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:...

68536457

Dia of boring: 80 mm.

Didy	Core Reco	Change of Suna			8	A.S.S Potential	
Progress	Death	Tyce or %	Legand	Depth	Feral 7 n D	Description of Strata	totentiu
21.3.03						CLAY mad. plasticity Brown moist/weit soft	63 2-
		q		-1.0	70	SANDY CLAY mod plasticity Br. & yell. wet, soft	1 6 18 4
		12 Y		€ .		FINE SAND, slightly	lial
	at a	x		-2.0	ē	Yellow wet, loose	potential
	Sample 107/1	CE				FINE SAND Grey	Very slight manageme
				3.0		salurated, loose	No ma
	Sample	Ţ	7			Esturine CLAY	45
	107/2			4.0		Grey with yellow streaks wet, soft	Very high Potential
			X			2	·
	Sample	 		5.0		Slightly SANDY CLAY Grey wet, suft	High Potential
	107/3	D.				wet, zuft	High Rey
Key to two	o of sample		\simeq	6.0		vations on ground-water, etc.)	



RECORD OF BOREHOLE No. 108

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

Dia of horing: 80 mm Ground level Type of baring Continuous solid Hight auger Lining tubes: Mil Closege of Smita Daily Potential Description of Strata Progress egend Denth Dogin 21.3.03 CLAY high plasticity Grey moist soft /firm CLAYEY SAND mod plasticity light grey FINE SAND Light grey Saturated loose 3.0 FINE SAND, Slightly silty Grey, saturated bose Sample Esturine CLAY 4.0 D 108/2 Grey west soft Elightly SANDY CLAY 5.0 Sample Grey D 108/3 wet, soft End of Hole Remarks (Observations on ground-water, etc.)

U = (80) = -50 mm. dia. undisturbed sample,

- disturbed sample.



No in brackers gives

No. of blum/300 into, penetration

RECORD OF BOREHOLE No. 109 CLIENT: Luke & Company PROJECT: A.S.S Assessment, Lake Ca

Dia of boring ... Barren ... Ground level ... Amil Pty Ut MD200 Tayota - mounted

D 41'4	Samples of Cold Person	ervii.	C	hange of S	'* 1' A	n at Serve	A.S.S Potentia
Pingress	Death	Typa or %	Lanned	Depth	S F D	Description of Strata	rolentia
21.3.03			11/3	-		Sandy Topsoil	
						FINE SAND	
	* 6 . *					Brown	
				-1.0		wet, loose	. A
	2 1 N 5 1						27 E
		161					
-	2 8 W	i.e		- 2-0		FINE SILTY SAND	7
		7				Brown	Dtential res
-	Sample. 109/1	\mathcal{D}				saturated medium dense	jh Pote Feguries
-:	-,/	ļ		-		neatom sterio	High Botani Fequities
				-3.0			75
ŀį.			1	-			1 al
	Sample. 109/2	D				CLAYEY SAND fine grained	potential agement
	3/2]		-4.0		Grey	slight potential management required.
	6 K		X			saturated	2 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
		*				loose/med.dense	
-	V g					Esturine CLAY	12 9 1 3 1 5 1 5 1 5 1 5 1 5 1 5 1 5 1 5 1 5
- .]	Simple	D		-5.0		Dark grey	test to be
	105/3					,	73, 07. \$
	s" .	1.0		-			8 9 ₁₀
Kay to Iv	rpe of sample .			Remark	. (Obse	rvations on ground-water, etc.)	



RECORD OF BOREHOLE No. 110 CLIENT: Luke & Company PROJECT: A.S.S Assessment, Lake Cathie

Groundlave	Pl	n continueto	-Mounted		Dia, of boring 주요 않아	en apr
Type of int	inil Pty. Ltd. M	امالات ون	flight .	auger	Linning (ul)es . Mil.	
Only	Samples (57	Change of S			A.S.S
Progress	Death One	Type	egood Oppib	Z = Z 	באביים מפת ביו לאיאום	Patential
21.3.03			7			
	Sample 110/1 Sample 110/2 Sample 110/3		2-0		CLAY high plasticity Grey with some yellow mottling moist/wet Soft FINE SAND White wet, loose FINE SAND, slightly silty dirty white saturated med. dense Serpentimite CLAY high plasticity greenish grey soft, wet	Moderate Slight Very slight potential Potential Potential no management Requires management required
		1	٤٢-		V bit refusal in Serpentinite	
	×				Serpentinite	
			-5.0			
	2.					
			-			
النيب			6:0		Carried Control Control	ļ
	Pe of sample — 50 days, the true	Situation Co.	Remark	 Obse 	rvations on ground-water, etc.)	
0	- disturbed sampl		- pre.		at a	E
	- standard penetr				a e	
1.0	ackets gives				12.10	
0100	owi/300 mm, pene	riation				



RECORD OF BOREHOLE No. 111

OLIENT: Luke & Company

PROJECT: A.S.S Assessment, Lake Cathie

O' tivy	Samples r	ne .		ight auger	Lining tobes Cil	A.S.S Potentia
Progress	Doorh	T	Fadeuq	Death i		10.00
21.3.03			1 [[]		Clayey Topsoil	1
				•13	CLAY high plasticity Brown	
	! :				moist, firm/soft	3 E 18
	50. K		//	-1.0	CLAYEY SAND, Grey wet, soft	.",
		8			FINE SAND	
	9 N S	.40		-	Yellow wet, loose	
	, 2000 m 1980 m			-2.0		1 +
	Sample	10	2		SILTY SAND fine grained	Styly potential regulates
	111/1				wet, med dense /loose	pot
				-3.0		regot
, es:	y (40)				SANDY CLAY Red brown wet. soft	37
	(4)				CLAY, high plasticity Yellow brown moist, firm	
				4.0	End of Hole in residual clays	
	z .				3	
5	3			-		8
				-5.0		
	* 5	=			\$ 12.5	
		14 3) 788		6:0	l e	7 *

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

13 samples soppited by Holmes & Holms on 26th March, 2033 - Lab, Joh No. E0244. Analysis requested by Bill Holmes - Your Project: Order No. M0095

