Transpower Edgecumbe Substation

33kV Indoor Conversion

Assessment of Effects on Security of the Rangitaiki River Stopbank

Prepared for

Bay of Plenty Regional Council

and

Transpower

August 2014

ICE GEO & CIVIL

Contents

1 Introduction

There is a history of seepage problems and breaches along the Rangitaiki River stopbanks, the most recent breach being in 2004. The Bay of Plenty Regional Council enacted the Floodway and Drainage Bylaw to control activities that could affect flood protection works throughout the region. This bylaw requires any excavation work within 150m of the Rangitaiki River to be assessed for possible effects on the security of the adjacent stopbank. Transpower are proposing to carry out a variety of excavations up to about 20m from the inland toe of the stopbank adjacent to their Edgecumbe substation on Hydro Road. The excavations are required for the 33kV Indoor Conversion Project. Ice Geo and Civil Ltd has previously carried out assessments of the stopbank security on both sides of the Substation and has been engaged by the Bay of Plenty Regional Council to assess the effects of the proposed Transpower work.

Problems with excessive seepage were experienced at the stopbank by the Transpower substation in a flood in July 1998. Rock buttressing was quickly placed during the flood. Opus International Consultants Ltd investigated the area and made recommendations for a pressure relief trench which has been installed around the river bend within the Transpower boundaries. Further geotechnical investigations were carried out by Opus in June 2014 following the appearance of two small tomos within the substation in March 2013 and June / July 3013. Other geotechnical investigations have been carried out within and around the substation for the 33kV conversion project and an earlier project. There is therefore a reasonable amount of subsurface information within and close to the substation. The following documents have been used in the preparation of this report:

- Opus International Consultants Ltd (June 2000) Stopbank Assessment Rangitaiki River, Edgecumbe.
- Ice Geo and Civil (24 September 2004, Letter report to BOPRC) Rangitaiki River Stopbank: Black's Farm (Mc Crackens Bend).
- Ice Geo and Civil (May 2006) Rangitaiki River Stopbanks Assessment Section 6, Right Bank 11850 to 12300m.
- Ice Geo and Civil (September 2008) Rangitaiki River Stopbanks Assessment Section 6 Addendum, Right Bank 11850 to 12300m.
- AECOM NZ Ltd (December 2009) Edgecumbe Substation Contingency Spare Transformer, Geotechnical Assessment.
- Beca Carter Hollings and Ferner Ltd (October 2011) Edgecumbe 33kV Outdoor to Indoor Conversion Geotechnical Assessment.
- Opus International Consultants Ltd (February 2014) Edgecumbe Substation Inspection Report.
- State Hydro Electricity Department Drawing X1439(1959), Edgecumbe Substation Control block and workshop buildings site plan.
- State Hydro Electricity Department Drawing EHN 1470/20 (1958) Edgecumbe Substation, Contours of departmental property.
- Aerial photo McCrackens Bend.
- Transpower drawing TP101003 Sheets 1 and 2 Edgecumbe Substation 33kV Switchgear building drainage.

- Transpower drawing TP100995 Sheets 2 and 3 Edgecumbe Substation 33kV Indoor conversion cable layout.
- Transpower drawing EDG – Excavations required for the 33kV indoor conversion.

This report presents the following:

- information on the subsurface soil profile developed from the in situ investigations,
- the results of laboratory tests,
- the results of seepage analyses for a 300 year return period flood and
- a recommendation for a modification to the trench design.

This report is the property of the Bay of Plenty Regional Council, Transpower NZ and Ice Geo and Civil. The comments within it only relate to the work associated with the 33kV outdoor to indoor conversion.

The conclusions of this report are based on the interpretation of investigations carried out at isolated points only and limited laboratory testing. Therefore there could be ground conditions which differ from those described.

Figure 1: McCrackens Bend and substation site

2 Site Description

The Transpower site lies within a bend of the Rangitaiki River as shown in the upper part of Figure 1. This shows the area before major stopbank construction was carried out and McCrackens Bend, just upstream of the site was cut off and filled in. A few trees can be seen in the area now between the back of the substation and the stopbank. It is likely that there were more trees before this photo as taken.

Drawing EHN 1470 / 20 shows the ground contours early on in the development of the substation. This shows a low ridge running through the substation area and a shallow dip between the substation and the point of the bend. This geography is considered to be due to the formation of sand bars and channels as the Rangitaiki River formed the plains. Figure 2 is a LIDAR plot of the ground levels in the substation area. Some of the original contours can be picked up in this plot but it appears that some fill has been placed where the substation yard is closest to the river. In this area there is a row of old concrete poles on the ground surrounding two soak holes used to dispose of stormwater from the substation. It is possible that these poles and other fill material were placed to counteract uplift and heave problems during floods in the river as discussed in the 2000 Opus report.

The contours shown in the LIDAR plot are those in 2006, prior to soil overlays being placed across McCrackens Bend, upstream of the Transpower boundary and the properties immediately downstream of the Transpower boundary. 1.5m of soil has been placed against the stopbank toe, tapering to ground level 50m from the stopbank at McCrackens Bend. Downstream 1m of soil was placed to 35m of the stopbank toe, tapering to meet the ground level at RL4.6. These overlays were required to reduce the risk of upper soil layers heaving and piping developing beneath the stopbank in large floods. The pressure relief trench at the toe of the stopbank behind the substation had been installed before this overlay work was carried out.

3 Geology

The Rangitaiki Plains are the most northern extent of the Taupo Volcanic Zone on land[1]. They lie in the Whakatane Graben (depressed block of land) with hills to the west, east and south. Geological studies indicate that the graben has been widening at an average rate of 7mm per year, with associated small subsidence. The alluvial plains within 10km of the coast have formed only in the last 8,000 years. They have been built up by over-bank deposits from meandering rivers in flood, wind blown sand, airfall ash deposits and peat formation in depressions. The active volcanism of the upper Rangitaiki catchment and the high erodibility of the volcanic tephra result in a large source of sediment for deposition on the plains. The outcome of the plain formation processes is a wide and unpredictable variety of soil types and grain sizes within small horizontal and vertical distances.

[1] Soons, J.M. and Selby, M.J. (1982) Landforms of New Zealand, Longman Paul

A critical soil property for stopbank security is the permeability of the underlying soils. Most of the soils in the plains are silts, sands and gravels with moderate to high permeability. The rapid variation in soil types and layering makes it very difficult to ensure stopbank security.

4 Subsurface Investigations

The locations of the subsurface investigations carried out around the substation for this report and prior studies are shown marked up on Figure 2. The logs of the investigations are included in Appendix A.

Opus International Consultants carried out some subsurface investigations around the substation after the 1998 floods. These investigations consisted of two boreholes to about 7m depth at the toe of the stopbank (OBH6 and OBH7) and ground penetrating radar surveys. The soils were found to be silt overlying silty fine sand, medium to coarse grained sand, loose pumiceous gravely sand and sandy silt.

A 15m deep borehole was drilled through the stopbank just downstream of the substation by the Regional Council (BH1). Surface silt layers were found overlying, silty fine sand, medium to course sand and a complex layering of pumice gravel and silt. Clayey soils with some organics were found below RL-4.8 and organic silt at RL-7.1.

AECOM drilled one borehole to 20m depth (ABH1) and carried out five cone penetrometer tests (CPT) around the substation (AC1 to 5). The borehole was between the substation and Hydro Road. A 4.5m thick layer of coarse gravelly sand was found at 2.9m depth. This was underlain by layers of sand, silt and clayey silt. An organic clayey silt was found at 18m depth.

Beca also drilled one borehole to 24.5m depth (BBH1) and carried out five CPT tests at the site of the proposed conversion building (BC1 to 5). Among the layers of sand and silt a 200mm thick layer of organic silt was found at 4m depth, a 5m thick layer of clayey soil was found at 9m depth and the same organic clayey silt layer as in the AECOM hole was found at 17.9m depth. It can be seen from these two boreholes that although the deep organic layer is consistent the layers above it vary significantly in depth and thickness.

The three boreholes around the switchroom and workshop shown on Drawing X1439 show a peat layer between 400 and 800mm thick at 5.1 to 5.4m depth (E1 to 3). The remainder of the soils are described as pumice and sand, with no particle sizes given. The identification of this upper peat layer is useful as it can be used as a marker bed to show the dip on some of the soil layers.

Opus carried out two hand augers to 4m depth in the tomos (AS1 and AS2). The surface silty soils were found to directly overlie the upper peat layer at only 2.5 to 2.6m depth. Medium to coarse sands only appeared below the peat layer.

Nine further hand augers were carried out to about 3.5m depth for this report in the areas of the proposed trenches and foundations. These typically

showed surface silt, over silty fine sand, medium to coarse sand, fine pumice gravel and gravelly sand. The only peat found was a very thin layer at 3m depth at the HA7 location. This is considered to be the same layer as in AS1 and AS2. The three tests are possibly in the old depression shown on Drawing EHN 1470/20, whereas HA6, just to the south may be at the edge of the ridge.

Constant head permeability tests were carried out in the upper silty fine sands in hand augers 3 and 8. The calculated permeabilities were 3.3×10^{-6} and 2.1×10^{-6} m/s. It was assumed that the horizontal permeability was equal to the vertical as there was no obvious layering in the hand augers. An earlier falling head test in the same sand just downstream gave a permeability of 3.6×10^{-6}m/s. There is therefore reasonable consistency in the results.

5 Laboratory Test Results

Hydrometer particle grading tests were carried out on six samples from the hand augers to provide information on the permeability of the soil layers (Appendix B). The grading test results are summarised in Table 1. The permeabilities given are estimates based on the Hazen formula:

$$k=c*D_{10}^2 \text{ (m/s)}$$

where the value of c is dependent on the coefficient of uniformity[2] D_{60}/D_{10}.

Table 1: Particle Grading Results

Sample	Description	D_{10} (mm)	D_{60} (mm)	permeability
HA2 2.0m	medium to coarse sand	0.18	0.60	2.9×10^{-4} m/s
HA3 0.9m	silt			
HA3 2.5m	medium to coarse sand	0.19	0.70	3.3×10^{-4} m/s
HA9 0.9m	medium to coarse sand	0.22	0.90	4.4×10^{-4} m/s
HA9 2.5m	well graded sand	0.05	0.22	2.3×10^{-5} m/s
HA10 2.3m	gravelly medium to coarse sand	0.2	1.1	3.2×10^{-4} m/s

These test results have been used in conjunction with the results from other laboratory and in situ tests from along the river to estimate the permeability characteristics of each soil type.

[2] CIRIA C731, The International Levee Handbook,Table 7.112

6 Analyses

6.1 Tomo formation and internal erosion

Possible mechanisms for the formation of tomos near the stopbank include the following:

- The initiation or complete formation of a pipe under the stopbank due to high hydraulic gradients when the river level is high.
- The collapse of surface soils into voids formed by the ejection of soil from sand boils following the 1987 Edgecumbe Earthquake.
- The collapse of surface soils into voids formed by the rotting out of old stumps.
- The activities of rabbits.
- The movement of fine soil particles into voids within a coarser grained soil.

The silty fine sands just below the surface silts at the site are particularly light and fluffy and have been observed to be favoured by rabbits. In some areas clayey overlays have been placed over the silty sands to dissuade the rabbits. There are some tomos beyond the substation fence which are considered to be due to rabbit activity. It is thought that the tomos within the substation are unlikely to be caused by rabbits due to the gravel surface.

As there is peat above the normal ground water level at the tomo locations and an absence of peat towards the river, it is considered unlikely that the tomos are due to the development of sand boils. Sand boils are more likely to have occurred where flow to the surface was unimpeded by a layer with some cohesion.

As Opus noted in their tomo report (2014) the river level did not rise above the toe of the stopbank during the period before the observation of the tomos. There was however a reasonable amount of rain. From October 2012 to March 2013 about 300mm or rain was recorded at Te Teko, much of it in concentrated periods. Nearly another 300mm fell in May and June 2013 and another 150mm in July. As the tomo locations are down slope of the surrounding ground there may therefore have been a reasonable depth of water ponded on the ground surface at times.

The particle grading information from the tests discussed above and other grading tests from the previous stopbank investigations have been used to assess whether soil particles from one layer can wash into a coarser layer. Standard filter grading criteria have been used[3]. It appears from the analyses that the upper silt and silty fine sand should not wash into the medium to coarse sand found beneath it. Although no grading curve is available for the coarse pumice sand / fine lapilli layer, observations of the soil on site suggest that movement of fines through this layer is possible.

[3] CIRIA C731, The International Levee Handbook, Tables 8.22 and 8.23

It is proposed to fill the upper part of the cable trenches for the 33 kV conversion project with GAP40 aggregate. The majority of the trenches will be within the upper silty fine sand layer. Comparison of the standard GAP40 grading with that of the silty fine sand showed that if the GAP40 grading is on the coarse side of the allowable envelope some fines could be lost from the silty fine sand into it. An earth strap was observed in the tomo at the AS2 location. If the earth strap trench was backfilled with coarse aggregate there could have been some movement of fine soil into it, although the tomo extends below the earth strap.

A comparison was made between the silty fine sand grading and the average GAP20 grading. It was found that the GAP20 should act as a filter allowing water movement but not that of soil particles. It is therefore recommended that the trenches be backfilled with GAP20, rather than GAP40.

It is not clear from the analyses discussed in the following sections which of the formation mechanisms could be the cause the tomos within the substation. It is considered that the tomos should be excavated out and investigated during the 33kV conversion work.

6.2 Seepage Analyses

The possibility of seepage from the river causing the tomos and problems associated with the proposed 33kV conversion work has been assessed using the Geo-Slope Seep/W (2012 Version) computer programme. This is a two dimensional programme therefore three dimensional effects, such as lateral changes in the soil profile, the presence of an impermeable surface of given width or flow across a river bend, can not be accurately modelled. The seepage analyses carried out must therefore be considered indicative only.

The two problems being investigated are heave and piping. Heave is indicated when the water pressure beneath a low permeability soil layer or a structure is higher than the weight of that layer or structure. Uplift and a rapid loss of soil can be caused leading to a pipe forming under the stopbank and potential complete stopbank collapse. Piping occurs when the hydraulic gradient at the ground surface is sufficient to wash soil particles out, leading to the formation of a pipe. It is considered that hydraulic gradients should be kept below 0.4 in the light pumice soils in this area to reduce the risk of piping initiating. Once it has initiated gradients as low as 0.1 could maintain pipe formation.

Seepage of only small volumes of water from the ground surface can significantly reduce the uplift pressures on a surface layer with a lower permeability than those underlying it. Seepage from the ground surface inside the stopbank has therefore been allowed, except under structures. The increase in uplift pressures below impermeable surfaces is significant compared to the adjacent permeable ground surface. The build up in water pressure below a structure can lead to high hydraulic gradients around the edge of the structure.

Four cross sections through the stopbank and various trenches and structures relating to the 33kV conversion project, as marked up on Transpower drawing EDG – Excavations required for the 33kV indoor conversion, have been analysed. The locations of the cross sections are marked up on Figure 2. The sub surface investigations close to the cross sections have been used to develop the soil profile at each cross section and these are included in Appendix C.

6.2.1 Flood Hydrograph

As the substation is a critical structure the design standard for the stopbank adjacent to it has been taken as a 300 year return period flood. Due to the nature of the soils in the Rangitaiki Plains steady state bank full analyses of the stopbanks lead to unacceptable piping and uplift pressures in many places; therefore transient analyses are necessary. The Regional Council has provided an estimate of a 300 year return period flood flow hydrograph for the Rangitaiki River at their benchmark number 31. This is a 13 day hydrograph which rises to a peak well above the top of the stopbank. It has been assumed in the analyses that the river will over-top the stopbank away from the substation and will be lapping at the top of the stopbank for two days. The truncated hydrograph used in the analyses is shown in Figure 3. A four hour time step was used in the analyses.

