Appendix 3

Holmes and Holmes Pty Ltd

Acid Sulphate Soil Investigation
March 2003

RECORD OF BOREHOLE No. 107

CLIENT: Luke & Company

PROJECT: A.S.S Assessment, Lake Cathie

Ground level: ..... Dia. of boring: 80 mm

Auger Mill Pty. Ltd, MD200, Toyota - mounted

Type of boring: continuous solid flight auger Lining tubes: Nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A S D Level	Description of Strata	A.S.S Potential
21.3.03						CLAY mod. plasticity Brown moist/wet soft	
				1.0		SANDY CLAY mod. plasticity Br. & yell. wet, soft	
				2.0		FINE SAND, slightly silty Yellow wet, loose	Very slight potential No management required
	Sample 107/1	D		3.0		FINE SAND Grey saturated, loose	
	Sample 107/2	D		4.0		Esturine CLAY Grey with yellow streaks wet, soft	Very high Potential Requires management
	Sample 107/3	D		5.0		Slightly SANDY CLAY Grey wet, soft	High Potential
				6.0		End of Hole	

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test. No. in brackets gives No. of blows/300 mm penetration

Remarks: (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 108

CLIENT: Luke & Company

PROJECT: A.S.S Assessment, Lake Cathie

Ground level: ..... Dia. of boring: 80 mm

Auger: Amil Pty. Ltd, MD200, Toyota - mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: R.L. or Level	Description of Strata	A.S.S Potential
21.3.03						CLAY high plasticity Grey moist soft/firm	
				1.0		CLAYEY SAND mod. plasticity light grey; wet, soft	
	Sample 108/1	D		2.0		FINE SAND Light grey Saturated loose	Very slight potential No management required
				3.0		FINE SAND, Slightly silty Grey, saturated loose	
	Sample 108/2	D		4.0		Esturine CLAY Grey wet soft	Very high potential Requires management
	Sample 108/3	D		5.0		Slightly SANDY CLAY Grey wet, soft	High potential
				6.0		End of Hole	

Key to type of sample

U (50) – 50 mm. dia. undisturbed sample.

D – disturbed sample.

N ( ) – standard penetration test. No. in brackets gives No. of blows/300 mm penetration

Remarks: (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 109

CLIENT: Luke & Company

PROJECT: A.S.S Assessment, Lake Cathie

Ground level: ..... Dia. of boring: 80 mm

Aimil. Pty. Ltd. MD20D Toyota-mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: R.L. or D	Description of Strata	A.S.S Potential
21.3.03						Sandy Topsoil	
						FINE SAND Brown wet, loose	
				1.0			
						FINE SILTY SAND Brown saturated medium dense	High Potential requires management
	Sample 109/1	D		2.0			
				3.0			
	Sample 109/2	D				CLAYEY SAND fine grained Grey saturated loose/med. dense	very slight potential no management required.
				4.0			
	Sample 109/3	D				Esturine CLAY Dark grey v. wet, v. soft	Very high Potential requires management
				5.0			
				6.0			

Key to type of sample

U (50) – 50 mm. dia. undisturbed sample.

D – disturbed sample

N ( ) – standard penetration test. No. in brackets gives No. of blows/300 mm. penetration

Remarks (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 110

CLIENT: Luke & Company

PROJECT: A.S.S Assessment, Lake Cathie

Ground level: ..... Dia. of boring: 90 mm.

Type of boring: Aimil Pty. Ltd, MD200, Toyota-mounted continuous solid flight auger Casing tubes: nil

Date / Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A = D Level	Description of Strata	A.S.S Potential
21.3.03						CLAY high plasticity Grey with some yellow mottling moist/wet soft	
	Sample 110/1			-1.0			
				-2.0		FINE SAND white wet, loose	Very slight potential no management required
	Sample 110/2			-3.0		FINE SAND, slightly silty dirty white saturated med. dense	Slight Potential
	Sample 110/3			-4.0		Serpentinite CLAY high plasticity greenish grey soft, wet	Moderate Potential Requires management
				-5.0		V bit refusal in Serpentinite	
				-6.0			

Key to type of sample
U (50) – 50 mm. Dia. undisturbed sample.
D – disturbed sample.
N (...) – standard penetration test.
No in brackets gives No. of blows/300 mm. penetration

Remarks: (Observations on ground water, etc.)

RECORD OF BOREHOLE No. 111

CLIENT: Luke & Company

PROJECT: A.S.S Assessment, Lake Cathie

Ground level: ..... Dia. of boring: 80 mm.

Type of boring: Aimil Pty. Ltd, MD200, Toyota-mounted continuous solid flight auger Lining tubes: nil

Date / Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A H D Level	Description of Strata	A.S.S Potential
21.3.03						Clayey Topsoil	
						CLAY high plasticity Brown moist, firm/soft	
				1.0		CLAYEY SAND, Grey wet, soft	
						FINE SAND Yellow wet, loose	
				2.0			
	Sample 111/1	D				SILTY SAND fine grained wet, med. dense/loose	Slight potential requires management
				3.0			
						SANDY CLAY Red brown wet. soft	
						CLAY, high plasticity Yellow brown moist, firm	
				4.0		End of Hole in residual clays	
				5.0			
				6.0			

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample
D – disturbed sample
N ( ) – standard penetration test. No in brackets gives No. of blows/300 mm. penetration

Remarks (Observations on ground-water, etc.)

RESULTS OF ACID SULPHATE SOIL ANALYSIS (Page 1 of 1)

13 samples supplied by Holmes & Holmes on 26th March, 2003 - Lab. Job No. E0244
Analysis requested by Bill Holmes - Your Project: Order No. MO095

