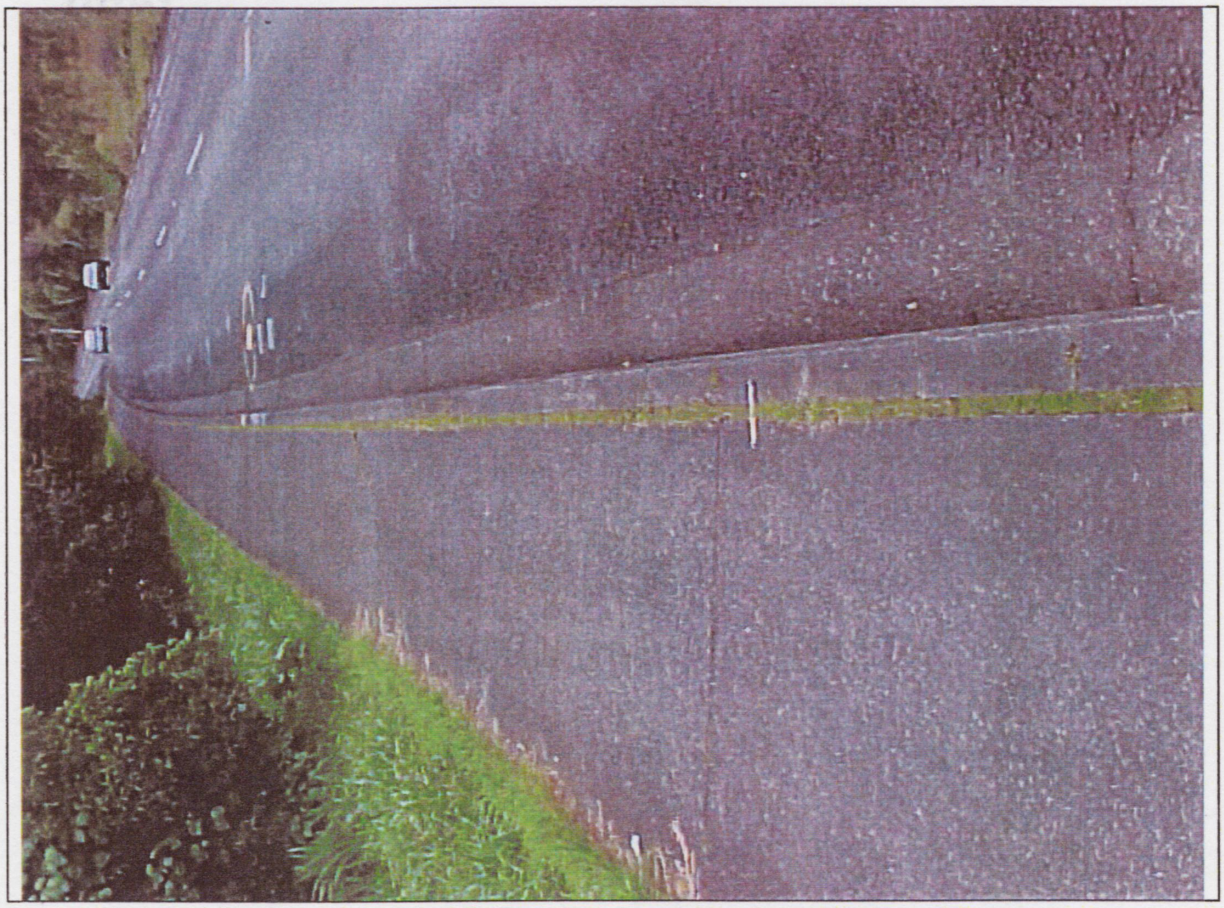
Looking West along Waima Road at intersection of Manaku Road