The initial ground water levels were taken as RL2.7 in the river and RL3.0 inland. The water level measured at the time of the hand augers was about RL1.3. This was after a relatively dry period; the ground water level during a 300 year return period flood is likely to be considerably higher.

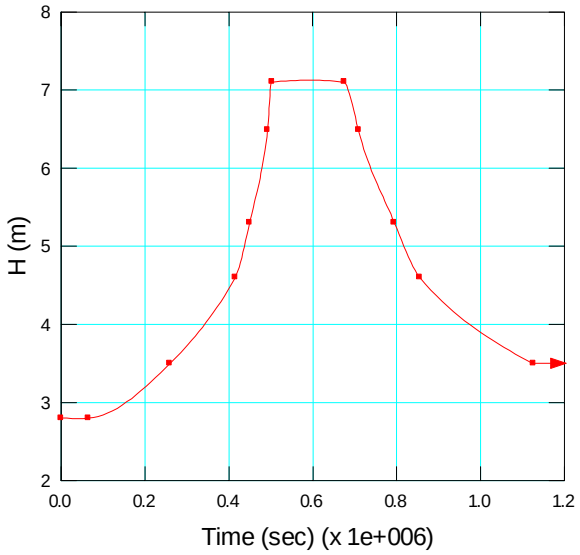


Figure 2: Truncated 300 year return period hydrograph

6.2.2 Soil Model

The soil layers found in the hand augers and boreholes have been simplified for the seepage analyses. In particular the complex soil layering below the upper peat layer has been modelled as one layer with different horizontal and vertical permeabilities. The basement soil has been considered to be the clayey silt found at depth as layers beneath this will have little influence on the substation area. Boreholes through the stopbank show the layering resulting from compaction processes, therefore different vertical and horizontal permeabilities have been assumed in fills.

Soil permeabilities have been estimated from previous particle grading and permeability tests. Table 2 summarises the saturated permeabilities assumed. These are similar to the permeabilities used by Opus in the analyses carried out in 2000.

Table 2: Assumed Soil Permeabilities

soil	$\mathbf{k_h}$ (m/s)	$\mathbf{k_v}$ (m/s)
stopbank fill	4×10^{-6}	2×10^{-6}
surface silt	5×10^{-7}	5×10^{-7}
silty fine sand	4×10^{-6}	4×10^{-6}
medium to coarse sand	3×10^{-4}	5×10^{-5}
well graded sand	3×10^{-5}	3×10^{-5}
coarse sand / fine lapilli	5×10^{-4}	1×10^{-4}
layered sand and silt	5×10^{-5}	5×10^{-7}
clayey silt / peat	5×10^{-8}	5×10^{-8}
drainage metal	1×10^{-2}	1×10^{-2}
GAP20	2×10^{-3}	2×10^{-3}

6.2.3 Cross Section 1

This cross section passes across the overlay downstream of the substation and two sections of the proposed trenches. The subsurface profile suggests an old buried coarse sand levee in the area of BBH1. The upper peat layer has been assumed to end at HA7.

The initial 300 year return period flood flow analysis showed that no problems are expected along this cross section. Trench A should be within the silty fine sand layer whereas Trench B may intersect a medium to coarse sand layer. During the 300 year flood water could come up into Trench B and may flow out at a rate of about 1 litre per metre of trench per hour. No problems are expected.

6.2.4 Cross Section 2

This cross section passes through several section of trench, the main 33kV conversion structure and the soak pit. It was also used to assess excavation H and a representative manhole. The cross section passes close to the AS1 tomo but it has been assumed that the subsurface profile is governed by BH1 and HA6, which do not show the peat found in AS1. It can be seen from the LIDAR plot that the cross section is through ground that was slightly lower than at the AS1 location prior to the placement of the overlay.

An initial transient analysis of the 300 year flood indicated that there should be no problems along this cross section.

An analysis carried out with Foundation E excavated showed that water could rise into the base of the excavation when the river level approaches the toe of the stopbank (RL5.0). At this level the factor of safety against heave of the base of the foundation is about 1.2; therefore care should be taken if the river rises in the excavation phase. Excavation should not be carried out if there is heavy rain in the long range forecast. In the worst case if the excavation is open and the river rises before concrete is poured the hole may need to be temporarily backfilled. Once the concrete foundation is in place the uplift pressures beneath it and the flow gradients up the side of the foundation should not be high enough to cause problems. It has been assumed that there will be no problems with the adjacent shallower foundation H. Similarly no problems are expected with the manholes.

The water level will rise to the ground surface at the locations of trenches C and D at the height of the 300 year flood. The hydraulic gradient into the trenches could be as high as 0.6; therefore it is recommended that the trenches be filled with GAP20 as discussed above to prevent the loss of fine soil particles.

There was some concern that water would flow from the proposed soak hole (structure G) at the height of a flood; however an analysis showed that it is far enough from the river to prevent large inflows. The soak hole was modelled down to the high permeability pumice gravel layer in case this layer is encountered during installation.

6.2.5 Cross Section 3

This cross section passes close to the tomo at the AS1 location and across two trenches at locations J and K. It is through the section of stopbank containing the toe drain but without the overlay. According to the Opus (2000) report the drain is 2m deep. The BH1 soil profile has been assumed at the stopbank, not the Opus BH7 profile. The upper peat layer was assumed to end at AS1. This cross section shows a thicker layer of silt at the ground surface, possibly the result of the original depression in this location.

If the upper peat layer ends near the AS1 / AS2 location any water draining down from the surface will flow inland along the peat layer or towards the river and down off the end of the peat layer. There is a shallow depression at the

AS1 location which would pond water and concentrate downwards flow. It is not known if the depression was there before the tomo developed or is the result of a bigger area of lost soil beneath the ground surface. The reason for the absence of the coarse sand and gravel layers in this area is unclear but may simply be due to natural river deposition and erosion processes. If there is a gravel layer close to the tomos the ponding of water at the ground surface may provide sufficient water pressure to wash fines into the gravel.

An initial transient analysis with the 300 year return period flood indicated that even with the toe drain in the stopbank there could be problems with heave of the upper silt layer and high hydraulic gradients at the ground surface between the stopbank and the substation fence. Once beyond the fence the uplift pressures and gradients diminish. It is likely that Opus designed the drainage system for a 100 year return period flood, not a 300 year return period flood as this has been a more recent requirement. The model was checked with a pumice gravel layer above the upper peat at the AS2 location to allow for the three dimensional effects of water possibly flowing through gravel layers from upstream and downstream. The expected flow from the toe drain at the peak of the flood could be in the order of 100 litres per hour per metre of trench. It appears that this water will flow into the substation.

The analysis of the 300 year return period flood showed that water will flow into and out of Trench J. This trench therefore should be filled with GAP20 to prevent the loss of fines.

A preliminary analysis was carried out adding an overlay to the ground surface between the stopbank and the substation fence. An overlay starting at RL5.8 at the stopbank may provide some margin against uplift but the hydraulic gradients still appear a bit high near the substation. This analysis relied on the outlet of the toe drain being at its present level. One advantage of the overlay is that it should dissuade rabbits from burrowing, however it will promote more run off into the substation and a concrete channel along the fence line leading to a pumped drainage sump may be required. This may be advisable even without the overlay to capture the flow from the toe drain before it enters the substation yard.

Another analysis was carried out with a row of pressure relief wells between the stopbank and substation fence. This showed that uplift pressures and hydraulic gradients could be reduced to reasonable levels. These wells may be hard to locate due to the overhead and underground cables in the area and they do not help the rabbit problem.

It is recommended that as-built information on the toe drains be sought and possibly more subsurface investigations carried out to confirm whether further remedial measures are required between the stopbank and the substation and which is the most practical option.

6.2.6 Cross Section 4

Cross Section 4 was developed to investigate foundations L and M. A combination of Opus boreholes 6 and 7 was used to define the deep soil

profile near the stopbank, the AECOM borehole was used on the far side of the substation and AC3 in the middle of the profile. The ground level at the time the Opus boreholes were drilled is unknown so this profile may not be very accurate. The contour of the coarse sand / gravel layer suggests a typical erosion pattern across a bend. The only upper peat layer indicated was at the AC3 location, where it is about 500mm thick.

An initial 300 year return period flood flow analysis suggests problems with high uplift pressures and hydraulic gradients between the stopbank and the substation fence as with Cross Section 3.

No problems with high uplift pressures or hydraulic gradients are expected at the two foundations.

7 Recommendations

1. Excavation of the structures extending below 2m depth should not be carried out if there is a bad long term weather forecast. If flood conditions develop in the river when deep excavations are open, they should be temporarily backfilled.

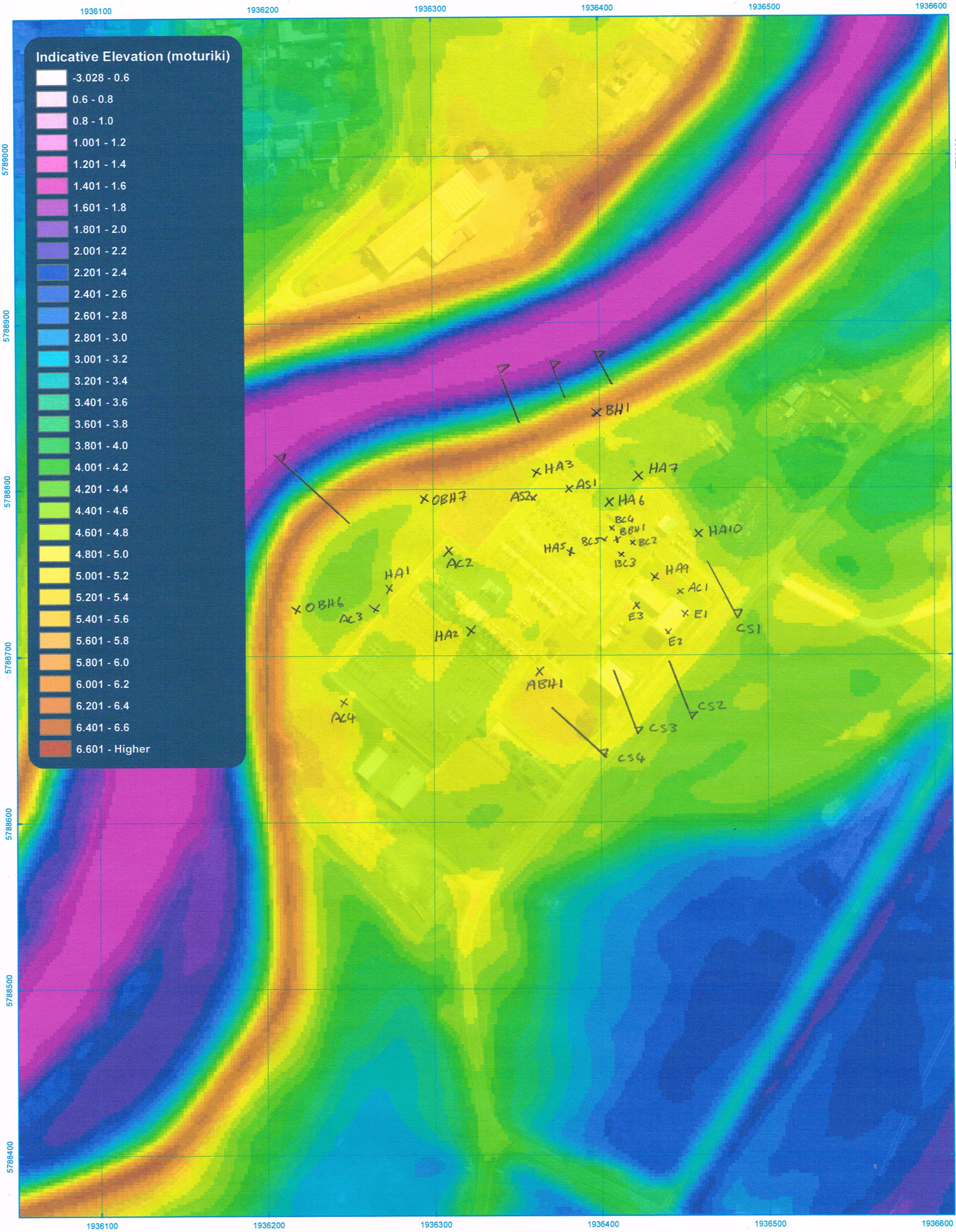
2. The tomos within the substation should be excavated out and investigated during the 33kV conversion work then backfilled in conjunction with the adjacent trenches.

3. The upper part of the cable trenches should be backfilled with GAP20 aggregate rather than GAP40 to prevent the loss of fine soil particles into the trench backfill.

4. As-built information on the stopbank toe drains should be sought and further subsurface investigations carried out to determine if remedial work is required between the stopbank and the substation.

5. A concrete stormwater channel along the substation fence line would reduce stormwater flows into the substation in normal and flood conditions. A pumped sump may be required to dispose of the water.

M. O'Halloran 24 August 2014
BE, PhD, Dip BA, MIPENZ (Geotechnical), CPEng, IntPE



Projection and Grid Information
HORIZONTAL DATUM: New Zealand Geodetic Datum 2000
For practical purposes, NZGD2000 equates to WGS84
VERTICAL DATUM: Mean Sea Level
PROJECTION: New Zealand Transverse Mercator 2000

Rangitaiki River
Edgecumbe Substation - DEM

Scale 1:2000

40 0 40 80 120
Metres

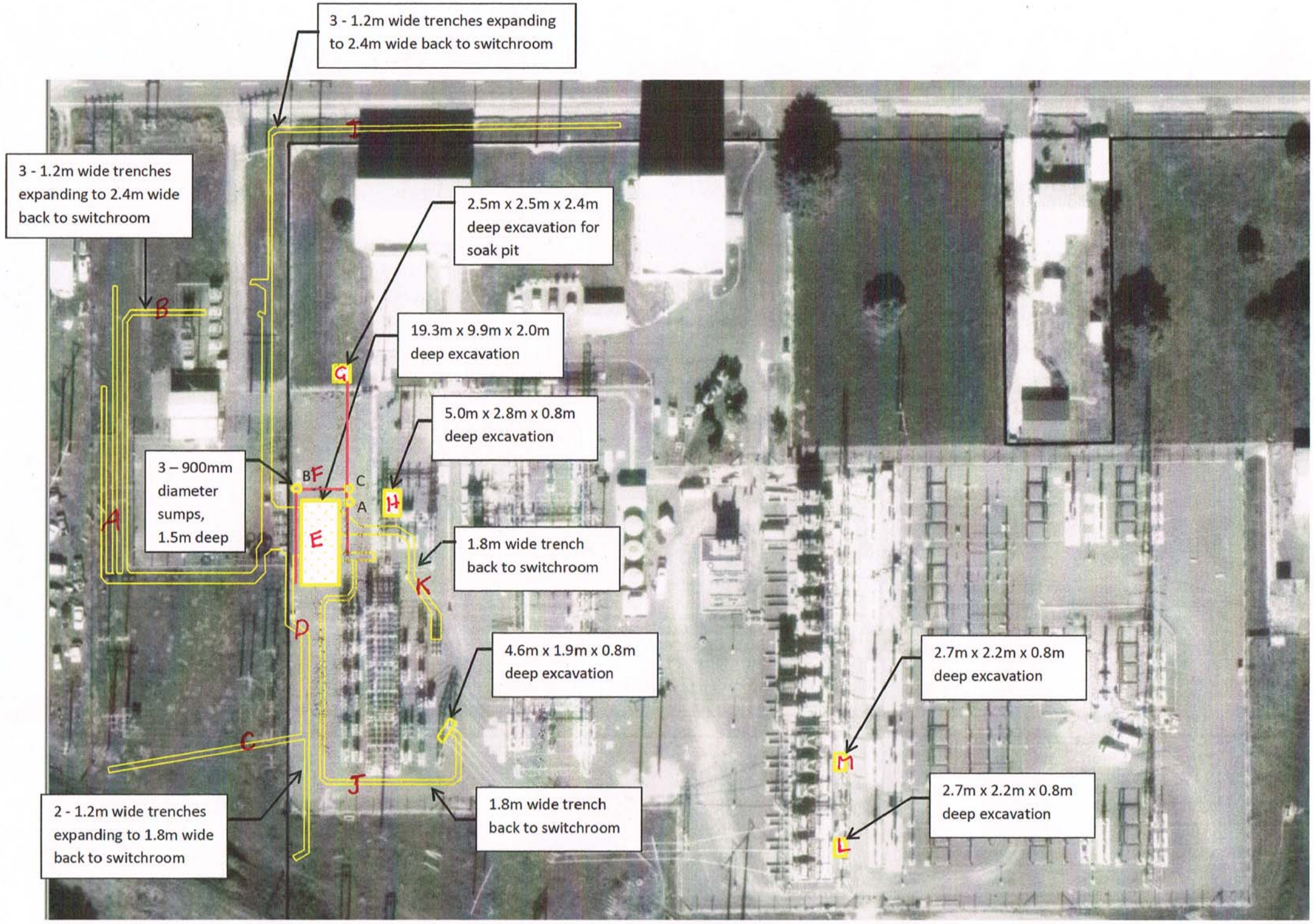
Survey Plan 298
Sheet 1 of 1
Printed 28/07/2014