Sample Site	Depth (m)	Texture (note 9)	Reduced Inorganic Sulphur (% chromium reducible S) (%Scr) (note 2)	% ANC $\%CaCO_3$ (note 11)	NAGP Kg H_2SO_4/ Tonne soil (note 12)	TAA pH	Total Actual Acidity (TAA) mole / Kg	Lab. Bulk Density tonne DW/m^3	Potential Acidity Neutralising Calculation Kg Lime/m^3 (based on %Scr)	Potential Acidity Neutralising Calculation Kg Lime/m^3 (based on NAGP)	Actual Acidity Neutralising Calculation Kg Lime/m^3 (based on TAA)	COMMENTS RE: Classification as potential acid sulphate soil (based on %Scr results)
107/1	2.3-2.8	Coarse	0.033	0.05	0.5	4.68	0.004	1.70	1.8	0.9	0.3	NOT Potential ASS
107/2	3.8-4.4	Fine	0.978	0.00	30.6	4.99	0.006	1.17	35.1	35.9	0.3	YES Potential ASS
107/3	5.2-5.8	Fine	0.212	0.00	5.6	5.47	0.001	1.39	9.0	9.3	0.0	YES Potential ASS
108/1	2.3-2.8	Coarse	0.018	..	..	5.10	0.002	1.77	1.0	..	0.1	NOT Potential ASS
108/2	3.8-4.4	Fine	0.858	0.35	23.4	4.95	0.005	1.44	37.9	33.7	0.3	YES Potential ASS
108/3	5.0-5.5	Fine	0.305	0.40	5.5	5.46	0.001	1.40	13.1	7.8	0.0	YES Potential ASS
109/1	2.3-2.8	Coarse	0.217	0.00	6.8	5.02	0.006	1.57	10.4	10.6	0.5	YES Potential ASS
109/2	3.5-4.0	Coarse	0.009	..	..	4.83	0.007	1.46	0.4	..	0.5	NOT Potential ASS
109/3	5.0-5.5	Fine	0.948	0.00	29.7	4.90	0.008	1.03	30.6	30.6	0.4	YES Potential ASS
110/1	2.0-2.4	Coarse	0.008	..	..	5.78	0.000	1.52	0.4	.	0.0	NOT Potential ASS
110/2	2.8-3.2	Coarse	0.051	0.15	0.1	6.05	0.000	1.38	2.1	0.1	0.0	YES Potential ASS
110/3	3.5-4.0	Fine	0.205	0.45	1.9	6.99	0.000	1.43	9.0	2.8	0.0	YES Potential ASS
111/1	2.3-2.8	Coarse	0.106	0.10	2.3	4.73	0.008	1.51	4.9 Refer Note 6 & 7	3.5 Refer Note 6 & 7	0.6 Refer Note 6 & 7	YES Potential ASS

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)

2 - Samples analysed by POCAS method (ie Peroxide Oxidation - Combined Acidity and Sulphate - Version 3 modified published method) and 'Chromium Reducible Sulphur' technique (Scr - Method 22B)

3 - Methods from Stone, Y, Ahern CR, and Blunden B (1998). Acid Sulphate Soil Manual 1998. ASSMAC Wollongbar, NSW.

4 - Total carbon and total sulphur determined using a LECO CNS 2000 analyser

5 - Bulk density was determined immediately on arrival to laboratory (insitu bulk density is preferred)

6 - Neutralising Requirement (based on NAGP, chromium reducible sulphur or total sulphur) = Kg H_2SO_4/tonne x bulk density

7 - The neutralising requirement does not include a safety margin for complete neutralisation (a factor of 1.5 is often recommended)

8 - Conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm

9 - For Texture; coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays.

10 - Neutralisation Calculation for neutralisation of actual and potential acidity (ie. sum of calculation based on Scr and TAA)

11 - ANC= Acid Neutralising Capacity of the Soil (Detection limit of 0.05% $CaCO_3$ Equivalent)

12 - NAGP= Net Acid Generating Potential= (31.2*%S_{Cr})-(10*%ANC) (From Mulvey, 1993)

(Classification of potential acid sulphate material if: coarse Scr≥0.03%S; medium Scr≥0.06%S fine Scr≥0.1%S)

(equivalent conversions - 0.03%S = 0.019 mole/ Kg; 0.06%S = 0.037 mole/ Kg; 0.1%S = 0.062 mole/ Kg)

* Projects that disturb >1000 tonnes of ASS soils with ≥0.03% S a detailed management plan may be required

checked: .....

Appendix 4

Holmes and Holmes Pty Ltd

Acid Sulphate Soil Investigation
April 2003

RECORD OF BOREHOLE No. 29448

CLIENT: Luke & Company at BH W17

PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: RL 5.38 Dia. of boring: 80 mm

Aimil Pty. Ltd, MD200, Toyota-mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Date of Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A = D Level	Description of Strata	Anticipated A.S.S Potential
3.4.03						Dk. grey clayey Topsoil	
				1.0		CLAY high plasticity Dk grey wet soft	
	Sample 48/1	D		2.0		CLAY high plasticity Grey with yellow-br. mottlings wet soft	
				3.0		FINE SAND Light grey saturated medium dense	← No management required
	Sample 48/2	D		4.0		CLAY mod. plasticity (residual) yell. br. wet firm	
						End of Hole	
				5.0			
				6.0			

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test
No in brackets gives
No. of blows/300 mm penetration

Remarks (Observations on ground-water, etc.)

RECORD OF BOREHOLE No: 29449

CLIENT: Luke & Company at BH W10

PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: ..... Dia. of boring: 80 mm

Type of boring: Airsil Pty. Ltd. MD200 Toyota-mounted continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A.H.D Level	Description of Strata	Anticipated A.S.S Potential
3.4.03						Dk grey clayey Topsoil	
						CLAYEY SAND Grey-brown, moist, soft	
				1.0		FINE SAND Grey-brown moist, loose	
				2.0		FINE SAND Grey moist/wet loose/med. dense	No management required
				3.0			
				4.0		Estuarine CLAY Grey wet soft/firm	High Potential requires management.
				5.0		End of Hole	
				6.0			

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test. No. in brackets gives No. of blows/300 mm. penetration

Remarks: (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 29466

CLIENT: Luke & Company
PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: RL 5.22 Dia. of boring: 80 mm
Airmil Pty. Ltd, MD200, Toyota-mounted
Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or No.	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A - D Level	Description of Strata	Anticipated A.S.S Potential
3.4.03						FINE SAND, v. slightly silty Dk. grey moist, loose	
				1.0		FINE SAND Light grey moist/wet loose	
				2.0			
				3.0		FINE SAND with some intermittent fine gravelly layers, Brown wet, medium dense	High Potential → no management required
	Sample 66/1	D		4.0		CLAYEY SAND, fine grained Grey, wet, soft	requires management
						Estuarine CLAY, wet, soft	
				5.0		End of Hole	
				6.0			

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test. No. in brackets gives No. of blows/300 mm penetration

Remarks: (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 29472

CLIENT: Luke & Company

PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: RL 5.37 Dia. of boring: 90 mm

Aimil Pty. Ltd. MD200 Toyota mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: R.L. Level	Description of Strata	Anticipated A.S.S. Potential
3.4.03						SILTY SAND, fine grained Dk. grey moist, loose	
				1.0		SAND, fine grained Light grey-brown moist, becoming wet loose	
				2.0			
				3.0		SAND & fine/med gravel	
						FINE SAND Grey-brown saturated, med. dense	
				4.0		SAND & fine/med. gravel	
	Sample 72/1	D				FINE SAND (soft coffee rock) Brown, wet, med. dense	
						CLAYEY SAND Grey saturated, loose	
				5.0		Estuarine CLAY Wet Soft	
				6.0			

No management required

High Potential requires management

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test.
No. in brackets gives No. of blows/300 mm penetration

Remarks: (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 29475

CLIENT: Luke & Company

PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: RL 5.27 Dia. of boring: 80 mm

Auger: Pty. Ltd, MD200, Toyota - mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Type or %	Change of Strata: Legend	Depth	R.L. or D Level	Description of Strata	Anticipated A.S.S. Potential
3.4.03						FINE SAND, v. slightly silty, moist, loose, Grey-brown	
						FINE SAND, Brown, moist, loose	
				1.0		FINE SAND, Dk yellow, moist, loose/med. dense	
				2.0		FINE SAND, Light brown, wet, loose/medium dense	no management required
				3.0		FINE SAND, v. slightly silty, hard and softer layers, Brown, wet, med. dense (coffee Rock)	
	Sample 75/1	D		4.0		CLAYEY SAND, fine grained, Grey-brown, soft, wet	High Potential requires management
						Estuarine CLAY, wet, soft,	
				5.0		End of Hole	
				6.0			

Key to type of sample
U (50) = 50 mm. dia. undisturbed sample
D = disturbed sample
N ( ) = standard penetration test
No. in brackets gives No. of blows/300 mm penetration

Remarks (Observations on ground water, etc.)