Huia Filter Station Risk Assessment
Site Photographs
GHD Ltd - August 2002

Looking West along Waima Road

Looking West along Waima Road from Nihotupu Filter Station

Huia Filter Station Risk Assessment
Site Photographs
GHD Ltd - August 2002

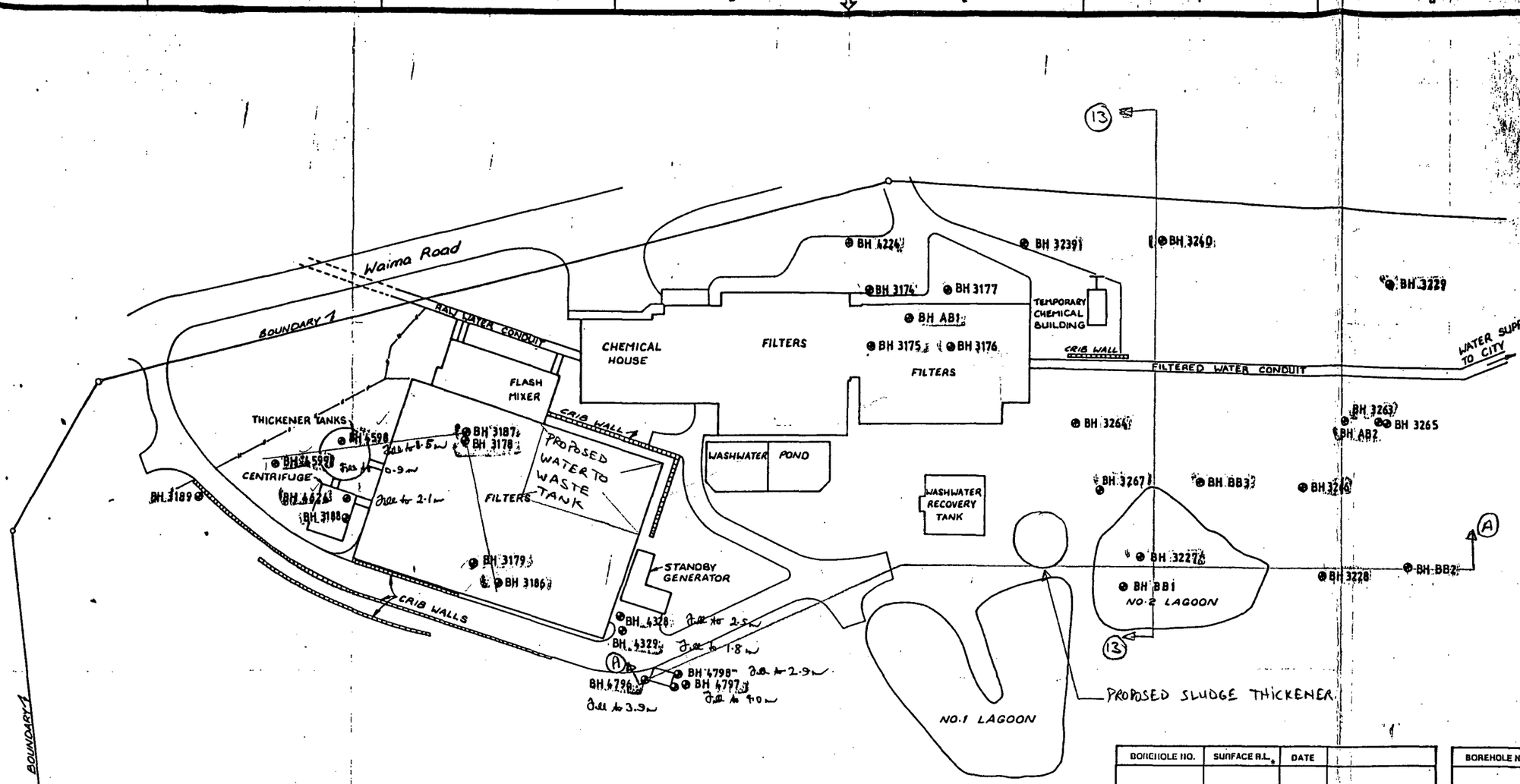


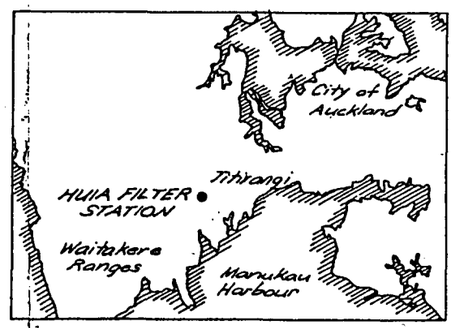
Looking West along Waima Road – showing minor sideling fill movement

The northern side of Waima Road near Nihotupu Filter Station – showing exposed sandstone

Appendix C

Borelogs and Plan of Borehole Locations





LOCALITY PLAN
N.T.S.

COMPILED FROM DRAWINGS: 331371-06
331386-02
331392-02

● DENOTES BOREHOLE LOCATIONS

BOREHOLE NO.	SURFACE R.L.*	DATE	
3174	115.95	-/72	
3175	116.01	-/72	
3176	115.83	-/72	
3177	116.13	-/72	
3178	114.25	-/72	
3187	114.00	-/72	
3188	114.00	-/72	
3189	114.00	-/72	
3227	115.83	-/72	
3228	118.56	-/72	
3229	105.46	2/691	
3239	107.29	2/69	
3240	118.56	2/69	
3263	116.44	2/69	
3264	121.62	2/69	
3265	113.10		
	108.53		
	113.10		

BOREHOLE NO.	SURFACE R.L.*	DATE	
3266	112.73		
3267	107.92		
4224			APPROX. LOCATION
4328			
4329			
4598	115.29	9/791	CONTRACT 1243 DWG. #331392-02 ORIGIN OF LEVELS; DATUM UNKNOWN
4599	115.77	9/79	
4624	115.27	4/80	
4796		7/84	
4797		7/84	
4798		7/84	
AB1	116.13		
AB2	114.00		
BB1	106.03		
BB2	113.08		
BB3	107.29		

* = LANDS & SURVEY AUCKLAND DATUM 1946 (METRES)
(SOURCE OF LEVELS ARA HORNIAL DATUM)

ISSUE	DATE	AMENDMENT	BY	CHKD	APPD.

DESIGNED			
DES. CHECKED			
DRAWN	SDG		7/88
TRACED			
DRG. CHECKED			

AUCKLAND REGIONAL AUTHORITY — WORKS DIVISION

DIRECTOR OF WORKS

HUIA FILTER STATION
BOREHOLE LOCATIONS PLAN

ORIGINAL SCALE A1
1:500

CONTRACT No.

DRAWING No.

ISSUE

BOREHOLE NO. 3228 SHEET 1 OF 1

SYMBOL	SOIL DESCRIPTION	DEPTH (m)
	Topsoil	0.0
	Firm yellow and grey CLAY	0.4
		1.25
	Stiff yellow and grey clayey SILT	2.0
	Firm grey and yellow silty CLAY	2.2
	Firm grey CLAY	3.2
		1.0
	Hard brown SANDSTONE fragments in grey CLAY matrix	4.2
	End of borehole @4.4m	
		6.0
		8.0
		10.0

PENETRATION RESISTANCE (BLOWS/300mm)
10 20 30 40 50 60
-20 10 60 80 100 120 140 160 180 200 220 240 260
SHEAR STRENGTH (kPa)

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

BULK DENSITY kg/m3

DRY DENSITY kg/m3

LEGEND:
PENETRATION RESISTANCE
50mm O.D. SPLIT TUBE
50mm I.D. SHELBY TUBE
50mm DIA CONE

SHEAR STRENGTH
UNDRAINED TRIAXIAL ⊕
SHEAR VANE (CORRECTED) +
UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
LIQUID LIMIT
PLASTIC LIMIT
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 107.271 m
DATUM: Lands & Survey

LOGGED: RMG
DRAWN: (S.GRACE)
DATE: 2/69 (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO.

CONTRACT NO.

BOREHOLE NO. 3240 SHEET 1 OF 2

SYMBOL	SOIL DESCRIPTION	DEPTH (m)
	Stiff yellow brown CLAY	0.0
		1.5
	Stiff yellow brown clayey sandy SILT	2.0
		4.0
		6.0
		6.6
	Dense grey SAND	8.0
	Brown grey SANDSTONE	10.0

PENETRATION RESISTANCE (BLOWS/300mm)
10 20 30 40 50 60
20 40 60 80 100 120 140 160 180 200 220 240 260
SHEAR STRENGTH (kPa)

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

BULK DENSITY kg/m3

DRY DENSITY kg/m3

LEGEND:
PENETRATION RESISTANCE
50mm O.D. SPLIT TUBE
50mm I.D. SHELBY TUBE
50mm DIA CONE

SHEAR STRENGTH
UNDRAINED TRIAXIAL ⊕
SHEAR VANE (CORRECTED) +
UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
LIQUID LIMIT
PLASTIC LIMIT
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 121.597m
DATUM: Lands + Survey

LOGGED: RMG
DRAWN: (S.GRACE)
DATE: 2/69 (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO.

CONTRACT NO.