Figure 2: Investigation and Cross Section Locations

Ice Geo

Appendix A

Subsurface Information



C trench or structure

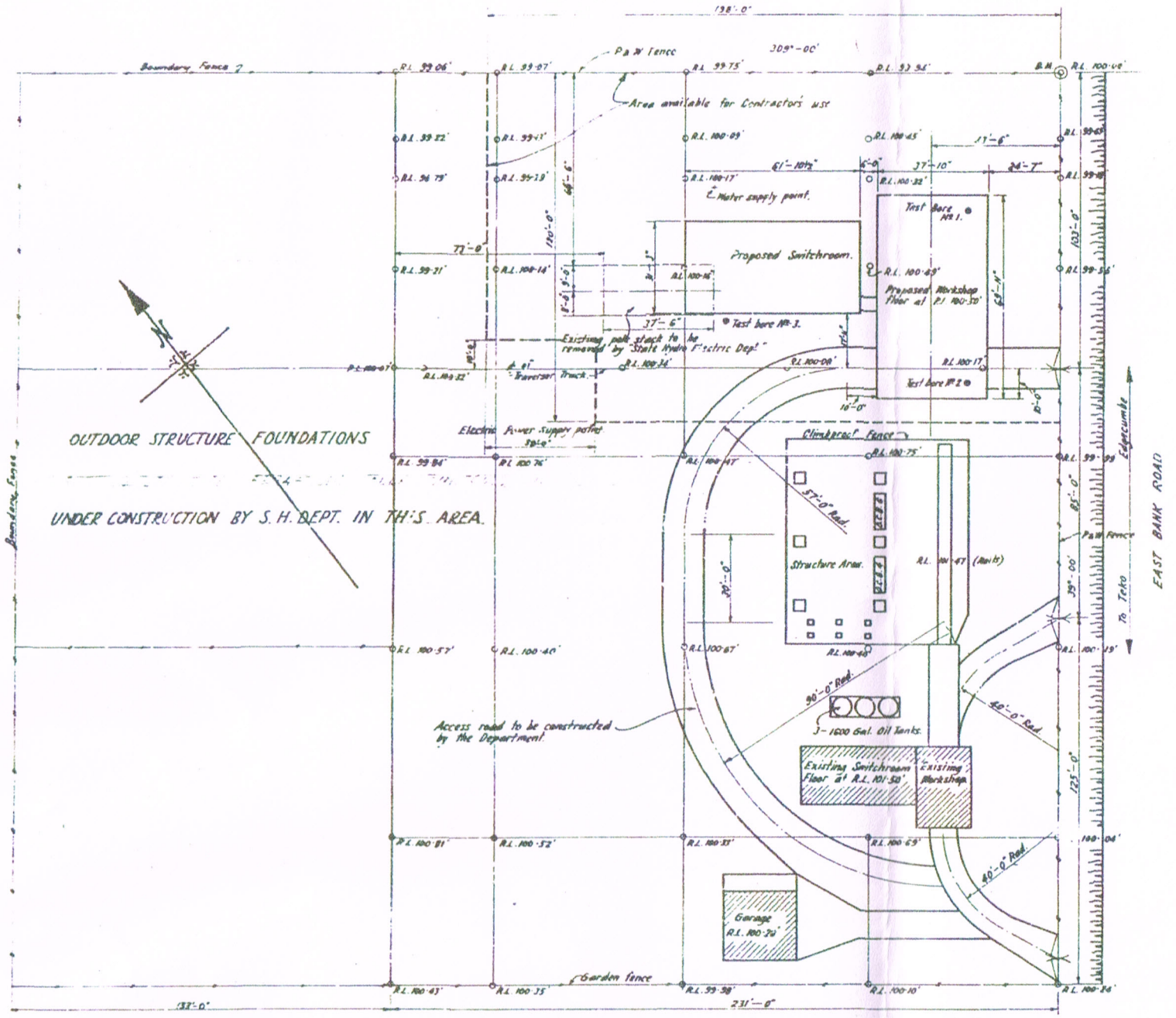
Note: All trenches to be 1m deep.

A batter allowance has been added to the excavation dimensions noted above.

Disturbed Soil shown as a red line

EDG – Excavations Required for the 33kV Indoor Conversion - rev. C (soak pit/sumps/disturbed soil added, pole locations confirmed)

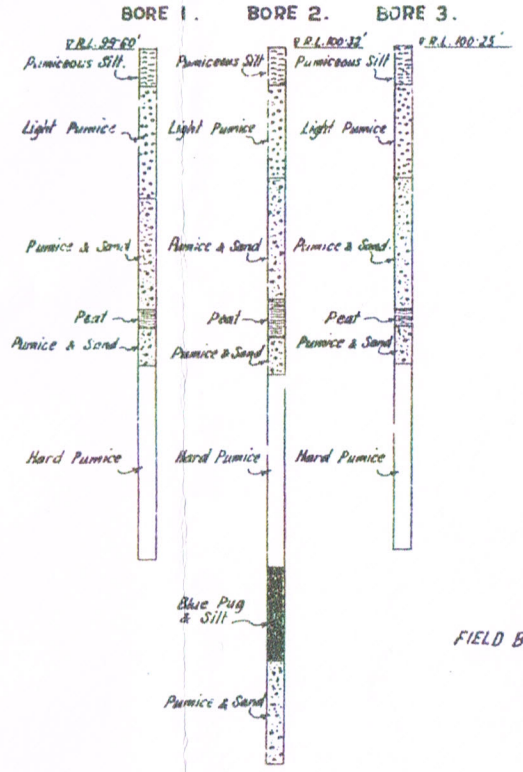
X1439



LOCALITY PLAN OF EXISTINS AND PROPOSED BUILDINGS.
SCALE:- 1 IN. = 20 FT.
Site information and ground levels adapted from Drgs: E^RN. 463 & E4201.

NOTE:-
1. All levels are ± terms of the B.M. at R.L. 100·00' in the East corner of the Site.
2. For details of test bores and piles see T.D.C 5327

PLAN REFERENCES:-
1336. Workshop Building. General Layout.
1331. Details of Control Room and Switch Room.



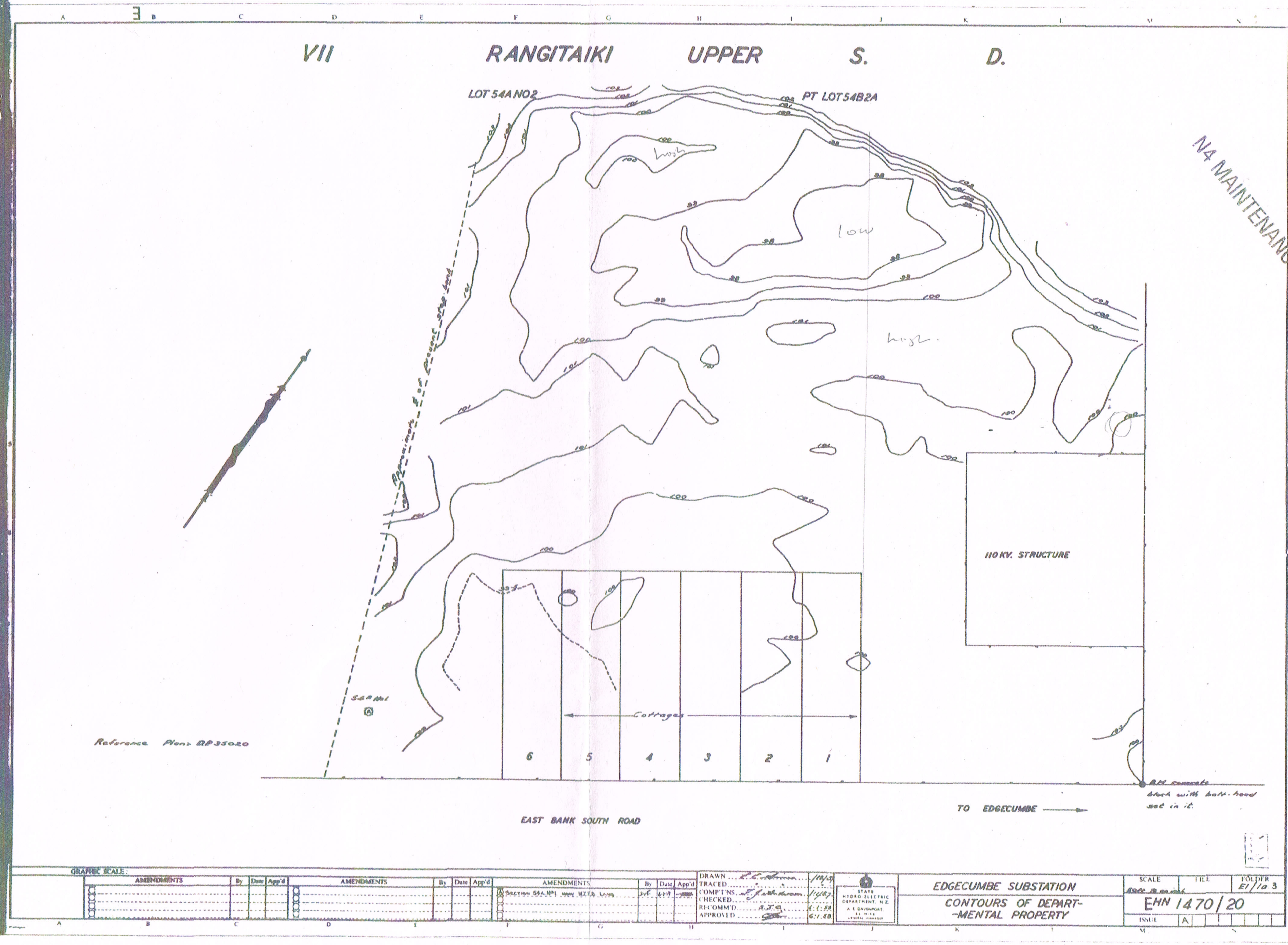
SCALE: 4 Feet to an Inch.
DETAILS OF TEST BORES.

FIELD BOOK 118.

N4 MAINTENANCE

② As Built

	③ As Built			EDGECUMBE SUBSTATION. CONTROL BLOCK & WORKSHOP BUILDINGS SITE PLAN.	SCALES As shown	FOLDER E1/181
						PLAN 92/15/10
					X1439.	
					ISSUE A	



VII RANGITAIKI UPPER S. D.
LOT 54A NO2
PT LOT54B2A
N4 MAINTENANCE
low
high
110 KV. STRUCTURE
Cottages
6
5
4
3
2
1
EAST BANK SOUTH ROAD
TO EDGECUMBE
B.M. concrete block with bolt-head set in it
Reference Plans DP35020
Approximate foot of present stop bank
EDGECUMBE SUBSTATION
CONTOURS OF DEPARTMENTAL PROPERTY
EHN 1470/20
FOLDER E1/10.3
ISSUE A
DRAWN
TRACED
COMPT'NS.
CHECKED
RECOMM'D.
APPROVED
AMENDMENTS
GRAPHIC SCALE
STATE HYDRO ELECTRIC DEPARTMENT, N.Z.

BORE HOLE LOG

BORE HOLE NO: BH 6

PROJECT: RANGITAIKI STOPBANK INVESTIGATION **LOCATION :** Base of Stopbank
RL GROUND(m) : **CO - ORDINATES :**
DATUM (m) :

PROJECT NO: 2-89030.01
LAB REF NO: 000TC

CORE DESCRIPTION *Rock or Soil Type ,* *Colour, Strength, Structure, Particle Size, Weathering* *Lithological Features, (bedding, foliation, texture, mineralogy, etc)*	Depth (m)	Graphic Log	ROCK DEFECTS / COMMENTS *Joints, bedding, seams, shear and crush Zones*	Water Level (Date)	Shear Strength (kPa)	SPT Values
Topsoil	0.10					
Light brown fine sandy SILT, pumiceous, firm, moist, current bedded	0.80					
Light brown silty fine to medium SAND, loose, moist, current bedded	1.10					
Greyish brown silty fine SAND, pumiceous, medium dense, moist, some iron staining, current bedded	1.50					
Light brown fine to medium SAND, pumiceous, loose to medium dense, moist, current bedded	2.50					
Greyish brown silty fine to medium SAND, loose to medium dense, moist, pumiceous, current bedded, minor iron staining	3.30		Water Table 3.0m	26/11/98		
Greyish brown medium to coarse SAND, loose to medium dense, wet, pumiceous, current bedded, minor iron staining, some pumice gravel up to 5mm dia.	5.60		SPT 5.50 - 5.95m			6//11/19 (N=20) 30
Grey silty very fine SAND, pumiceous, very dense, wet	6.40		SPT 5.95 - 6.40m			7//10/13 (N=23)
EOB - (Auger Refusal)						

Depth (m)

Driller : Perry Drilling
Operator : G Wright
Started : 26/11/98
Finished : 26/11/98

OPUS INTERNATIONAL CONSULTANTS

Tauranga Office
13 McLean Street
PO Box 646
Tauranga, New Zealand
Ph: +64 7 578 2089
Fax: +64 7 578 2086

Drilling Method: Hollow Stem Auger (100mm ID)
Sampling Method: Continuos Wire Line Split Spoon Sampling (750mm long x 75mm diameter)

		Checked	Date
Logged by :	M Burt	MB	26/11/98
Drawn by :	M Burt	MB	30/11/98

BORE HOLE LOG

BORE HOLE NO: **BH 7**

PROJECT: RANGITAIKI STOPBANK INVESTIGATION **LOCATION :** Base of Stopbank
RL GROUND(m) :
DATUM (m) :
CO - ORDINATES :

PROJECT NO: 2-89030.01
LAB REF NO: 000TC

CORE DESCRIPTION *Rock or Soil Type ,* *Colour, Strength, Structure, Particle Size, Weathering* *Lithological Features, (bedding, foliation, texture, mineralogy, etc)*	Depth (m)	Graphic Log	ROCK DEFECTS / COMMENTS *Joints, bedding, seams, shear and crush Zones*	Water Level (Date)	Shear Strength (kPa)	SPT Values
Topsoil	0.10					
Brown fine sandy SILT, firm, moist, current bedded	0.40					
Greyish brown SILT, firm, moist, minor sand, current bedded	1.00					
Greyish brown silty fine SAND, pumiceous, dense, moist, current bedded, some thin 10 - 20mm silt layers	3.20		Water Table 3.0m	26/11/98		
Dark grey silty fine SAND, dense, moist, current bedded	3.30					
LOST CORE						
Light grey medium to coarse SAND, loose to medium dense, pumiceous, current bedded	4.70					
Brown medium to coarse SAND, medium dense to dense, pumiceous, current bedded, minor gravel up to 5mm dia.	5.50					
Light greyish brown gravelly SAND, dense, saturated, curent bedded, pumice gravel up to 20mm dia.	6.50					
Light grey fine sandy SILT, very dense, wet, current bedded, some gravel up to 5mm dia.	7.50					
EOB - (Refusal)						