RECORD OF BOREHOLE No. 29482

CLIENT: Luke & Company
PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: R.L. 5.43 Dia. of boring: 80 mm
Aimil Pty Ltd, MD200 Toyota-mounted
Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A - D Level	Description of Strata	Anticipated A.S.S Potential
3.4.03						FINE SILTY SAND Light grey moist loose	
				1.0		FINE SAND dirty white moist becoming wet loose	
				2.0			
				3.0		FINE SAND Grey brown	
	Sample 82/1	D		4.0		FINE SAND Brown & Dk. brown (soft "coffee rock") wet medium dense	
				5.0		FINE SAND, Grey saturated loose	No management required
				6.0		Grey estuarine CLAY wet soft End of Hole	High Potential → requires management

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test. No. in brackets gives No. of blows/300 mm. penetration

Remarks: (Observations on ground water, etc.)

RECORD OF BOREHOLE No. 29484

CLIENT: Luke & Company

PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: RL 5.39 Dia. of boring: 80 mm

Auger: Pty. Ltd, MD200, Toyota - mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type of	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A - D Level	Description of Strata	Anticipated A.S.S. Potential
3.4.03						FINE SILTY SAND Grey, moist, loose	
				1.0		FINE SAND with some layers containing med. & coarse sand Lt. grey moist becoming wet loose	
				2.0			
				3.0		FINE SAND (soft "coffee rock") Brown wet medium dense.	
	Sample 84/1	D		4.0		FINE SAND with fine-medium rounded gravel saturated loose	No management required
				5.0		Estuarine CLAY Dk. grey soft wet	High Potential management required
				6.0		End of Hole	

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample.
D " – disturbed sample.
N ( ) – standard penetration test. No. in brackets gives No. of blows/300 mm. penetration

Remarks: (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 29485 A

o/s 40m from 485 towards 484

CLIENT: Luke & Company

PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: ..... Dia of boring: 80 mm

Type of boring: Aimil Pty. Ltd. MD200 Toyota mounted continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A = D Level	Description of Strata	Anticipated A.S.S Potential
3.4.03						SILTY SAND, fine grained Light grey moist loose/medium dense	
				1.0		FINE SAND Light grey wet loose	
	Sample 85A/1	D		3.0		FINE SAND with a little fine gravel Brown wet medium dense	No management required
				4.0		CLAYEY SAND, fine Grey, wet, soft	High Potential requires management
						Estuarine CLAY, grey, wet	
				5.0		End of Hole	
				6.0			

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test. No in brackets gives No. of blows/300 mm. penetration

Remarks: (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 29491

CLIENT: Luke & Company

PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: RL 4.64 Dia. of boring: 80 mm

Auger: Pty. Ltd, MD200, Toyota-mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A - D Level	Description of Strata	Anticipated A.S.S Potential
3.4.03						Grey-br. SAND	
						SANDY CLAY Dk. grey	
						SANDY CLAY Lt. gy-br.	
				-1.0		FINE SAND Yellow moist, loose	
				-2.0		FINE SAND Grey wet, loose/med. dense	
	Sample 91/1	D		-3.0		FINE SAND Dk. brown (soft "coffee rock") saturated medium dense	
						SANDY CLAY Grey, wet, soft	
				-4.0		Estuarine CLAY Dk. grey wet, soft	High Potential → management required
						End of Hole	No management required
				-5.0			
				-6.0			

Key to type of sample
U (50) = 50 mm. dia. undisturbed sample
D = disturbed sample.
N ( ) = standard penetration test. No. in brackets gives No. of blows/300mm. penetration

Remarks (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 29492

CLIENT: Luke & Company

PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: R.L 5.43 Dia. of boring: 80 mm

Auger: Ausdrill Pty. Ltd, MD200, Toyota-mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A - D Level	Description of Strata	Anticipated A.S.S Potential
3.4.03						FINE SILTY SAND Black moist loose	
				1.0		FINE SAND Light grey moist, loose	
				2.0		FINE SAND Brown, with some layers of soft "coffee rock" moist becoming wet medium dense	
				3.0			
	Sample 92/1	D		4.0			
						FINE SAND & fine-med. Gravel, sat. loose.	No management required
				5.0		Estuarine CLAY Dk. grey soft wet	High Potential management required
				6.0			

Key to type of sample
U (50) – 50 mm dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test. No. in brackets gives No. of blows/300 mm. penetration

Remarks: (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 29493

CLIENT: Luke & Company
PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: RL 4.94 Dia. of boring: 80 mm
Auger: Aimil Pty. Ltd, MD200 Toyota-mounted
Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: R.L. Level	Description of Strata	Anticipated A.S.S. Potential
3.4.03						FINE SAND Grey moist, loose	
						FINE SAND Yellow-brown moist loose	
				1.0		FINE SAND Lt. brown moist, loose	
						FINE SAND Grey moist/wet loose	
				2.0		FINE SAND, slightly silty Brown & dk. brown wet, medium dense	Moderate Potential → no management required
	Sample 93/1	D		3.0			
				4.0		CLAYEY SAND, fine grained Grey-brown Soft, wet	Moderate Potential → requires management
						Estuarine CLAY, grey, wet	High Potential →
				5.0		End of Hole	
				6.0			

Key to type of sample
U (50) – 50 mm dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test. No in brackets gives No. of blows/300 mm penetration

Remarks: (Observations on ground-water, etc.)

RECORD OF BOREHOLE No. 29496

CLIENT: Luke & Company

PROJECT: A.S.S. Assessment, Lake Cathie

Ground level: RL 4.92 Dia of boring: 80 mm

Auger: Pty. Ltd, MD200, Toyota - mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A = D Level	Description of Strata	Anticipated A.S.S Potential
3.4.03						Dk grey clayey Topsoil	
				1.0		CLAY, mod. plasticity Grey-brown wet soft	
						SANDY CLAY Grey, wet, soft	
				2.0		CLAYEY SAND fine grained Grey wet loose	
	Sample 96/1	D		3.0			
						SAND, slightly clayey fine grained Grey-brown, wet, loose	no management required
				4.0		CLAY, high plasticity Lt. grey, estuarine? v. wet, v. soft	High Potential requires management
				5.0		CLAY moderate plasticity (residual) Yellow brown wet, soft, becoming firm with depth	
				6.0		End of Hole	

Remarks: (Observations on ground-water, etc.)

