Figure 3: Results for Boreholes BH1 to BH20

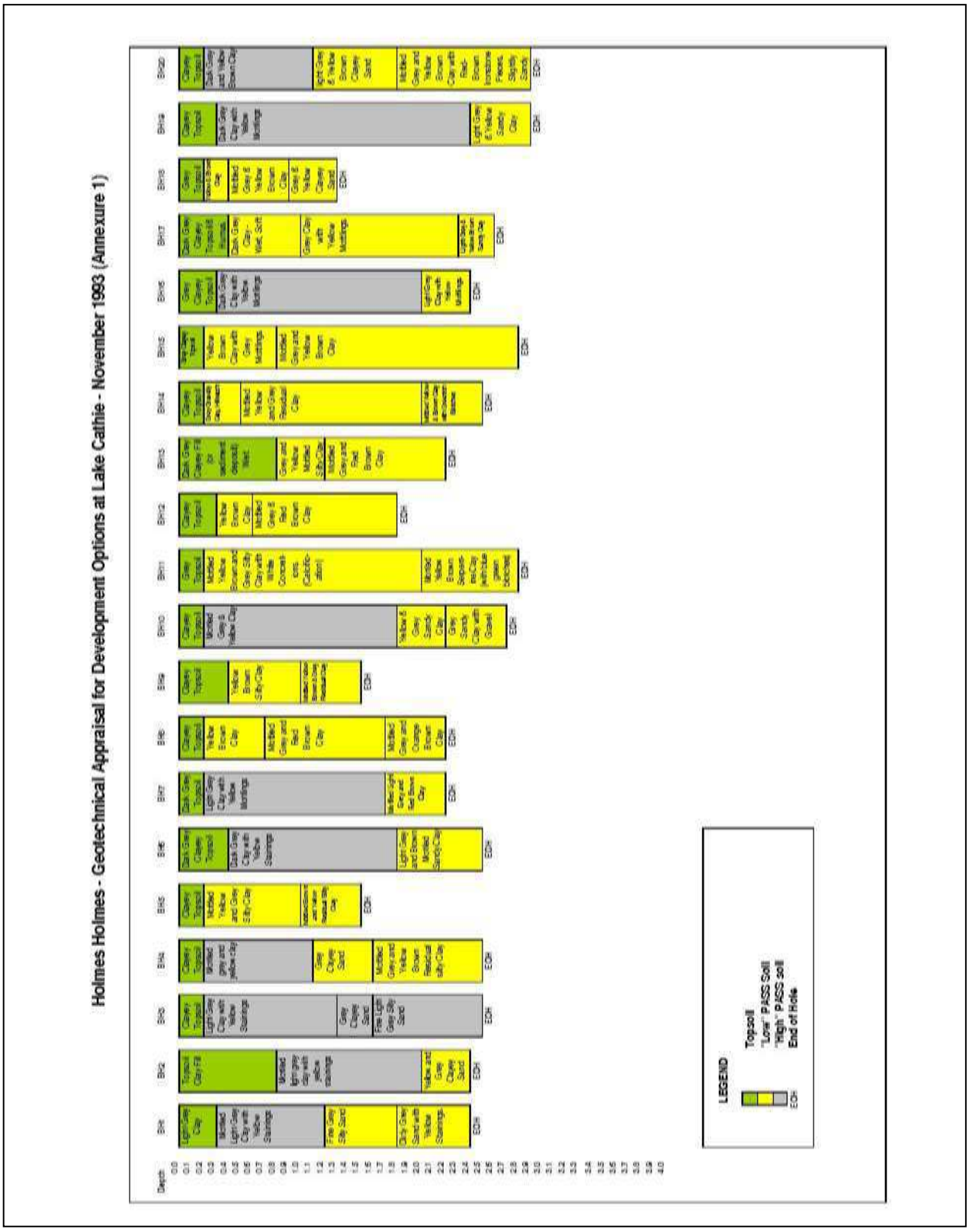
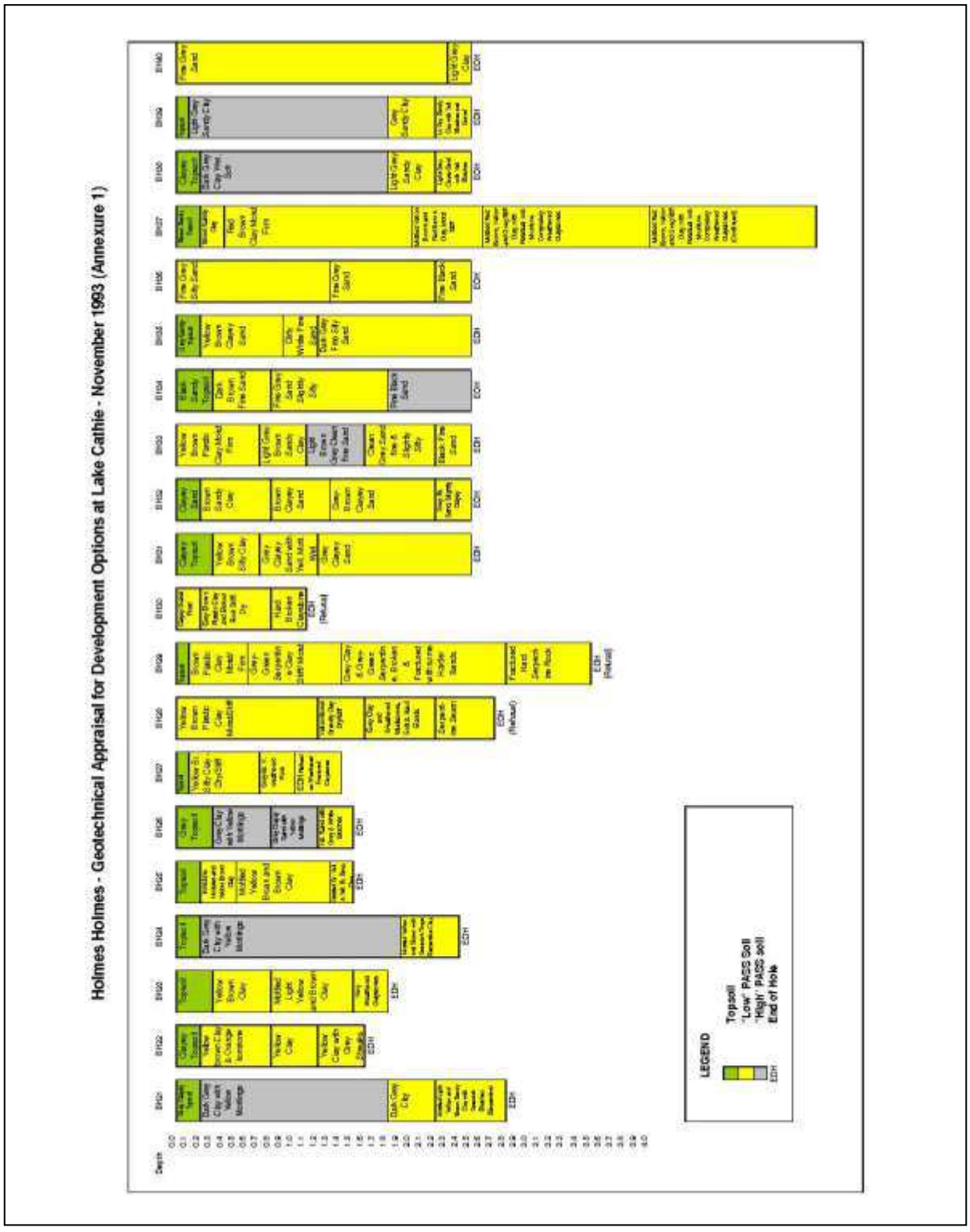