Graphic Log: Depth (m) 0.0, -0.5, -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, -7.5, -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, -14.5, -15.0

Driller : Perry Drilling
Operator : G Wright
Started : 26/11/98
Finished : 26/11/98

OPUS INTERNATIONAL CONSULTANTS

Tauranga Office
13 McLean Street
PO Box 646
Tauranga, New Zealand
Ph: +64 7 578 2089
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Drilling Method: Hollow Stem Auger (100mm ID)
Sampling Method: Continuos Wire Line Split Spoon Sampling (750mm long x 75mm diameter)

		Checked	Date
Logged by :	M Burt	MB	26/11/98
Drawn by :	M Burt	MB	30/11/98

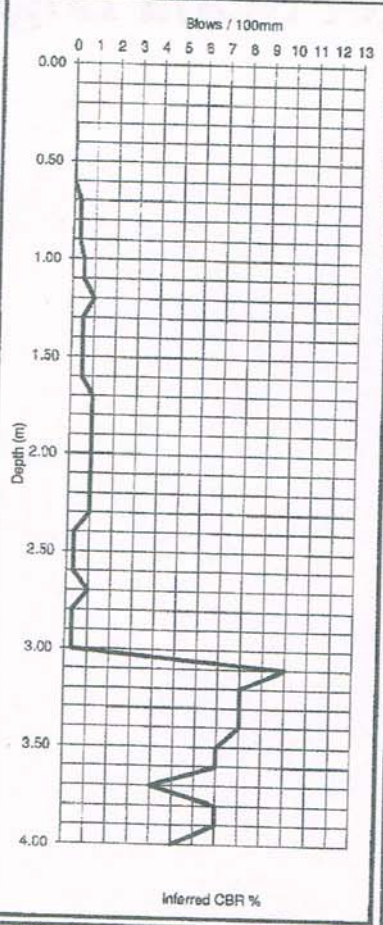
AUGER / SCALA PENETROMETER TEST REPORT

Location : **Edgecumbe Substation**
Client : **Transpower NZ Ltd.**
Contractor : **Opus**
Test number : **AS1**

Water level (m): **No groundwater observed.**

Project No : 2-32312.00
Lab Ref No : AS1
Client Ref No :

Scala Penetrometer



Test Results

Depth (m)	Shear Strength (kPa)	Soil Description
		Void from ground level to 0.25m depth. Testing commence from 0.25m.
0.25		Soft slightly sandy SILT, moist; brown.
0.50		Fine to medium SAND; light brown, some silt, with some fine to coarse, sub-rounded to rounded gravel. Moist, loose.
1.20		Becomes slightly clayey, silty SAND, wet, non plastic, dilatent
1.55		Becomes fine to medium SAND, some silt; grey brown.
2.30		Saturated
2.50		Soft, peaty SILT, peat is amorphous to fibrous; dark brown and is 20-50% of soil.
2.70		Light medium to coarse pumice SAND, hole closing. Medium dense.
2.80		End of Auger at 2.8m. Auger rotated in sand without progress

Test Methods

Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2 Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001	Field Descriptions of Soils and Rocks in Engineering Use, NZ Geomechanics Society, and inferred CBR % are not IANZ endorsed

Date tested : 17/02/2014
Date reported :

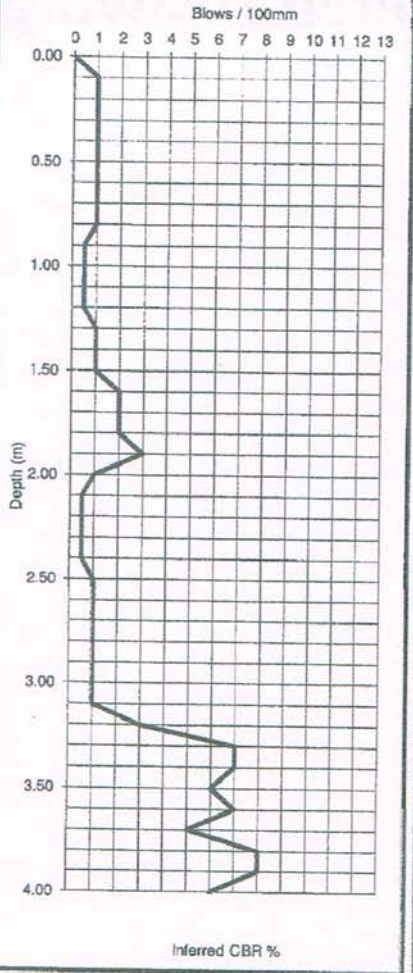
Designation : *Engineer*
Date :

AUGER / SCALA PENETROMETER TEST REPORT

Project : **Edgecumbe Substation**
Location : **Edgecumbe**
Client : **Transpower NZ Ltd.**
Contractor : **Opus**
Test number : **AS2**
Shear vane number :
Shear vane correction :
Water level (m):
Reduced level (m):

Project No : **2-32312.00**
Lab Ref No : **AS2**
Client Ref No :

Scala Penetrometer



Test Results

Depth (m)	Shear Strength (kPa)	Soil Description
		FILL: Gravel surfacing, brown.
0.35		TOPSOIL/SUBSOIL: Sandy silt, brown.
0.70		VOID
0.90		Sandy SILT, non plastic, soft, moist, dilatent; orange brown. Sand is fine.
1.45		Silty SAND, moist; brown grey, loose.
2.00		Moist/wet (0.9-2.6m)
2.60		Peaty SILT; dark brown, soft, peat is amorphous to fibrous Peat is 20 to 50% of soil.
3.10		Medium to coarse pumice SAND, some silt, wet, medium dense.
3.30		End of Auger at 3.3m. Auger rotated in sand without progress

Test Methods

Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2 Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001	Field Descriptions of Soils and Rocks in Engineering Use, NZ Geomechanics Society, and inferred CBR % are not IANZ endorsed

Date tested : 17/02/2014
Date reported :

Designation : *Engineer*
Date :

AECOM

LOG OF DRILLHOLE

HOLE IDENTIFICATION **DH01**

Client Transpower NZ Ltd
Project Contingency Spare Transformers
Project number 60100255

Co-ordinates
Orientation -90° Elevation
Location Edgecumbe Substation
Feature East side near transformer row

GEOLOGICAL DESCRIPTION (Weathering, Relative Strength, Colour, Name, Lithological Features, Stratigraphic Unit)	Test Records: Shear Vane residual - peak (0 - 200 kPa)	Test Records: N Values (0 - 50)	Drilling Method / Casing remarks	Core Loss/Lift (0 - 100%)	Depth	Graphic Log	MATERIAL DESCRIPTION (consistency, relative density, water content, plasticity, grading, etc)	Instrumentation
TOPSOIL: Topsoil.			HQ3				Sandy SILT; dark brown. Moist, soft to firm. Fine rare rootlets and pumice fragments (clasts ~2mm).	
UNDIFFERENTIATED ALLUVIUM: Mixed alluvium - sand and silt beds with rare organic and clay beds. Low energy fluvial sediments.			HQ3		1		Fine to medium SAND; light grey brown mottled orange brown. Moist, loose.	
		SS 3,5,6 N=11	SPT				Fine to medium SAND with some fine to medium pumice gravel; light grey and grey brown. Moist, loose. Pumice clasts slightly to moderately weathered, subangular.	
			HQ3		2			1
		SS 4,5,6 N=11	SPT		3		100mm thick bed of fine to coarse Pumice GRAVEL; whitish grey. Clasts slightly to moderately weathered. Moist, loose.	
			HQ3				Gravelly coarse SAND; light yellow brown to grey brown. Pumiceous. Sand uniformly grade. Gravel subangular to subrounded.	
					4		4.0 to 4.2m grades to dark orange brown.	
		SS 4,7,15 N=22	SPT					
			HQ3		5			
							5.5m, 20mm bed of coarse pumice SAND, whitish grey, clasts subrounded.	
		SS 8,10,13 N=23	SPT		6		5.6m, grades to dark grey with white pumice clasts.	
			HQ3		7			
		SS 10,13,16 N=29	SPT				SILT; dark grey. Pumiceous, rare black carbonsied wood fragments. Moist, firm to stiff.	
					8		Pumiceous fine SAND; dark grey. Minor pumice clasts. Moist, medium dense.	
			HQ3				SILT with minor fine gravel; dark grey. Moist, medium dense. Gravel is black.	
							Fine SAND; dark grey. Moist, firm to stiff.	
							at 8.55m a 20mm bed of medium pumice sand.	
		SS 2,2,4 N=6	SPT		9		grades to fine sand with some silt, rare pumice clasts (~2mm)	
			PT				grades to medium to coarse, pumiceous, light grey.	
							SILT; light grey and light grey. Moist, firm to stiff, pumice derived. Thin black carbonised layer and black lithics.	
					10		Silty medium to coarse SAND; dark grey. Moist. grades to clayey SILT; greenish light grey. Moist, slightly plastic, black lithics.	
			HQ3				Clayey SILT and Pumiceous coarse SAND.	
							Coarse pumiceous SAND rare fine pumice gravel; dark grey.	

GROUNDWATER OBSERVATIONS

Depth	Piezometer	Reading	Date
2.9m	1		28/07/2009

Date logged 27/07/2009
Logged JMT
Checked RGK

Casing Details
Depth Diameter

Remarks
Static water level measured in hole prior to recommencement of drilling on 28/07/2009.

Hand held Shear Vane
Vane number GEO160 Blade 19mm Factor 1.592
vane shear strength per NZGS guideline

Driller Perry
Started 27/07/2009
Drill Rig Tractor Rig
Finished 28/07/2009
Core Boxes 6

DRILLHOLE LOG SOIL EDGECUMBE SUBSTATION.GPJ BASE.GDT 05/08/09

Date Printed: 5/08/2009

AECOM

LOG OF DRILLHOLE

HOLE IDENTIFICATION **DH01**

Client Transpower NZ Ltd
Project Contingency Spare Transformers
Project number 60100255

Co-ordinates
Orientation -90° Elevation
Location Edgecumbe Substation
Feature East side near transformer row

GEOLOGICAL DESCRIPTION (Weathering, Relative Strength, Colour, Name, Lithological Features, Stratigraphic Unit)	Test Records (Shear Vane residual - peak 0 - 200 kPa; N Values 0 - 50)	Drilling Method / Casing remarks	Core Loss/Lift (0 - 100%)	Depth	Graphic Log	MATERIAL DESCRIPTION (consistency, relative density, water content, plasticity, grading, etc)	Instrumentation
UNDIFFERENTIATED ALLUVIUM Mixed alluvium - sand and silt beds with rare organic and clay beds. Low energy fluvial sediments.	SS 1,1,2 N=3	SPT		11		Rootlets and wood fragments. Moist, loose, uniformly graded.	
		PT				SILT with rare fine sand and clay; dark greenish grey. Moist, slightly plastic, roots and fine carbonised specks.	
		HQ3				11.55m, grades to silty fine SAND; greenish grey. Moist, loose. Roots, wood fragments.	
	SS 2,2,3 N=5	SPT		12		Clayey SILT/Silty CLAY; dark grey brown. Moist, slightly to moderately plastic, firm, rare pumice clasts.	
		HQ3		13		Alternating bands of Fine SAND and SILT; dark greenish grey. Non to slightly plastic, moist, soft to firm.	
	SS 3,6,13 N=19	SPT					
		HQ3		14		Fine SAND; dark greenish grey. Moist, dense. 14.95m, a 10mm band of dark brown staining and wood fragments.	
	SS 11,50 for 50mm Rods jammed N>50	SPT		15		15.0m, grades to coarse pumiceous SAND with some pumiceous fine gravel. Loose to medium dense. Pumiceous fine gravel and black subangular fine gravel. Pumice clasts moderately to highly weathered.	
		HQ3		16		Silty fine SAND; light grey and dark grey brown mottled. Moist, firm/medium dense, non plastic.	
	SS 13,15,9 N=24	SPT				Coarse pumiceous SAND with minor to some pumiceous fine gravel; dark grey. Moist, medium dense, uniformly graded. Pumice gravel becomes more dominant at 17.5m. at 17.65m a 10mm band of fine to coarse SAND.	
		HQ3		17			
	SS 3,4,7 N=11	SPT		18		Clayey organic SILT; light and dark grey brown. Decomposed organic matter. Moist, soft to firm. at 18.8m minor to some pumice gravel, a 50mm layer of fibrous organic matter.	
		HQ3		19		Fine to medium SAND; light grey. Pumiceous. Moist, medium dense.	
	SS 10,21,28 N=49	SPT				SILT with minor fine sand; greenish light grey and dark grey brown. Moist, firm.	
				20		at 19.25m grades to silty fine SAND, light greenish grey, moist, medium dense. from 19.35m with black organics. from 19.5m minor to some fine pumice clasts. Pumice fine to medium, completely weathered (breaks down in fingers).	
						DH01 terminated at 19.95m	

GROUNDWATER OBSERVATIONS
Depth Piezometer Reading Date

Date logged 27/07/2009
Logged JMT
Checked RGK

Casing Details
Depth Diameter

Remarks
Static water level measured in hole prior to recommencement of drilling on 28/07/2009.

Hand held Shear Vane
Vane number GEO160 Blade 19mm Factor 1.592
vane shear strength per NZGS guideline

Driller Started
Perry 27/07/2009
Drill Rig Finished
Tractor Rig 28/07/2009
Core Boxes 6

Date Printed: 5/08/2009

DRILLHOLE LOG SOIL EDGECUMBE SUBSTATION.GPJ BASE.GDT 05/08/09

Beca

B RE LE No: **BH01**

S EET 1 of 3

MACHINE BOREHOLE LOG

PR ECT: Edgecumbe 33kV utdoor to Indoor — B NUMBER: 2862484

SITE L CATI N: Edgecumbe Substation — CLIENT: Transpo er Ne ealand Ltd

CIRCUIT:

C RDINATES: N E

B RE LE L CATI N: Substation

R L:

DATUM: Moturiki

DRILLING: FLUID L SS	ATER LEVEL	C RE REC VER	MET D	RQD	CASING	IN-SITU TESTS: SV	τ (kPa)	SPT N	SAMPLES	DEPT (m)	GRAP IC L G	USCS	M ISTURE	S IL/R C DESCRIPTI N	GE L GICAL UNIT	DEPT (m)
		100 %	TT							0.0		GP	M	Dense GRAVEL; dark grey; moist, non plastic. Gravel: poorly graded, angular.	Dune sand	0
												L	M	[Basecourse].		
										0.6		SP	D	Soft organic SILT, minor clay; black; moist, lo plasticity. [Topsoil].		
														Very loose, fine to medium SAND; bro nish orange; dry, non plastic.		
		33 %	SPT					2 2 2 3 3 3		1.6		S		Medium dense, fine to coarse SAND; dark grey speckled hite; et, non plastic.	Undifferentiated Alluvium	1
		95 %	TT					N 11		2.0						2
														Minor fine gravel. Gravel: poorly graded, subrounded pumice.		
		67 %	SPT					2 2 2 2 3 3				SP	M	Medium dense, fine gravelly medium to coarse pumice SAND; light grey; moist, non plastic. Gravel: poorly graded, subangular to subrounded pumice.		3
		100 %	TT					N 10		3.8						
										4.0		M	M	Soft, clayey SILT, minor fine sand; dark bro n; moist, high plasticity.		4
														Very thin lens of fine to medium pumice sand; dark grey; moist, non plastic.		
										4.6			M	Soft, organic SILT, some clay; black; moist, high plasticity. rganics: amorphous and fibrous. [5].		
		78 %	SPT					1 1 1 1 2 3				S	M	et.		
		95 %	TT					N 7		5.0				Loose, fine gravelly fine to coarse pumice SAND; greyish bro n; moist, non plastic. Gravel: poorly graded, subrounded, pumice. Very thin lens of organic SILT, high plasticity; black; moist, high plasticity.		5
												SP	M	Medium dense, fine SAND, minor silt; grey; moist, non plastic.		
												ML	M	Medium dense, SILT, minor fine sand; grey; moist, non plastic.		6
		89 %	SPT					3 4 5 5 4 4		6.0		S	M	Medium dense, fine to coarse pumice SAND, minor fine gravel; grey; moist, non plastic. Gravel: poorly graded, subrounded pumice.		
		100 %	TT					N 18								
										7.0		ML	M	Medium dense, fine sandy SILT; grey; moist, non plastic.		7
														Very thin lens of fine gravel, coarse pumice SAND; light grey; moist.		
		78 %	SPT					5 5 4 4 7 8				SP	M	Medium dense, fine SAND; moist, non plastic. Some silt.		
		95 %	TT					N 23		8.0		ML	M	Medium dense, SILT, minor fine sand, minor clay; grey; moist, lo plasticity.		8
												SP	M	Medium dense, fine SAND, minor silt; grey; moist, non plastic.		
														Some silt.		
		0 %	SPT					1 1 1 1 1 2		9.0		M	M	Very thin lens of fine to medium pumice SAND; light grey; moist, non plastic.		9
		100 %	TT					N 5						Firm clayey SILT, some fibrous organics; hite speckled black; moist, high plasticity, sensitive.		

