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G.2 Geochemistry

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G.2.1 Sample Collation Methodology for Geochemistry Analysis

Appendix G.2.1 Sample Collation Methodology for Geochemical Analysis - Overburden Characterisation

Manning Vale

	Sample 1: Weathered O/B	Sample 2: Fresh O/B WP	Sample 3: Fresh O/B WP/A	Sample 4: Fresh O/B A/B	Sample 5: B6 Split	Sample 6: D6 Split	Sample 7: D8 Split	Sample 8: E4 Split	Sample 9: F Floor
Hole No.	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*
122	9144-9149		9150-9153	9155-9161	9165	9171			
123	9176-9178					9183	9184	9189-9191	
113	9051-9055		9056-9058	9060-9061	9069-9070	9074		9077-9083	9085
124	9193-9197		9198-9199	9201-9209	9214	9218	9220-9222		
117	9086-9088	9089	9093-9098	9103-9108	9113-9114				

Manning Vale (Town)

	Sample 10: Weathered O/B	Sample 11: Fresh O/B A/B	Sample 12: B3 Split	Sample 13: B8 Split	Sample 14: D6 Split	Sample 15: D8 Split	Sample 16: E4 Split	Sample 17: F Floor
Hole No.	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*
112	4721-4725	4726-4731	4734-4736	4739	4741-4743	4745-4750, 4709-4710		
111	2776-2781		2784-2786		2792	2797-2798	2799-2800, 4711-4714	4717
126	9269-9276	9277-9278			9288	9291-9292	9294-9297	9310

Sabine

	Sample 18: Weathered O/B	Sample 19: Fresh O/B A/B	Sample 20: E4 Split	Sample 21: F Floor
Hole No.	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*
119	9115-9119	9120-9126		9139
125	9225-9230	9233-9254	9262-9264	9266-9268

Willaroo

	Sample 22: Weathered O/B	Sample 23: Fresh O/B A/B	Sample 24: B3 Split	Sample 25: C8 Split	Sample 26: E4 Split
Hole No.	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*	*D/H Sample No.*
110	4480-4486	4488-4492	4497-4498	4704	4707-4708

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G.2.2 Laboratory Analysis Instructions

Appendix G.2.2 Laboratory Instructions

NAC sent the 26 combined overburden characterisation samples to Australian Laboratory Services Pty Ltd (ALS) for geochemical analysis on 28 July 2008. **Table 1** outlines the parameters used for the geochemical analysis of the 26 combined overburden characterisation samples.

Table 1 Geochemical Analytical Parameters – Overburden Characterisation

Acid-Base Accounting	Multi-element Analysis
CEC – Exchangeable Cations (Ca, Mg, Na, K)	Silver (Ag)
Additional CEC – Al	Aluminium (Al)
Exchangeable Sodium Percent (ESP)	Arsenic (As)
pH (saturated paste)	Barium (Ba)
Electrical Conductivity (saturated paste)	Beryllium (Be)
Chromium Reducible Sulphur (CRS)	Bismuth (Bi)
Acid Neutralising Capacity (ANC)	Cadmium (Cd)
Net Acid Generation (NAG)	Cerium (Ce)
1:5 solid water leach for pH, EC, NO_3, CL^-	Cobalt (Co)
pH (1:5)	Chromium (Cr)
Electrical Conductivity (1:5)	Copper (Cu)
Soluble Chloride	Iron (Fe)
Soluble Sulphate	Gallium (Ga)
Major Cations (soluble) Ca, Mg, Na, K	Lanthanum (La)
Sodium Absorption Ration (SAR)	Lithium (Li)
Nitrate as N	Manganese (Mn)
Bicarbonate Extractable P (Colwell)	Molybdenum (Mo)
Sulphur – Total as S	Nickel (Ni)
Particle Size Analysis plus Hydrometer	Phosphorus (P)
	Lead (Pb)
	Rubidium (Rb)
	Sulphur (S)
	Antimony (Sb)

Acid-Base Accounting	Multi-element Analysis
	Selenium (Se)
	Tin (Sn)
	Strontium (Sr)
	Thorium (Th)
	Thallium (Tl)
	Uranium (U)
	Vanadium (V)
	Tungsten (W)
	Zinc (Zn)
	Zirconium (Zr)
	Mercury (Hg)
	Boron (B)
	Fluorine (F)
	Silicon (Si)

NAC received the analytical results for the 26 combined overburden characterisation samples from ALS in two separate batches on 18 August and 27 October 2008, respectively.

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G.2.3 Acid Based Accounting

Appendix G.2.3 Acid Based Accounting Results

Table 1 Acid Based Accounting Results

				pH (1:5)	EC (1:5)	Total S	SO4 2-	NAG pH	NAG (pH 4.5)	ANC	MPA	NAPP	Classification
				pH Unit	µS/cm	%	mg/kg	pH Unit	kg H2SO4/t	(kg H2SO4/t)	(kg H2SO4/t)	(kg H2SO4/t)	CoA (2007)
ALS Sample number:	Date:	Sample Description	ID	0.1	1	0.01	10	0.1	0.1	0.5			
EB0810234001	29/07/2008	Weathered O/B	1	9.6	505	0.03	80	9.6	<0.1	32.5	0.92	-31.6	NAF
EB0810234010	29/07/2008	Weathered O/B	10	9.2	377	0.02	100	8.5	<0.1	28.3	0.61	-27.7	NAF
EB0810234018	29/07/2008	Weathered O/B	18	9.6	333	0.03	130	9.1	<0.1	37.8	0.92	-36.9	NAF
EB0810234022	29/07/2008	Weathered O/B	22	9.1	232	0.01	40	9.4	<0.1	36.6	0.31	-36.3	NAF
EB0810234002	29/07/2008	Fresh O/B	2	9.6	586	0.04	220	8.3	<0.1	11.1	1.22	-9.9	NAF
EB0810234003	29/07/2008	Fresh O/B	3	9.8	407	0.03	180	8.6	<0.1	138	0.92	-137.1	ACM
EB0810234004	29/07/2008	Fresh O/B	4	9.8	356	0.04	260	9.6	<0.1	52.4	1.22	-51.2	NAF
EB0810234011	29/07/2008	Fresh O/B	11	9.2	301	0.05	420	7.8	<0.1	14.9	1.53	-13.4	NAF
EB0810234019	29/07/2008	Fresh O/B	19	9.7	287	0.06	270	8.5	<0.1	31	1.84	-29.2	NAF
EB0810234023	29/07/2008	Fresh O/B	23	9.5	232	0.07	210	8.4	<0.1	18.2	2.14	-16.1	NAF
EB0810234012	29/07/2008	B3 Split	12	9.4	309	0.05	330	7.8	<0.1	14.9	1.53	-13.4	NAF