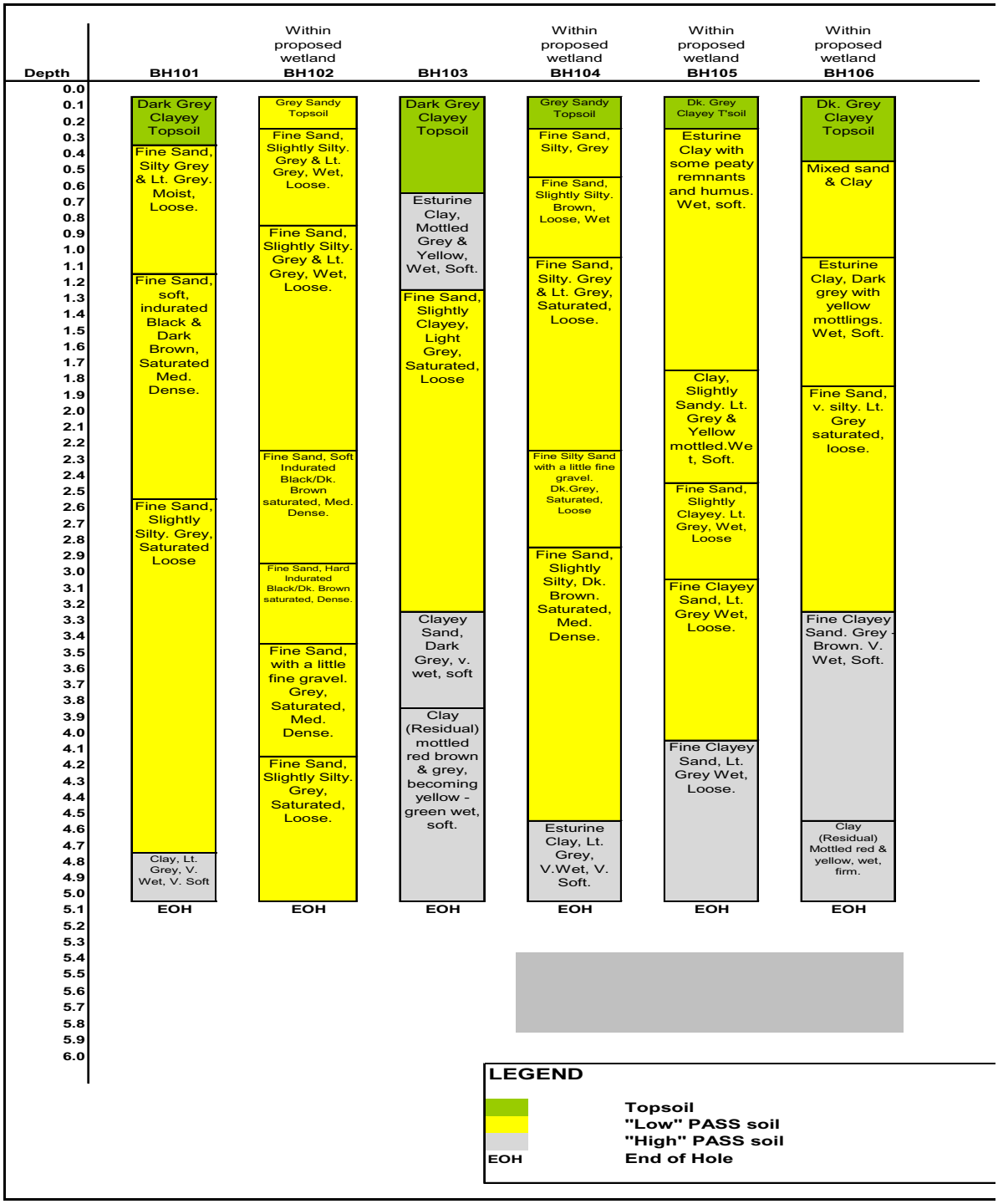
Figure 4: Results for Boreholes 21 to 40