DATE STARTED: 22/8/11 — DRILLED B : Perry Drilling Ltd

DATE FINIS ED: 22/8/11 — EQUIPMENT: ohn Deere Tractor Rig

L GGED B : — DRILL MET D: Rotary ireline

S EAR VANE No: GE 950 — DRILL FLUID: BioVis

DIAMETER/INCLINATI N: 96 mm / 90

C MMENTS:

F R E PLANATI N F S MB LS AND ABBREVIATI NS SEE E S EET

Revision A

A4 Scale 1:50

MAC INE B RE LE P: 286 2862484 TGE GE TEC NICAL INVESTIGATI N GINT EDGECUMBE SUBSTATI N.GP BECA.GDT 29/8/11

MACHINE BOREHOLE LOG

BORE LE No: **BH01**

SHEET 2 of 3

PROJECT: Edgecumbe 33kV Outdoor to Indoor

JOB NUMBER: 2862484

SITE LOCATION: Edgecumbe Substation

CLIENT: Transpower New Zealand Ltd

CIRCUIT:

COORDINATES: N
E

BORE LEVEL LOCATION: Substation
RL:
DATUM: Moturiki

DRILLING						IN-SITU TESTS										
FLUID LOSS	WATER LEVEL	CORE REC/VER	METHOD	ROD	CASING	SV	T (kPa)	SPT N	SAMPLES	DEPTH (m)	GRAPHICLOG	USCS	MOISTURE	SOIL/ROCK DESCRIPTION	GEOLOGICAL UNIT	DEPTH (m)
		100 %	TT									M	M	Soft clayey SILT, some fibrous organics; white; moist, high plasticity, sensitive.		
		22 %	SPT			8/2	12/3	1 1 1 0 1 0 0 N 2		11						11
		86 %	TT											Fresh wood for 100mm. No sand.		
														Trace amorphous organics; brownish grey, moderately sensitive.		
		100 %	SPT			20/14	31/9	0 1 0 0 1 1 N 2		12						12
		100 %	TT													
		89 %	SPT			44/12	69/19	1 1 2 5 5 4 N 16		13		C	M	Stiff silty CLAY; light greenish grey; moist, high plasticity, moderately sensitive. Thin lens of fine sandy SILT; moist.		13
		100 %	TT							14						14
		89 %	SPT					1 2 1 3 7 8 N 19				SP	M	Medium dense, fine SAND, some silt; light brown banded dark grey; moist, non plasticity. No silt; fine to medium sand.		
		100 %	TT							15						15
		89 %	SPT					4 3 3 3 4 4 N 14				S	M	Medium dense, fine gravelly fine to coarse SAND; grey speckled white; moist, non plastic. Thin lens of fine SAND; dark grey; moist, non plastic. Fine to medium gravel. Gravel: poorly graded, subrounded, pumice and alluvium.		
		90 %	TT							16						16
		78 %	SPT			48/12	75/19	0 2 8 10 9 12 N 39		17		M	M	Stiff clayey SILT, some organics; dark brown; moist, high plasticity, sensitive. Organics: fibrous and amorphous, partially decomposed.		17
		86 %	TT							18		S	M	Dense, fine to coarse pumice SAND; grey; moist, non plastic.		18
		93 %	SPT					7 7 7 8		19		SP		Fine sand; grey. Minor silt.		19

Undifferentiated Alluvium *(Contd.)*

DATE STARTED: 22/8/11
DATE FINISHED: 22/8/11
LOGGED B:
SHEAR VANE No: GE 950

DRILLED B: Perry Drilling Ltd
EQUIPMENT: John Deere Tractor Rig
DRILL METHOD: Rotary Wireline
DRILL FLUID: BioVis
DIAMETER/INCLINATION: 96 mm / 90

COMMENTS:

FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE NOTES SHEET

Revision A

A4 Scale 1:50

MACHINE BORE LE P: 286 2862484 TGE GE TECHNICAL INVESTIGATION EDGECUMBE SUBSTATION.GPJ BECA.GDT 29/8/11

Beca

B RE LE No: **BH01**

MACHINE BOREHOLE LOG

S EET 3 of 3

PR ECT: Edgecumbe 33kV utdoor to Indoor
B NUMBER: 2862484
SITE L CATI N: Edgecumbe Substation
CLIENT: Transpo er Ne ealand Ltd

CIRCUIT:
C RDINATES: N
E
B RE LE L CATI N: Substation
R L:
DATUM: Moturiki

DRILLING: FLUID L SS	ATER LEVEL	C RE REC VER	MET D	ROD	CASING	IN-SITU TESTS: SV	T (kPa)	SPT N	SAMPLES	DEPT (m)	GRAP IC L G	USCS	M ISTURE	S IL/R C DESCRIPTI N	GE L GICAL UNIT	DEPT (m)
		100 %	TT					12 15 N 42				S	M	Stiff clayey SILT; light pinkish hite; moist, high plasticity.	Undifferentiated Alluvium (Contd.)	
												ML	M	Firm SILT, some fine sand, trace clay; light pinkish hite; moist, lo plasticity.		
												M	M	Stiff SILT, some clay, minor fine sand; light pinkish hite; moist, high plasticity, extra sensitive.		
		22 %	SPT					11 22 30 20 50mm N 50		21				Trace fine sand.		21
		100 %	TT									ML		Trace clay; light grey; saturated, lo plasticity. Liquefied.		
										22				Minor clay.		22
		56 %	SPT					10 13 15 15 15 5 for 10mm N 50		23						23
		95 %	TT									SP	M	Some fine to coarse sand. Very dense, medium to coarse pumiceous SAND; light grey; moist, non plastic.		
														Interlayered ith closely spaced SILT, minor clay; light grey; moist, lo plasticity.		
		100 %	SPT					10 12 12 13 13 12 for 65mm N 50		24		SP	M	Very dense, fine to medium SAND; black; moist, non plastic. Fine to coarse sand, trace fine pumice gravel. Trace organics: black, amorphous and fibrous.		24
														END F L G 24.45 m		
										25						25
										26						26
										27						27
										28						28
										29						29

DATE STARTED: 22/8/11
DATE FINIS ED: 22/8/11
L GGED B :
S EAR VANE No: GE 950

DRILLED B : Perry Drilling Ltd
EQUIPMENT: ohn Deere Tractor Rig
DRILL MET D: Rotary ireline
DRILL FLUID: BioVis
DIAMETER/INCLINATI N: 96 mm / 90

C MMENTS:

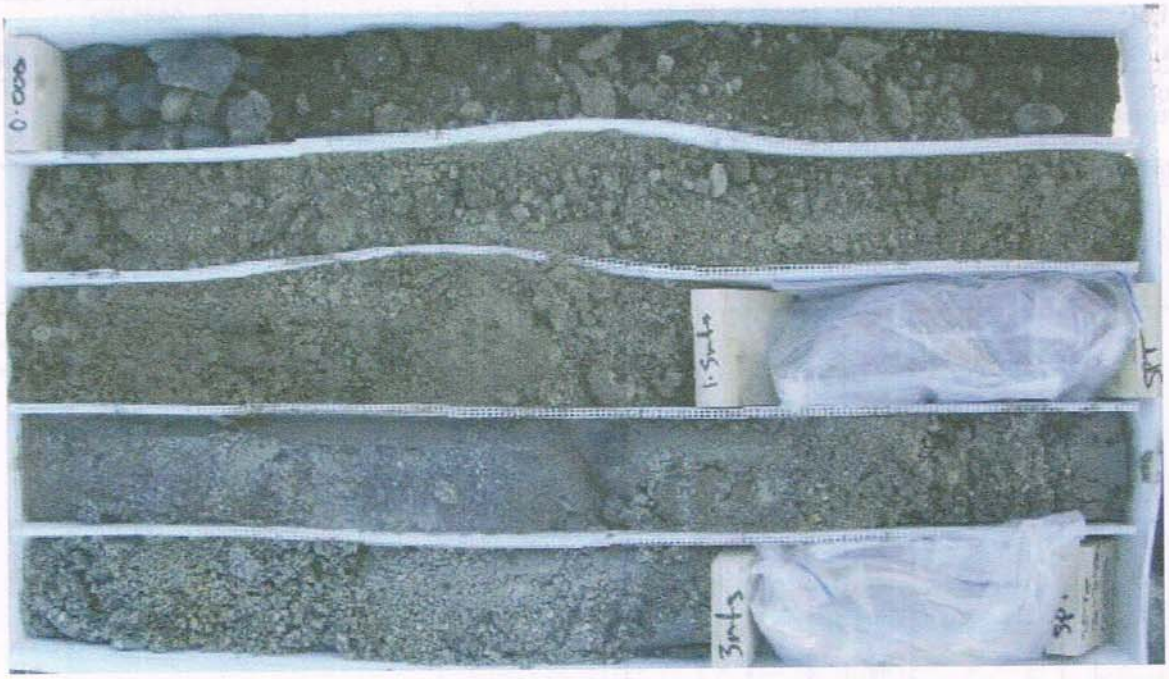
F R E PLANATI N F S MB LS AND ABBREVIATI NS SEE E S EET

Revision A

MAC INE B RE LE P: 286 2862484 TGE GE TEC NICAL INVESTIGATI N GINT EDGECUMBE SUBSTATI N.GP BECA.GDT 29/8/11

A4 Scale 1:50

Edgecumbe 33kV Outdoor to Indoor



BOX: 1

DEPTH: 0.0 to 3.5m

BOX: 2

DEPTH: 3.5 to 7.0m

BH01

Bore Hole Log

Borehole: BH1

Project: **Rangitaiki Stopbanks**
Client: **Environment Bay of Plenty**

Location: **Section 6**
Co-ordinates: East 0 North 0
Elevation: 7.40 Datum: Moturiki

depth (m)	elevation (m)	recovery (m)	graphic log	Classification	description	samp depth (m)	sample type	SPT result	Vane result (kPa)	other
0.00	7.35				brown **silty fine SAND**					
	6.95	100			brown / grey **medium to coarse pumice SAND**					
0.50					brown / grey **silty fine to medium SAND**, some coarse sand					
1.00		100								
1.50	5.90				brown / grey **fine sandy SILT**					
2.00	5.30	100			brown / grey **silty fine to medium SAND**, some coarse sand					
2.50										
	4.50									
3.00	4.40				lost					
	4.30				grey silty fine SAND / sandy SILT					
	4.15				brown **gritty SILT**, grit Tarawera Ash					
3.50		100			brown / grey with Fe mottles **clayey SILT**	3.5	dis.			
4.00	3.30				lost					
4.50	2.90				brown / grey with Fe mottles **clayey SILT**					
	2.60				grey fine **sandy SILT**, firm					
5.00	2.40				grey **silty fine SAND**, loose	5.1	dis.			
	2.20	100			grey with Fe staining **medium to coarse gravelly SAND**, trace silt, some bands fine lapilli to 1.5mm, with rounded grey and brown gravel to 2mm and lapilli to 3mm, rare gravel to 10mm	5.3	dis.			
5.50										
	1.50									
6.00	1.40				lost					
	1.00				grey with Fe staining **medium to coarse gravelly SAND**, trace silt, some bands fine lapilli to 1.5mm, with rounded grey and brown gravel to 2mm and lapilli to 3mm, rare gravel to 10mm					
6.50	0.95									
	0.90	60			**TIMBER**	6.6	dis.			
	0.88				brown **silty fine SAND**					
7.00					**TIMBER**					
					grey **pumice GRAVEL**, rounded and angular to 10mm, some charcoal fragments and fine sand					
7.50										
	-0.45									
8.00					grey pumice **fine sandy SILT**, firm					

Observations:

Vane no.
Core Dia. 68mm

Rig: Edson
Contractor: Perry

Date started:
Date finished: 05/08/2008
Logged by: MO'H

Bore Hole Log

Borehole: BH1

ICE GEO & CIVIL
A division of ICE CONSTRUCTION LTD

Project: **Rangitaiki Stopbanks**
Client: **Environment Bay of Plenty**

Location: **Section 6**
Co-ordinates: East 0 North 0
Elevation: 7.40 Datum: Moturiki

depth (m)	elevation (m)	recovery (m)	graphic log	Classification	description	samp depth (m)	sample type	SPT result	Vane result (kPa)	other
8.00	-0.70				grey pumice **SILT**, rare pumice to 5mm, 8.15 to 8.18m pumice fragements to 10mm, firm					
8.50	-1.20				grey **pumice GRAVEL**, rounded and angular to 10mm, some charcoal fragments and fine sand, rare pumice to 40mm, rare charcoal to 20mm					
	-1.40				lost					
9.00	-1.60				grey **pumice GRAVEL**, rounded and angular to 10mm, some charcoal fragments and fine sand, rare pumice to 40mm, rare charcoal to 20mm					
	-1.90				grey **pumice SILT**, stiff, some darker bands, brittle, some varved layers					
9.50		100			lost	9.5	dis			
10.00	-2.80				grey **pumice SILT**, stiff, some darker bands, brittle, some varved layers, 11.3m softer?					
10.50	-3.10				lost					
		100								
11.00	-3.90									
11.50										
12.00	-4.60									
	-4.70				grey **pumice SILT**, stiff, some darker bands, brittle, some varved layers, 11.3m softer?					
	-4.80				3mm fine pumice lapilli over green grey **CLAY**, plastic, medium to firm					
	-5.00				dark brown fibrous **organic material in CLAY**, some lapilli to 3mm					
12.50	-5.15	100			green grey **CLAY**, rounded **pumice GRAVEL** to 10mm and **timber**					
	-5.40				green grey **fine sandy SILT**, firm					
13.00	-5.60				green grey **CLAY** some fine fibres					
	-5.70				green grey **fine sandy SILT**					
13.50	-6.10				lost					
					green grey **fine sandy SILT/silty SAND**, firm, dliatant					
14.00	-6.60				grey **silty fine SAND**, some timber and organic material					
		100			brown **organic SILT**, spongy to stiff, layers of leaves, fine stems etc.	14.8	dis			
14.50	-7.10									
15.00	-7.60									
15.50										
16.00										