				pH (1:5)	EC (1:5)	Total S	SO4 2-	NAG pH	NAG (pH 4.5)	ANC	MPA	NAPP	Classification
				pH Unit	µS/cm	%	mg/kg	pH Unit	kg H2SO4/t	(kg H2SO4/t)	(kg H2SO4/t)	(kg H2SO4/t)	CoA (2007)
ALS Sample number:	Date:	Sample Description	ID	0.1	1	0.01	10	0.1	0.1	0.5			
EB0810234024	29/07/2008	B3 Split	24	9.4	199	0.05	230	9.3	<0.1	52.5	1.53	-51.0	NAF
EB0810234005	29/07/2008	B6 Split	5	9.9	402	0.04	190	9.2	<0.1	36.6	1.22	-35.4	NAF
EB0810234013	29/07/2008	B8 Split	13	9.5	220	0.22	270	2.8	78.4	8.8	6.73	-2.1	Uncertain
EB0810234025	29/07/2008	C8 Split	25	9	218	0.12	320	2.9	16	10.1	3.67	-6.4	Uncertain
EB0810234006	29/07/2008	D6 Split	6	9.9	324	0.08	170	5.6	<0.1	8.9	2.45	-6.5	NAF
EB0810234014	29/07/2008	D6 Split	14	9.4	274	0.1	360	6.6	<0.1	10.1	3.06	-7.0	NAF
EB0810234007	29/07/2008	D8 Split	7	9.9	279	0.08	160	5.8	<0.1	8.6	2.45	-6.2	NAF
EB0810234015	29/07/2008	D8 Split	15	9.8	307	0.07	190	8.9	<0.1	33.6	2.14	-31.5	NAF
EB0810234008	29/07/2008	E4 Split	8	10	300	0.04	160	9.2	<0.1	24.8	1.22	-23.6	NAF
EB0810234016	29/07/2008	E4 Split	16	9.6	308	0.1	200	9.6	<0.1	22.7	3.06	-19.6	NAF
EB0810234020	29/07/2008	E4 Split	20	9.8	255	0.07	210	5.8	<0.1	3	2.14	-0.9	NAF
EB0810234026	29/07/2008	E4 Split	26	9.4	226	0.02	300	9.5	<0.1	56	0.61	-55.4	NAF
EB0810234009	29/07/2008	F Floor	9	10.1	463	0.05	160	9	<0.1	31.2	1.53	-29.7	NAF

				pH (1:5)	EC (1:5)	Total S	SO4 2-	NAG pH	NAG (pH 4.5)	ANC	MPA	NAPP	Classification
				pH Unit	µS/cm	%	mg/kg	pH Unit	kg H2SO4/t	(kg H2SO4/t)	(kg H2SO4/t)	(kg H2SO4/t)	CoA (2007)
ALS Sample number:	**Date:**	**Sample Description**	**ID**	**0.1**	**1**	**0.01**	**10**	**0.1**	**0.1**	**0.5**			
EB0810234017	29/07/2008	F Floor	17	9.7	359	0.05	150	8.9	<0.1	18.7	1.53	-17.2	NAF
EB0810234021	29/07/2008	F Floor	21	10	371	0.06	240	6.9	<0.1	12	1.84	-10.2	NAF
Minimum				9	199	0.01	40	2.8	16	3	0.306	-137.1	
Maximum				10.1	586	0.22	420	9.6	78.4	138	6.73	-0.9	
Average				9.6	324.2	0.1	213.5	7.9	47.2	29.0	1.9	-27.1	

ANC/MPA - where ANC/MPA ratio is >2, there's a high probability that material will remain near-neutral in pH and should not be problematic with respect to AMD.

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G.2.4 Geochemistry Classifications