6.3 Summary of Acid Sulphate Soil Investigations, December 1998

Six (6) boreholes (BH101 to BH106) were drilled, sampled and tested for PASS. All of the boreholes encountered high PASS (requiring remediation if disturbed) at depths varying between 3m and 5m below the natural surface level (NSL). These are shown graphically in Figure 5.

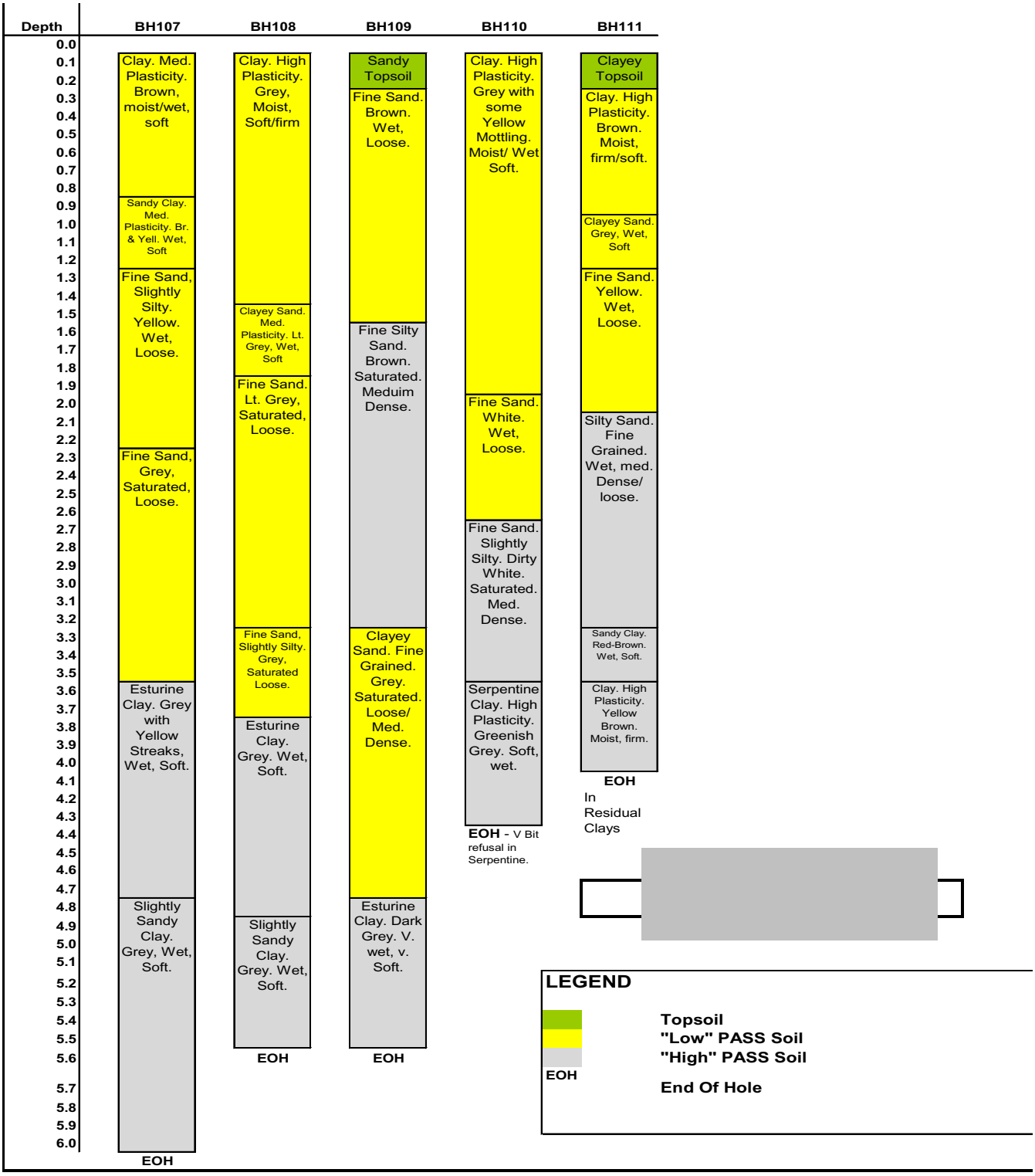
Figure 5: Summary of results for Boreholes 101 - 106