Observations:

Vane no. Core Dia. 68mm	Rig: Edson Contractor: Perry	Date started: Date finished: 05/08/2008 Logged by: MO'H

Project: **33kV Indoor Conversion**
Client: Transpower
Location: Edfecumbe Substation
Number:

Test: **HA1**

Elevation: 4.7
Date: 23/07/2014
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0				
	4.4		**organic gravelly fine sandy SILT**, brown, angular gravel to 50mm, stiff, damp	
0.5			**organic fine sandy SILT**, brown, firm, damp	
	4			
	3.9		fine **sandy SILT**, orange brown, light, damp	
	3.8		**silty fine SAND**, light orange brown, dense, damp	
1.0	3.7		fine **sandy SILT**, orange brown, light, damp	
			SILT, some clay, grey with Fe staining, firm, moist	
	3.3			
1.5			**silty fine SAND**, grey with Fe mottles, mod. dense, damp	
2.0				
2.5				
	1.95			
			pumice medium to coarse SAND and fine LAPILLI to 2mm, grey	
	1.8			
3.0			**pumice coarse SAND and fine LAPILLI**, grey	
3.5				
	1.05			
			EOB	
4.0				

ICE GEO & CIVIL
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Project: **33kV Indoor Conversion**
Client: Transpower
Location: Edfecumbe Substation
Number:

Test: **HA10**

Elevation: 4.8
Date: 24/07/2014
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**organic SILT**, trace fine sand, dark brown, firm, damp	
	4.25		**silty fine SAND**, grey brown, light, fluffy	
	3.55			
	3.5		pumice **LAPILLI** to 3mm, grey banded **medium to coarse SAND**, black and white speckled and pumice **coarse SAND / fine LAPILLI**, grey bands 20 to 50mm thick	
	2.8		**gravelly medium to coarse SAND**, lapilli to 6mm, hard rounded gravel to 8mm, grey and brown	dis.
	2.1			
	2		pumice **coarse SAND / fine LAPILLI,** grey	
			pumice **LAPILLI** to 2mm, some fine sand, grey, moist to wet	
	1.55		EOB	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

▼

ICE GEO & CIVIL
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Project: **33kV Indoor Conversion**
Client: Transpower
Location: Edfecumbe Substation
Number:

Test: **HA2**

Elevation: 4.75
Date: 23/07/2014
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0	4.72		hard **GRAVEL** to 30mm, grey	
	4.6		**gravelly fine silty SAND**, brown, dense	
			fine **sandy SILT**, brown/grey, firm, damp	
	4.4		fine **sandy SILT**, light brown, damp	
0.5	4.25		**silty fine SAND**, light brown grey, light, fluffy, damp	dis.
1.0	3.75		fine to medium **SAND,** trace silt, light brown with some Fe staining, damp to moist	
	3.5		1.15 50mm layer with fine pumice lapilli to 2mm	
			fine to medium **SAND**, some silt, grey, damp	
	3.35		pumice **medium to coarse SAND / fine LAPILLI** to 1mm, grey	
1.5				dis.
2.0				dis.
	2.55		pumice **coarse SAND / fine LAPILLI** to 1.5mm, damp	
			2.4m some hard rounded gravel to 5mm	
2.5	2.25		**coarse SAND and fine GRAVEL** to 10mm, brown	
3.0				dis.
	1.45		EOB	
3.5				
4.0				

ICE GEO & CIVIL
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Project: **33kV Indoor Conversion**
Client: Transpower
Location: Edfecumbe Substation
Number:

Test: **HA3**

Elevation: 4.9
Date: 24/07/2014
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**organic fine sandy SILT**, brown, firm, moist	
	4.6			
0.5			fine **sandy SILT**, brown grey, firm, damp	
	4.3			
			silty fine SAND / fine sandy SILT, brown, grey	
1.0				dis.
1.5				dis.
	3			
2.0			**silty fine SAND**, grey, moist to wet	
	2.7			
			medium to coarse **SAND**, grey speckled, moist	
2.5				dis.
	2.1			
	2		pumice **LAPILLI** to 2mm, grey	
3.0	1.9		coarse **SAND**, brown, grey	
			pumice **gravelly coarse SAND**, pumice to 5mm, grey, wet	
	1.6			
			EOB	
3.5				
4.0				

ICE GEO & CIVIL
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Project: **33kV Indoor Conversion**
Client: Transpower
Location: Edfecumbe Substation
Number:

Test: **HA5**

Elevation: 4.9
Date: 23/07/2014
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0	4.85		hard angular **GRAVEL** to 30mm	
	4.8		**gravelly fine sandy SILT**, brown, stiff, damp	
	4.6		fine **sandy SILT,** brown, firm, damp	
			SILT, some clay, brown grey, firm, damp	
0.5	4.4		fine **sandy SILT**, brown grey, firm, damp	
1.0	3.8		**silty fine SAND**, grey with Fe staining, mod. dense, damp	
1.5			1.35m 50mm layer with some fine pumice lapilli	
	3.2			
	3.1		banded **coarse SAND / fine LAPILLI with medium to coarse SAND**, grey	dis.
2.0			medium to coarse **SAND**, some hard rounded gravel to 5mm, brown grey, moist	dis.
	2.65		fine pumice **LAPILLI / coarse SAND**, orange	
	2.5		pumice medium to coarse **gravelly SAND**, orange and grey, moist	
2.5	2.3		pumice medium to coarse **SAND and LAPILLI** to 2mm, grey	dis.
3.0	1.85		EOB	
3.5				
4.0				

ICE GEO & CIVIL
A division of ICE CONSTRUCTION LTD

Project: **33kV Indoor Conversion**
Client: Transpower
Location: Edfecumbe Substation
Number:

Test: **HA6**

Elevation: 4.9
Date: 24/07/2014
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0	4.8		**organic silty SAND**, dark brown, firm, moist	
			silty medium to coarse SAND, brown, firm, damp, overlay	
0.5	4.4		**SILT,** some fine sand, some Tarawera Ash grit, dark brown, firm, damp	
1.0	3.9		**SILT,** trace fine sand, brown, firm, moist	
	3.7		**silty fine SAND**, brown grey, light, fluffy, damp	
1.5				
2.0				
2.5				
	2.1		fine to medium **SAND**, brown grey, damp	
3.0	1.9		medium to coarse **SAND**, orange and black, moist	
	1.8		medium to coarse **SAND**, grey speckled, wet	
			▼	
3.5	1.45		EOB	
4.0				

ICE GEO & CIVIL
A division of ICE CONSTRUCTION LTD

Project: **33kV Indoor Conversion**
Client: Transpower
Location: Edfecumbe Substation
Number:

Test: **HA7**

Elevation: 4.9
Date: 24/07/2014
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0	4.85		**silty fine SAND**, dark brown	
			silty fine to coarse SAND, brown, dense, damp, overlay	
	4.6		mixed overlay and topsoil, **organic silty fine to coarse SAND**, dense, brown	
0.5	4.3		**organic SILT**, trace fine sand, black, firm, damp, topsoil	
	4		**SILT**, trace fine sand, brown, firm, damp	
1.0				
1.5	3.4		**silty fine SAND**, brown grey, damp	
	3		**silty fine SAND**, grey, mod. dense, moist	
2.0				
2.5				
	2.2			
	2.15		pumice medium to coarse **SAND** and fine **LAPILLI**, grey	
	2		medium **SAND**, grey speckled, moist	
3.0			pumice coarse **SAND / fine LAPILLI**, grey, moist	
	1.85			
	1.82		**PEAT**, black, greasy amorphous	
	1.7		medium **SAND**, grey speckled, moist	
			pumice coarse **SAND and fine LAPILLI** to 4mm, grey	
	1.5			
3.5			**gravelly medium to coarse SAND**, hard rounded gravel to 5mm, grey brown, wet	
	1.2			
			EOB	
4.0				

ICE GEO & CIVIL
A division of ICE CONSTRUCTION LTD

Project: **33kV Indoor Conversion**
Client: Transpower
Location: Edfecumbe Substation
Number:

Test: **HA8**

Elevation: 4.8
Date: 23/07/2014
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0	4.7		medium angular hard **GRAVEL**, grey	
			SILT, some fine sand and clay, brown, firm, damp	
0.5				
1.0	3.8		**silty fine SAND**, light grey brown, mod. dense, damp	
1.5				
	3.2		medium to coarse **SAND**, grey speckled	
2.0				dis.
	2.7		pumice **gravelly medium to coarse SAND,** lappilli to 5mm, grey	
2.5				dis.
3.0				
	1.6			
▼	1.5		pumice **GRAVEL** to 4mm, orange, wet	
			EOB	
3.5				
4.0				

ICE GEO & CIVIL
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Project: **33kV Indoor Conversion**
Client: Transpower
Location: Edfecumbe Substation
Number:

Test: **HA9**

Elevation: 5.1
Date: 23/07/2014
Logged by: M. O'Halloran

Depth (m)	Elev(m)	Graphic Log	Description	Sample
0.0			**organic sandy SILT**, brown, firm, damp	
			0.5m some clay	
0.5	4.4		pumice **medium to coarse SAND / fine LAPILLI** to 1.5mm, orange brown, mod. dense,	
1.0	4.1		pumice and hard **coarse SAND**, some lapilli to 15mm, grey	dis.
			1.1m Fe rich layer	
1.5				
	3.35			
	3.3		pumice medium to coarse **SAND**, grey, mod. dense	
2.0	3.1		pumice **coarse SAND / fine LAPILLI** to 2mm, grey	
			medium **SAND**, orange and black, damp	
	2.9			
	2.85		pumice **fine sandy GRAVEL** to 10mm, grey, damp	
2.5			pumice **well graded SAND**, some silt and gravel to 10mm, grey, damp	dis.
3.0			3.1 moist	
	1.8			
	1.7		medium **SAND**, grey, wet	
3.5	1.6		pumice **coarse SAND / fine LAPILLI** to 2mm, wet	
			EOB	
4.0				

HAND AUGER SAMPLE AUGER LOGS.GPJ HAND AUGER SAMPLE.GDT 24/8/14

ICE GEO & CIVIL
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Appendix B

Particle Grading Results

Opus International Consultants Ltd
Tauranga Laboratory
278 Chadwick Road, Greerton
PO Box 9057, Tauranga 3142
New Zealand

t: +64 7 578 5425
f: +64 7 578 3382
w: www.opus.co.nz

19 August 2014

Dr M O'Halloran
Ice Geo and Civil
PO Box 11098
Papamoa 3151

14/534

Dear Marianne

Edgecumbe Substation

Attached are the results of particle size distribution tests carried out on five samples of sand & one sample of silt obtained from 4 boreholes at the Edgecumbe substation project.

The samples were received for testing on 1 August 2014 and all remaining materials will be disposed of unless a request to the contrary is received by 30 September 2014.

Regards

Bruce Hudson
Laboratory Manager

PARTICLE SIZE DISTRIBUTION TEST REPORT

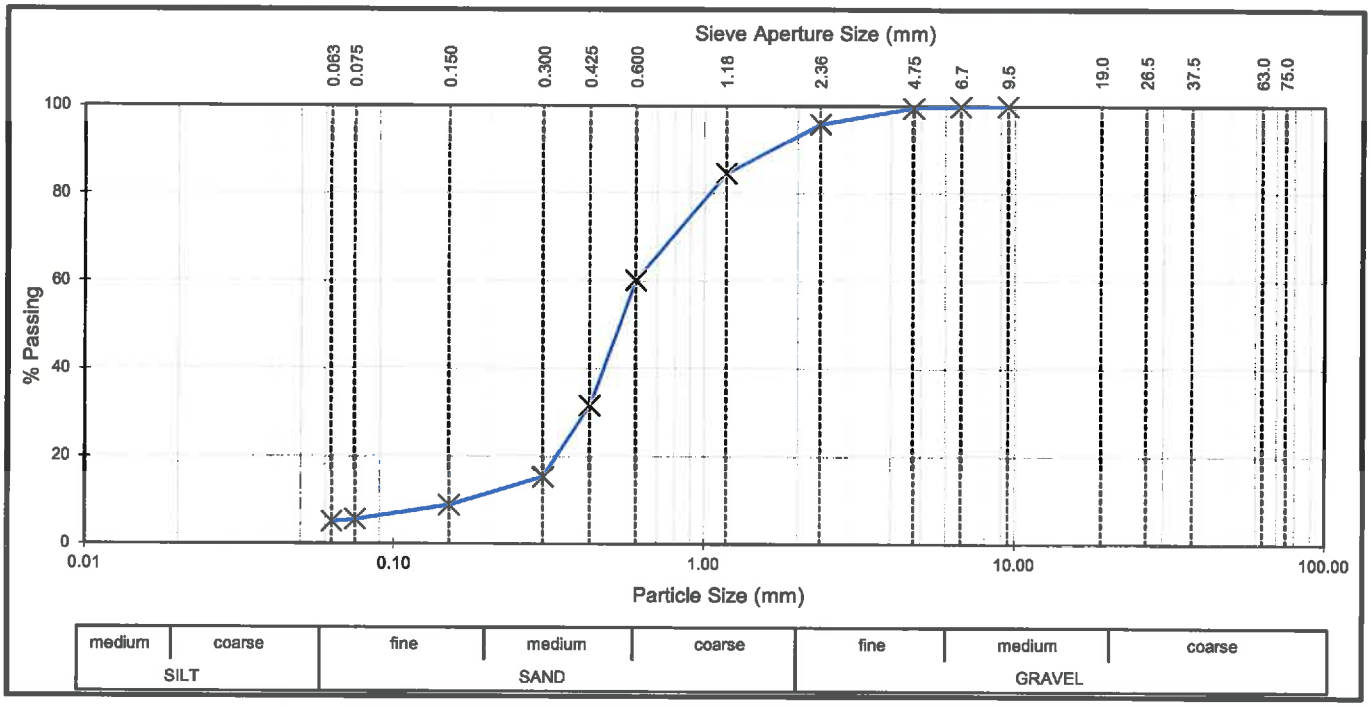
OPUS

Project :	**Edgecumbe Substation**
Location :	**Edgecumbe**
Client :	**Ice Geo & Civil**
Contractor :	**N/A**
Sampled by :	**Marianne O'Halloran (Ice Geo & Civil)**
Date sampled :	**Unknown**
Sampling method :	**Borehole**
Sample description :	**Fine - coarse SAND with traces of Gravel & fine Silt**
Sample condition	**Natural State (as received)**
Bore hole no :	**HA 2**
Depth :	**2.0 Metres**

Project No :	**255549.00/0TL**
Lab Ref No :	**14/534A**
Client Ref No :	**--**

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	2.36	**96**	0.300	**15**
63.00	-	9.50	**100**	1.18	**84**	0.150	**9**
37.50	-	6.70	**100**	0.60	**60**	0.075	**6**
26.50	-	4.75	**100**	0.425	**32**	0.063	**5**



Test Method	Notes
Particle Size Distribution - NZS 4402 : 1986 : Test 2.8.1	Percentage passing the finest seive was obtained by difference. This report may only be reproduced in full.