Appendix G.2.4 Geochemical Classifications

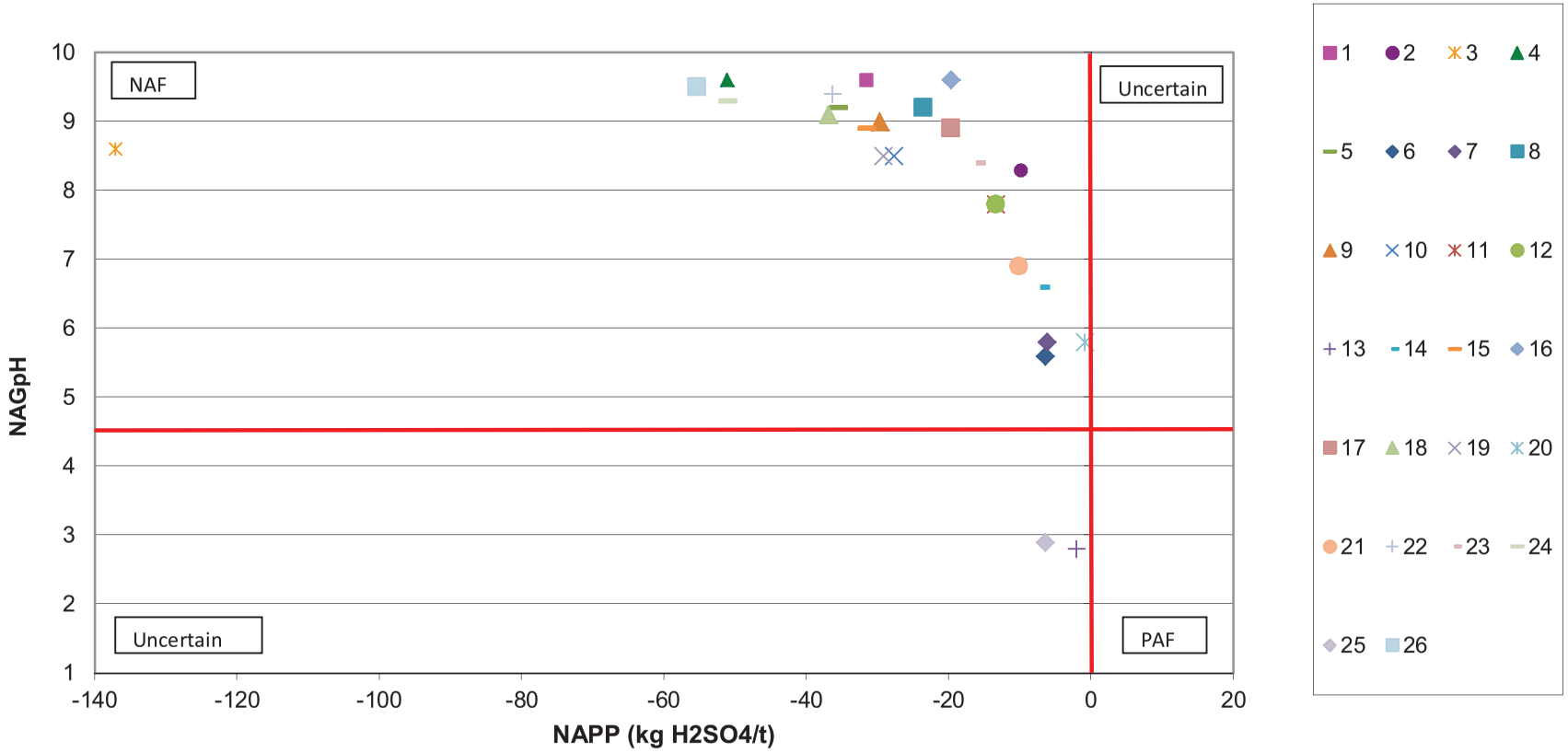

Figure 1 Geochemical Classification for Samples

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G.2.5 Trace Metals and Major Cations

Appendix G.2.5 Trace Metals and Major Cations

Parameter	ID					1	10	18	22	2	3	4	11	19	23	12	24	5	13	25	6	14	7	15	8	16	20	26	17	9	21	Max	Min	Average
	Unit	Bowen 1979 Crustal Abundance	LOD	QLD EPA	NEPC HIL	Weathered O/B	Weathered O/B	Weathered O/B	Weathered O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	B3 Split	B3 Split	B6 Split	B8 Split	C8 Split	D6 Split	D6 Split	D8 Split	D8 Split	E4 Split	E4 Split	E4 Split	E4 Split	F Floor	F Floor	F Floor			
Ag	mg/kg	0.07				0.11	0.13	0.12	0.09	0.19	0.19	0.17	0.11	0.08	0.09	0.11	0.1	0.12	0.08	0.05	0.14	0.12	0.15	0.08	0.12	0.11	0.1	0.17	0.09	0.11	0.08	0.19	0.05	0.12
Al	%	8.20%				7.45	7.12	6.91	7.79	7.17	6.6	7.22	8.27	7.54	7.72	8.31	8.47	7.84	5.55	9.38	8.17	8.47	8.64	8.43	9.01	8.59	8.24	7.94	8.42	8.44	8	9.38	5.55	7.91
As	mg/kg	1.5		20	200	5.9	7.2	5.5	5.7	5.8	6.9	5.3	1.5	5.2	2.4	3.7	3.8	2.4	2	4.1	3.5	3.5	5	3.7	3.9	6.2	2.7	6.1	2.3	2.5	2.4	7.2	1.5	4.20
B	mg/kg	10				10	20	30	40	10	10	20	20	30	40	30	40	20	30	40	30	30	20	20	20	30	40	20	30	20	40	40	10	27
Ba	mg/kg	500				400	440	440	420	360	340	350	400	430	310	490	400	410	140	360	430	370	420	460	510	440	510	690	450	550	450	690	140	422
Be	mg/kg	2.6				1.83	1.61	1.61	1.65	1.5	1.52	1.31	1.47	1.56	1.79	1.49	1.48	1.09	1.36	1.36	1.55	1.67	1.77	1.3	1.5	1.59	1.74	1.36	1.57	1.74	1.48	1.83	1.09	1.53
Bi	mg/kg	0.048				0.21	0.2	0.2	0.23	0.46	0.2	0.2	0.23	0.13	0.29	0.22	0.21	0.15	0.25	0.19	0.32	0.32	0.25	0.18	0.21	0.29	0.3	0.22	0.26	0.27	0.25	0.46	0.13	0.24
Cd	mg/kg	0.11		3	40	0.14	0.2	0.22	0.21	0.21	0.21	0.28	0.13	0.19	0.22	0.23	0.2	0.19	0.19	0.2	0.27	0.26	0.21	0.2	0.17	0.22	0.24	0.15	0.24	0.19	0.2	0.28	0.13	0.21
Ce	mg/kg	68				53.7	50.8	51.3	59.1	60.2	57.1	50.1	45.2	45.5	54.3	51.9	51.3	39.5	41.2	46.7	55	57.8	56.1	46.2	49.1	53	58	41	50.5	52.7	47.2	60.2	39.5	50.94
Co	mg/kg	20		2-170 (bkgrd)	200	15.7	16.2	11.9	11.1	10.7	11.4	16	8.7	21.4	7.6	10.9	6.7	5.6	6.9	6.4	7.4	9.1	13.8	10.1	11.1	9.9	7.9	20.4	9.6	23.6	15.5	23.6	5.6	11.75
Cr	mg/kg	100?		50 (III)	200	27	28	34	31	35	30	26	19	24	25	24	23	22	12	34	27	27	27	23	26	28	30	25	29	30	24	35	12	26.54