6.4 Summary of Acid Sulphate Soil Investigations, March 2003

Five boreholes (107 to 111) were drilled, sampled and tested for PASS in the area proposed for filling. Each of the boreholes encountered high PASS at varying depths. These are shown graphically in Figure 6.

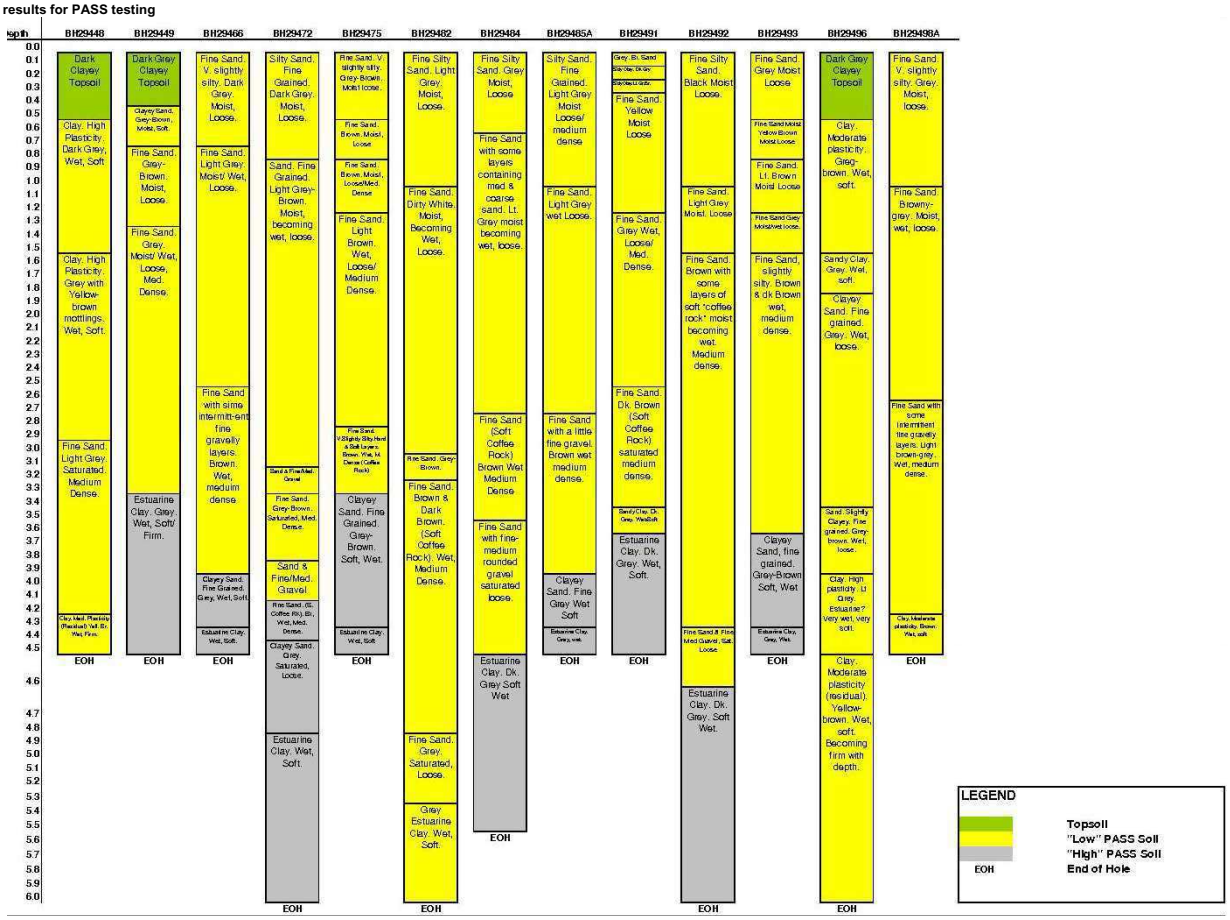
Figure 6: Summary of results for Boreholes 107 – 111