	<i>(%)</i>				
COMMENTS RE: Classification ax potential acid subphase sot teased on %Scr. pesuits)	VOT Polential ASS YES Petential ASS YES Petential ASS	NOT Potential ASS YES Potential ASS YES Potential ASS	YES Patential ASS NOT Potential ASS YES Potential ASS	NOT Folential ASS YES Potential ASS YES Potential ASS	YES Potential ASS
Acust Actory Realraidsog Calcutation Kg Limom*	0.0 0.0	6.0 6.0	9.0	0.0	0.6 Roler Note 6 & 7
Polential Acidity Neutral slog Calculation Kg Lime/m* Cased on NAGP1	0.9 36.8 9.3	33.7	10.6 30.6	2.8	3 5 Refer Note 6.8.7
Potential Actifity Veutralishing Calcutation Kg Limeling Freed on MSCO	1.8 35.1 9.0	1.0 37.9 13.1	10.4 0.4 30.6	0,4 0.0	4.9 Pater Mado 6.8.7
Lab. Bulk Density tonna Divina	1.70	1.77	1.57	1.52	1.51
Yotal Actual Acidity (FAA) -mole ? Kg	0.004	0.002 0.005 0.001	0.006 0.007 0.008	0.000	0.008
TA TO	4.88 4.99 5.47	5.10 4.95 5.46	5.02 4.83 4.90	5.78 5.05 6.99	4.73
MGP MANG Kg H,SO4 KGBGD, Tanne soll	9.5 30.6 3.6	23.4 5.5	6.8	1.9	2 3
% ANG %GRED!	0.00	0.35	0.00	0.15	0.10
Reduced (norganio Subriur Subrium reducible 5)	0.033 0.978 0.212	0.018 0.858 0.305	0.217 0.009 0.943	0.008 0.051 0.205	0.106
Texture	Coarse Fine	Coarse Fire	Coarse Coarse Fine	Coarse Coarse Fine	Coarse
Depth (m)	2.3-2.8 3.8-4.4 5.2-5.8	2.3-2.8 3.8-4.4 5.0-5.5	2.3-2.8 3.5-4.0 5.0-5.5	2.0-2.4	2.3-2.8
Sampto Sie	107/1 107/2 107/2	108/1	109/1 109/2 109/3	110/1 110/2 110/3	111/1

NOTE

. All analysis is Cry Weight (DW) - scupplis dried and ground kninedialely, upon arrival (unless supplied diad and ground)

2 - Samphos analysed by POCAS method fe Pervide Oxfeeton - Combined Acidity and Suphale - Velsion 3. Lectural and Chiefled and "Chromium Reducible Sulphur Icchnique (Scr - Method 228)

- Nethiods from Stone, Y. Abern CR, and Blunden B (1938). Acid Sulphtue Soit Namual 1998. ASSIAAC Wollongbar, 143W

. Yolal cabon and total sulphur determined using a LECO CNS 2000 analyses

s - Bulk density was determined incrediately on arrival to laboratory (maits bulk density is preferred)

3 - Neviralising Requirement (based on NASP, checinium reducible culptur or total sulptur) = Kg HySO4/toune x book detaily

The naticalising requirement that not include a safety margin for complete naticalization to actor of 1.5 is often retoinmended)

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

9 - For Tealune, coarse a sands to loamy sands; medium a sandy paras to fight days; find a medium to heavy clays and My days; 10 - Neutralisation Caleutation for reutrationloa of actual and potential ecitify (i.e., sum of calculation besed on Grs and "AA)

11. AMC= Acid Moutalising Cabacily of the Soil (Detector) limit of 0.05% CaCCs, Equivalent)

12 - NAGFa Net Add Generating Potentia= (31.7%S_{e.1})-(10%AUC) (From Murrey, 1950)

(Claasification of potential acid sulphate material II: coarse Scr26.03%S; medium Scr20.06%S fine Scr20.1%S) (equivalent corversions - 0.03%S = 0.019 mole/ Kg; 0.08%S = 0.007 mole/ Kg; 0.1%S = 0.062 mole/ Kgi

exploses that disturb > 1000 tonnes of ASS sods with 21,03%. Sile detailed management pian may be required

heckad:

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 leve	RLS	38	٠		7	Dia, of horing: 80 mm	1 A
	A- Type of har	ing continue	المع ويد	d H	ight.	auger	Lining tubes: ကျဲ	
5	Dirty	- Samples Core Page	nr .		renor of S		PS	Anticipated
*	Progress	Dage	Tyne'	Legend	Death	7 = D	Description of Strain	A.S.S Potential
81 04	3.4.03				•		Dk.grey clayey Topsoil	
					-0		CLAY high plasticity Dk grey wet soft	
×		Sample 48/1	А		- -2:0		CLAY high plasticity Grey with yellow-br. mottlings wet soft	Z
		Sample			-3·0 -3·0		FINE SAND Light grey Saturated	agament requi
		48/2	D:		-4.0 -		medium dense CLAY mod. plasticity wet (residual) yell. br. firm	- No men
					5.0		End of Hole	
	U (50) D N () No in br	ypo of sample 50 mm, dia, un disturbed samp standard penetr ackets gives ows/300 mm, pene	le: etion lest		Firmark	< IOuse	rvations on ground-water, ètc:)	



RECORD OF BOREHOLE No. 29449 CLIENT: Luke & Company & BH WID PROJECT: A.S.S. Assessment, Lake Cathie

	Samples Core Renor	01		igngr of S		· · · · · · · · · · · · · · · · · · ·	Antici pated
Progress	Dooth Dooth	Type or N	reduna	Dapih	A of D	Description of Strata	A.S.S.
3-4.03	., .			-2		Dk grey clayey Topsoil	2 *1x
						CLAYEY SAND Grey-brown, moist, soft	2 g X
						FINE SAND Grey-brown	
				-1·0 -		moist, loose	
						(Å)	Janie G
	200	, as ₁	\		1(4)1	FIME SAND	2
		89. R **		-2:0		Grey	Jenent
						noist/wet loose/med.dense	mara
		- 2	(s) - x t			W _{ax}	No.
				-3·Ø			L X
٠		7			10	Estu arine CLAY	1 4
	(a)	174				Grey	3 to 8 to
				-4·o		wet Soft/firm	Potential
		بينا		•		F1 -C 41a	-
2	8 2 2 8					End of Hole	
		n in is 535		-5.0			
			-				
5 e				۔ م. م		8 8 8	
	se of sample 50 mm, dia, un	disturbed	íamole	Ritmark	s lObs	ervations on ground-water, etc.)	5 8
۵	disturbed same	pię	10	•		हा - अस्ति	