Parameter	ID					1	10	18	22	2	3	4	11	19	23	12	24	5	13	25	6	14	7	15	8	16	20	26	17	9	21	Max	Min	Average
	Unit	Bowen 1979 Crustal Abundance	LOD	QLD EPA	NEPC HIL	Weathered O/B	Weathered O/B	Weathered O/B	Weathered O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	B3 Split	B3 Split	B6 Split	B8 Split	C8 Split	D6 Split	D6 Split	D8 Split	D8 Split	E4 Split	E4 Split	E4 Split	E4 Split	F Floor	F Floor	F Floor			
Cs	mg/kg	3				5.21	4.67	4.2	5.79	5.24	5.44	3.98	7.44	3.38	6.09	4.46	4.61	3.6	1.05	4.62	5.98	5.89	6.59	4.69	6.17	7.08	6.71	4.61	6.34	7.99	7.75	7.99	1.05	5.37
Cu	mg/kg	50		60	2000	28.1	27.9	28.5	30.9	39.5	25.6	25.8	17	23.1	29.8	32.9	30.2	31.3	22.3	29.4	33.3	35.1	31.1	26.3	20.8	35.6	43	30.5	32.3	28.3	28.9	43	17	29.52
F	mg/kg	950				130	60	100	70	160	150	50	150	40	90	40	100	60	140	90	140	50	150	50	70	70	70	50	90	90	100	160	40	91
Fe	%	4.10%				4.26	4.7	3.37	2.57	3.9	3.35	1.53	1.75	3.42	1.94	1.66	2.92	1.55	0.67	1.46	1.72	1.53	1.61	2.16	1.93	3.48	1.51	2	2.67	3.48	1.97	4.7	0.67	2.43
Ga	mg/kg	18				20.3	17.2	18.25	19.7	19.1	17.1	18.3	23.3	18.7	20.5	21.2	19.5	19.9	15.55	18.15	21.4	22	21.2	19.85	21	20.7	20.4	21.6	20.7	21	20.1	23.3	15.6	19.9
Hg	mg/kg	0.05		1	30	0.032	0.039	0.027	0.024	0.037	0.042	0.05	0.082	0.04	0.057	0.046	0.045	0.038	0.082	0.058	0.068	0.067	0.053	0.045	0.043	0.046	0.042	0.054	0.039	0.045	0.056	0.082	0.024	0.05
La	mg/kg	32				24.7	23.8	24.1	27.6	28.1	26.8	23.5	21.2	21.3	25.5	24.6	23.6	19.3	18.4	21.8	25.9	27	26.3	21.9	23.5	25.1	27.4	17.4	23.9	25	22	28.1	17.4	23.8
Li	mg/kg	20				18.2	16.6	16.8	20.2	19.6	19	17.7	26.6	14.4	19.3	19.6	20.5	14.9	15.6	20	19.9	21.9	21	17.7	22.5	20.4	22.2	21.7	21.4	21.5	22.1	26.6	14.4	19.7
Mn	mg/kg	950		500	3000	807	837	501	498	799	715	203	162	877	260	147	367	142	24	126	121	103	77	316	88	651	112	225	566	827	124	877	24	372
Mo	mg/kg	1.5		<1 - 20 (bkgrd)		1.05	0.91	1.14	0.94	1.14	0.96	0.77	1.17	0.77	1.07	1.08	0.74	0.89	1.84	0.67	1.18	1.02	0.72	0.86	0.74	0.74	0.82	1.83	0.77	0.97	0.88	1.84	0.67	0.99
Ni	mg/kg	80?		60	600	11.8	12.9	14	12.8	11.8	11.3	10.5	7.2	11.2	8.4	12.4	7.7	7	8.4	7.3	9.3	10.3	10.6	8	9.8	9.3	9.9	18.6	9.4	18.1	13.1	18.6	7	10.8
P	mg/kg	1000				510	500	410	460	630	490	370	850	550	260	260	460	190	80	230	230	350	370	450	270	520	280	250	550	430	260	850	80	393
Pb	mg/kg	14		300	600	16.4	18	16.2	17.7	23.6	16.6	18	18.5	14.2	19.8	18.3	16.9	15.4	19.8	16.2	20.2	20.6	19.5	16.1	16.3	19	18.8	23.8	16.6	16.8	16.6	23.8	14.2	18.1