Key to type of sample
U (50) – 50 mm. dia. undisturbed sample.
D – disturbed sample.
N ( ) – standard penetration test. No. in brackets gives No. of blows/300 mm. penetration

RECORD OF BOREHOLE No. 29498A

CLIENT: Luke & Company

PROJECT: A.S.S. Assessment, Lake Cathie

o/s 21m from 29498 towards 29474.

Ground level: estimated RL 5.4 Dia. of boring: 80 mm

Auger: Aimil Pty. Ltd./MD200/Toyota-mounted

Type of boring: continuous solid flight auger Lining tubes: nil

Daily Progress	Samples or Core Recovery: Depth	Samples or Core Recovery: Type or %	Change of Strata: Legend	Change of Strata: Depth	Change of Strata: A.H.D. Level	Description of Strata	Anticipated A.S.S. Potential
3.4.03						FINE SAND v. slightly silty Grey moist, loose	
				1.0			
						FINE SAND Browny grey moist/wet loose	
				2.0			
						FINE SAND with some intermittent fine gravelly layers, Light brown-grey wet medium dense	
				3.0			
	Sample 98A/1	D					
				4.0		CLAY, mod. plasticity Brown. wet, soft	
						End of Hole	
				5.0			
				6.0			

Anticipated A.S.S. Potential: ↓ management required

Key to type of sample
U (50) = 50 mm. dia. undisturbed sample.
D = disturbed sample.
N ( ) = standard penetration test.
No in brackets gives
No. of blows/300 mm. penetration

Remarks: (Observations on ground-water, etc.)

THU 12:37 HOLMES & HOLMES PTY. LTD P.01

HOLMES & HOLMES PTY. LTD.

CHARTERED ENGINEERS (AUSTRALIA)

P.O. Box J 159, Coffs Harbour Jetty, 2450.
Laboratory: Rippingale Road, Korora, 2450.
Telephone: (066) 53 6457

93/492
25/11/93

Att. Phil Luke
Luke and Company
Global at Lake ... tree

Here is text of report on developmental options — I would be happier if we had a contour pl... and perhaps sketch on it preliminary limitations to define areas worthy of more intense investigation.
Also the whole thing needs to be tied into the hydraulics of the area and possibilities for filling flood prone land without adverse effects on hydraulics.
Maybe what we need is a schedule when all these different inputs can be got together.

Regards
Bill

PS I am doing site classification of that fill & natural ground section at south west end of site as a separate report so that it can be presented to Council for release of land for sale.

2 mots ... list of

Appendix 5

Chandler Geotechnical Pty Ltd

Acid Sulphate Soil Investigation
April 2004

Chandler Geotechnical Pty Ltd

ABN 83 066 029 329

PO Box 5720 Port Macquarie NSW 2444 Phone (02)65810142 Fax (02)65810129

TEST BORE REPORT

CLIENT: Luke & Co Pty Ltd
PROJECT: Rainbow Beach
LOCATION: Bonny Hills

PROJECT NO: 23159
DATE: 14.4.04
LEVEL: Existing

BOREHOLE: 1
METHOD OF ADVANCE: Spiral flight auger

DEPTH METRES	SAMPLES TESTS	DESCRIPTION OF STRATA (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
0.50	"D" PM 5402	TOPSOIL. Silty SAND, dark brown, sands fine grained, low to non-plastic fines.
1.00	"D" PM 5403	SAND, pale grey, fine to medium grained.
1.50	"D" PM 5404	SAND, orange-yellow, fine to medium grained, wet.
2.00	"D" PM 5405	
2.50	"D" PM 5406	Silty CLAY, pale grey, medium to high plasticity, sands fine grained, mc >> wp.
3.00	"D" PM 5407	Silty sandy CLAY, mottled grey & red, medium to high plasticity, sands fine to medium grained, mc > wp.
3.50	"D"PM 5408	
4.00	"D" PM 5409	Borehole terminated 3.5 metres.

RIG: Jacro
GROUND WATER: None encountered
REMARKS:

LOGGED: SC

SAMPLES & TESTS

D Disturbed sample U Undisturbed tube sample
B Bulk sample pp pocket penetrometer

Chandler Geotechnical Pty Ltd

ABN 83 066 029 329

PO Box 5720 Port Macquarie NSW 2444 Phone (02)65810142 Fax (02)65810129

TEST BORE REPORT

CLIENT: Luke & Co Pty Ltd
PROJECT: Rainbow Beach
LOCATION: Bonny Hills

PROJECT NO: 23159
DATE: 14.4.04
LEVEL: Existing

BOREHOLE: 2
METHOD OF ADVANCE: Spiral flight auger

DEPTH METRES	SAMPLES TESTS	DESCRIPTION OF STRATA (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
0.50	"D" PM 5410	TOPSOIL. Silty SAND, dark grey, sands fine to medium grained, low to non-plastic fines.
1.00	"D" PM 5411	Silty CLAY, pale grey, medium to high plasticity, sands fine grained, mc >> wp.
	"D" PM 5412	
1.50	"D" PM 5413	SAND, grey, fine to medium grained.
2.00	"D" PM 5414	SAND, orange-yellow, fine to medium grained.
2.50	"D" PM 5415	
		SAND, pale grey, fine to medium grained.
3.00	"D" PM 5416	
3.50	"D" PM 5417	
4.00	"D" PM 5418	Borehole terminated 4.0 metres.

RIG: Jacro
GROUND WATER: None encountered
REMARKS:

LOGGED: SC

SAMPLES & TESTS

D Disturbed sample U Undisturbed tube sample
B Bulk sample pp pocket penetrometer

Chandler Geotechnical Pty Ltd

ABN 83 066 029 329

PO Box 5720 Port Macquarie NSW 2444 Phone (02)65810142 Fax (02)65810129

TEST BORE REPORT

CLIENT: Luke & Co Pty Ltd
PROJECT: Rainbow Beach
LOCATION: Bonny Hills

PROJECT NO: 23159
DATE: 14.4.04
LEVEL: Existing

BOREHOLE: 3
METHOD OF ADVANCE: Spiral flight auger

DEPTH METRES	SAMPLES TESTS	DESCRIPTION OF STRATA (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
		TOPSOIL, Silty SAND, dark grey, sands fine to medium grained.
		Silty CLAY, pale grey, medium to high plasticity, sands fine grained, mc > wp
0.50	"D" PM 5419	
1.00	"D" PM 5420	
		Sandy CLAY, grey with some orange staining, medium to high plasticity sands fine to medium grained, mc > wp.
1.50	"D" PM 5421	
		SAND, pale grey-brown, fine to medium grained.
2.00	"D" PM 5422	
2.50	"D" PM 5423	
3.00	"D" PM 5424	
3.50	"D" PM 5425	
4.00	"D" PM 5426	Borehole terminated 4.0 metres.