RECORD OF BOREHOLE No. 294 GG CLIENT: Luke & Company PROJECT: A.S.S. Assessment, Lake Cathie

66536457

Dia. of boring: 80 mm

100	Airell Fr	9. 62				
Type	I horing Coc	Jinuous	solid flight	auger	Lining	tubes:
			- X		-	

FINE SAND with some moist/wet loose FINE SAND with some intermittent fine gravely layers, Brown wet, wediem dense 4.0 Sample D 4.0 CAN FINE SAND with some intermittent fine gravely layers, Brown wet, wediem dense of Grey, wet, soft EstwarmeCLAY, wet, soft EstwarmeCLAY, wet, soft End of Hole	עוונס	Core Reico	or .	C	rarige al S	tens	Osseriation of Strata	Anticipate A.S.S	
FINE SAND Light grey moist/wet losse FINE SAND with some intermittent fine gravelly layers, Brown wet, medium dense CLAYEY SAND fine gravely wet, soft EstrameCLAY, wet, soft End of Hole	Progress	:	Type	Legend	Danih	7 - D	Description of Strais	Potential	
FINE SAND Light grey moist/wet loose FINE SAND with some intermittent fine gravelly layers, Brown wet, medium dense Quarter SAND, fine graved wet, soft EstwarmeCLAY, wet, soft End of Hole FINE SAND FINE SA	.4.03		24 (2 (24) (224)				Ik. grey		
FINE SAND Light grey moist/wet loose FINE SAND with some intermittent fine gravelly layers, Brown wet, medium dense Quet, soft EstwarmeCLAY, wet, soft End of Hole FINE SAND FINE SAND FINE SAND FINE SAND FINE SAND FINE SAND FINE FOR GREY FINE SAND FINE FINE FINE SAND FINE FINE FINE SAND FINE F	5,		* * * *		-:1·0	27		e le	
FINE SAND with some intermittent fine gravelly layers, Brown wet, medium dense of Grey, wet, soft EstwarmeCLAY, wet, soft End of Hole			<		•				
FINE SAND with some intermittent fine gravelly layers, Brown wet, medium dense of Sanple D CLAYEY SAND fine grained Grey, wet, soft Estracine CLAY, wet, soft End of Hole	a j		. * . * ! .		и 6 у и				
Sample D Sample			2004 (a) 2004 (a) 3004 (a)	6.	-20		1	gar.	
Sample D Sample	0.00	500 500 5						\$	
Sample D Sample			- N	0			FINE SAND with	8	
Sample D CLAYEY SAND, fine grained Grey, wet, soft EstwarmeCLAY, wet, soft End of Hole			94 72 - 34 -	63	-3.0		some intermittent	mage	
Sample D CLAYEY SAND, fine grained Grey, wet, soft EstwarmeCLAY, wet, soft End of Hole	•	va Sa		0.0			Braun	43	
Sample D Grey, wet, soft 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5			** E/ =			4			
-5.0 End of Hole		Sample	D		-4.0		grained Grey, wet, soft	sh sential	
-5.0		1/00/1				-1		= 20 5 3	
		- y = - 8	10 - 523 III	-	2	2"	End of Hole		
	-				-5.0			W 6	
			8 / 2 E						
Key to type of sample Remarks: (Observations on ground-water, etc.)			, (1)-		- G-A				

66536457



RECORD OF BOREHOLE No. 29472 CLIENT: Luke & Company PROJECT: A.S.S. Assessment, Lake Cathie

Ground levi A	1150	RL5	DROTTON	ota um	ounted	us s	Dia. of horing: #2 mm	Toronto Transport
Type of hor	ring	continuo	اصع ون	id H	ight:	auger	Lining tubes:(11),1	***************************************
	1.	Core Recov	11		range at S		25.	Antici pate
Progress	-	- Depth	Type	Legend	Death	2 - D	Days-Iption of Strata	A.S.S Potential
3.4.03		-		1.	28		SILTY SAND, fine	ж 3а
		5 -					grained	97
				1				
	-		DC .	*:	9.		Dk.greg	
5.777				3.1			moist, loose	* * **
				10				
		13 E			-1.0		4	
							** 10* (*)	
×		200	× 5	24	•		SAND, fine grained	
		i an s	100		-			**************************************
							Light grey-brown	= 1065
0, e		1	· ·	11.1			the state of the s	: i
4					i e	9	moist, becoming wet	
· ×2			a #		-2.0			~:
	400	-		33			loose	. 3 .
			а в.				2)	
			(P)		-		8 Apr 1 100	8
						12.	is it s	
: "							(d)	· · : 15. ·
* x y			× "				*	. d
		,*****	* 5.		-3.0			. 9
	100			0.0.0.			SAND & fine/med gravel	4
			2 9	0.00			Print & Amelinan Print	3
	-		a v	1.4	١.		FINE SAND	. 8
				, : .			Grey - brown	. 0
					1		saturated, medidense	7.
	20 Y			00,0	Ť			i a grie
· .				000	-4.0		SAND & fine/med gravel	
,			1	2000			FINE SAND (soft colles rock)) · ^
		Sample	Н	7.77			Brown, wet, med. dense	<u> </u>
87		72/1		17	1		CLAYEY SAND Grey	\ \frac{1}{2} \ .
		1	D.D	1/1	1		saturated, loose	100 to
				3/1		ĺ	Saistarea, west	28.5
* · ·		*.** :	Γ	1	[·	1		-30 = 3
· a t				11	-5.0	2	EstuarineCLAY	tligh Poten regoires
		5 1	100	11				9 2
28		A 50 pt		11	1		Wet	ž
* ;				11			Soft.	1440
			2.5	11	1			
3		28 -	1	11	j -	ŀ	55h (1) 1	1
¥0.4				1	10.0	1		1
Key to	typ	of sample	·		. Hemai	ks- 100s	ervations on ground-water, etc.)	
		50 mm. dia. ur		sample.	3			
. 0		disturbed same		. 8	*		988 W W W	v * 4
		standard penet kets gives		100	1		* 4	±
		y/300 mm per			9.8	.8	·	



RECORD OF BOREHOLE No. 29475

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

5.27 Dia, of horing: 80 mm Ground level: RL 5.2/
Andil Pty Ltd MozooToyota-mounted
Type of horing Continuous solid flight auger Clipner of Stres Core Recovery A.S.S Potential Description of Strata Progress Ocean Dopth FINE SAND, v. slightly 3-4.03 silty Grey-brown FINE SAND, Brown moist, loose FINE SAND, Dk yellow 1.0 moist, loose/med. dense FINE SAND Light brown 20 wet loose/medium dense FINE SAND, v. slightly silty hard and softer layers ∙3∙⊘ Brown not med dense CLAYEY SAND, fine grained Grey-brown soft, wet Sample. \mathcal{D} 75/1 Estudrine GLAY, wet, soft, End of Hole 5.0

Humarks (Observations on ground water, etc.)