BOREHOLE NO. 3240 SHEET 2 OF 2

SYMBOL	SOIL DESCRIPTION	DEPTH (m)	PENETRATION RESISTANCE (BLOWS/300mm) / SHEAR STRENGTH (kPa)	INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	BULK DENSITY kg/m3	DRY DENSITY kg/m3	
	Brown grey SANDSTONE poorly cemented	10.0					
	becomes grey	12.0					
		12.6					
		14.0					
	End of borehole @ 14.2m	16.0					
		18.0					
		20.0					

PENETRATION RESISTANCE: 10 20 30 40 50 60

SHEAR STRENGTH (kPa): 20 40 60 80 100 120 140 160 180 200 220 240 260

LEGEND:

PENETRATION RESISTANCE
- 50mm O.D. SPLIT TUBE
- 50mm I.D. SHELBY TUBE
- 50mm DIA CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL ⊕
- SHEAR VANE (CORRECTED) +
- UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT
- NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 121.597m
DATUM: Lands + Survey

LOGGED:
DRAWN: (S.GRACE)
DATE: 2/69 ? (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO.

CONTRACT NO.

BOREHOLE NO. 3263 SHEET 1 OF 1

SYMBOL	SOIL DESCRIPTION	DEPTH (m)
	Topsoil (depth?).	0.0
	Yellow brown CLAY (?)	
		2.0
	becomes grey and streaked with brown sand	3.05
		4.0
		6.0
	with sandstone gravels	7.32
		8.0
		8.53
	Sandstone gravels in SAND matrix End of borehole @ 8.53	10.0

PENETRATION RESISTANCE (BLOWS/300mm)
10 20 30 40 50 60
20 40 60 80 100 120 140 160 180 200 220 240 260
SHEAR STRENGTH (kPa)

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

BULK DENSITY kg/m3

DRY DENSITY kg/m3

LEGEND:
PENETRATION RESISTANCE
50mm O.D. SPLIT TUBE
50mm I.D. SHELBY TUBE
50mm DIA CONE

SHEAR STRENGTH
UNDRAINED TRIAXIAL ⊕
SHEAR VANE (CORRECTED) +
UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
LIQUID LIMIT
PLASTIC LIMIT
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 114.232 m
DATUM: Lands+ Survey

LOGGED:
DRAWN: (S.GRACE)
DATE: (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO.

CONTRACT NO.

BOREHOLE NO. 3264 SHEET 1 OF 1

SYMBOL	SOIL DESCRIPTION	DEPTH (m)
	Topsoil (depth?)	0.0
	Yellow brown CLAY(?)	
	becomes grey	1.83
		2.0
	becomes streaked with brown sand and with sandstone fragments	1.0
		4.57
	Sandstone fragments in SAND matrix	6.0
		8.0
	End of borehole @ 15.85	

PENETRATION RESISTANCE (BLOWS/300mm)
10 20 30 40 50 60
20 40 60 80 100 120 140 160 180 200 220 240 260
SHEAR STRENGTH (kPa)

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

BULK DENSITY kg/m3

DRY DENSITY kg/m3

LEGEND:
PENETRATION RESISTANCE
50mm O.D. SPLIT TUBE
50mm I.D. SHELBY TUBE
50mm DIA CONE

SHEAR STRENGTH
UNDRAINED TRIAXIAL ⊕
SHEAR VANE (CORRECTED) +
UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
LIQUID LIMIT
PLASTIC LIMIT
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 109.710
DATUM: Lands + Survey

LOGGED:
DRAWN: (S.GRACE)
DATE: (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO.

CONTRACT NO.

BOREHOLE NO. 3267 SHEET 1 OF 1

SYMBOL	SOIL DESCRIPTION	DEPTH (m)
	Topsoil (depth?)	0.0
	Yellow brown. CLAY (?)	
	becomes grey and streaked with brown sand and with sandstone gravels	2.0 2.44 4.0
		6.0
	Sandstone gravels in SAND matrix	6.1
		8.0
	End of borehole @9.45 m	10.0

PENETRATION RESISTANCE (BLOWS/300mm)
10 20 30 40 50 60
20 40 60 80 100 120 140 160 180 200 220 240 260
SHEAR STRENGTH (kPa)

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

BULK DENSITY kg/m3

DRY DENSITY kg/m3

LEGEND: PENETRATION RESISTANCE
50mm O.D. SPLIT TUBE
50mm I.D. SHELBY TUBE
50mm DIA CONE

SHEAR STRENGTH
UNDRAINED TRIAXIAL ⊕
SHEAR VANE (CORRECTED) +
UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
LIQUID LIMIT
PLASTIC LIMIT
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^LI

GROUND LEVEL: DATUM:	LOGGED: DRAWN: DATE:	AUCKLAND REGIONAL AUTHORITY SITE:	DRAWING NO.	PROJECT NO.	CONTRACT NO.

BOREHOLE NO. AB2 SHEET 1 OF 1

SYMBOL	SOIL DESCRIPTION	DEPTH (m)
	Yellow - brown CLAY	0.0
	becomes slightly grey	2.0
	becomes grey-brown	4.0
	becomes silty	5.3
	Grey clayey SAND	6.0
	fragments of SANDSTONE	8.0
	End of borehole @ 11.3m	10.0

PENETRATION RESISTANCE (BLOWS/300mm)
10 20 30 40 50 60
20 40 60 80 100 120 140 160 180 200 220 240 260
SHEAR STRENGTH (kPa)

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

BULK DENSITY kg/m3

DRY DENSITY kg/m3

ϕ'

18°

LEGEND:
PENETRATION RESISTANCE
50mm O.D. SPLIT TUBE
50mm I.D. SHELBY TUBE
50mm DIA CONE

SHEAR STRENGTH
UNDRAINED TRIAXIAL ⊕ kPa
SHEAR VANE (CORRECTED) +
UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
LIQUID LIMIT
PLASTIC LIMIT
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 113.977 m
DATUM: Lands + Survey

LOGGED:
DRAWN: (S.GRACE)
DATE: (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO.

CONTRACT NO.

BOREHOLE NO. BB1 SHEET 1 OF 2

SYMBOL	SOIL DESCRIPTION	DEPTH (m)
	Topsoil (depth ?).	0.0
	Firm yellow grey CLAY(?)	1.5Z
	becomes grey	2.0
	becomes sandy	4.0
		6.0
		8.0
		10.0

PENETRATION RESISTANCE (BLOWS/300mm)
10 20 30 40 50 60
20 40 60 80 100 120 140 160 180 200 220 240 260
SHEAR STRENGTH (kPa)

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

DENSITY kg/m3 kg/m3

LEGEND:

PENETRATION RESISTANCE
- 50mm O.D. SPLIT TUBE
- 50mm I.D. SHELBY TUBE
- 50mm DIA CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL ⊕
- SHEAR VANE (CORRECTED) +
- UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT
- NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 106.052 m DATUM: Lands + Survey	LOGGED: DRAWN: (S.GRACE) DATE: (6/88)	AUCKLAND REGIONAL AUTHORITY SITE: HUIA FILTER STATION WAIMA RD, TITIRANGI	DRAWING NO.	PROJECT NO.	CONTRACT NO.