RIG: Jacro
LOGGED: SC
GROUND WATER: None encountered
REMARKS:

SAMPLES & TESTS

D Disturbed sample U Undisturbed tube sample
B Bulk sample pp pocket penetrometer

Chandler Geotechnical Pty Ltd

ABN 83 066 029 329

PO Box 6720 Port Macquarie NSW 2444 Phone (02)65810142 Fax (02)65810129

TEST BORE REPORT

CLIENT: Luke & Co Pty Ltd
PROJECT: Rainbow Beach
LOCATION: Bonny Hills

PROJECT NO: 23159
DATE: 14.4.04
LEVEL: Existing

BOREHOLE: 4
METHOD OF ADVANCE: Spiral flight auger

DEPTH METRES	SAMPLES TESTS	DESCRIPTION OF STRATA (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
		TOPSOIL, Silty SAND, dark grey, sands fine to medium grained.
		SAND, pale grey-white, medium grained.
0.50	"D" PM 5427	
1.00	"D" PM 5428	
1.50	"D" PM 5429	SAND, dark brown, fine to medium grained wet.
2.00	"D" PM 5430	
2.50	"D" PM 5431	
3.00	"D" PM 5432	
3.50	"D" PM 5433	
		Silty CLAY, (marine mud) grey, high plasticity, mc >> wp.
4.00	"D" PM 5434	Borehole terminated 4.0 metres.

RIG: Jacro
GROUND WATER: None encountered
REMARKS:

LOGGED: SC

SAMPLES & TESTS

D Disturbed sample U Undisturbed tube sample
B Bulk sample pp pocket penetrometer

RESULTS OF ACID SULPHATE SOIL ANALYSIS (Page 1 of 2)

30 samples supplied by Chandler Geotechnical on 23rd April, 2004 - Lab. Job No. E1988

Analysis requested by Steve Chandler.

Sample Site	Depth (m)	Texture (note 9)	FIELD SCREENING TECHNIQUE: initial pH (Water)	pH after peroxide	pH change	Reaction	Reduced Inorganic Sulphur (% chromium reducible S) (%Scr) (note 2)	TAA pH	Total Actual Acidity (TAA) mole / Kg	Lab Bulk Density tonne DW/m³	Potential Acidity Neutralising Calculation Kg Lime/m³ (based on %Scr)	Actual Acidity Neutralising Calculation Kg Lime/m³ (based on TAA)	COMMENTS RE: Classification as potential acid sulphate soil (ASS) based on %Scr results)
BH1	0.5	Fine	4.10	4.35	0.25	No	..	4.27	0.106	1.24	..	6.5	NOT Potential ASS
BH1	1.0	Fine	3.71	4.07	0.36	No	0.009	4.25	0.032	1.35	0.2	2.1	NOT Potential ASS
BH1	1.2	Medium	4.32	4.40	0.08	No	..	4.66	0.018	1.49	..	1.3	NOT Potential ASS
BH1	1.6	Medium	4.25	4.57	0.32	No	..	4.83	0.007	1.79	..	0.6	NOT Potential ASS
BH1	2.2	Medium	4.11	4.40	0.29	No	..	4.71	0.008	1.44	..	0.6	NOT Potential ASS
BH1	2.5	Fine	3.89	4.20	0.3	No	..	4.31	0.023	1.46	..	1.6	NOT Potential ASS
BH1	3.0	Fine	3.61	3.95	0.34	No	0.005	4.05	0.028	1.35	0.2	1.9	NOT Potential ASS
BH1	3.5	Fine	3.79	4.10	0.31	No	0.003	4.16	0.027	1.25	0.1	1.6	NOT Potential ASS
BH2	0.5	Medium	4.43	4.28	-0.15	No	..	..	..	1.20	..	..	NOT Potential ASS
BH2	1.0	Fine	3.84	3.80	-0.04	No	0.012	4.05	0.080	1.09	0.4	4.3	NOT Potential ASS
BH2	1.3	Fine	3.73	3.74	0.01	No	0.003	3.98	0.059	1.00	0.1	2.9	NOT Potential ASS
BH2	1.5	Coarse	4.18	4.25	0.07	No	.	4.57	0.011	1.66	..	0.9	NOT Potential ASS
BH2	2.0	Coarse	4.27	4.21	-0.06	No	.	4.69	0.008	1.53	..	0.6	NOT Potential ASS
BH2	2.5	Coarse	4.62	4.60	-0.02	No	..	..	..	1.62	..	..	NOT Potential ASS
BH2	3.0	Medium	4.76	4.70	-0.06	No	..	..	..	1.52	..	..	NOT Potential ASS
BH2	3.5	Medium	4.82	3.89	-0.93	YES	0.082	..	..	1.32	3.4	..	YES Potential ASS
BH2	4.0	Coarse	4.79	3.91	-0.88	No	0.067	5.40	0.001	1.39	2.9 Refer Note 6 & 7	0.1 Refer Note 6 & 7	YES Potential ASS

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)

2 - Samples analysed by POCAS method (ie Peroxide Oxidation - Combined Acidity and Sulphate Version 3 (updated published method) and 'Chromium Reducible Sulphur' technique (Scr - Method 22B)

3 - Methods from Stone, Y. Ahern CR and Blunden B (998). Acid Sulphate Soil Manual 1998. ASSMAC. Wollongbar, NSW.

4 - Total carbon and total sulphur determined using a LECO CNS 2000 analyser

5 - Bulk density was determined immediately on arrival to laboratory (oven bulk density is preferred)

6 - Neutralising Requirement (based on NAGP, chromium reducible sulphur or total sulphur) = Kg H_2SO_4/tonne x bulk density

7 - The neutralising requirement does not include a safety margin for complete neutralisation (a factor of 1.5 is often recommended)

8 - Conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm

9 - For Texture: coarse = sands to loamy sands, medium = sandy loams to light clays; fine = medium to heavy clays and silty clays

10 - Neutralisation Calculation for neutralisation of actual and potential acidity (ie sum of calculation based on Crs and TAA)

11 - The acid sulphate screening technique is currently NOT NATA registered

(Classification of potential acid sulphate material if: coarse Scr≥0.03%S; medium Scr≥0.06%S; fine Scr≥0.1%S)

(equivalent conversions - 0.03%S = 9.019 mole/ Kg; 0.06%S = 0.037 mole/ Kg; 0.1%S = 0.062 mole/ Kg)

* Projects that disturb >1000 tonnes of ASS soils with ≥0.03% S, a detailed management plan may be required.

checked: .....