6.5 Summary of Acid Sulphate Soil Investigations, April 2003

Thirteen boreholes were drilled, sampled and tested for PASS (Nos 29448, 29449, 29466, 29472, 29475, 29482, 29484, 29485A, 29491, 29492, 29493, 29496, 29498A). These are shown graphically in Figure 7.

Figure 7: Summary borehole results for PASS testing



6.6 Summary of Acid Sulphate Soil Investigations, April 2004

Four boreholes (BH1 to BH4) were drilled, sampled and tested for PASS to supplement earlier investigations by Holmes and Holmes. Two of the holes encountered PASS at depths of 3.5m below Natural Surface Level.

7. Boreholes in the Constructed Wetland Area & ASS

7.1 Location Plan

A more detailed plan of the boreholes in the locality of the proposed constructed wetland is shown in Figure 8.

7.2 Borehole Logs

The borehole logs shown graphically in figures 9& 10 demonstrate that the boundary between the “low PASS soils” (requiring minimal or no treatment) and the high PASS soils (requiring significant treatment) is clearly defined.

The Cardno Water Engineering Report (Section 2.5.2 and Section 4.15) describes the subsurface stratigraphy and the clear definition of the boundary between the “low” PASS soils and the “high” PASS soils. The clear definition provides the ability to set the level of the bed of the constructed wetlands so as to minimise intersection of the “high” PASS soils.