BOREHOLE NO. BB1 SHEET 2 OF 2

SYMBOL	SOIL DESCRIPTION	DEPTH (m)
	Firm grey sandy CLAY (1)	10.0
	with inclusions of sandstone and gravels	12.0
		14.0
		16.0
		16.76
	SANOSTONE with inclusions of gravels	18.0
	End of borehole @ 23.16m	20.0

PENETRATION RESISTANCE (BLOWS/300mm)
10 20 30 40 50 60
20 40 60 80 100 120 140 160 180 200 220 240 260
SHEAR STRENGTH (kPa)

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

BULK DENSITY kg/m3

DRY DENSITY kg/m3

LEGEND:
PENETRATION RESISTANCE
50mm O.D. SPLIT TUBE
50mm I.D. SHELBY TUBE
50mm DIA CONE

SHEAR STRENGTH
UNDRAINED TRIAXIAL ⊕
SHEAR VANE (CORRECTED) +
UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
LIQUID LIMIT
PLASTIC LIMIT
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 106.052m
DATUM: Lands + Survey

LOGGED:
DRAWN: (S.GRACE)
DATE: (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO.

CONTRACT NO.

BOREHOLE NO. BB2 SHEET 1 OF 1

SYMBOL	SOIL DESCRIPTION	DEPTH (m)
	Topsoil	0.0
	Firm yellow-grey CLAY(?)	
	becomes grey	2.0
	becomes sandy	3.66
		4.0
		4.57
	with SANDSTONE gravels	6.0
		7.92
	SANDSTONE gravels in SAND matrix	8.0
		8.2
	End of borehole @ 24.4m	

PENETRATION RESISTANCE (BLOWS/300mm)

10 20 30 40 50 60

20 40 60 80 100 120 140 160 180 200 220 240 260

SHEAR STRENGTH (kPa)

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

BULK DENSITY kg/m3

DRY DENSITY kg/m3

ϕ'

30

29

28

LEGEND: PENETRATION RESISTANCE
- 50mm O.D. SPLIT TUBE
- 50mm I.D. SHELBY TUBE
- 50mm DIA CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL ⊕ kPa
- SHEAR VANE (CORRECTED) +
- UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT
- NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 104.85
DATUM: OLD ARA

LOGGED:
DRAWN: (S.GRACE)
DATE: (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO.

CONTRACT NO.

BOREHOLE NO. BB3 SHEET 1 OF 1

SYMBOL	SOIL DESCRIPTION	DEPTH (m)	PENETRATION RESISTANCE (BLOWS/300mm) / SHEAR STRENGTH (kPa)	INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	BULK DENSITY kg/m3	DRY DENSITY kg/m3	ϕ'	c'
	Topsoil (depth?)	0.0						
	Firm yellow grey CLAY (?) becomes sandy @ 0.6m	1.83					27° ✓	17
	with SANDSTONE gravels	4.88						
	SANDSTONE gravels in SAND matrix	7.01						
	End of borehole @ 24.38m	8.0 10.0						

LEGEND:

PENETRATION RESISTANCE
- 50mm O.D. SPLIT TUBE
- 50mm I.D. SHELBY TUBE
- 50mm DIA CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL ⊕
- SHEAR VANE (CORRECTED) +
- UNCONFINED COMPRESSION ⊗

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT
- NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX x^{LI}

GROUND LEVEL: 107.271 m
DATUM: Lands + Survey

LOGGED:
DRAWN: (S.GRACE)
DATE: (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO.

CONTRACT NO.

BOREHOLE NO. 4796 SHEET 1 OF 3

SYMBOL	SOIL DESCRIPTION	DEPTH (m)	PENETRATION RESISTANCE (BLOWS/300mm) / SHEAR STRENGTH (kPa)	INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	BULK DENSITY kg/m3	DRY DENSITY kg/m3
	Firm dark brown clayey SILT with scoria and basalt gravels	0.0				
	Firm orange grey silty CLAY with basalt gravels	1.0				
	Firm brownish red clayey SILT with roots	1.3	⊗85	50.3	1690	1120
	becomes brown with highly weathered coarse sand grains	2.0				
	becomes firmer, red-orange-grey		⊗8	55.3	1630	1050
	Firm orange brown silty CLAY	3.0				
	Organic silty CLAY with hardwood fragments	3.9				
	Firm grey brown silty CLAY with roots	4.0				
	becomes more silty, orange	5.0	⊗67	49.4	1680	1130

DEPTH OF FILL

NATURAL GROUND

PENETRATION RESISTANCE (BLOWS/300mm): 10 20 30 40 50 60

SHEAR STRENGTH (kPa): 20 10 60 80 100 120 140 160 180 200 220 240 260

INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT: 10 20 30 40 50 60 70 80 90

LEGEND:

PENETRATION RESISTANCE
- 50mm O.D. SPLIT TUBE
- 50mm I.D. SHELBY TUBE
- 50mm DIA CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL ⊕
- SHEAR VANE (CORRECTED) +
- UNCONFINED COMPRESSION ⊗ kPa

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT
- NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX (WC / LI)

GROUND LEVEL: DATUM:	LOGGED: WFK 7/84 DRAWN: WFK (SG) DATE: 7/84 (6/88)	AUCKLAND REGIONAL AUTHORITY SITE: HUIA FILTER STATION WAIMA RD, TITIRANGI	DRAWING NO.	PROJECT NO. 93032	CONTRACT NO.