RESULTS OF ACID SULPHATE SOIL ANALYSIS (Page 2 of 2)

33 samples supplied by Chandler Geotechnical on 23rd April, 2004 - Lab Job No. E1988

Analysis requested by Steve Chandler.

Sample Site	Depth (m)	Texture (note 9)	FIELD SCREENING TECHNIQUE: Initial pH (Water)	pH after peroxide	pH change	Reaction	Reduced Inorganic Sulphur (% chromium reducible S) (%Scr) (note 2)	TAA pH	Total Actual Acidity (TAA) mole / Kg	Lab. Bulk Density tonne DW/m³	Potential Acidity Neutralising Calculation Kg Lime/m³ (based on %Scr)	Actual Acidity Neutralising Calculation Kg Lime/m³ (based on TAA)	COMMENTS RE: Classification as potential acid sulphate soil (ASS) (based on %Scr results)
BH3	0.5	Fine	4.23	4.19	-0.04	No	0.007	4.20	0.044	1.14	0.2	2.5	NOT Potential ASS
BH3	1.0	Medium	4.30	4.38	0.06	No	..	4.52	0.011	1.76	..	0.9	NOT Potential ASS
BH3	1.5	Medium	3.94	3.96	0.0	No	0.005	4.20	0.028	1.59	0.2	2.1	NOT Potential ASS
BH3	2.0	Coarse	4.02	4.09	0.07	No	0.005	4.38	0.015	1.56	0.2	1.1	NOT Potential ASS
BH3	2.5	Coarse	4.63	4.84	0.21	No	..	..	..	1.59	..	..	NOT Potential ASS
BH3	3.0	Coarse	4.54	4.65	0.11	No	0.005	4.86	0.006	1.67	0.3	0.5	NOT Potential ASS
BH3	3.5	Coarse	4.72	4.95	0.23	No	..	..	..	1.73	..	..	NOT Potential ASS
BH3	4.0	Coarse	4.80	4.70	-0.10	No	..	..	..	1.68	..	..	NOT Potential ASS
BH4	0.6	Coarse	4.77	4.98	0.21	No	.	..	..	1.47	..	..	NOT Potential ASS
BH4	1.0	Coarse	5.04	4.96	0.91	No	..	..	..	1.45	..	..	NOT Potential ASS
BH4	1.5	Coarse	4.41	4.35	-0.06	No	0.005	4.64	0.025	1.20	0.2	1.5	NOT Potential ASS
BH4	2.0	Coarse	4.46	4.60	0.04	No	..	..	..	1.49	..	..	NOT Potential ASS
BH4	2.5	Coarse	4.53	4.60	0.07	No	..	..	..	1.49	..	..	NOT Potential ASS
BH4	3.0	Coarse	4.58	4.58	0.00	No	0.007	4.98	0.005	1.48	0.3	0.4	NOT Potential ASS
BH4	3.5	Coarse	4.56	3.10	-1.46	YES	0.247	4.79	0.009	1.59	12.3	0.7	YES Potential ASS
BH4	4.0	Coarse	4.04	1.99	-2.05	YES	1.677	4.40	0.019	1.30	68.3	1.2	YES Potential ASS
											Refer Note 6 & 7	Refer Note 6 & 7	

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)

2 - Samples analysed by POCAS method (ie Peroxide Oxidation - Combined Acidity and Sulphate - Version 5 updated published method) and 'Chromium Reducible Sulphur' technique (Scr - Method 22B)

3 - Methods from Stone, Y. Ahern CR, and Blunden B (1998). Acid Sulphate Soil Manual 1998. ASSMAC, Wollongbar, NSW.

4 - Total carbon and total sulphur determined using a LECO CNS 2000 analyser

5 - Bulk density was determined immediately on arrival to laboratory (in situ bulk density is preferred)

6 - Neutralising Requirement (based on NAGP, chromium reducible sulphur or total sulphur) = Kg H_2SO_4/tonne x bulk density

7 The neutralising requirement does not include a safety margin for complete neutralisation (a factor of 1.5 is often recommended)

8 - Conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm

9 - For Texture: coarse = sands to loamy sands, medium = sandy loams to light clays; fine = medium to heavy clays and silty clays

10 - Neutralisation Calculation for neutralisation of actual and potential acidity (ie. sum of calculation based on Cra and TAA)

11 - The acid sulphate screening technique is currently NOT NATA registered

(Classification of potential acid sulphate material if: coarse Scr≥0.03%S; medium Scr≥0.06%S; fine Scr≥0.1%S)

(equivalent conversions - 0.03%S = 0.019 mole/ Kg; 0.06%S = 0.037 mole/ Kg; 0.1%S = 0.062 mole/ Kg)

* Projects that disturb >1000 tonnes of ASS soils with ≥0.03% S, a detailed management plan may be required.

checked ....

Rainbow Beach Estate.

Client Luke & Co Project 25036

Date 25/10/5 Technician Captain Navas. AbleSeaman Chook.

Sample Location Bonny hills Lake.

Sample time 3:42

Depth	2.5m	2.0m	1.5m	1.0m	0.5m	0.0m.	3 <
Temp	19.97	21.31	25.26	25.47	25.52	25.55	19.
Dissolved Oxygen	74.5	88.4	127.4	128.2	128.3	128.5	88.
Ph	6.49	6.50	7.07	7.08	7.10	7.09.	6.5
ORP	139.8	143.7	139.6	141.0	141.8	141.3	132
ms/cm²	0.200.	0.218.	0.201	0.199.	0.199.	0.203.	0.2

Notes:

Rainbow Beach Estate.

Client Luke & Co Project 25036

Date 13-10-5 Technician Chook & Mumy.

Sample Location Buoy Centre of Lake.

Sample time 12:00

Depth	2.5m	2.0m	1.5m	1.0m	0.5m	0.0m.
Temp	19.72	23.2	23.36	23.42	23.44	23.42
Dissolved Oxygen	78.4	127.2	129.1	127.5	129.5	128.0.
Ph	6.40	6.94	6.99	7.00	7.01	7.00
ORP	197.2	186.5	186.8	185.1	186.0	185.8.
ms/cm²	0.169	0.169	0.169	0.169	0.169	0.169.

Notes:

Rainbow Beach Estate.

Client Luke & Co Project 25036

Date 29/9/05 Technician Noods & Chuck.

Sample Location Bray Centre of Lake.