Parameter	ID					1	10	18	22	2	3	4	11	19	23	12	24	5	13	25	6	14	7	15	8	16	20	26	17	9	21	Max	Min	Average
	Unit	Bowen 1979 Crustal Abundance	LOD	QLD EPA	NEPC HIL	Weathered O/B	Weathered O/B	Weathered O/B	Weathered O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	B3 Split	B3 Split	B6 Split	B8 Split	C8 Split	D6 Split	D6 Split	D8 Split	D8 Split	E4 Split	E4 Split	E4 Split	E4 Split	F Floor	F Floor	F Floor			
Rb	mg/kg	90				65.2	57.3	52.7	75.1	73.5	67.5	56.3	51.2	55.9	63.4	61.4	62.1	51.9	6.8	62.8	66.3	67	72	56.1	64.9	76.8	77.6	47.7	70.7	76.6	71.9	77.6	6.8	62.0
S	%	0.026				0.03	0.02	0.03	0.02	0.07	0.03	0.04	0.05	0.05	0.07	0.06	0.06	0.04	0.19	0.15	0.11	0.1	0.07	0.05	0.05	0.06	0.07	0.06	0.05	0.05	0.05	0.19	0.02	0.06
Sb	mg/kg	0.2		20		0.43	0.55	0.51	0.42	0.43	0.35	0.38	0.33	0.35	0.4	0.37	0.34	0.29	0.29	0.33	0.4	0.41	0.44	0.35	0.34	0.36	0.47	0.4	0.39	0.39	0.38	0.55	0.29	0.39
Se	mg/kg	0.05				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.00
Si	%	27.7				27.3	28.1	29.2	30.3	29.6	27.2	29.1	27.8	28.5	27.2	28.4	27.6	28.4	12.5	22.8	23.7	27.6	27.9	29.1	29.1	27.7	28.6	27.8	28	27	28.7	30.3	12.5	27.3
Sn	mg/kg	2.2		50		1.8	1.7	1.7	2.1	2.8	1.7	1.6	2.2	1.3	2	2	1.6	1.4	1.5	1.5	2	2.1	1.9	1.5	1.8	2	2	1.7	1.9	1.9	1.9	2.8	1.3	1.83
Sr	mg/kg	370				181	150	180.5	112	120	157	175.5	122.5	413	125	191.5	155	269	186	129.5	178.5	256	226	396	241	280	199.5	188.5	327	311	268	413	112	213
Th	mg/kg	12				8.4	7.9	8.6	9.4	9.9	8.9	7.3	8.8	7	10.5	9.4	8.7	7.2	8.2	7.9	9.7	10.5	10	8.3	8.8	9.3	10.2	6.3	9	9.1	8.4	10.5	6.3	8.76
Tl	mg/kg	0.6				0.44	0.41	0.35	0.44	0.61	0.62	0.55	0.46	0.52	0.57	0.52	0.49	0.46	0.28	0.5	0.59	0.57	0.61	0.48	0.53	0.53	0.61	0.53	0.56	0.57	0.61	0.62	0.28	0.52
U	mg/kg	2.4				2.3	2	2.1	2.3	2.3	2.1	1.8	2	1.6	2.5	2.2	2	1.7	2.1	1.8	2.3	2.5	2.3	1.8	2.1	2.2	2.4	1.6	2.1	2.1	2	2.5	1.6	2.08
V	mg/kg	160				97	101	84	99	86	79	81	77	87	93	94	97	82	42	150	99	103	107	99	98	115	110	107	115	113	108	150	42	97
W	mg/kg	1				1.3	1.4	1.2	1.4	1.7	1.4	1.1	1.3	1.4	1.2	1.2	1	1.3	1	1	1.2	1.2	1.3	1.3	1.2	1.2	1.3	1.2	1.3	1.5	1.3	1.7	1	1.3
Zn	mg/kg	75		200	14000	81	76	79	92	107	74	78	67	73	73	93	84	88	36	95	85	95	85	79	76	90	89	97	85	89	92	107	36	83
Zr	mg/kg	190				124.5	120	128.5	134	137.5	126	107	172	92.8	152	127	118.5	105.5	153	111.5	139	152.5	140	102	130	135	142.5	119.5	129.5	129.5	127	172	92.8	129.1

Parameter	ID					1	10	18	22	2	3	4	11	19	23	12	24	5	13	25	6	14	7	15	8	16	20	26	17	9	21	Max	Min	Average
	Unit	Bowen 1979 Crustal Abundance	LOD	QLD EPA	NEPC HIL	Weathered O/B	Weathered O/B	Weathered O/B	Weathered O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	Fresh O/B	B3 Split	B3 Split	B6 Split	B8 Split	C8 Split	D6 Split	D6 Split	D8 Split	D8 Split	E4 Split	E4 Split	E4 Split	E4 Split	F Floor	F Floor	F Floor			
Ca	mg/kg		10			<10	30	20	40	10	10	10	40	10	10	30	20	<10	20	10	<10	20	<10	<10	<10	20	<10	20	20	20	30	40	10	20.5
Mg	mg/kg		10			<10	30	30	50	10	<10	<10	30	10	20	20	20	<10	10	10	<10	<10	<10	<10	<10	<10	<10	10	10	30	30	50	10	21.3
Na	mg/kg		10			550	370	430	170	620	440	380	270	350	270	290	210	480	230	240	400	300	320	380	370	430	470	240	560	650	570	650	170	384
K	mg/kg		10			<10	<10	30	<10	<10	10	10	20	20	10	10	10	10	<10	10	10	10	10	10	10	10	30	10	20	40	60	60	10	17.1
Cl	mg/kg		10			460	360	210	230	540	230	150	40	30	20	100	20	270	<10	60	140	60	170	120	100	220	240	20	240	230	240	540	20	180

807 Values above the QLD EPA guideline

20.2 Values above the Average Crustal Abundance (Bowen, 1979)

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G.2.6 Nutrients and Exchangeable Cations