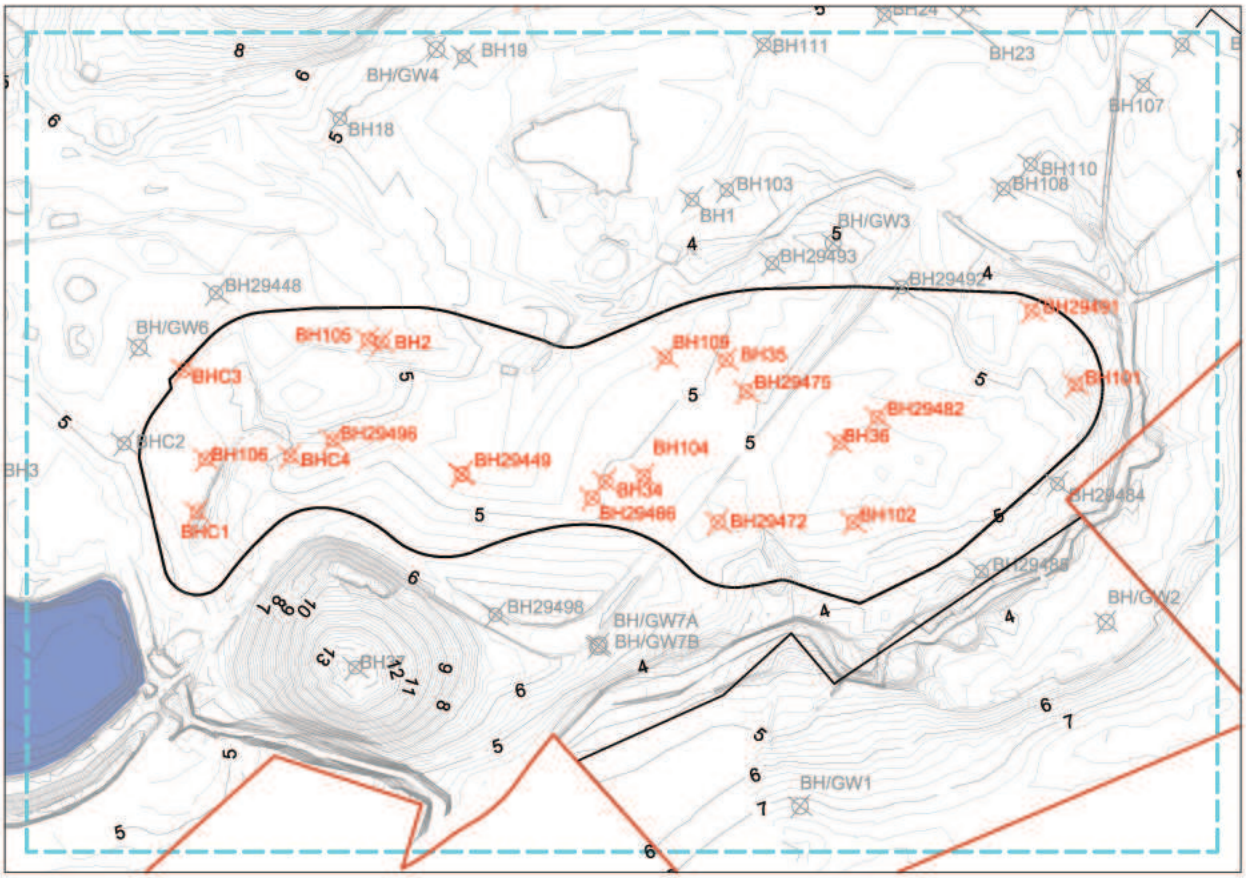


Figure 8

DETAILED WETLAND BOREHOLE LOCATIONS

Plan G3

REFER TO BOREHOLE LOCATIONS PLAN G1

SUBJECT LAND

EXISTING CONTOURS 0.20 METRE INTERVALS

BH 23 BOREHOLE LOCATIONS AND REFERENCE NUMBERS LOCATED WITHIN AREA OF PROPOSED WETLAND (AREA OF EXCAVATION)

BH 23 BOREHOLE LOCATIONS AND REFERENCE NUMBERS LOCATED OUTSIDE OF PROPOSED WETLAND (AREA OF EXCAVATION)