BOREHOLE NO. 4796 SHEET 2 OF 3

SYMBOL	SOIL DESCRIPTION	DEPTH (m)	PENETRATION RESISTANCE (BLOWS/300mm) 10 20 30 40 50 60 / SHEAR STRENGTH (kPa) 20 40 60 80 100 120 140 160 180 200 220 240 260	INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT 10 20 30 40 50 60 70 80 90	BULK DENSITY kg/m3	DRY DENSITY kg/m3
	Firm red orange brown clayey SILT with highly weathered coarse sand grains and vertical veins of white clay and black oxide	5.0				
	becomes reddish brown	6.0				
	becomes soft yellow orange -brown	7.0				
		8.0				
		8.25	⊗16	●SB·0	1650	1040
	becomes soft-firm light brown fine silt with traces of clay and sand grains as above	9.0				
	becomes firmer	10.0				

LEGEND:

PENETRATION RESISTANCE
- 50mm O.D. SPLIT TUBE
- 50mm I.D. SHELBY TUBE
- 50mm DIA CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL ⊕
- SHEAR VANE (CORRECTED) +
- UNCONFINED COMPRESSION ⊗ kPa

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT
- NATURAL MOISTURE CONTENT ● wc
- AND LIQUIDITY INDEX x LI

GROUND LEVEL:
DATUM:

LOGGED: WFK 7/84
DRAWN: WFK (S.GRACE)
DATE: 7/84 (6/88)

AUCKLAND REGIONAL AUTHORITY
SITE: HUIA FILTER STATION
WAIMA RD, TITIRANGI

DRAWING NO.

PROJECT NO. 93032

CONTRACT NO.

SYMBOL	BOREHOLE NO. 4796 SHEET 3 OF 3 SOIL DESCRIPTION	DEPTH (m)	PENETRATION RESISTANCE (BLOWS/300mm) 10 20 30 40 50 60 20 40 60 80 100 120 140 160 180 200 220 240 260 SHEAR STRENGTH (kPa)	INSITU MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	BULK DENSITY kg/m3	DRY DENSITY kg/m3	
	Soft-firm light brown fine SILT with clay traces and slightly sandy becomes firmer with depth highly weathered slickenslide fracture @ 50° to horizontal in silt matrix	10.0 11.0 12.0					
	End of borehole @ 12.0m	13.0 14.0 15.0					

LEGEND: PENETRATION RESISTANCE
50mm O.D. SPLIT TUBE
50mm I.D. SHELBY TUBE
50mm DIA CONE

SHEAR STRENGTH
UNDRAINED TRIAXIAL ⊕
SHEAR VANE (CORRECTED) +
UNCONFINED COMPRESSION ⊗ kPa

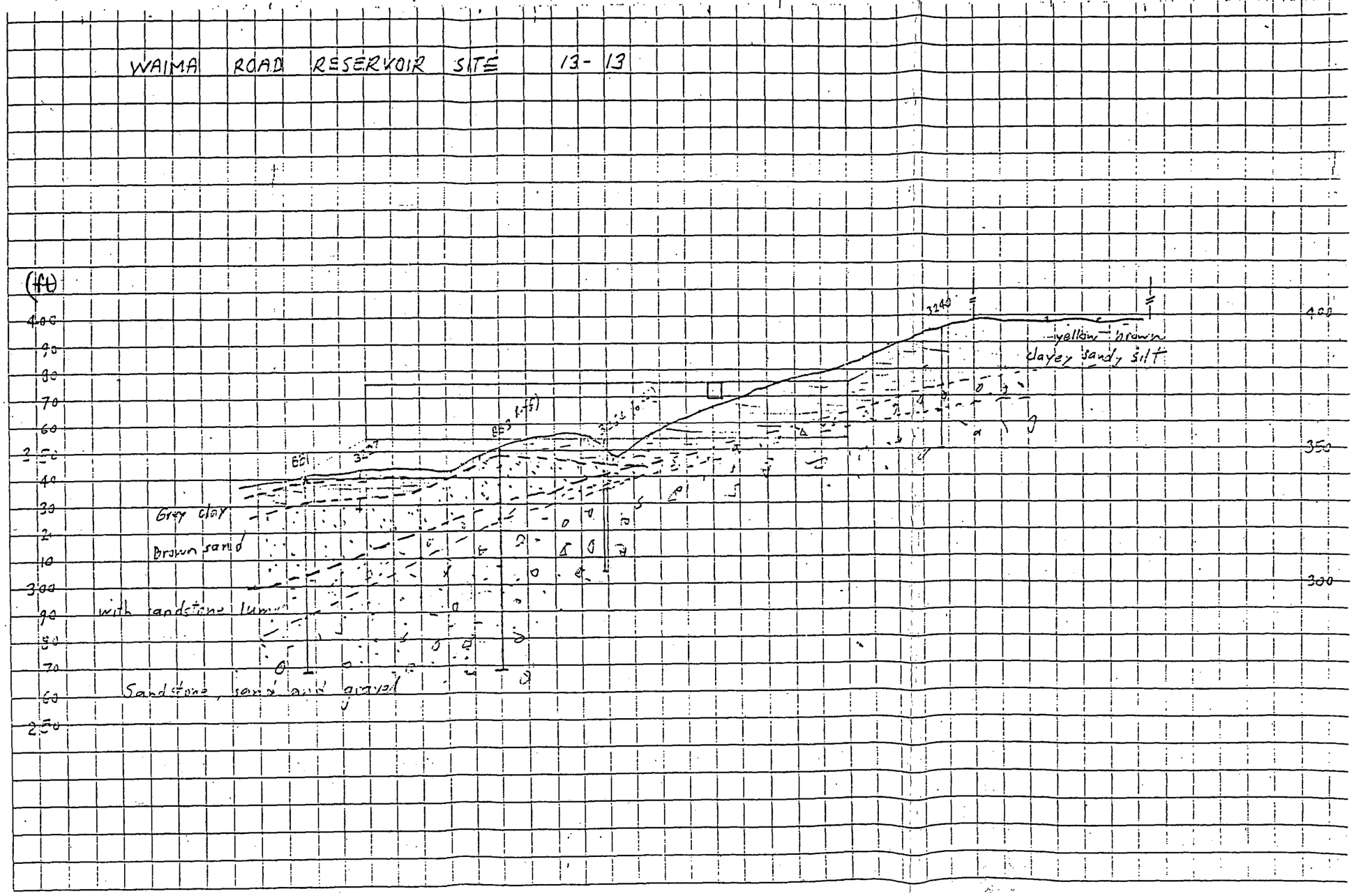
ATTERBERG LIMITS
LIQUID LIMIT
PLASTIC LIMIT
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX ⊗ WC, × LI

GROUND LEVEL: DATUM:	LOGGED: WFK (7/84) DRAWN: WFK (S. GRACE) DATE: 7/84 (6/88)	AUCKLAND REGIONAL AUTHORITY SITE: HUIA FILTER STATION WAIMA RD., TITIRANGI	DRAWING NO.	PROJECT NO. 93902	CONTRACT NO.