Appendix G.2.6 Nutrients and Exchangeable Cations

Table 1 Nutrients and Exchangeable Cations Results

				CEC	Exch. Ca	Exch Mg	Exch K	Exch Al	Exch Na	ESP	SO4 2-	Cl	Nitrite as N (Sol.)	Nitrate as N (Sol.)	Nitrite + Nitrate as N (Sol.)	Bicarbonate Ext. P
				meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ALS number:	Date:	Origin	ID	0.1	0.1	0.1	0.1	0.1	0.1	0.1	10	10	0.1	0.1	0.1	2
EB0810234001	29/07/2008	Weathered O/B	1	32.8	20.3	7.6	0.87	9.9	4.07	12.4	80	460	<0.100	0.654	0.654	<2
EB0810234010	29/07/2008	Weathered O/B	10	30.3	18.1	8.9	0.77	0.8	2.43	8	100	360	<0.100	41.3	41.3	<2
EB0810234018	29/07/2008	Weathered O/B	18	35.7	20.8	10.8	0.58	0.9	3.61	10.1	130	210	<0.100	3.45	3.45	<2
EB0810234022	29/07/2008	Weathered O/B	22	31.6	21.1	8.6	0.78	1.1	1.12	3.6	40	230	<0.100	2.53	2.53	<2
EB0810234011	29/07/2008	Fresh O/B	11	31.4	13.4	14.9	1.03	1.2	2.02	6.4	420	40	<0.100	10.6	10.6	<2
EB0810234002	29/07/2008	Fresh O/B	2	15.3	6.3	4.8	0.85	0.8	3.33	21.8	220	540	<0.100	79	79	<2
EB0810234003	29/07/2008	Fresh O/B	3	25.4	19.1	3.5	0.66	1.1	2.17	8.5	180	230	0.199	114	114	<2
EB0810234004	29/07/2008	Fresh O/B	4	33.8	23.3	6.4	0.92	1.4	3.18	9.4	260	150	<0.100	39.4	39.4	<2
EB0810234019	29/07/2008	Fresh O/B	19	24.4	13.5	7.1	0.85	1.2	2.85	11.7	270	30	<0.100	2.29	2.29	11
EB0810234023	29/07/2008	Fresh O/B	23	34.8	16	14.9	1.32	1.1	2.54	7.3	210	20	<0.100	0.686	0.686	19
EB0810234012	29/07/2008	B3 Split	12	20.6	10.6	6.9	0.84	1.2	2.25	10.9	330	100	<0.100	13.4	13.4	<2
EB0810234024	29/07/2008	B3 Split	24	28.1	17.2	8.3	1.01	1.5	1.62	5.8	230	20	<0.100	0.477	0.477	<2

				CEC	Exch. Ca	Exch Mg	Exch K	Exch Al	Exch Na	ESP	SO4 2-	Cl	Nitrite as N (Sol.)	Nitrate as N (Sol.)	Nitrite + Nitrate as N (Sol.)	Bicarbonate Ext. P
				meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ALS number:	Date:	Origin	ID	0.1	0.1	0.1	0.1	0.1	0.1	0.1	10	10	0.1	0.1	0.1	2
EB0810234005	29/07/2008	B6 Split	5	30.3	20.6	4.3	0.89	1.1	4.47	14.7	190	270	<0.100	259	259	<2
EB0810234013	29/07/2008	B8 Split	13	24.6	12.9	9	0.53	<0.1	2.15	8.7	270	<10	<0.100	1.74	1.74	<2
EB0810234025	29/07/2008	C8 Split	25	16.1	4.8	8.7	0.88	1.3	1.74	10.8	320	60	<0.100	1.46	1.46	<2
EB0810234006	29/07/2008	D6 Split	6	17.2	10.2	2.5	0.88	<0.1	3.5	20.4	170	140	<0.100	61.1	61.1	<2
EB0810234014	29/07/2008	D6 Split	14	19.7	12.2	4.3	0.89	1.1	2.24	11.4	360	60	<0.100	13.4	13.4	<2
EB0810234007	29/07/2008	D8 Split	7	21	12.6	4.2	1.06	1.3	3.15	15	160	170	<0.100	16.5	16.5	<2
EB0810234015	29/07/2008	D8 Split	15	27.9	20.2	3	0.92	1	3.7	13.3	190	120	0.101	3.68	3.78	<2
EB0810234008	29/07/2008	E4 Split	8	24.6	18	2.4	0.72	1.4	3.46	14.1	160	100	<0.100	250	250	<2
EB0810234016	29/07/2008	E4 Split	16	33.5	25.1	4	1.21	1	3.11	9.3	200	220	<0.100	21.7	21.7	<2
EB0810234020	29/07/2008	E4 Split	20	20	11.7	1.9	1.12	1.4	5.31	26.5	210	240	<0.100	4.52	4.52	<2
EB0810234026	29/07/2008	E4 Split	26	32.7	25.4	4.8	0.82	1.3	1.67	5.1	300	20	<0.100	2.88	2.88	<2
EB0810234009	29/07/2008	F Floor	9	35.3	23.6	2.3	1.11	1.2	8.29	23.5	160	230	<0.100	246	246	<2
EB0810234017	29/07/2008	F Floor	17	38.6	28.5	2.8	1.3	1.1	6.04	15.6	150	240	<0.100	2.39	2.39	<2
EB0810234021	29/07/2008	F Floor	21	28.7	16.5	2.3	1.3	1	8.64	30.1	240	240	<0.100	6.58	6.58	<2

				CEC	Exch. Ca	Exch Mg	Exch K	Exch Al	Exch Na	ESP	SO4 2-	Cl	Nitrite as N (Sol.)	Nitrate as N (Sol.)	Nitrite + Nitrate as N (Sol.)	Bicarbonate Ext. P
				meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ALS number:	Date:	Origin	ID	0.1	0.1	0.1	0.1	0.1	0.1	0.1	10	10	0.1	0.1	0.1	2
Minimum				15.3	4.8	1.9	0.53	0.8	1.12	3.6	40	20	0.101	0.477	0.477	11
Maximum				38.6	28.5	14.9	1.32	9.9	8.64	30.1	420	540	0.199	259	259	19
Average				27.5	17.0	6.1	0.9	1.5	3.4	12.9	213.5	180.0	0.2	46.1	46.1	15.0

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G.2.7 Particle Size Distribution