U (50) - 50 mm, dia, undesturbed remple.

D disturbed sample .

N f -1 - stenderd penetration rost

No in brackets gives

No. of blows/300 mm penetration



RECORD OF BOREHOLE No. 29482

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

Ground level: RL 5.43

Aimyl Pty Lty Mozoo Tayota - mounted

Type of noring continuous solid flight auger Dia. of horing: 80 mm. Anticipated A.S.S Potential Samplet or · Change of Strata DINY Description of Strata Progress -Denih סיִסוֹא 3:4:03 FINE SILTY SAND Light grey moist loose FINE SAND dirty white 2.0 moist becoming. loose. 3.0 FINE SAND Grey brown FINE SAND . Brown & Dk. brown (soft coffee rock" wet Sample medium dense FINE SAND, Grey saturated 5.0 loose Grey estuarine CLAY wet Soft Remarks: IObservations on ground U (50) - 50 mm, dia, undisturbed temple . - disturbed sample. N I 1 - standard penetration text. No. in brackers gives.



No in brackets gives

No. of blams (300 mm, penetration .

RECORD OF BOREHOLE No. 29484

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

Dia. of horing: \$0,000 5.39 Ground level: KL 5. 57

Aimil Pty. Ity Mozoo Toyota mounted

Type of horing continuous edial flight auger Lining types: Dil..... Samples or Change of Strata DINV A.S.S Description of Strata Tyce Potential Progress Otoin Droth FINE SILTY SAND 3.4.03 Grey moist, loose 1.0 FINE SAND with some layers containing med of coarse sand Lt. grey moist becoming wet 20 loose FINE SAND (soft coffee rock Brown 3.0 wet medium dense. FINE SAND with finemedium rounded gravel saturated Sample. loose. Estuarine CLAY Dk. grey 5.0 soft wet End of Hole Hornarks: (Observations on ground-water, etc.) U (50) - 50 mm, dia undisturbed sample. D: . - disturbed sample. N () = standard penatration test.



RECORD OF BOREHOLE No. 294 85 A

CLIENT: Luke & Company of 40m from 485 toward PROJECT: A.S.S. Assessment, Lake Cothie

Dia of boring: 80 mm Gripund level:
Aimi Pty. Ltd. MD200 Tayota amounted
Type of horing: Continuous solid flight auger Lining tubes: nil..... Anticipated A.S.S Samplet or Core Rendvery Change of Straia Daily Description of Strata Potentia Progress Denth 3.4.03 SILTY SAND, fine grained Light grey moist loose/medium dense 1.0 FINE SAND Light grey wet 20 loose FINE SAND with a 3.0 little fine gravel Brown wet medium dense CLAYEY SAND, fine . Grey, wet, soft. Estuarine CLAY, grey, wet End of Hole 5.0 Anmarks: (Observations on ground-water, etc.) U 1501 - S0 mm, dia, undisturbed sample, - disturbed sample. N | 1 - Standard penetration lest. No in brackers gives : No. of blovd/300 mm, penetration



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RECORD OF BOREHOLE No. 29491

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

Ground level RL 4.64

Armil Pty Lty MD200Toyota -mounted

Type of horing Continuous solid flight auges Dia, of horing: 80 mm Lining tubes: 51 Anticipated A.S.S Potential Description of Strata aragress Ocoth . egnnd Death Grey br. SAND 3.4.03 SANDY CLAY Dk. grey SANDY CLAY Lt.gr-br. FINE SAND Yellow moist, loose -1-0 FINE SAND Grey wet, loose/med.dense -2-0 FINE SAND Dk. brown (soft coffee rock 30 saturated Sample medium dense SANDY CLAY Grey, wetself Estuarine CLAY 4-0 Dk grey End of Hole 5.0 Altmarks (Observations on ground-water, etc.) U: (50) - 50 mm; dia, undisturbed sample disturbed sample. N T 1 - standard penetration test. No, in brackers gives Nr. of blows (300 mm, penetration



RECORD OF BOREHOLE No. 29492 CLIENT: Luke & Company PROJECT: A.S.S. Assessment, Lake Cathie

Ground level	11 Pt 1+1 M	noopTaye	sta -m	ounted		Dia, of horing: 80 mm	
Type of hocie	ontinue	العد دا	id fil	ight .	auger	Laring Jubes: Dil	
Duly	Core Recov	11		iange of S		,,,	Artici pated
Progress	Droth	Type	Lagend	Death	7 - D	Description of Strata	A.S.S Potential
3.4.03			2016	******			(*) (1)
		2		•		F CUTY CAND	
		. 2		•		FINE SILTY SAND	
	1.1	8 "			8	Black	- E 10
14 1		2		a		moist	
				-1.0		loose	
			35.5			FINE SAND	
		50 040				Light grey	
20 %	1 .1.		40.0			moist, loose	
± 348				•		E	
7.					1		
1				-2.0		2 2	
1		12				FINE SAND	
		8	1			Brown, with some.	
		15 th 11				layers of soft	le a .
3 5			17.			layers of soft "collec rock"	Z
	1, 20	4					2
4.5		2000		-3.0		moist becoming wet	\$
			3/2			medium dense	1
x 2 ×	1 1 5	(e)				<u>.</u> -	5
							9
						780	4
4		2	7.7	-4.0		a a	2
	Sample			7.0		(K 524	0
	92/1	D				FINE SAND & fine-med.	
			50.5			Gravel, sat. loose.	
	**	2	77				1.4
			11	•		Estuarine CLAY	2
N 50	× 8			-5.0		, i	igh Potentia
9 .	1.		11.	2 1870 3872 1 5		Dk. grey	tg .4º
590						Soft	Vo 8
					8	soft wet	草
# 0200m		145	1				+ 5
19.		×.	11	~ . ^] : · · · · · · · · · · · · · · · · · ·
	pe of sample			Hemark	s. (Obse	ervations on ground-water, etc.)	a ta M
	U (80) = 50 mm; dia, undisturbed sample. D = disturbed sample.					● 5	SE SE E
N I') -	standard penet	ration lest	5			a 14 g	a 1
No. of bit	ows/300 mm, pen		801			2 2	
	, Den	2.7011011					



