Rangitaiki River Stopbanks Assessment

Section 6 Addendum

Right Bank 11850 to 12300m

Prepared for

Environment Bay of Plenty

September 2008

ICE GEO & CIVIL

A division of ICE CONSTRUCTION LTD

Contents

1 Introduction

The security of the length of stopbank along the right bank of the Rangitaiki River between the Transpower Substation and Miro Place in Edgecumbe was investigated in 2006. This investigation was based on the seepage analysis of a 100 year return period flood with freeboard. The results were presented in the Ice Geo & Civil report, "Rangitaiki River Stopbanks Assessment, Section 6, Right Bank 11,850 to 12300m" (May 2006). The report recommended a series of pressure relief trenches and overlays to improve the security of the stopbank.

Transpower has requested that the stopbanks in the vicinity of their substation be assessed for their ability to withstand a 300 year return period flood. This report presents the results of this assessment and is an addendum to the previous report. New information on this length of stopbank has been gained since the previous report. Five deep boreholes have been carried out to provide more detailed soil information at depth and LIDAR ground contouring is now available.

This report presents the following information to be considered in addition to that in the previous report:

- the logs of the deep bore holes,
- the results of seepage analyses for an estimated 300 year return period flood and
- possible measures to improve the resilience of the stopbank.

This report is the property of our client, Environment Bay of Plenty and Ice Geo and Civil. The comments within relate only to the length of stopbank along the Rangitaiki River left bank from 11,850m to 12,300m.

2 Subsurface Investigations

Seepage assessment of the 300 year flood based on the information from 22 hand augers showed the influence of the thickness of various layers with high permeability on uplift pressures. It was therefore considered that deeper investigations were required to define the layer thicknesses and refine the analyses. The subsurface investigations carried out consisted of five boreholes through the crest of the stopbank (see attached Long Section). The target depth of the boreholes was 15m but BH3 appeared to hit some timber at 14.3m depth and was stopped. BH2 was extended to 16.5m as the borehole was still in a layer of coarse pumice lapilli at 15.0m. The boreholes were located to provide information at the most problematic cross sections previously analysed. BH2 was moved downstream from the previous Cross Section 2 due to a 33kV cable being under the stopbank at the cross section. BH3 was moved to be opposite a power pole which had water coming up around it in the 2004 flood. Figure 1 shows the locations of the in situ investigations.

The bore logs and photographs are included in Appendix A. 14 falling head tests were carried out through the base of the bore holes to gain a feel for the in situ permeabilities of the soils.

The deep investigations confirmed the trends shown in the shallow hand augers. The Long Section shows layers of highly permeable gravely sands, pumice lapilli and fine gravel less that 2.5m below the natural ground surface at the upstream end of the study section. The general permeability of the soils decreases in the down stream direction with a high proportion of silts and clayey silts. At the down stream end the highest permeability near surface layer is a fine sand about 1.5m below the ground surface.

The attached LIDAR plot shows a depression, possibly an old ox-bow, in the area of cross sections 1 and 2 and a low cut off bend in the river at cross sections 3 and 4. In comparison cross sections 5 to 9 are in higher ground, although there is a depression close to the stopbank at Cross Section 9. This complex ground surface geometry is reflected in the subsurface soils with isolated lenses of coarse sands, gravels, peat etc.

The stopbank has been constructed of mainly silty fine sands and silts, however between cross sections 5 and 9 it appears to have been topped up with coarse sand following the Edgecumbe Earthquake. This coarse sand is up to 1.4m deep and is being removed and replaced with a lower permeability soil.

3 Analyses

3.1 Discussion

It can be seen from the LIDAR plot that there is a considerable three dimensional aspect to the ground surface, and consequently the subsurface, along the study length of stopbank. The computer programme used to analyse the seepage problems, Geo-Slope Seep/W (2004), is a two dimensional programme. Cross sections of the stopbank and adjacent ground have been analysed assuming flow directly from and to the river. There could be significant flows along highly permeable layers within old river channels roughly parallel to the river which by pass soils with low permeability under the stopbank. These flow paths could have influence on water pressures at cross sections 1 to 4 in particular. The seepage models used can not account for this lateral flow; therefore to allow for the possibilities of lateral flow and variation in estimated soil permeabilities, some sensitivity analyses were carried out and a conservative approach taken for remedial measures in some areas. The seepage analyses carried out must be considered indicative only.