Appendix D

North / South Cross Section

WAIMA ROAD RESERVOIR SITE 13-13



Appendix E

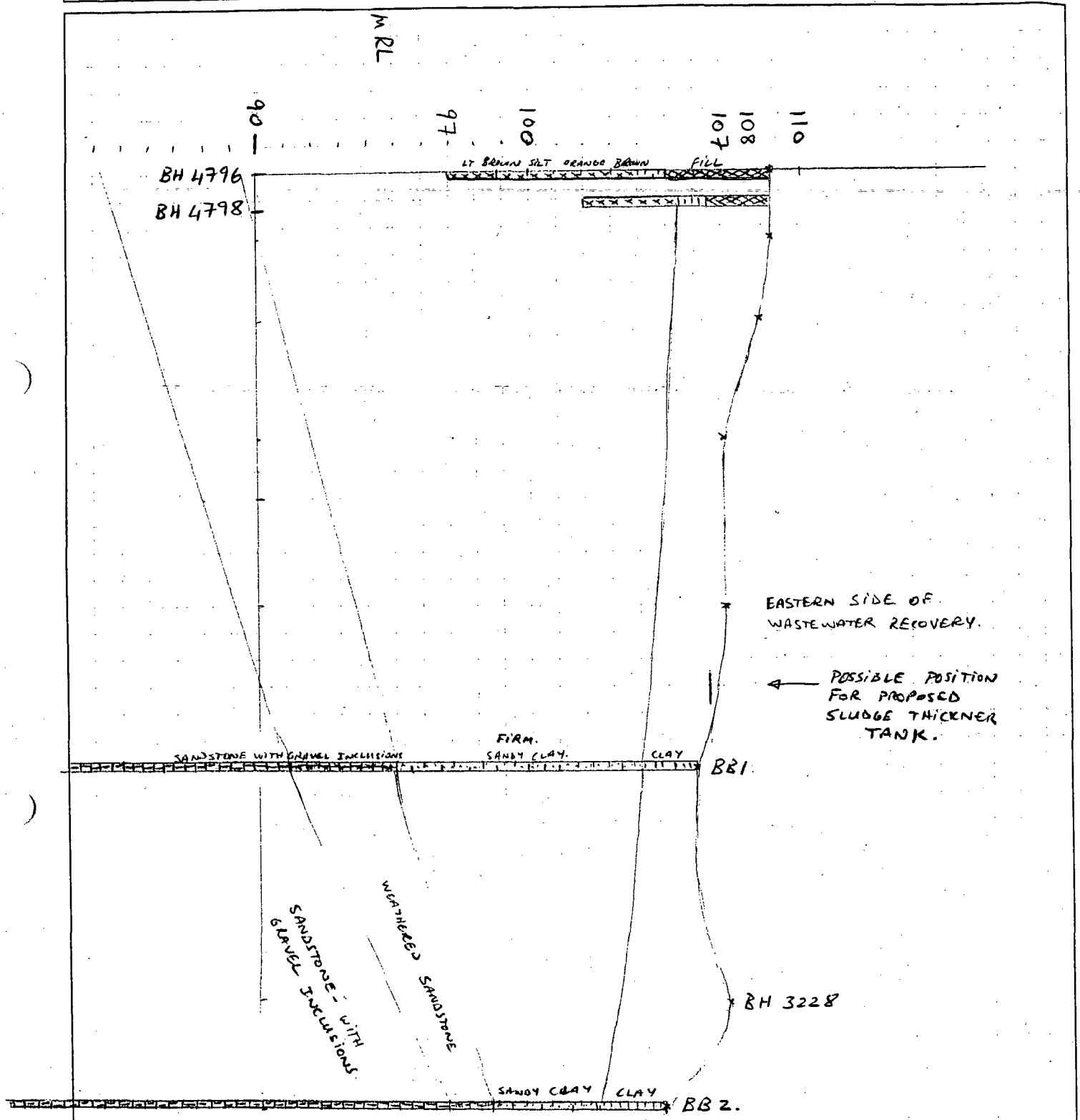
East / West Cross Section

GHD MANAGEMENT ENGINEERING ENVIRONMENT

Calculations

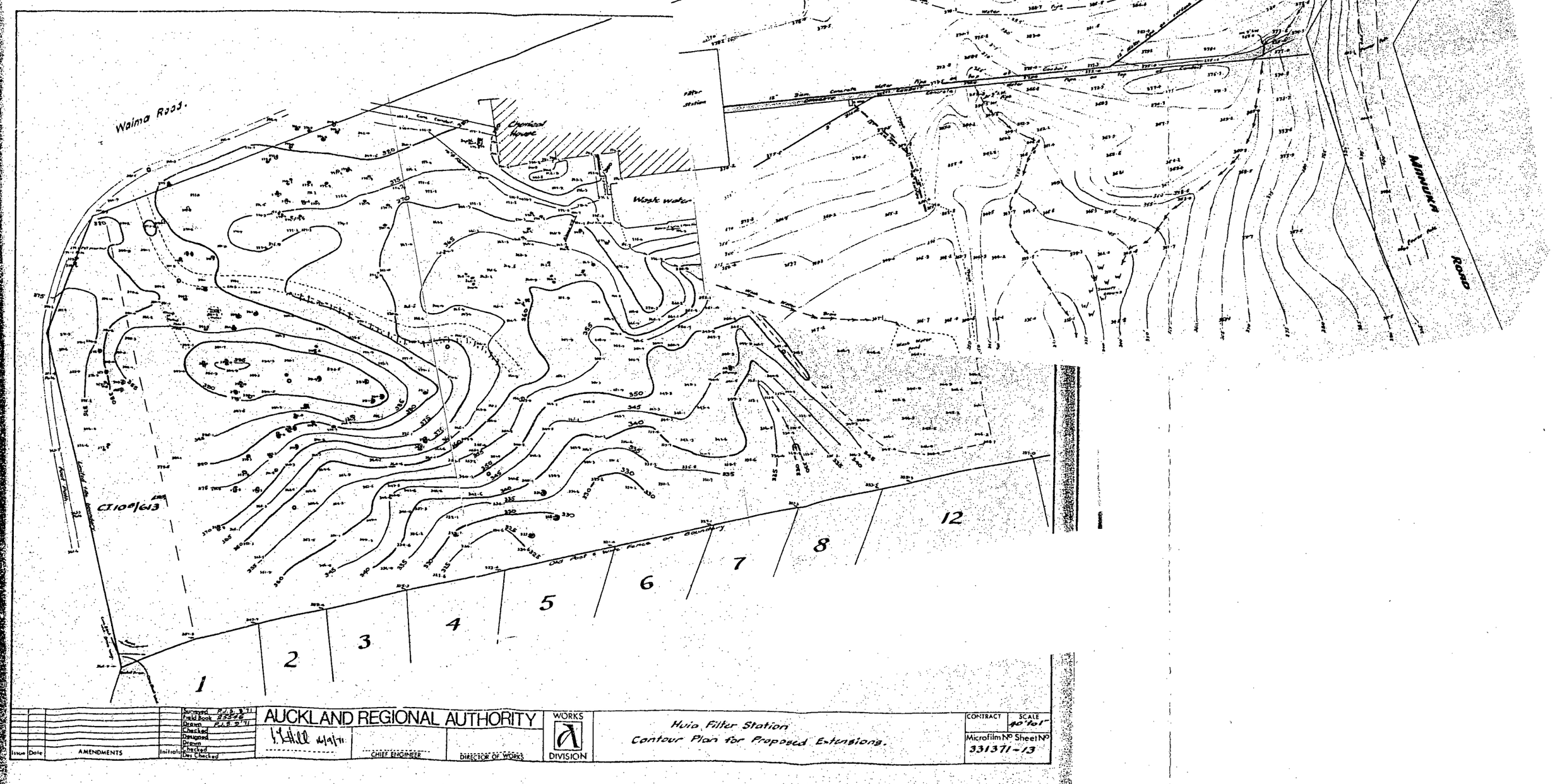
GHD Limited

CLIENT:	WSL.	JOB No:	19079.	SHEET:	1 of 1.
JOB:	HUIA FILTER STATION.	CALCS BY:	NK. (PRINT NAME)	DATE:	2/7/02
SUBJECT:	EAST/WEST CROSS SECTION.	CHECKED BY:	— (PRINT NAME)	DATE:	—



Appendix F

1968 & 1971 Contours



Issue	Date	AMENDMENTS	Initials
			Surveyed P.J.S. 9'71
			Field Book 23546
			Drawn P.J.S 9'71
			Checked
			Designed
			Drawn
			Checked
			Des Checked

AUCKLAND REGIONAL AUTHORITY

WORKS DIVISION

L.T. Hill 16/9/71

CHIEF ENGINEER

DIRECTOR OF WORKS