Date tested : 4 August 2014
Date reported : 19 August 2014

IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 19 August 2014

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Opus International Consultants Ltd
Tauranga Laboratory
Quality Management Systems Certified to ISO 9001

278 Chadwick Road, Greerton
PO Box 9057, Tauranga 3142, New Zealand

Telephone +64 7 578 5425
Facsimile +64 7 578 3382
Website www.opus.co.nz

PARTICLE SIZE DISTRIBUTION TEST REPORT

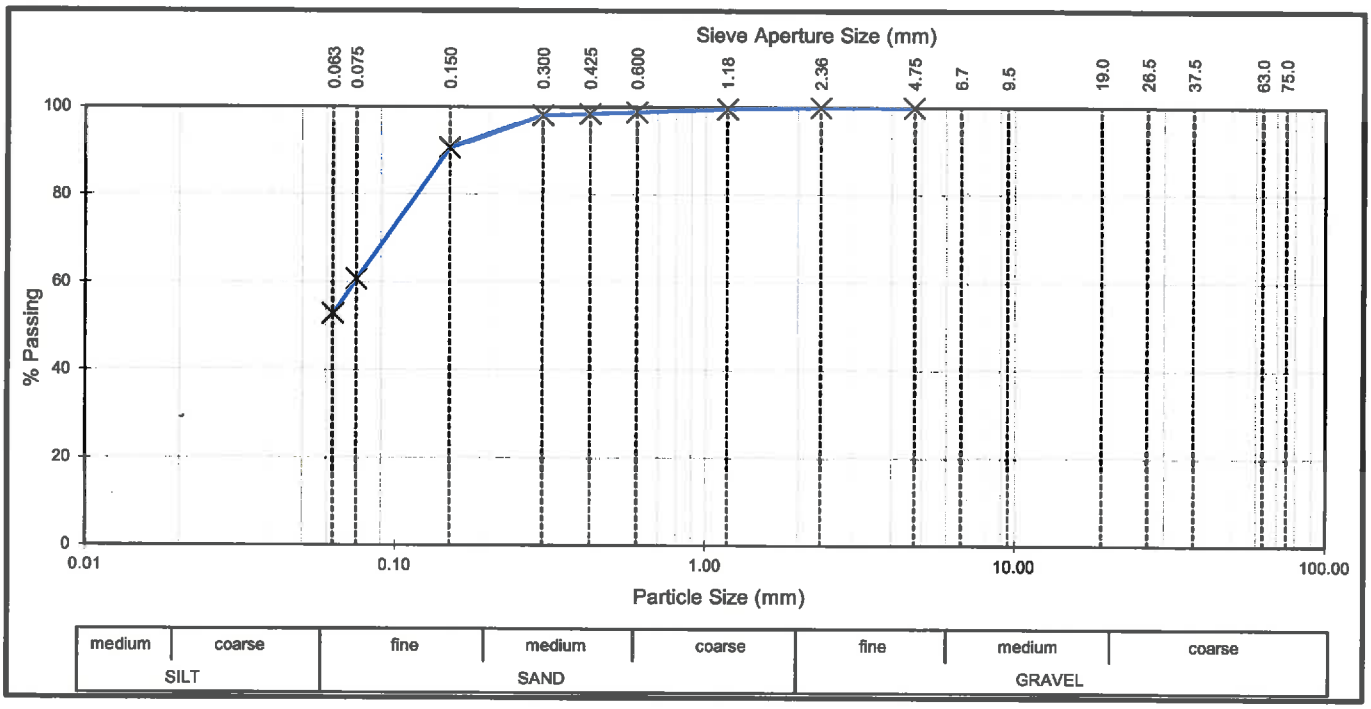
OPUS

Project :	**Edgecumbe Substation**
Location :	**Edgecumbe**
Client :	**Ice Geo & Civil**
Contractor :	**N/A**
Sampled by :	**Marianne O'Halloran (Ice Geo & Civil)**
Date sampled :	**Unknown**
Sampling method :	**Borehole**
Sample description :	**Fine - medium Sandy SILT**
Sample condition	**Natural State (as received)**
Bore hole no :	**HA 3**
Depth :	**0.9 Metres**

Project No :	**255549.00/0TL**
Lab Ref No :	**14/534B**
Client Ref No :	**--**

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	2.36	**100**	0.300	**98**
63.00	-	9.50	-	1.18	**100**	0.150	**91**
37.50	-	6.70	-	0.60	**99**	0.075	**61**
26.50	-	4.75	**100**	0.425	**99**	0.063	**53**



Test Method	Notes
Particle Size Distribution - NZS 4402 : 1986 : Test 2.8.1	Percentage passing the finest seive was obtained by difference. This report may only be reproduced in full.

Date tested : 4 August 2014
Date reported : 19 August 2014

IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 19 August 2014

IANZ ACCREDITED LABORATORY

Tests indicated as not accredited are outside the scope of the laboratory's accreditation

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PO Box 9057, Tauranga 3142, New Zealand

Telephone +64 7 578 5425
Facsimile +64 7 578 3382
Website www.opus.co.nz

PARTICLE SIZE DISTRIBUTION TEST REPORT

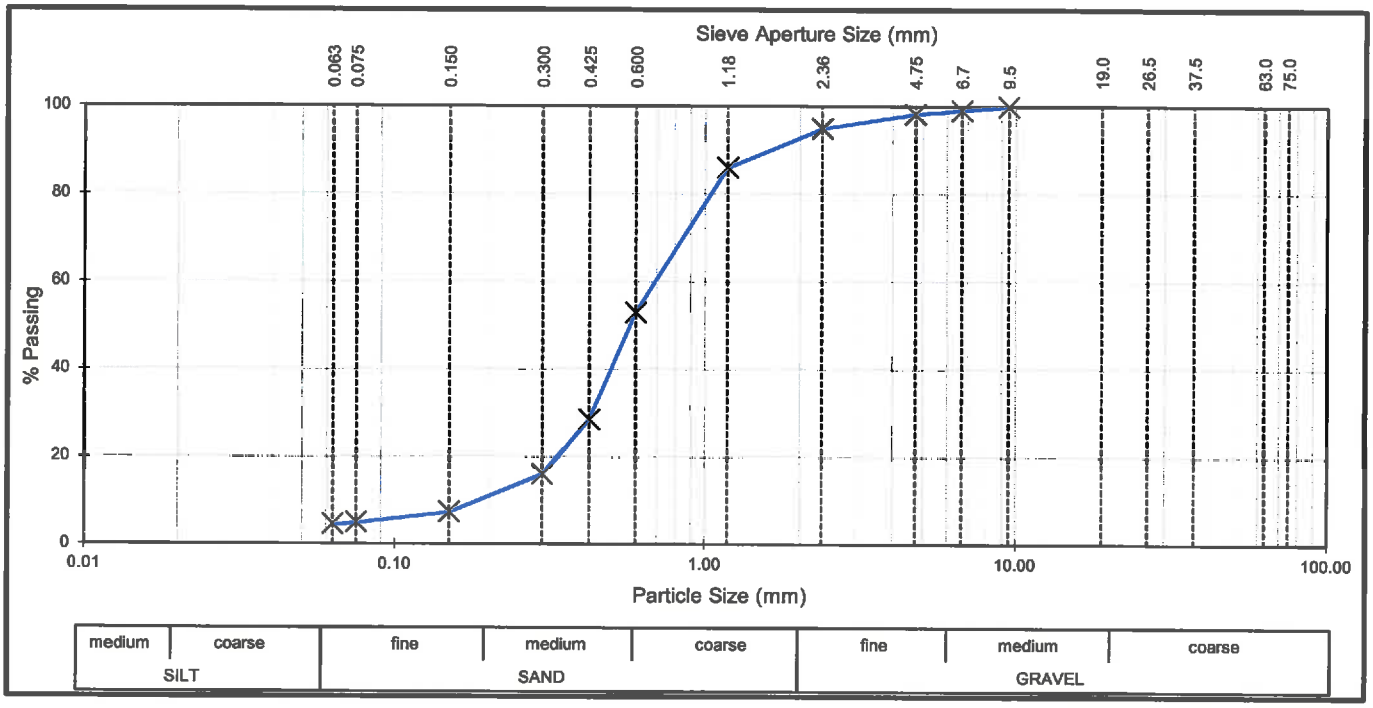
OPUS

Project :	**Edgecumbe Substation**
Location :	**Edgecumbe**
Client :	**Ice Geo & Civil**
Contractor :	**N/A**
Sampled by :	**Marianne O'Halloran (Ice Geo & Civil)**
Date sampled :	**Unknown**
Sampling method :	**Borehole**
Sample description :	**Fine - Coarse SAND with traces of Gravel & fine Silt**
Sample condition	**Natural State (as received)**
Bore hole no :	**HA 3**
Depth :	**2.5 Metres**

Project No :	**255549.00/0TL**
Lab Ref No :	**14/534C**
Client Ref No :	**--**

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	2.36	**95**	0.300	**16**
63.00	-	9.50	**100**	1.18	**86**	0.150	**7**
37.50	-	6.70	**99**	0.60	**53**	0.075	**5**
26.50	-	4.75	**98**	0.425	**29**	0.063	**5**



Test Method	Notes
Particle Size Distribution - NZS 4402 : 1986 : Test 2.8.1	Percentage passing the finest seive was obtained by difference. This report may only be reproduced in full.

Date tested : 4 August 2014
Date reported : 19 August 2014

IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 19 August 2014

IANZ ACCREDITED LABORATORY

Tests indicated as not accredited are outside the scope of the laboratory's accreditation

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PARTICLE SIZE DISTRIBUTION TEST REPORT

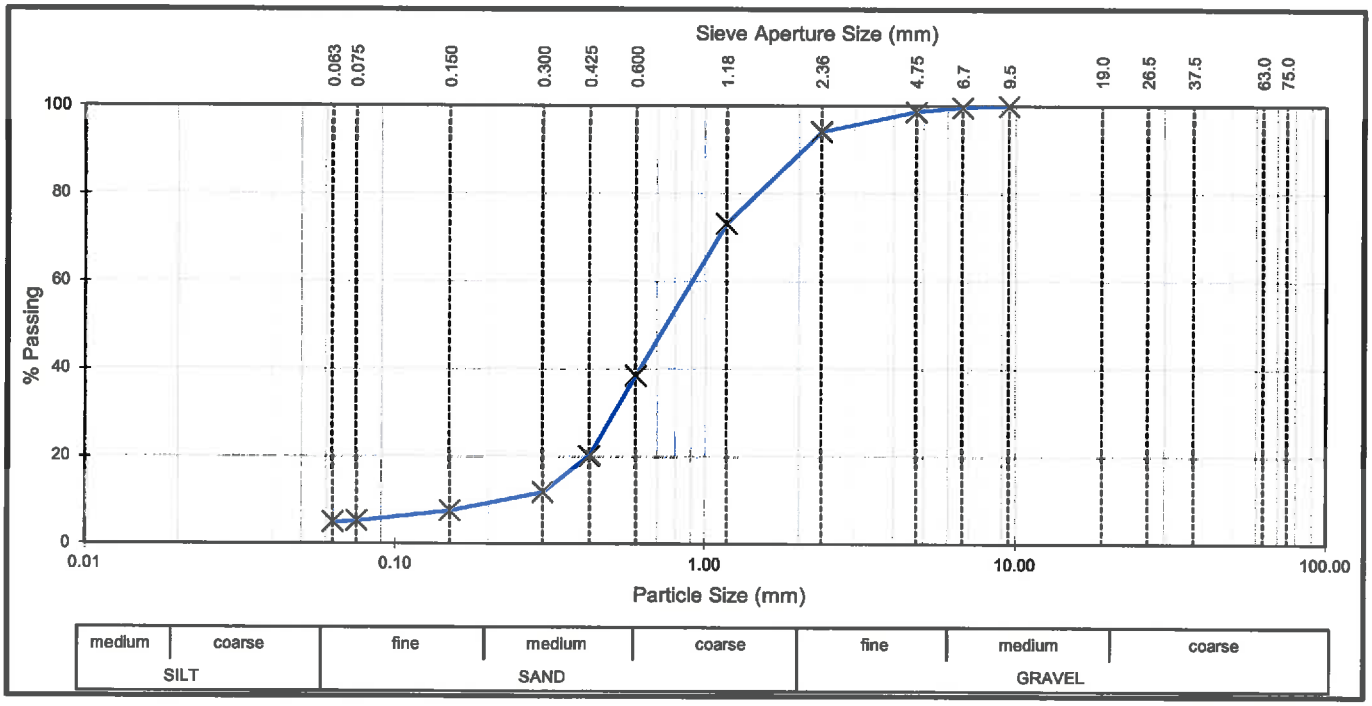
OPUS

Project :	**Edgecumbe Substation**
Location :	**Edgecumbe**
Client :	**Ice Geo & Civil**
Contractor :	**N/A**
Sampled by :	**Marianne O'Halloran (Ice Geo & Civil)**
Date sampled :	**Unknown**
Sampling method :	**Borehole**
Sample description :	**Fine - coarse SAND, minor fine Gravel, trace of Silt**
Sample condition	**Natural State (as received)**
Bore hole no :	**HA 9**
Depth :	**0.9 Metres**

Project No :	**255549.00/0TL**
Lab Ref No :	**14/534D**
Client Ref No :	**--**

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	2.36	**94**	0.300	**12**
63.00	-	9.50	**100**	1.18	**73**	0.150	**8**
37.50	-	6.70	**100**	0.60	**39**	0.075	**5**
26.50	-	4.75	**99**	0.425	**20**	0.063	**5**



Test Method	Notes
Particle Size Distribution - NZS 4402 : 1986 : Test 2.8.1	Percentage passing the finest seive was obtained by difference.
	This report may only be reproduced in full.

Date tested : 7 August 2014
Date reported : 19 August 2014

IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 19 August 2014

IANZ ACCREDITED LABORATORY

Tests indicated as not accredited are outside the scope of the laboratory's accreditation

Opus International Consultants Ltd
Tauranga Laboratory
Quality Management Systems Certified to ISO 9001

278 Chadwick Road, Greerton
PO Box 9057, Tauranga 3142, New Zealand

Telephone +64 7 578 5425
Facsimile +64 7 578 3382
Website www.opus.co.nz

PARTICLE SIZE DISTRIBUTION TEST REPORT

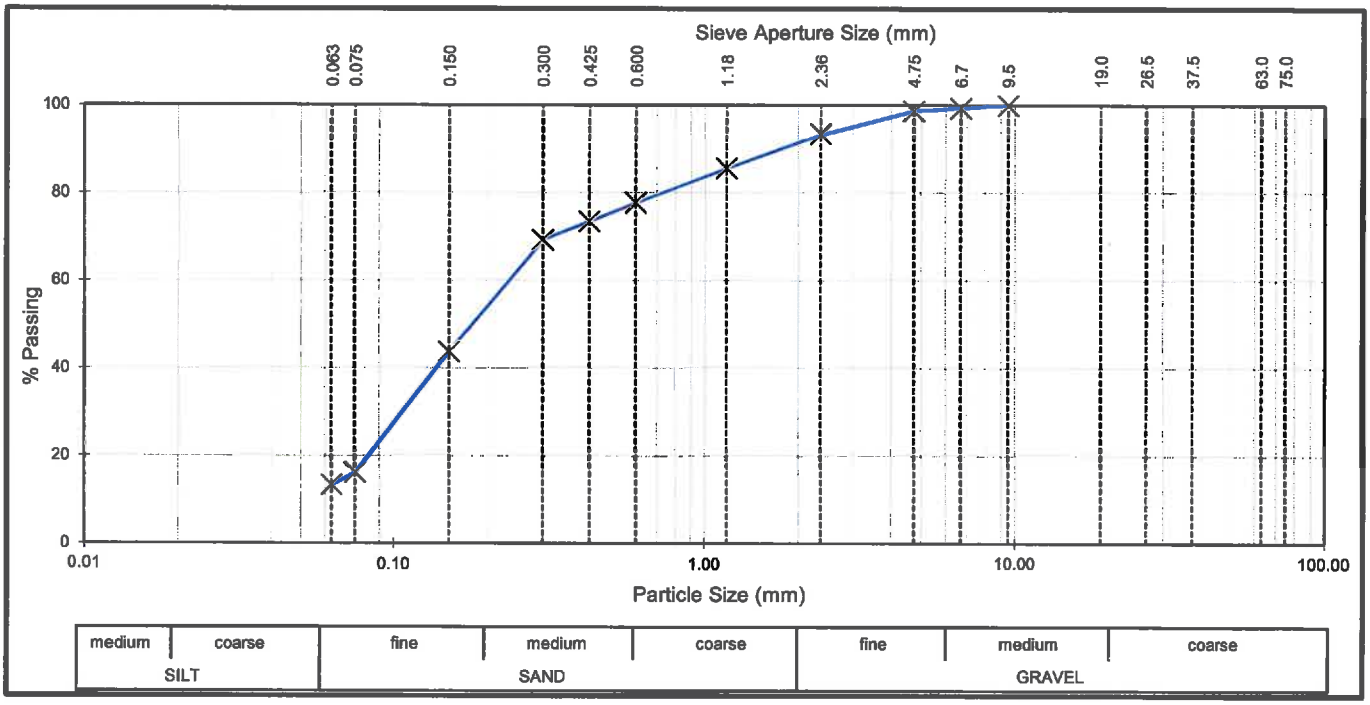
OPUS

Project :	**Edgecumbe Substation**
Location :	**Edgecumbe**
Client :	**Ice Geo & Civil**
Contractor :	**Unknown**
Sampled by :	**Marianne O'Halloran (Ice Geo & Civil)**
Date sampled :	**N/A**
Sampling method :	**Borehole**
Sample description :	**SAND with some Silt & minor fine Gravel**
Sample condition	**Natural State (as received)**
Bore hole no :	**HA 9**
Depth :	**2.5 Metres**

Project No :	**255549.00/0TL**
Lab Ref No :	**14/534E**
Client Ref No :	**--**

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	2.36	**93**	0.300	**69**
63.00	-	9.50	**100**	1.18	**86**	0.150	**44**
37.50	-	6.70	**99**	0.60	**78**	0.075	**16**
26.50	-	4.75	**99**	0.425	**73**	0.063	**13**



Test Method	Notes
Particle Size Distribution - NZS 4402 : 1986 : Test 2.8.1	Percentage passing the finest seive was obtained by difference. This report may only be reproduced in full.