Appendix G.2.7 Particle Size Distributions Results

Table 1 Particle Size Distribution Results

ALS Number	Client Sample ID	Origin	Percent Gravel (+ 2 mm)	Percent Sand (2 mm - ~0.060 mm)	Percent Silt (~0.060mm - 0.002mm)	Percent Clay (-0.002mm)
EB0810234	Sample 1	Weathered O/B	12%	32%	42%	14%
EB0810234	Sample 10	Weathered O/B	8%	32%	38%	22%
EB0810234	Sample 18	Weathered O/B	1%	28%	29%	42%
EB0810234	Sample 22	Weathered O/B	7%	24%	49%	20%
EB0810234	Sample 2	Fresh O/B	4%	22%	57%	17%
EB0810234	Sample 3	Fresh O/B	35%	22%	35%	8%
EB0810234	Sample 4	Fresh O/B	14%	51%	26%	9%
EB0810234	Sample 11	Fresh O/B	18%	23%	40%	19%
EB0810234	Sample 19	Fresh O/B	3%	55%	22%	20%
EB0810234	Sample 23	Fresh O/B	10%	17%	49%	24%
EB0810234	Sample 12	B3 Split	49%	28%	15%	8%
EB0810234	Sample 24	B3 Split	10%	49%	30%	11%
EB0810234	Sample 5	B6 Split	14%	68%	13%	5%

ALS Number	Client Sample ID	Origin	Percent Gravel (+ 2 mm)	Percent Sand (2 mm - ~0.060 mm)	Percent Silt (~0.060mm - 0.002mm)	Percent Clay (-0.002mm)
EB0810234	Sample 13	B8 Split	57%	31%	9%	3%
EB0810234	Sample 25	C8 Split	13%	16%	50%	21%
EB0810234	Sample 6	D6 Split	39%	45%	12%	4%
EB0810234	Sample 14	D6 Split	33%	41%	20%	6%
EB0810234	Sample 7	D8 Split	23%	45%	26%	6%
EB0810234	Sample 15	D8 Split	9%	45%	32%	14%
EB0810234	Sample 8	E4 Split	55%	32%	11%	2%
EB0810234	Sample 16	E4 Split	25%	41%	26%	8%
EB0810234	Sample 20	E4 Split	7%	55%	28%	10%
EB0810234	Sample 26	E4 Split	9%	45%	30%	16%
EB0810234	Sample 9	F Floor	20%	39%	33%	8%
EB0810234	Sample 17	F Floor	17%	28%	43%	12%
EB0810234	Sample 21	F Floor	5%	27%	45%	23%

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G.2.8 Overburden and Interburden Characteristics

Shell Coal

Fuel Supply

August 1999

Appendix 16

Overburden / Interburden Characteristics

LAND
RECLAMATION
SERVICES

INVESTIGATION OF OVERBURDEN AND INTERBURDEN CHARACTERISTICS IN THE EPC 513 (ACLAND AREA) FOR ACLAND ENERGY

- POTENTIAL ACID PRODUCTION CHARACTERISTICS

- CHEMICAL AND PHYSICAL CHARACTERISTICS

- GEOCHEMISTRY

Prepared by
B.R. Emmerton
February 1997

O Box 527 • 132 Opal St
Emerald Q 4720 Australia
Telephone (079) 82 2964
Facsimile (079) 82 2628

Land Reclamation Services
Pty Limited ACN 010 392 748

1. Overview

The envisaged development in the Acland area will involve the development of a power station and approximately four to five operating pits over the life of the project to supply the power station.

The purpose of the following work was to indicate the nature of the wastes which may be generated by mining and subsequently from this information determine how those wastes may be best disposed of and the area rehabilitated.

The seam stratrigraphy is extremely complex being composed of approximately 50 plies which are often seperated by varying depths of interburden. In addition, several pits may be mined.

The purpose of this report was to indicate the nature of the wastes which will be encountered in the early stages of mining (in Pit 1).

There was minor pyritic activity encountered with materials having no, or extremely low levels of Nett Acid Generation or Nett Acid Producing Potential. Some of the materials do however contain high levels of non carbonate carbon which may be present as organic carbon or as a hydrocarbon material. This material initially oxidised in the Nett Acid Generation testing to give extremely low pH's and the Nett Acid Generation test is not suitable for this type of material.

Further work will be required on highly carbonaceous waste to determine the nature of the carbonaceous material and its behavior in a disposal situation. This should take the form of establishment of column leach tests with a more complete range of samples collected during the next drilling program. It is outside of the scope of the present study to undertake this work, however, the behavior of the materials and leachate could affect disposal methods and have implications in terms of contaminated land legislation.

Additionally there are elevated levels of As, Bi, Cd, S, and Se with lesser Cs, Hg and Zn present in some strata. These elements need to also be studied in their reaction in the column leach studies and the nature of the leachate from the waste dumps should be predicted.

2. Outline of the method of appraisal and analyses carried out

The purpose of the work carried out was to indicate the nature of the wastes which may be generated by mining and subsequently, from this information determine how those wastes may be best disposed of and the area rehabilitated.

The seam stratrigraphy is extremely complex, being composed of approximately 50 plies which are often seperated by varying depths of interburden. In addition, several pits may be mined, and the method of mining (areas to be taken as product and areas to be discarded) is as yet not defined.

The purpose of this report was to indicate the nature of the wastes which will be encountered in the early stages of mining (in Pit 1).

The samples used in the appraisal came from three primary sources:

- Chip samples of full profiles and of weathered profiles above where coring began.

- Crushed interburden samples returned from CASCO laboratories (these did not include larger interburden increments which were not available).

- Core samples of lower weathered strata and interburden taken from two available cores which had been previously sampled for coal (some interburden material was not available).

All samples obtained were a result of the 1996 drilling program, however, owing to the reuse of the core trays used and testing of coal and non coal material for calorific value (to assist in determining the method of mining) material representing the full stratigraphy to be encountered was not available from any one hole. Material from a combination of several holes was used to represent the range of materials to be encountered and some material from holes in Pit 2 was also sourced to provide additional overburden and interburden material which was not available from Pit 1.

The samples submitted for analysis were submitted to cover as full a range of stratigraphy as possible, and this was considered more important than trying to assess lateral variability.