Huia Filter Station
Contour Plan for Proposed Extensions.

CONTRACT

SCALE 40'to1"

Microfilm No Sheet No
331371-13

Appendix G

WSL Clarifier Settlement Drawing

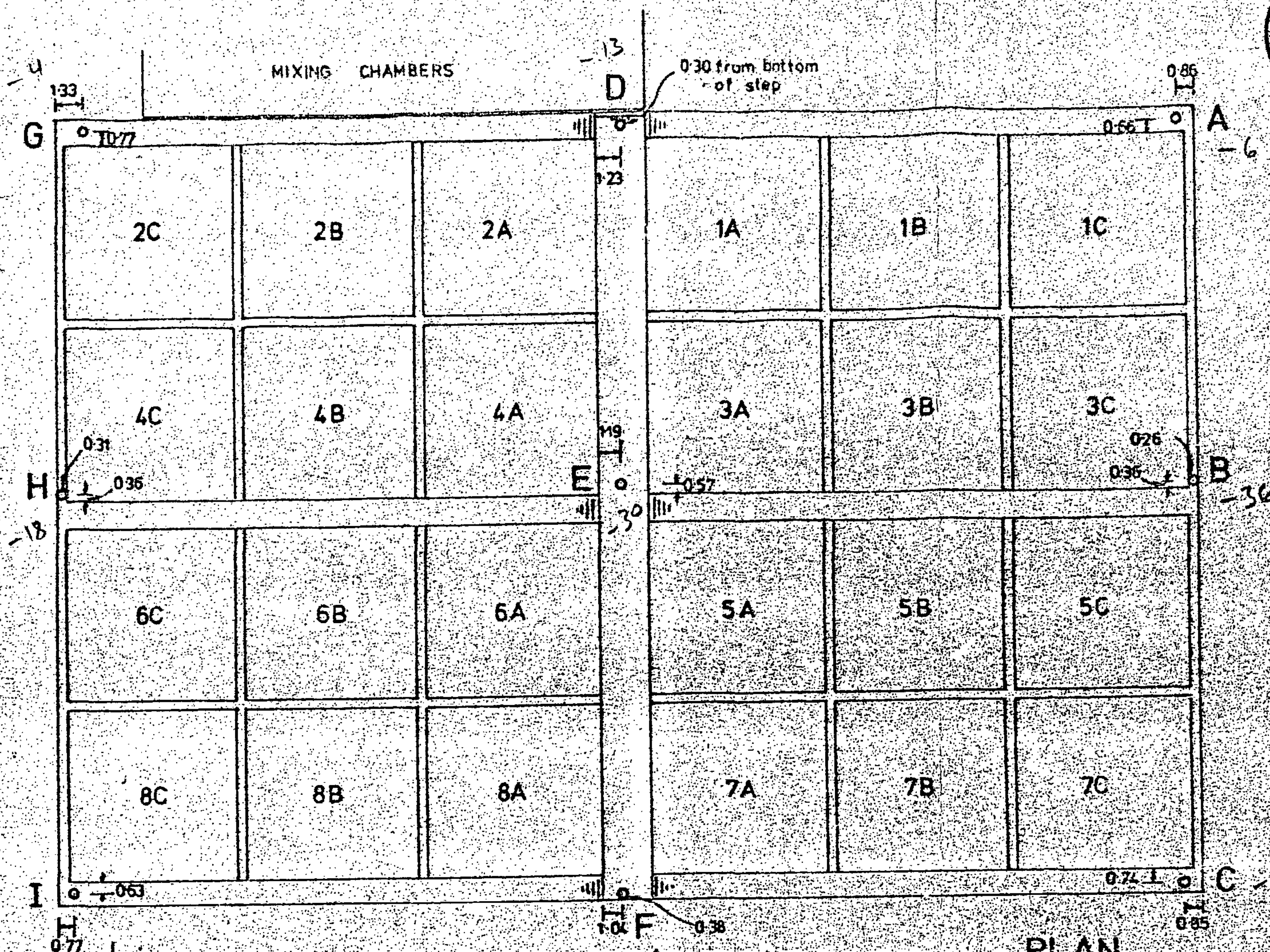
DATE	6/1/76	19/6/77	9/2/78	1/10/79	2/10/80	19/10/83	9/10/86
URVEYOR	R.H.F.	R.H.F.	R.H.F.	R.H.F.	R.H.F.	R.H.F.	R.H.F.
TEMPARATURE	20°C	17°C	23°C	16°C	18°C	19°C	18°C
SETTLING TANK NOS	DEPTH OF WATER IN EACH TANK						
1A	6·1						
1B	6·1						
1C	6·1						
2A	1·2						
2B	6·1						
2C	6·1						
3A	3·0						
3B	3·0						
3C	4·5						
4A	3·0						
4B	3·0						
4C	3·0						
5A	1·2			6·1			
5B	1·2			6·1			
5C	1·2			6·1			
6A	1·2						
6B	1·2						
6C	1·2						
7A	1·2						
7B	1·2						
7C	1·2						
8A	1·2						
8B	1·2						
8C	1·2						