REVISIONS
A: 15.1.08
D: 22.4.08
E: 23.9.09
F: 29.10.09

Rainbow Beach Estate

Concept Plan Application Set

Job. No. 4509.ND Dwn: CM

Luke and Company Pty Ltd

Scale:
1:500@A3 1:250@A1

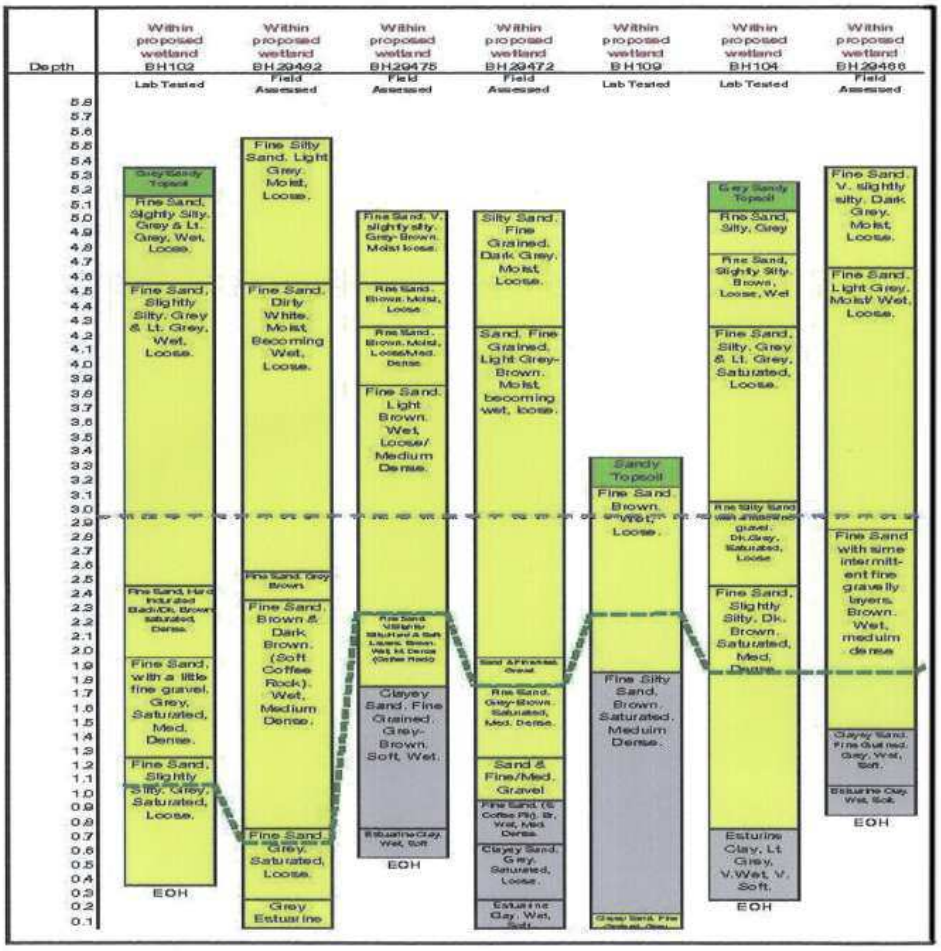


Figure 9
Borehole Logs

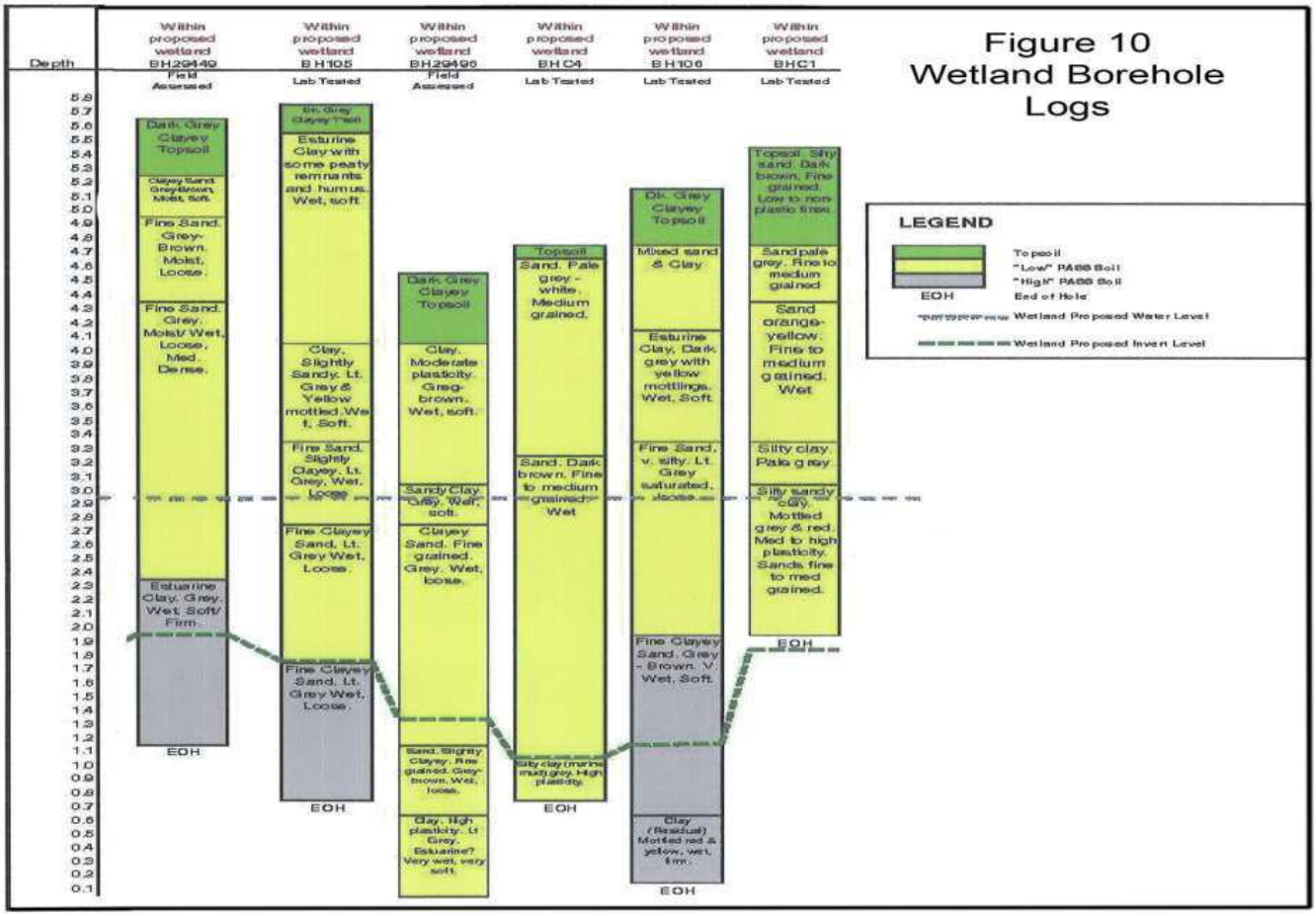


Figure 10
Wetland Borehole Logs
Depth
Within proposed wetland BH29449 Field Assessed
Within proposed wetland BH105 Lab Tested
Within proposed wetland BH29496 Field Assessed
Within proposed wetland BHC4 Lab Tested
Within proposed wetland BH106 Lab Tested
Within proposed wetland BHC1 Lab Tested
Dark Grey Clayey Topsoil
Clayey Sand Grey/Brown, Moist, Soft.
Fine Sand. Grey-Brown. Moist, Loose.
Fine Sand. Grey. Moist/ Wet, Loose, Med. Dense.
Estuarine Clay. Grey. Wet. Soft/ Firm.
EOH
Dk Grey Clayey Topsoil
Estuarine Clay with some peaty remnants and humus. Wet, soft.
Clay, Slightly Sandy. Lt. Grey & Yellow mottled. Wet, Soft.
Fine Sand. Slightly Clayey. Lt. Grey. Wet. Loose.
Fine Clayey Sand. Lt. Grey Wet, Loose.
EOH
Dark Grey Clayey Topsoil
Clay. Moderate plasticity. Grey-brown. Wet, soft.
Sandy Clay. Grey. Wet, soft.
Clayey Sand. Fine grained. Grey. Wet, loose.
Sand. Slightly Clayey. Fine grained. Grey-brown. Wet, loose.
Clay. High plasticity. Lt Grey. Estuarine? Very wet, very soft.
Topsoil
Sand. Pale grey - white. Medium grained.
Sand. Dark brown. Fine to medium grained. Wet
Silty clay (marine) mottl grey. High plasticity.
EOH
Dk. Grey Clayey Topsoil
Mixed sand & Clay
Estuarine Clay. Dark grey with yellow mottlings. Wet, Soft
Fine Sand, v. silty. Lt. Grey saturated, loose.
Fine Clayey Sand. Grey - Brown. V. Wet, Soft.
Clay (Residual) Mottled red & yellow, wet, firm.
EOH
Topsoil. Silty sand. Dark brown. Fine grained. Low to non plastic fines.
Sand pale grey. Fine to medium grained
Sand orange-yellow. Fine to medium grained. Wet
Silty clay. Pale grey.
Silty sandy clay. Mottled grey & red. Med to high plasticity. Sands fine to med grained.
EOH
LEGEND
Topsoil
"Low" PASS Soil
"High" PASS Soil
EOH
End of Hole
Wetland Proposed Water Level
Wetland Proposed Invert Level

7.3 Calculation of the "High" PASS Profile

The estimated "high" PASS profile has been modelled using laboratory tested or field assessed results from all boreholes within the "constructed wetlands", excluding BH106 and BH29449. These boreholes have been omitted from the "high" PASS model as they represent isolated pockets of high level "high" PASS not common to the surrounding area.

The "constructed wetland" bed has been designed to reside at 0.5 metres above the estimated "high" PASS profile. The actual "constructed wetland" bed level may differ to design if areas of "high" PASS material are found during excavation works. "High" PASS material is to be avoided at all times. Fill may be reclaimed in other areas of the wetland if free of "high" PASS material, or alternatively any shortfall of fill may be imported to meet demand.

7.4 Proposed Cut and Fill