As much of this study length consists of open paddocks and there are high voltage cables along the toe of the stopbank, overlays are considered to be the preferred remedial option. These overlays will typically fill in the low areas shown on the LIDAR plot. Some pressure relief wells have been allowed for about 60m away from the stopbank to reduce the extent of the overlays and the uplift pressure under Hydro Road. The distance of the wells from the

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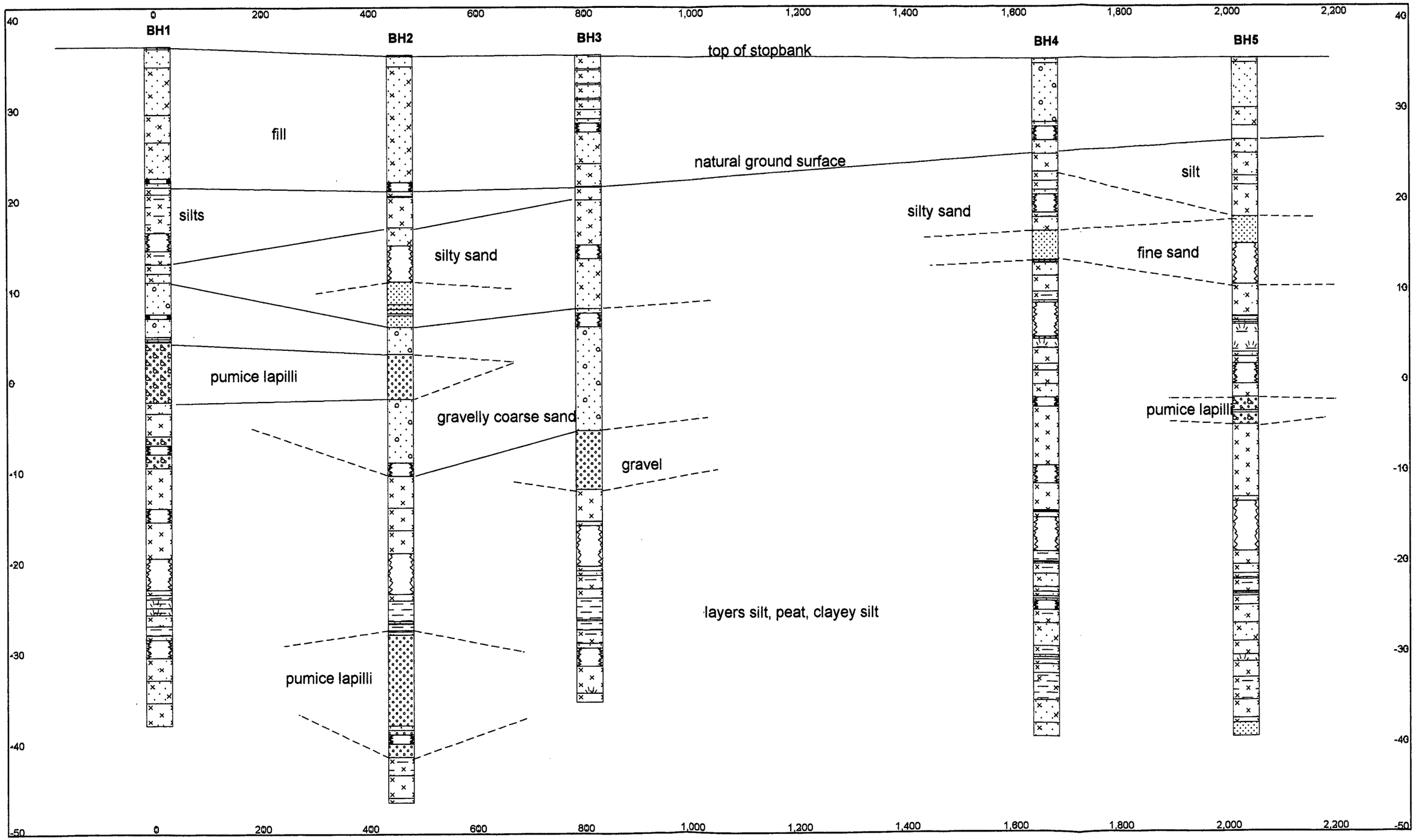
Site Plan

Project: Rangitaiki Stopbanks
Client: Environment Bay of Plenty
Location: Section 6

Subsurface Long Section



Ice Geo & Civil

29/8/08

recommended that the old barn be removed to place this overlay as it is suspected that water came up around the poles supporting the barn in the 2004 flood.

3.6 Cross Section 3

Coarse gravely sand was found about 2.5m below the ground level in BH3 opposite the power pole near Cross Section 3. This corresponds well with the layers found in the hand augers. It is possible that the power pole is founded in this coarse sand layer and there is a direct path for water to flow up to the surface during a flood. In 2004 a couple of truck loads of rock were placed around the pole to try to prevent a piping failure. It is considered that this rock should be removed and geotextile and drainage metal should be placed around it before the required overlay is placed.

As for cross sections 1 and 2 the transient analysis showed high hydraulic exit gradients and some heave potential. Figure 4 shows the required overlay, which consists of a layer 1m thick and 20m wide and a further 20m width 0.5m thick. The houses between cross sections 2 and 3 are on slightly elevated ground and the overlay should be able to be tied into the higher ground. Pressure relief wells are also recommended. The peak flows from the wells should be about 1.9 m^3/m spacing/day.

3.7 Cross Section 4

Cross Section 4 lies at the downstream edge of the depression formed by the old bend in the river. The coarse sands are a little deeper than at Cross Section 4 being 3.0 to 3.4m below the ground surface. A 30m wide, 0.5m thick overlay and 3m deep pressure relief wells 60m from the stopbank toe are required to reduce the risk of piping and heave (Figure 5).