RECORD OF BOREHOLE No. 29493

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

Ground level RL 4.94

Aimil Pty Ut MD200 Toyota - mounted

Type of horing continuous solid flight auger Dia of horing: 80 mm Lining tubes: nil..... Antici pated Change of Stries A.S.S Potentia Description of Strata 7 % D Progress. Denin Droth FINE SAND 3.4.03 Grey house FINE SAND Yellow- brown loase FINE SAND 1.0 Lt. brown moist, loose FINE SAND Grey moist/wet loose FINE SAND, sightly 2.0 Brown & de brown wet medium dense 3.0 Sample CLAYEY SAND, fine grained Grey - brown Soft, wet Estuarine CLAY, grey, wet End of Hole 5.0 Himarks (Observations on ground water, etc.) U (50) - 50 mm dia undisturbed sample. disturbed sample. N () - standard penetration test. No in brackers gives No of blows/300 mm penetration



RECORD OF BOREHOLE No. 29496

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

Dia of horing: BO May 4.92 Ground level: KL 4.72

Aim I Pty UL Mozoo Toyota - mounted

Type of horing Continuous solid flight auges Lining tubes: Articipated A.S.S Potential Samples of Core Recovery Change of Servia Only Description of Strata Type Depth Progress Dooth Dk grey clayey Topsoil 3.4.03 CLAY, mod. plasticity Goog-brown 1.0 wet Soft SANDY CLAY wet, soft Grey 2.0 CLAYEY SAND fine grained Grey wet loose 3.0 SAND slightly clayey Sample D Grey-brown, wet, loose CLAY, high plasticity Lt. grey, estuarine? v. wet, v. saft CLAY moderate plaisticity (residual) 5.0 Yellow brown wet, soft, depth. filmarks (Observations on ground water U (50) _ 50 mm, dia, undisturbed sample - disturbed famole, . 1 1 - standard penetration less. No. in brackets gives No. of blows/300 mm, penetration



RECORD OF BOREHOLE No. 29498 A

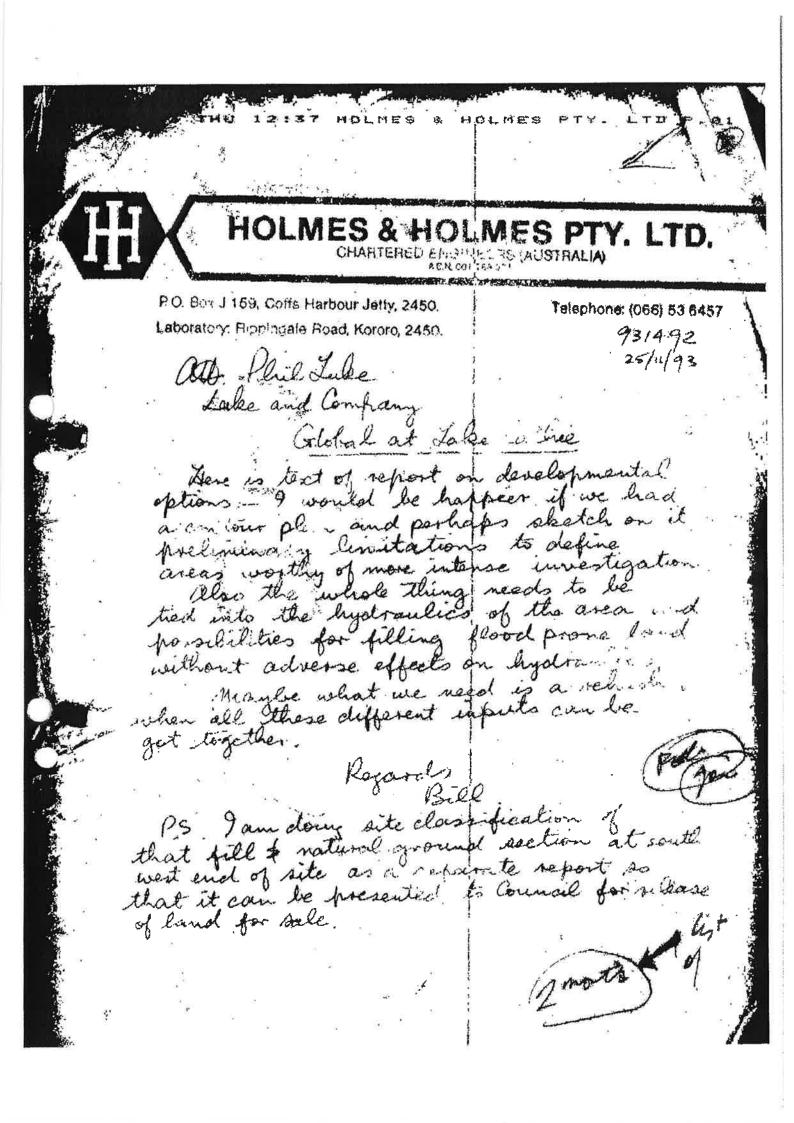
CLIENTI LUKE & Company 0/5 21 from 29498 PROJECT: A.S.S. Assessment, Lake Cathie