Date tested : 13 August 2014
Date reported : 19 August 2014

IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 19 August 2014

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PARTICLE SIZE DISTRIBUTION TEST REPORT

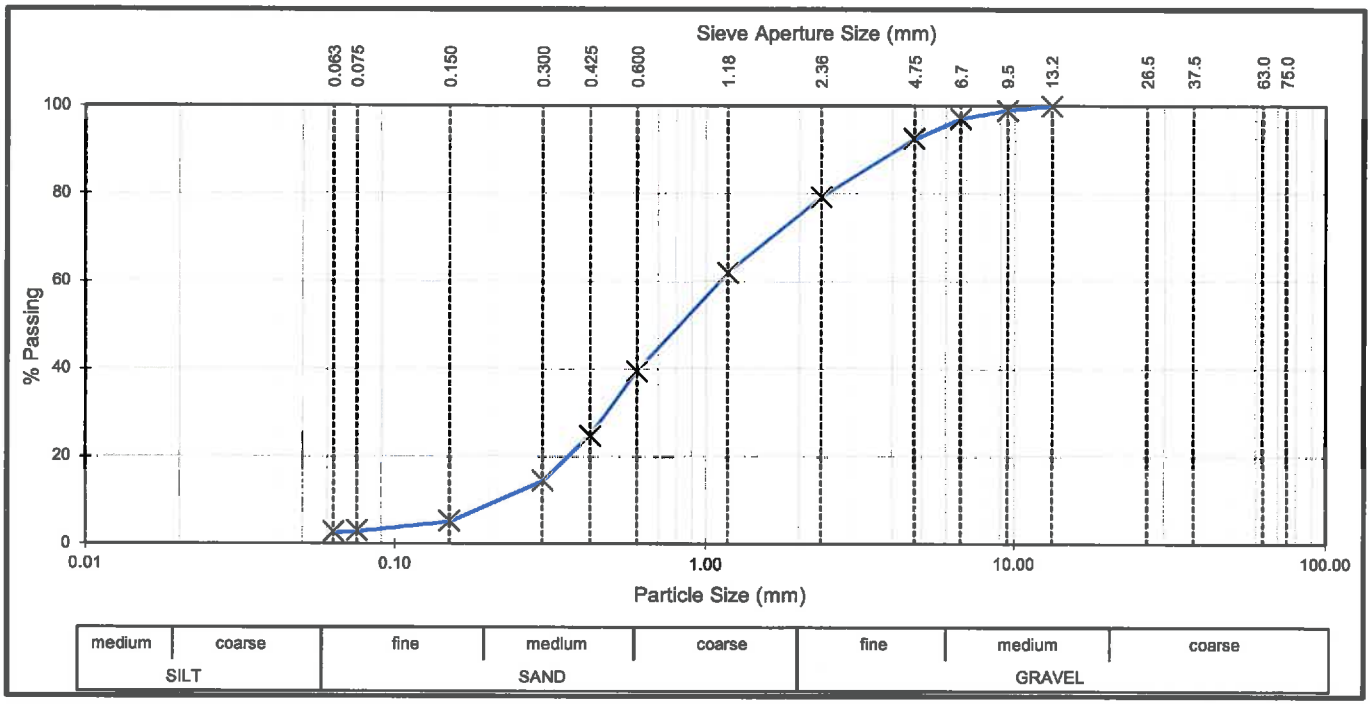
OPUS

Project :	**Edgecumbe Substation**
Location :	**Edgecumbe**
Client :	**Ice Geo & Civil**
Contractor :	**N/A**
Sampled by :	**Marianne O'Halloran (Ice Geo & Civil)**
Date sampled :	**Unknown**
Sampling method :	**Borehole**
Sample description :	**Gravelly SAND with a trace of Silt**
Sample condition	**Natural State (as received)**
Bore hole no :	**HA 10**
Depth :	**2.3 Metres**

Project No :	**255549.00/0TL**
Lab Ref No :	**14/534F**
Client Ref No :	**–**

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	13.20	**100**	2.36	**79**	0.300	**14**
63.00	-	9.50	**99**	1.18	**62**	0.150	**5**
37.50	-	6.70	**97**	0.60	**40**	0.075	**3**
26.50	-	4.75	**92**	0.425	**25**	0.063	**3**



Test Method	Notes
Particle Size Distribution - NZS 4402 : 1986 : Test 2.8.1	Percentage passing the finest seive was obtained by difference. This report may only be reproduced in full.

Date tested : 13 August 2014
Date reported : 19 August 2014

IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 19 August 2014

IANZ ACCREDITED LABORATORY

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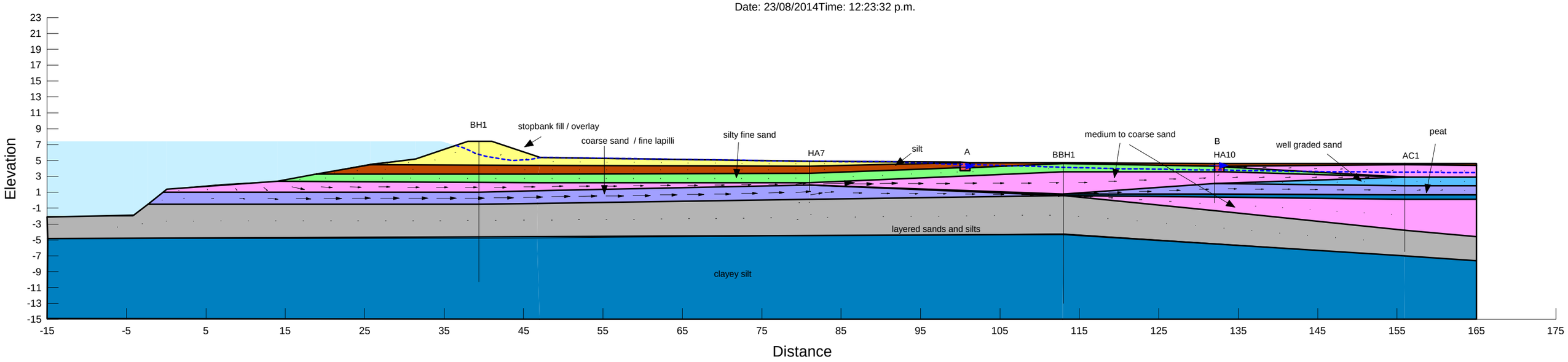
Appendix C

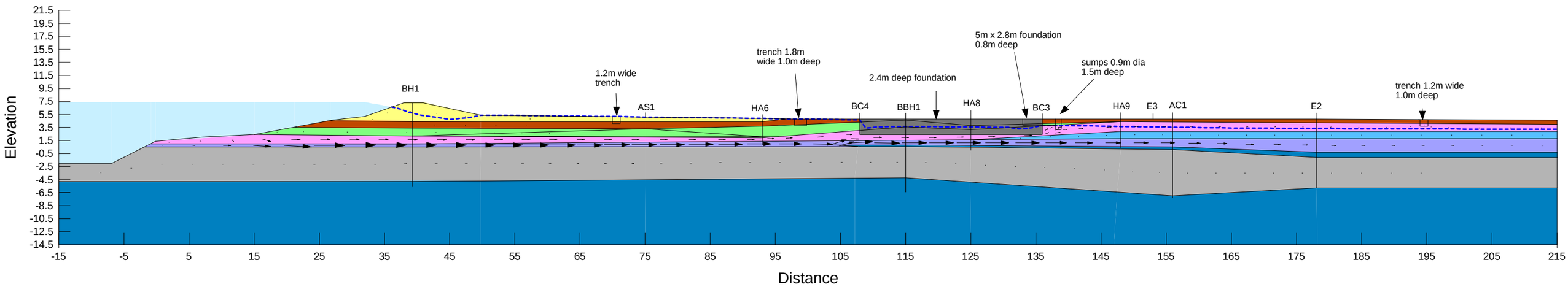
Soil Models

File Name: Cross Section 1 trenches.gsz
Date: 23/08/2014Time: 12:23:32 p.m.



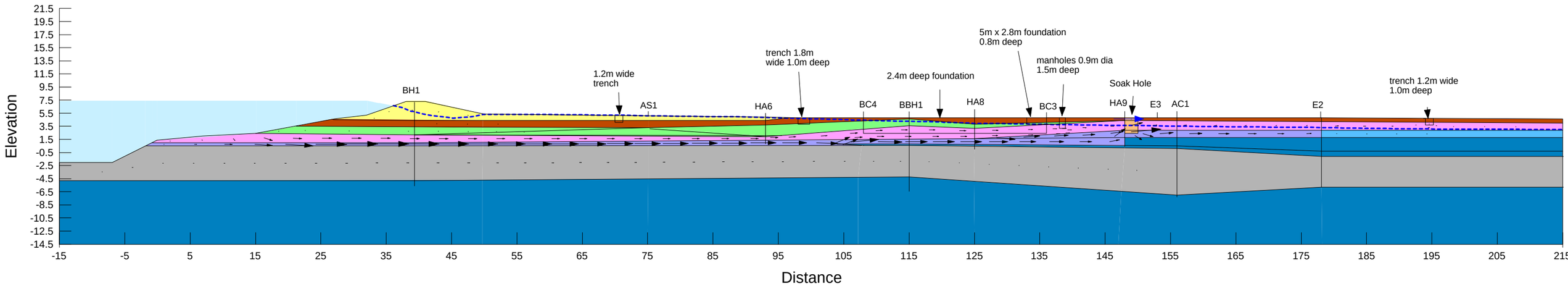
File Name: Cross Section 2 found a.gsz
Date: 21/08/2014Time: 2:04:14 p.m.

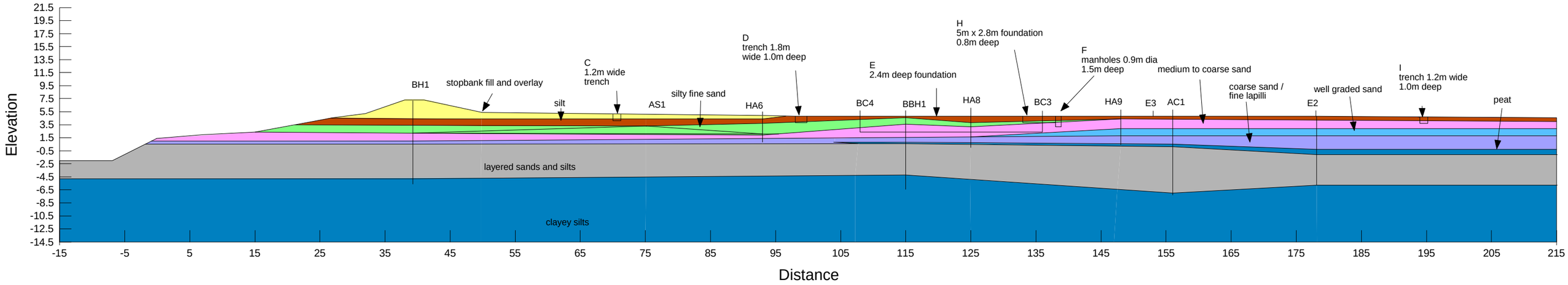
Foundation E - concrete



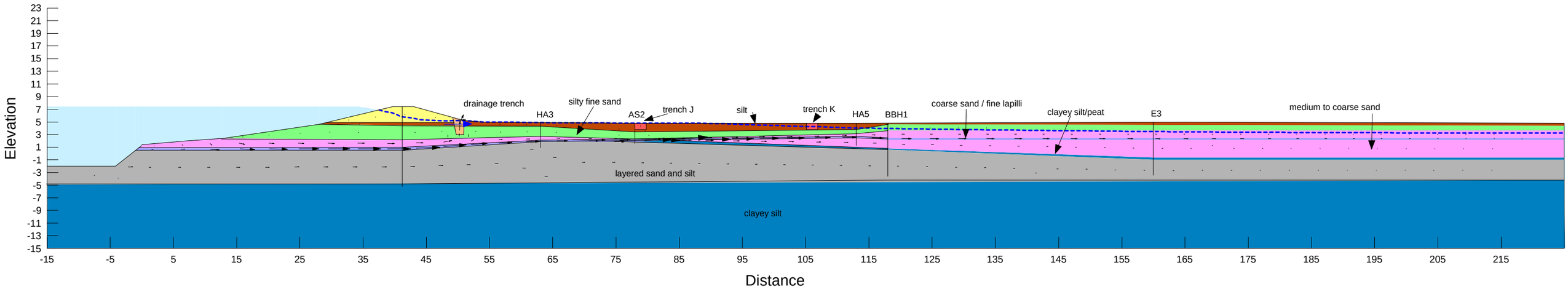
File Name: Cross Section 2 soak hole.gsz
Date: 25/08/2014Time: 8:35:23 a.m.

Soak Hole




BH1
stopbank fill and overlay
silt
C
1.2m wide
trench
AS1
silty fine sand
HA6
D
trench 1.8m
wide 1.0m deep
BC4
E
2.4m deep foundation
BBH1
HA8
H
5m x 2.8m foundation
0.8m deep
BC3
F
manholes 0.9m dia
1.5m deep
HA9
E3
AC1
medium to coarse sand
coarse sand /
fine lapilli
E2
well graded sand
I
trench 1.2m wide
1.0m deep
peat
layered sands and silts
clayey silts
Elevation
21.5
19.5
17.5
15.5
13.5
11.5
9.5
7.5
5.5
3.5
1.5
-0.5
-2.5
-4.5
-6.5
-8.5
-10.5
-12.5
-14.5
-15
-5
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155
165
175
185
195
205
215
Distance

File Name: Cross Section 3 cont gravel.gsz
Date: 22/08/2014Time: 12:31:22 p.m.



File Name: Cross Section 4.gsz
Date: 25/08/2014Time: 10:28:14 a.m.