3.8 Cross Section 5

The ground behind the stopbank at Cross Section 5 is 1.0 to 1.5m higher than the ground at cross sections 1 to 4 and no high permeability layers were found within 3.5m depth in the hand augers. The only problem identified in the transient flood flow analysis is a slightly high hydraulic exit gradient at the toe of the stopbank. A small toe filter is recommended. This needs to be above ground level to avoid the 33kV cable at the toe of the stopbank. Alternatively 1m of sandy fill could be placed at the toe of the stopbank to lengthen the seepage path (Figure 6)

3.9 Cross Section 6

The ground surface at Cross Section 6 is similar to Cross Section 5 except that the inland toe of the stopbank is flatter and there do not appear to be any problems with high hydraulic exit gradients. A sensitivity analysis was carried out to assess the heave potential of the ground surface. It was assumed that

the lost core at 5m depth in BH4 is a pumice lapilli and there is a connection to the fine sand layers found in the borehole and hand augers. This analysis indicated a marginal factor of safety against heave about 5m out from the toe of the stopbank. It is suggested that the small toe fill from Cross Section 5 be extended around to this Cross Section (Figure 7).

3.10 Cross Section 7

BH5 at Cross Section 7 showed a thick fine sand layer close to the ground surface and a pumice lapilli layer at 5.5m depth. The transient flood analysis showed a low factor of safety against heave to about 20m out from the toe of the stopbank. A 20m wide, 0.5m thick overlay is therefore recommended. The overlay will have to be shaped around the outlet from the toe drain already installed behind the houses down stream of this cross section. As high uplift pressures under the adjacent road are also possible, pressure relief wells along the road are advised (Figure 8).

3.11 Cross Sections 8 and 9

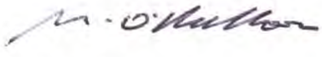
At Cross Section 8 a pressure relief drain has already been installed at the toe of the stopbank. At Cross Section 9 no sand layers were found within the depth of the hand augers, however if the lapilli layer found in BH5 extends downstream, high uplift pressures could develop near the road. It is therefore recommended that pressure relief wells be installed along the edge of the road between Cross Sections 7 and 9.

4 Conclusions

1. The borehole investigations confirmed the presence of the coarse sand and lapilli layers found in some of the previous hand augers. These layers are not as thick as had been assumed in the analyses for the 100 year return period flood.

2. The 300 year return period flood would over-top the stopbank downstream of the substation if the stopbank has not been over-topped elsewhere earlier in the flood. It will therefore be necessary to increase the freeboard around the substation.

3. Transient seepage analyses for the 300 year return period flood have indicated that extensive remedial works are required to improve the stopbank security. These works are shown on the LIDAR plot and in Figures 3 to 8.



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Appendix A

Bore logs


Rangitaiki
Section 6
BH1 5/9/08
0 - 3.0m
1.5
0
05/08/2008


Rangitaiki
Section 6
BH1 5/9/08
3.0
5.4
6.0m
7.5m
05/08/2008

Borehole 1

Bore Hole Log

Borehole: BH2

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

Location: **Section 6**
Co-ordinates: East 90
Elevation: 7.20

North 0
Datum: Moturiki

depth (m)	elevation (m)	recovery (m)	graphic log	description	samp depth (m)	sample type	SPT result	Vane result	other
7.50	-0.40			**pumice lapilli** to 3mm and dark grey **medium to coarse SAND**	7.8	dis			
8.00		45							
8.50									
9.00	-1.80			lost					
	-2.10			grey **pumice SILT**, rare angular pumice to 5mm, firm to stiff, 9.5m 50mm pumice rich band, rare organic fragments					
9.50		100							
10.00	-2.80			grey **pumice SILT**, some fine brown varving and leaves, sensitive					
10.50	-3.30	100		grey **pumice SILT**, brittle, dilatant, rare angular pumice to 4mm and organic fibres					
11.00	-3.80			lost, grey fine **pumice lapilli** to 1mm ?					
11.50									
	-4.70			light grey and grey varved **pumice SILT**, some organic material					
12.00	-4.85			dark brown / grey **organic CLAY** with fibrous material, spongy, medium strength					
12.50	-5.30			**timber**					
	-5.35			grey **fine SAND**					
	-5.36	100		dark brown / grey **organic CLAY** with fibrous material, spongy, medium strength					
	-5.50			grey fine **pumice lapilli** to 2mm					
13.00	-5.53			light **grey SILT**, some fibrous material					
	-5.60			5mm black organic layer over grey **fine pumice lapilli** to 2mm, rare to 5mm					
13.50									
14.00					14	dis			
		90							
14.50									
	-7.60								
15.00	-7.70			dark grey **medium SAND**					

Observations:

Vane no.
Core Dia. 68mm

Rig: Edson
Contractor: Perry

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