Sample time 13:00

Depth	2.5m	2.0m	1.5m	1.0m	0.5m	0.0m.
Temp	17.45	18.75	19.85	21.20	21.50	22.0
Dissolved Oxygen	63.5	88.8	104.0	117.7	116.7	120.1
Ph	6.34	6.44	6.60	6.78	6.80	6.83
ORP	310.6	287.1	261.2	222.0	211.7	200.0
ms/cm³	0.165	0.165	0.165	0.165	0.164	0.165

Notes:

Coffey Geosciences Pty Ltd

trading as

Chandler Geotechnical

Unit 1/37 Jindalee Road, Port Macquarie NSW 2444

Telephone (02) 65810142 Fax (02) 65810129

WATER TEST RESULTS

CLIENT :	Luke & Co	**PROJECT No :**	PML032
PROJECT :	Rainbow Beach Lake	**REPORT No :**	PML032-1
LOCATION :	Bonny Hills	**DATE :**	17.2.06

Depth (metres)	Surface	0.5m	1.0m	1.5m	2.0m	2.5m
Temperature °c		24.7	24.7	24.7	24.7	24.6
Dissolved Oxygen %		74.4	81.2	70.6	72.1	45.5
pH		6.96	7.07	6.91	7.40	7.01
ORP		53.0	82.1	50.9	76.2	74.3
Conductivity mS/cm		0.221	0.216	0.221	0.217	0.219

Equipment Used
YSI 556 Multi Probe System/Data Logger

S.Chandler

RESULTS OF WATER ANALYSIS (Page 1 of 1)

1 sample supplied by Chandler Geotechnical Pty Ltd on the 23rd February 2006 - Lab. Job No. E5292

Analysis requested by Steve Chandler - **Your Project: PML032, Rainbow Beach**

PARAMETER	METHODS REFERENCE	Sample 1 PM6873
	Job No.	*E5292/1*
TOTAL PHOSPHORUS (mg/L P)	APHA 4500 P-H	0.02
TOTAL NITROGEN (mg/L N)	APHA 4500 N-C	0.62

Notes:

1. 1 mg/L (milligram per litre) = 1 ppm (part per million) = 1000 µg/L (micrograms per litre)= 1000 ppb (part per billion)
2. Analysis performed according to APHA, 1998, "Standard Methods for the Examination of Water & Wastewater", 20th Edition, except where stated otherwise.
3. Analysis conducted between sample arrival date and Report provision date
4. ** denotes these test procedures are as yet not NATA registered but quality control data is available

checked: .....

Appendix 6

Cardno Pty Ltd

Water Engineering and Environmental Report

April 2010

APPENDIX A

Acid Sulfate Soil Management Plan

TABLE OF CONTENTS

LIST OF TABLES

A1. ASS MANAGEMENT PLAN OBJECTIVES AND METHODOLOGY

This ASS (Acid Sulfate Soils) Management Plan (ASSMP) has been compiled to-

- Ensure that the construction of the proposed development does not result in release of acidic leachate and subsequent environmental harm;
- Provide appropriate design, management, monitoring and corrective action measures required to minimise the potential impact on the environment.
- Comply with relevant legislation and regulations.

The ASSMP has been prepared in accordance with the NSW Acid Sulfate Soils Manual 1998 prepared by the Acid Sulfate Soils Management Advisory Committee (ASSMAC) (ASS Manual) as required under the Hastings Local Environment Plan 2001.

The ASSMP is designed to assist construction staff in complying with their obligations under the NSW Protection of the Environment Operation Act 1999 (PEOA 1999).

A2. PROPOSED CONSTRUCTION ACTIVITIES

Construction activities associated with the subject development may cause potential oxidation of the PASS materials. These include:

- bulk earthworks including the excavation of material from the waterways at the site;
- dewatering associated with the above; and
- excavation associated with the construction of stormwater, sewer and other buried infrastructure during civil works.

Detailed control measures, in line with the construction activities listed above, are provided in the following sections.

A3. RESPONSIBILITY OF THE CONTRACTOR

The Contractor(s) for earthworks and civil works on the site shall conduct operations in accordance with this ASS Management Plan. Prior to the commencement of works, the Contractor shall provide the following information to the Consultant:

- Contractor's environmental policy.
- Names and responsibilities of supervisory staff involved with the implementation of the ASS Management Plan.
- Schedule of site inspections (and personnel responsible) to identify environmental problems, and maintenance actions to remedy any environmental problems identified.
- An Incidents and Events Register, in which all environmental problems identified during inspections and monitoring, and complaints received are recorded and acted upon.
- Environmental Training Plan and Training Record Plan for all personnel involved in development of the site.

Emphasis shall be placed upon the timely resolution of any complaints received in relation to development of the site and the development and implementation of corrective actions in response to non-conformities to the Management Plan (identified by the monitoring process).

The Performance Objective regarding complaint resolution is for the issue causing each complaint to be resolved in such a manner that there is no further complaint for the same reason.

The Contractor is to maintain an "Incidents and Events Register" which lists the date of the incident or complaint and the type of incident or complaint. For each incident, an incident/complaint log is to be completed nominating:

- Date of incident;
- Nature of incident and associated information;
- Location of incident;
- Name of person or body which reported incident;
- Employee who received notice of incident;
- Project Manager's review and comment;
- Recommended action to resolve incident;
- List of organisations to be contacted with regard to incident;
- Outcome of actions undertaken subsequent to incident being recorded; and
- Date of resolution of incident.

Each incident is to be assigned a number to be entered on the master Incident and Event Register. Further, Council and the Environment Protection Agency are to be notified with regard to corrective action sought for incidents which have the potential to cause environmental harm.

A4. POLICY STATEMENT

- To avoid detrimental impact on the water quality through the effective identification, treatment and management of acid sulfate soils at the site.

- To comply with the *NSW Protection of the Environment Operation Act 1999 (PEOA 1999).*

- To manage acid sulfate soils in accordance with the NSW *Acid Sulfate Soils Manual 1998* prepared by the Acid Sulfate Soils Management Advisory Committee (ASSMAC) (ASS Manual).

A5. PERFORMANCE OBJECTIVES

The objectives of the ASS Management Plan are to ensure the following:

- Implementation of additional assessment procedures during earthworks operations to confirm neutralising dosing rates for the effective treatment and management of any drained, disturbed or excavated ASS in accordance with the *ASS Manual*.
- Remediation of acid trend waters if discovered, and provision of control structures to prevent leachate discharge off-site which does not meet specific water quality criteria.
- The control of erosion and sedimentation of ASS during earthworks.
- Where possible all site water shall be reused on site. If it is necessary to discharge site water off site it shall comply with the following criteria:

Table A1 Water Quality Release Criteria

Water Quality Parameter	Release Criteria
pH	6.5 - 8.5
Oil and grease	No visible film. No detectable odour.
Iron floc and scum	None visible
Floating matter	None visible
Suspended Solids	< 50 mg/L
Dissolved Oxygen	80-100 %
Iron	300 µg/L
Aluminium	Equal to background levels

The performance criteria for hydrosluiced materials are specified below.

- No sample shall exceed 25 moles H^+/tonne (0.04% S).
- If any single sample exceeds 18 moles H+/tonne (0.03% S), then the average of any 6 consecutive samples (including the exceeding sample) shall have an average not exceeding 25 moles H+/tonne (0.03% S).
- If more than one sample in any 6 consecutive sample exceeds 25 moles H^+/tonne (0.03% S), then the average of any 6 consecutive samples (including the exceeding samples) shall have an average content not exceeding 16 moles H^+/tonne (0.03% S).