Map 4 (Plan W9) shows the proposed cut and fill plan with a reference line for cross sections of the excavation for the proposed constructed wetlands and fill for residential lots and recreational areas.

Figures 1 to 4 (Sections W10, W6, W7 & W8) show the proposed cross sections of cut and fill in relation to the "high" PASS profile.

8. Conclusion

8.1 The geotechnical investigations indicate:

- The material to be excavated from the constructed wetland is a sandy alluvium suitable for use as filling on residential allotments, roads *et al*.

- Acid Sulphate Soil and Potential Acid Sulphate Soils occur throughout the area of the proposed constructed wetland.

- There is a clear demarcation between the surface soils with "low" potential acidity requiring little or no treatment and soils at deeper levels with "high" potential acidity requiring management and significant treatment.

- This demarcation boundary corresponds consistently with the occurrence of distinctive deeper grey clays of estuarine origin.

8.2 A description of the implications for the development proposal, of the presence of ASS and PASS soils and their management is contained in the Cardno Water Engineering and Environment Report.

8.3 The majority of the areas for excavation lie within an area classified as Class 4 in Hastings LEP 2001 *Acid Sulphate Soils Maps*. Hastings DCP 34 – *Acid Sulphate Soils* determines that development of Class 4 areas involving excavation beyond 2 metres below the natural ground level require the preparation of an Acid Sulphate Soils Management Plan (ASSMP). Therefore, an ASSMP is required for the proposed wetland excavation.

8.4 Borehole data has allowed the "high" PASS profile to be plotted and the excavation levels of the floor in the proposed constructed wetland, to be designed to minimise interception of the "high" PASS layer.

8.5 The Acid Sulphate Soil Management Plan (ASSMP) contained in the Cardno Water Engineering and Environment Report has been developed by Cardno to comply with Hastings Council DCP 34 and ASSM 1998.

8.6 The ASSMP stipulates that “high” PASS material shall be avoided at all times during excavation works. Constructed wetland bed levels may differ to design if areas of “high” PASS material are encountered. Fill may be reclaimed in other areas of the wetland if free of “high” PASS material, or alternatively any minor shortfall of fill may be imported to meet demand. Additional boreholes are to be undertaken within the proposed constructed wetland area prior to excavation to confirm the “high” PASS profile.

8.7 Therefore it may be seen that the extensive investigations over the subject land, have identified the presence and extent of potential acid sulphate soils over the site. This information has been used to develop an Acid Sulphate Soils Management Plan which is consistent with the requirements of the NSW Acid Sulphate Soil Manual 1998. In this manner, the DGRs identified as CP 4.3 for the Concept Plan application, and PA 6.3 for the Project Application, have been addressed.