NOTE: ONE LEG OF THE CONSTRUCTION CRANE IS ON THE CENTRE OF THE SETTLING TANKS (6/1/76)

19/6/77, 9/2/78, 2/10/80, 19/10/83, 9/10/86: ALL TANKS ARE FULL (8·2 m)

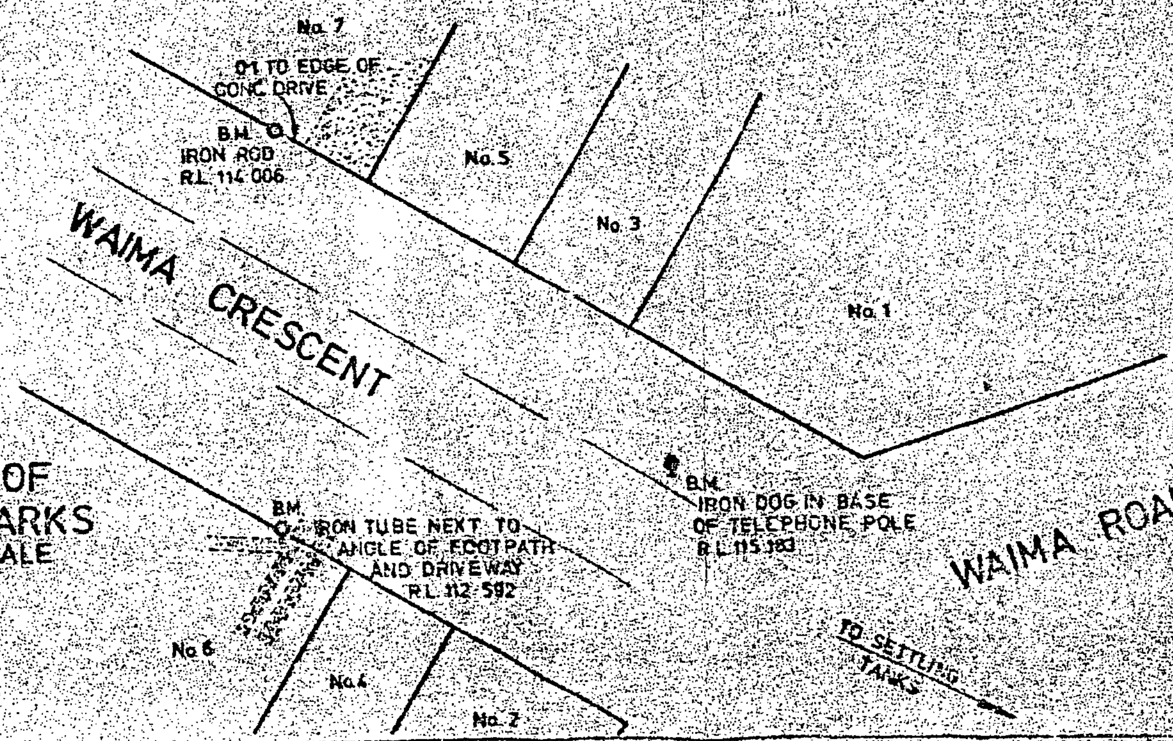
1/10/79: ALL OTHER TANKS ARE FULL (8·2m)

LEVELLING MARKS	OBSVD LEVELS	OBSVD LEVELS	DIFF FROM 6/1/76	OBSVD LEVELS	DIFF FROM 6/1/76	OBSVD LEVELS	DIFF FROM 6/1/76	OBSVD LEVELS	DIFF FROM 6/1/76	OBSVD LEVELS	DIFF FROM 6/1/76	OBSVD LEVELS	DIFF FROM 6/1/76
A	119·289	119·284	−5	119·286	−3	119·284	−5	119·284	−5	119·283	−6	119·283	−6
B	119·278	119·257	−21	119·257	−21	119·250	−28	119·249	−29	119·243	−35	119·242	−36
C	119·264	119·243	−21	119·243	−21	119·235	−29	119·234	−30	119·229	−35	119·228	−36
D	120·285	120·276	−9	120·277	−8	120·274	−11	120·274	−11	120·272	−13	120·272	−13
E	120·273	120·253	−20	120·254	−19	120·249	−24	120·248	−25	120·243	−30	120·243	−30
F	120·256	120·240	−16	120·241	−15	120·235	−21	120·234	−22	120·231	−25	120·230	−26
G	119·280	119·277	−3	119·278	−2	119·277	−3	119·277	−3	119·275	−5	119·276	−4
H	119·271	119·261	−10	119·263	−8	119·260	−11	119·260	−11	119·253	−18	119·253	−18
I	119·270	119·266	−4	119·268	−2	119·265	−5	119·265	−5	119·264	−6	119·264	−6
	m	m	mm	m	mm	m	mm	m	mm	m	mm	m	mm



PLAN
SCALE: 1:240 (1=20)

DIAGRAM OF BENCH MARKS
NOT TO SCALE



NOTE:
FROM THE BOTTOM OF THE SETTLING TANKS TO THE TOP OF THE SLUDGE POCKETS IS 6·4m
FROM THE BOTTOM OF THE SETTLING TANKS TO THE BOTTOM OF THE HOLES FOR THE DECANTING TROUGHS IS 8·2 m

LEVELS IN TERMS OF L & S DATUM
TO CONVERT TO A.R.A. DATUM SUBTRACT 1·180m
FOR PREVIOUS BENCH MARKS SEE 331371-11 & 16

ALL MARKS ARE BRONZE RAWLPLUGS DRIVEN INTO THE CONCRETE DECKING

ALL MEASUREMENTS ARE IN METRES

AMENDMENTS | Initials

AUCKLAND REGIONAL AUTHORITY

CHIEF ENGINEER | DIRECTOR OF WORKS

WORKS DIVISION

HUIA WATER TREATMENT STATION
SETTLING TANKS
CONTROL LEVELS FOR CHECKING STRUCTURE SETTLEMENT

CONTRACT | SCALE AS SHOWN

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