Ground level estimated RL 5.A.
Amil Pty HANDROOTOYOTA - mounted

66536457

Dia of boring: Borm

Daily	Samples of Core Risens	êry:	Cı	hange of S	11313		Anticipate
Pragress	2 Ocath	Type	Lagend	Deprh	A = D Level	Description of Strata	A.S.S Potential
.4.03		· v	200	0.00			S - Sec.
			7			FINE SAND v. slightly silty	*
9 m	37 = ° ×					v. slightly silty	
						Grey	
-	1. *		; .·.			moist, loose	1 1
· [3 .		5. 1	-		N 397	
; II	and a cefe :			-1.0			
	8 30 SEG					is a	2 10 2 2
1	Α*						1
				-		FINE SAND	
- 1			100			Browny grey	
	0.810	g 550				:+1 +	
	in a g			۳ ا	Ė	moist/wet	/ / g* %
Î	(4 Pag 11)	*	1.72.	-20		loose	
	80 80 80 80 80 80 80 80 80 80 80 80 80 8	341				*	1
1	1/N 3	X.					8
1	* 4.	E		-		28	الغ ا
	* "=		**:::	- 1			- · · · · · · · · · · · · · · · · · · ·
	34° - 8					9 1 9 1 1	2
	. 50 %	250 16	9.8			FINE SAND with	
		0 *		-30		some intermittent	1.
	8. * I	3	0.8	· .		Some me mile	5
8	793	2.0	200	3		fine gravelly layers,	, K
: a 111	g	da i				Light brown-grey	. 2
* * .		1 1		-	N .	wet	\$:
·			0,00			medium dense	ar.
	9 4		0.03			16 x x x x x	1 .
	Sample	7	(1)	-4.0			₹
1	201/	D	17/	-		as AV and placticity	
	98A/1					CLAY, mod plasticity Brown wet, soft	1 4 .
3 ° 4		1	111		<u></u>		
11	200 8	1			8	End of Hole	
		74 () 1961 ()		. 1	15	3 90	
l i	2 * * X			-5.0		ne 20	190 2 5
				2.0			
	1 4	*				*	
	74 S				Ű Í	9 g "	
li	N S 200						
. 1	, 4° %						1
]]	, " =					~ n	8
. Key to type	of sample			60		ervations on ground-water, etc.)	
U 1501 -		disturbed :	sample.	DMITIG: X	. (ODS	THE COURS OF STONE STORES COLOR	g ^{er} Ser av
0 4	disturbed samo				~		**
N 1 1 -	standard penetr						r saa "" "A.
No in bia							



Appendix 5

Chandler Geotechnical Pty Ltd

Acid Sulphate Soil Investigation April 2004

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

TEST BORE REPORT

CLIENT:

Tilke & Co Pty Ltd

PROJECT NO: 23159

14.4.04

BOREHOLE: 1

METHOD OF

PROJECT: Rainbow Beach LOCATION: Bonny Hills

DATE: LEVEL:

Existing

ADVANCE: Spiral flight

		auger
DEPTH METRES	SAMPLES TESTS	DESCRIPTION OF STRATA (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
i i		TOPSOIL. Silty SAND, dark brown, sands fine grained, low to non-plastic lines.
_ 0.50	"D" PM 6402	
		CAND vale and find a reduce of ad
10000		SAND, pale grey, fine to medium grained.
1.00	"D" PM 6403	
a i	"D" PM 5404	SAND, orange-yellow, fine to medium grained, wet.
1.50		
	"D" PM 5405	
2.00		
-	"D" PM 5406	Sitty CLAY, pale grey, medium to high plasticity, sands fine grained, mc >> wp.
2,50	Ups mas even	Silty sandy CLAY, mottled grey & rad, medium to high plasticity.
_ 2.00	"D" PM 5407	sands fine to medium grained, mc > wp.
	1	
3.00	"D"PM 5408	
		iii
iq G _{occusi} ,	0.50	
3.50	"D" PM 5409	Borehole terminated 3.5 metres.
		*
4.00		
1,40		I

RIG:

Jacro

LOGGED:

SĈ

GROUND WATER:

None encountered

REMARKS:

SAMPLES & TESTS

D Disturbed sample U Undisturbed was sample

8 Bulk sample

pp pocket penatrameter

07/03

T27

ABN 83 066 029 329

PO Box 5720 Port Mecquarie NSW 2444 Phona (02)65810142 Fax (02)65810129

TEST BORE REPORT

Luke & Co Pty Ltd

PROJECT NO: 23159

BOREHOLE: 2

PROJECT: Rainbow Beach LOCATION: RORRY Hills

14.4.04 DATE: Existing LEVEL:

METHOD OF ADVANCE: Spiral flight

LOCATION	Honny Hills	LEVEL:	Existing	ADVANCE:	auger
DEPTH METRES	SAMPLES TESTS	(SOIL TYP	DESCRIPTION OF E, STRENGTH, MOIST		I)
-		TOPSOIL, Sitty SAND, of low to non-plastic fines		medium grained,	
0.50 	"D" PM \$410				
1.00 	"D" PM 5411	Sity CLAY, pale grey, r sands fine grained, mo		ity,	
F	"D" PM 5412				
1.50	"D" PM 5413	SAND, grey, fine to me	dlum grained.		
2.00	"D" PM 5414	SAND, orange-yellow, t	fine to medium grained		
2,50	"D" PM 5416	SAND, pale grey, fine to	o medium grained.	alin de la constante de la con	
3.50	"D" PM 5416				
3.50	"D" PM 6417			×	
4.00	"D" PM 6418	Borshole terminated 4.	Q metres.	alle de la companya d	

RIG:

LOGGED:

SC

GROUND WATER: REMARKS:

None encountered

SAMPLES & TESTS

O Disturbed sample U Undisturbed cubs sample

8 Bulk sample

PP pocket penalromater

07/03

T27

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 NO: 23159

BOREHOLE: 3

PROJECT: Rainbow Beach

DATE:

14.4.04

METHOD OF

LOCATION BODDY Hills

LEVEL:

Existing

ADVANCE: Spiral flight

214 47211011	racinity (1882	auger
DEPTH METRES	SAMPLES TESTS	DESCRIPTION OF STRATA (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
	WE WE WITH THE THE	TOPSOIL. Silty SAND, dark gray, sands fine to medium grained.
- - - - - - - - - - - - - - - - - -	"D" PM 5419	Silty CLAY, pale grey, medium to high plasticity, sands fine greined, mc > wp
1.00	"D" PM 5420	the so high alapticity
1.60	"D" PM 5421	Sandy CLAY, grey with some orange staining, modium to high plasticity sands fine to medium grained, mc > wp.
2.00	"D" PM 5422	SAND, pale grey-brown, fine to medium greined.
2.50	"D" PM 5423	
3.00	"D" PM 5424	
3.50 	"D" PM 5428	
4.00	"D" PM 5426	Borehole terminated 4.0 metres.

RIG:

Jacro

LOGGED:

. Se nich A

SC

GROUND WATER:

None encountered

REMARKS:

SAMPLES & TESTS

Disturbed sample U Undisturbed tipe sample

H. Rolk asmpla

PP pockel penalromelar

ABN 83 066 029 329

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

TEST BORE REPORT

14.4.04

CLIENT:

Luke & Co Pty Ltd

PROJECT NO: 23159

BOREHOLE: 4

PROJECT: Rainbow Beach

DATE:

METHOD OF

LOCATION: Bonny Hills

LEVEL .