The following best environmental management practices shall also be employed:

- The area of disturbance during construction shall be limited to the immediate construction area and access routes.

- All earthworks areas shall be isolated by the provision of perimeter cutoff drains or bunds.
- Excavated material shall be retained within secure bunded areas until it has been assessed for acid sulfate potential and treated as required.
- Runoff shall be contained within the construction site for treatment prior to reuse on site, or if necessary discharge off site. This will require the construction of catch drains, perimeter bunds, temporary sediment ponds, etc.

A6. SITE MANAGEMENT PROCEDURES

A6.1 Introduction

Management of both excavated and in-situ soils are required under this Plan to ensure that the impacts of disturbance are within acceptable limits.

A6.2 Training

The Contractor shall employ suitably qualified personnel during all earthworks operations to supervise and monitor acid sulfate assessment, management and treatment, so as to comply with this Plan. These personnel shall be trained in the recognition of possible ASS.

A6.3 Excavation Techniques

Excavation shall be undertaken in stages to ensure that groundwater drawdown associated with dewatering of the excavation areas is minimised.

Only a single excavation cell within the waterways shall be completely dewatered at a time. Each excavation cell will be separated by a section of unexcavated material and once excavation of each cell is complete the cell will be re-flooded to reduce the potential for groundwater drawdown associated with the dewatering and excavation of the adjacent cell.

Excavated slopes shall be inspected on a daily basis and shall be treated by surface sprays and liming to prevent any acid formation.

All excavation and treatment areas shall be isolated from external areas by perimeter drains and/or bunds. All waters collected on the site shall be contained, collected, tested and treated prior to disposal to external areas. All excavated material shall be subjected to appropriate testing, and treated where required.

All soils including sands and the clay strata shall be sampled during excavation. The sampling frequency shall be 1 sample per 500 cubic metres. The soils Acid Neutralising Capacity (ANC) shall also be undertaken throughout the construction phase. The samples shall be tested in accordance with the Acid Sulfate Soils, Laboratory Methods Guidelines. The location and depth of all test samples shall be accurately recorded on a plan of the works area.

A6.4 Treatment

All soils indicated to exceed the oxidisable sulphur criteria shall be treated with fine agricultural lime after excavation. If ANC is included in calculations for liming rates, a fineness factor of at least 1.5 must be applied to account for likely lower acid neutralising capacity in the field.

The base of any stockpiling areas of excavated PASS shall be limed with a guard layer of at least 5kg/m^2/m depth of material excavated.

Mixing shall be carried out by spreading in layers of not more than 300 mm, and use of an agricultural spreader and disc plough, rotary hoe or similar. Care shall be taken to ensure that mixing occurs throughout the depth of the layer prior to placement of new material. The rate of lime application shall be determined in accordance with the Acid Sulfate Soils, Laboratory Methods Guidelines.

Following the successful treatment of the lot (as determined through the verification testing), the material shall be compacted and the next layer of excavated material to be treated shall be placed over the already treated material. This process shall be continued until the required site elevation is achieved.

A6.5 Validation Testing

The treated PASS shall be subject to validation testing at a rate of 1 test per 500 m^3 of treated soil (as per the QASSIT *2003 Laboratory Methods Guidelines*). The validation testing shall consist of the measurement of Scr, TAA, the pH of the soil (pH_{KCL}) and the measurement of excess acid neutralising capacity (ANC). A soil may be deemed to be effectively treated when it has no net acidity.

An excess ANC of 0.5 times the existing + potential acidity shall be used as the criteria for adequate neutralisation of ASS.

Verification testing shall include retained acidity where pH is < 4.5.

A6.6 Treatment of Fill Areas

The base of all fill areas where treated PASS are to be placed shall be treated with a guard layer of 5 kilograms per square metre of fine agricultural lime per metre depth of fill prior to the placement of any fill soils.

A6.7 Control of Discharge

All water generated from dewatering activities, seepage and site runoff shall be held on site. Ponded water shall be tested for pH on a daily basis, and no water shall be discharged from site unless it complies with the requirements of Table 1.

Treatment may include the addition of flocculating agents to reduce the suspended solids concentration, and the addition of hydrated or agricultural lime to control pH.

A6.8 Groundwater Monitoring and Treatment

Groundwater monitoring bores shall be drilled approximately 50 metres beyond the excavated area to monitor the effect of the earthworks operations on the surrounding groundwater. In addition, a baseline groundwater monitoring bore shall also be drilled at the boundary of the site remote from the excavations.

The groundwater level and pH in the bores shall be monitored prior to commencement of dewatering of the water body at the site and shall be monitored on a daily basis during excavation to determine if any remedial works are required. The groundwater pH value shall be maintained to within 1 of the baseline monitoring bore pH reading.

Remedial works may include temporary halt of excavation works to allow sufficient time for groundwater recharge, the construction of recharge trenches and addition of soluble lime to the water in recharge trenches.

A6.9 Storage of Lime

A sufficient supply of agricultural lime ($CaCO_3$) shall be retained at the site at all times for treatment of ASS. The supply shall be stored in a covered and bunded area to prevent accidental release to waters.

A quantity of hydrated lime shall be retained at the site at all times for treatment of acidic waters. Storage requirements for hydrated lime shall be identical to that specified above for agricultural lime.

A6.10 Monitoring

The Contractor shall monitor the works on a daily basis for evidence of:

- yellow efflorescence on soil surfaces
- sulfurous odour.

Laboratory analysis of soils during construction shall be in accordance with the ASS Manual.

Excavated soils subjected to analysis shall be sampled and tested at the rate of one test per 500 m^3 of placed material.

Satisfactory completion of treatment shall be validated in accordance with the ASS Manual. Validation testing of PASS material shall be undertaken at the rate of one test per 500 m^3 of placed material.

Lime delivery dockets are to be collected and checked against calculated amounts of lime used.

Daily on-site monitoring of water quality shall be required. All discharges from the site shall be continuously monitored for pH and turbidity. All water discharged from the site shall comply with the requirements of Table 1. Specifically, pH level must be between 6.5 and 8.5, and suspended solids (or equivalent turbidity) must not exceed 50 mg/L.

A7. REPORTING

The Contractor shall submit monthly reports on his activities to the Consultant and the Council including any non-conformances with this plan.

A8. CORRECTIVE ACTION

Corrective action shall be implemented if any complaints are received by the Contractor, Council or EPA.

Non-conformance with this plan shall be documented and a Corrective Action Request (CAR) issued. All CARs shall be included in the Non-Conformance Register.

The Contractor shall implement the corrective action as required within the agreed time frame noted on the CAR.

The Contractor shall advise Council and the Consultant upon completion of the corrective action.