Existing

ADVANCE: Spiral flight

auger

		adyui -
DEPTH METRES	SAMPLES TESTS	DESCRIPTION OF STRATA (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
		TOPSOIL. Slity SAND, dark grey, sands fine to medium grained.
-		SAND, pale grey-white, medium grained.
		, , , , , , , , , , , , , , , , , , ,
0.50	"D" PM 5427	
-		
-		
1.00	NOU DAL CACO	
_ 1.00	"D" PM 5428	
r I		
1.50	"D" PM 5429	SAND, dark brown, fine to medium grained wet.
-		
T i		
2.00	"D" PM 5430	
2.50	"D" PM 5431	
	C 2	
3.00	"D" PM 6432	
-		
-		
3.50	"D" PM 8433	
	(J (M) 5459	
		Silty CLAY, (marine mud) grey, high plasticity, mc >> wp.
4.00	"D" PM 5434	Borehole terminated 4.0 metres.

RIG:

Jacro

LOGGED:

COMMUNICATION N. ...

SC

GROUND WATER:

None encountered

REMARKS:

SAMPLES & TESTS

D. Disturbed sample U. Undusturbed tube sample

B Bulk sample

telamonianeq jexcoq qq

07/03

T27

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

33 samples supplied by Chendier Georgethness on 28rd April, 2004 - Lab. Job No. E1888 Anulysis requested by Stave Chandler.

CONTRENTS RE-Chaufication as polymidal actd sulphate and (ABS) Tyread in NSC results	NOT Potential ASS YES Potential ASS YES Potential ASS	
Noutraphing Calculation Kg Limping (pussed on TAR)	6.55 1,3 0.6 1.6 1.6 1.6 2.9 0.9 0.9 0.0	
Herranding Calcolation kg Linnaim?	0.2 0.2 0.2 0.1 0.4 0.1 1.4 2.8 Helder Necke 8.8.7	
Densky Genre DWim	1.24 1.35 1.49 1.44 1.46 1.35 1.25 1.26 1.09 1.09 1.32 1.32 1.32	-
Acidity (TAA) male / Kg	0.106 0.032 0.018 0.607 0.008 0.028 0.028 0.027 0.030 0.0308	
TÂ.P	4.25 4.83 4.83 4.05 4.05 4.05 4.05 4.05 6.40 6.40	-
Packaced scottship Eudphur (% zdaonikam rechebit.S) (%Scot) (nobe 2)	0.009 0.005 0.003 0.003 0.003	
Resetting	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	
SISLO SCREENING TECHNINGS		
DH Mer		
Ed logical	4.10 4.10 4.32 4.25 3.89 3.61 3.79 4.43 4.43 4.43 4.43 4.43 4.65 4.82 4.78	
	Fine Fine Medium Hins Fine Fine Fine Fine Fine Fine Fine Fine	
Oceanity (ms)	2.2 2.2 2.2 2.5 3.6 3.6 1.0 1.0 2.0 2.0 2.5 2.5 2.5 2.5 2.5 2.5 2.6 3.6 4.0 4.0 4.0	
Semple Ste	847 847 847 847 842 842 842 842 842 842 842 842 842 842	

2 - Samples analysed by POCAS endrod (a Ponsvide Oxidation - Contunga Aukrin and Bulphato Version Lipitate analysed planted and Chromism Reductible Substant seaturing (Ser - Wethod 228) I vot smokals is Din Varyon (UM) - simples wied and ground immediately upon titing furious exposed and grantial

3 - Methods from Styne, Y. Avert Cit. and Blimber D + 998). Acid Sulphate Sall Manual 1998. ABSWAC, Wellengsar, NSW.

4 - Total cabon and total gidplius determined using a Lecto CHB 2000 znalysai

E. BUIK IEKEMY WAS OBDOUTHYOU IMPROVISIBILY ON JOTHA ON INDICATORY (ATOM W DURK COMBINY IS DICHOLOGY)

6 - Northallang Rocuirabent (based in NAOP, chrominn fadwildle southar or had soublit) a Kg 4,500,00 no. x bulk denothy

7 - 18% neutralishing requirement closes mit include a scially margin for complete neutralishing requirement closes mit include a scially margin for complete neutralishing requirement of 1.5 le programment of 2.

B. Canduatyliy 1 (Sm = 1 mstark = 1000 pskm

9 - For Taching, coging - sancts to locally senze, medium - xanty losans to light days, link - hinchen to nearly clays and sky days no. Neutralgation tacks for neutralgation of color) and polynologically (it sum or saleulation tacks to Ora and 1944) 11. You day published screening testinates a compatibly floor fifth registered.

(Chaselikeston of potential soic sulphale malarial II: ogane Sorzülläkist snedtum Surzüldskis; iftne Sorzüllkis (equivalent contervations • 0.03%8 m 8.019 andle/ Mg; 0.06%S ≠ 0.037 inche/ Kg; 0.1%S ≈ 0.082 mole/ Kg} Projects that distrib 51000 than pis of ASS to be with 20,42% St a detailed numeroment of an 1869 te traduted

checked...

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

33 samples supplies by Chandlel Geoleachtica, on 2014 Afrit, 2004 - Lido Jobo Na. E1988 Anaysis requested by Steve Chander.

Sumple Sho	Depth	Texture	æ	REPOSOBER	NO TECSHINGLE	wi	Peobliced finorganitic Sulphur	궕:	Total Actual - Actually (TAR)	Lub, Bulk Deroffy	Kautralielnes Calculaten	Noticialing Calcutation	CONNEENTS RE: Classification as parendal acid authrets scil (ASS) (second sn 7555
	(m)	Stote II)	Hatter pH (Water)	percylde	pH charge	Resoction	[% chremlum reddoma \$} (%Sap) hale 2	£	By r Bloku	Johns Diving	thried on 'Cacri	(Dayer on TAX)	[skinter]
	i		60.4	9, 7	6	ź	200.0	4.20	0.044	1.14	0.2	2.5	NOT Polential ASS
\$ N	2	발.	1.63	r ·	ָּהְיִהְּיִּהְ הַיִּהְיִּהְ	2 :	20.1	4.55	7.11	176		49.0	NCT Promital ASS
PHS H	<u></u>	Medium	4.30	4.38	90.0	ğ		4		0 0	0		NCT Polemai ASE
SHS	1.5	Мести	3.94	3.96	.0.0	2	0,005	4.20	0.026	80.	6.0	. +	PACIT Polardal ASS
EH3	2.0	Coarse	4.02	4,09	10.07	Š	0.005	4,38	CIU.D	au.,	2.7	·	NOT PORTER ASS
BH3	22.27	Coarse	4.63	4.84	0.21	oN.	:			7. o.	. (, u	AOT Powerlist ASS
BH3	3.0	Coarse	4.54	4.65	1 0.11	No	0.002	4.88		1.67	?	n S	NAT Polenis ASS
843	(c)	Coarse	4.72	4.95	0,23	N O	3	1	ä	1.73	200	t	Not Palental ASS
BH3	4.0	Coarse	4.80	4.70	0.70	ž		•	3.	1.68	*		
			1	-	č	4			-	1.47		;	NOT Possifiel ASS
計本	9'0	Coarse	4.71		- C.Z.	2		:	:	4,4			NpT Polepulai ASS
SH4	1,0	Coarse	5.04	36.37	15,0	No No	:	= -		2 0	: 4	: ¥	NAT Polential ASS
BH4	155	Coarse	4.41	4.35	-0.06	2	0,605	4.64	0,925	. Z.u	>	?	NOT Poperlin ASS
BH4	2.0	Coarse	4.46	4.60	0,04	ž	·	1	<u> </u>	, . The contraction of the contr	1	;	MUT Potental ASS
BHA	2.5	Course	4.53	1.60	0.01	2		;		n 1	: }	; ?	NOT Potential ASS
HT4	3,0	Goarse	4.58	45.7	0.0	ફ	0.007	4.98		- 4g	, t		yes Potential RSS
BH4	60	Coarsa	4.56	3.10	-1.46	<u> </u>	0.247	4	_	60.	7	- c	Y ES Potential ASS
BH4	4.0	Coarse	4.04	1.89	-2.05	SE SE	1.677	4.40	6.018	06.	BM: NC4 6 & 7	1.2 Felse (42) 6.4.7	

Z - Sarpher analysed by POCAS melbou (as Perceide Duidabon - Combroad Addily and Suphale - Yagson 3. updated pediated pediated and Chinquium Analyside Sulphur Technique (Sor - Method 2007) · All anulysis is Dy worth (DW) - Samples of the and proturn annihilates upon unious funioss supplied drait and protive) Carrantees A malueix Exhibitions

3 - Visitodi Iron State, Y. Anem CR, and Blunden B ("008). And Supplate Sell Menual 1986. ASSUAC, Wolcoppar, NGW

4 - This cabon and both ordinar detentions using a LECO CHS 2000 snews

5 - Bulk Jennity was celetromed strimpyllately on arrare to laberatory limital bulk density is prederred)

 \mathfrak{g} - New limiteng Progression (brinked in 1946), chroming reducible scipping at \mathfrak{g} and \mathfrak{g} $\mathfrak{g}_{\mathcal{S}}$ where \mathfrak{x} is that density

The destrationing requirement does not luminde a salety margin for extripiate deviration (a harde of 1.5 is oden 1900 remonded)

B · Contouching 1 cs/m = 1 msien = 1000 JSlom

8. For Toxicia, coarse a calch is listing seneth medium = sandy coame to light days; fire a medium to hazing clays and addy clays

10 - Neparalisation Calquiation for maintailiation of actual and colembial sciency (the sum or calculation based on Cre and TAA).

(chas) incuton of potentiat self sulphate material II: coates Serzületing medium Serzületin Scrzületin Scrzületin (equivalent conversions - 0.03%) = 0.045 molet Kg; 0,08%) = 0.337 molet Kg; 0.1%) = 0.062 molet Kg • Projecta Upal distrib > 1000 paries of ASS boys with > 0.03% 9, a deathed microsperioric plan may be required.



Rambow Beach Estate.

Client Like & Co	Project 25036
Date 25/10/5	Technician Ablesemon Chook.
Sample Location Bonny	bills Lote.
Sample time 3:42	

vepth.	2.5m	2.0m	1.5m	1-0m	0.5m	0.0m.
Temp	19.97	21:31	25.26	25-47	25.52	25.55
Doolved Oxygen	74.5	88.4	127.4	128.2	128.3	128.5
Ph	6.49	6.50	7-07	7-08	7-10	7-09.
ORP	139.8	143.7	139-6	14,0	141.8	141.3
ms/cm³.	0.200.	0.218.	105.0	0.199	0 199	-0.203

Notes:		Marie	
	*		
	_		

Rambow Beach Estate.

Client Like & G Project 25036

Date 13-10-5 Technician Chook & Mumy.

Sample Location Bury Centre of Lake.

Sample time 12:00

vepth	2.5m	2.0m	1.5m	1.0m	0.5m	0.0-
Temp	19:72	23.2	23.36	2.3.42	23.44	23.42
Doolved Onygen	78.4	127.2	129.1	**************************************	129.5	1280.
Ph	6.40	6-94	6.99	7.00	7-01	7.00
ORP	197.2	186-5	186-8	185-1	186-0	/£ 5 -8.
ms/on2	0-169	0.169	0.169	0.169	0.169	0.169

Notes:		
e .		

Rambon Beach Estate.

Client Like & Co Project 25036 Date 29/9/05 Technician Noces & Chack. Sample Location Boay Contre of Lake.

Sample time 13:00

vepth.	2.5m	2.0m	15m	1-0m	0.5m	0.0m.
Temp	17-45	18.75	19-85	21.20	21.50	22.0
Doolved Onger	63-5	88.8	104-0	117.7	116.7	100-1
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

1110		
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
рН		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

checked: ______

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

		1941
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

Votes:

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



Appendix 6 Cardno Pty Ltd

Water Engineering and Environmental Report

April 2010



APPENDIX A

Acid Sulfate Soil Management Plan

TABLE OF CONTENTS

A1.	ASS MANAGEMENT PLAN OBJECTIVES AND METHODOLOGY			
A2.	PROPOSED CONSTRUCTION ACTIVITIES			
A3.	RESPONSIBILITY OF THE CONTRACTOR			
Αυ.				
A4 .	POLICY STATEMENT:			
A5.	PERFORMANCE OBJECTIVES:			
A6.	A6. SITE MANAGEMENT PROCEDURES			
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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
рН	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/m²/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 m³ 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 (CaCO₃) 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 m³ 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 m³ 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.