The holes from which the material was sourced are as follows with the area of placement of the holes within the pits shown in Figure 1.

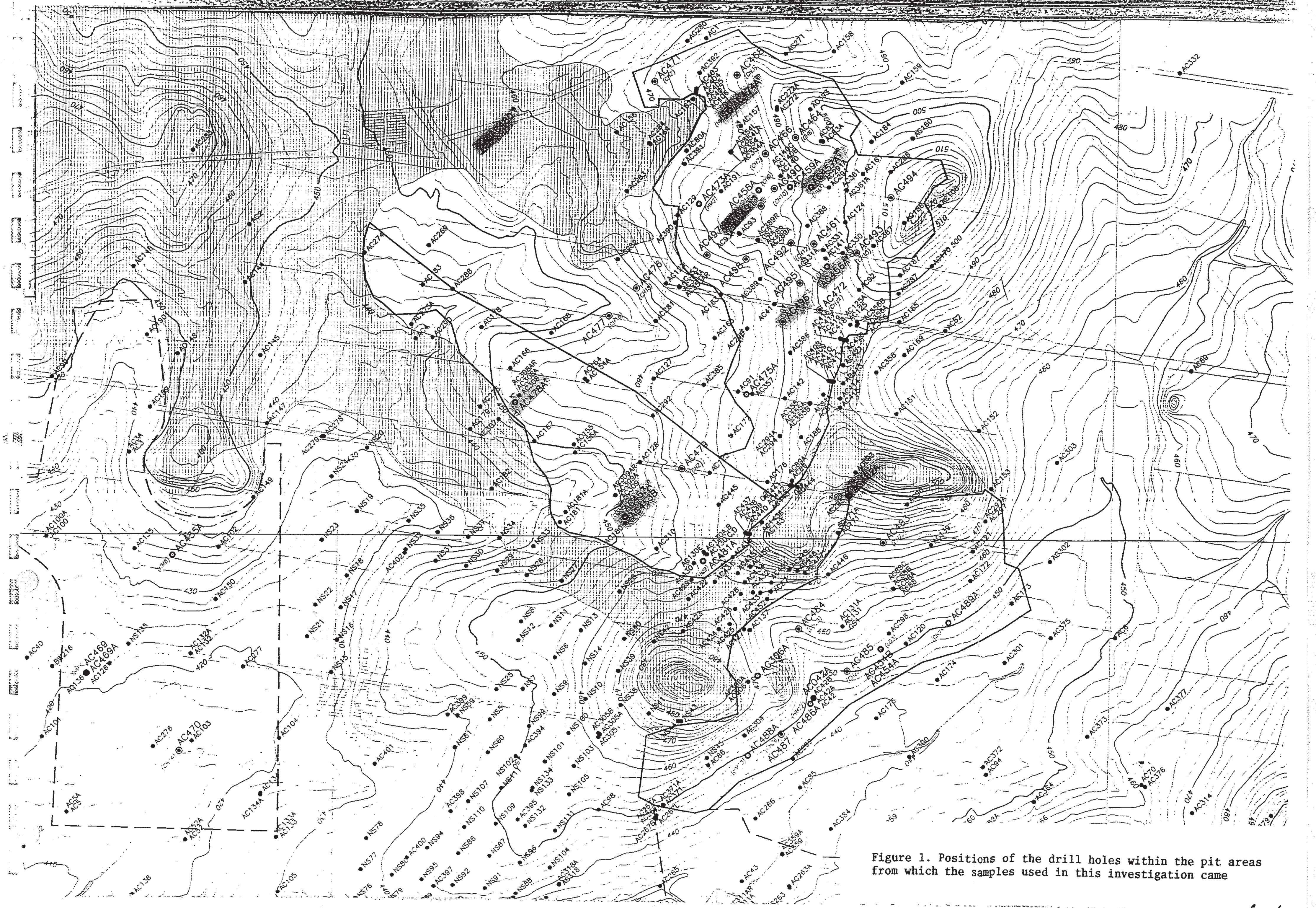

Figure 1. Positions of the drill holes within the pit areas from which the samples used in this investigation came

Holes and their location and relevance are as follows:

491 - A fully chipped hole of mid depth in Pit 1 (chips available), giving;

- pH and electrical conductivity down the profile (stratigraphy unknown).

496 - A fully chipped hole of mid depth in Pit 1 (chips available), giving;

- pH and electrical conductivity down the profile (stratigraphy unknown),
- acid neutralising capacity of weathered overburden and,
- physical and chemical characteristics of weathered overburden material.

474 - A chipped and cored hole of deeper depth in Pit 1 (chips and some crushed interburden samples available), giving;

- pH and electrical conductivity down the weathered profile as well as some of the interburden material,
- acid neutralising capacity of weathered overburden, and
- physical and chemical characteristics of weathered overburden material

457 - A chipped and cored hole of mid depth in Pit 1 (chips and some crushed interburden samples available), giving;

- pH and electrical conductivity down the weathered profile as well as some of the interburden material,
- acid neutralising capacity of weathered overburden as well as acid/base characteristics of fine grained carbonaceous interburden in the UA13 to 14B area and UA24 to 25A area,
- physical and chemical characteristics of weathered overburden as well as fine grained carbonaceous interburden in the UA13 to 14B area, and
- geochemical characteristics of weathered overburden and fine grained carbonaceous interburden in the UA13 to 14B area and UA24 to 25A area.

456 - A chipped and cored hole of mid depth in Pit 1 (no chips were available but the majority of non coal core was available) giving;

- pH and electrical conductivity in the lower weathered profile and larger increments of interburden material,

- acid neutralising capacity and acid/base characteristics of some lower weathered strata and larger increments of interburden material from LA21 down the profile,

- physical and chemical characteristics of lower weathered strata and larger increments of interburden material from LA21 down the profile, and

- geochemical characteristics of lower weathered strata incorporating UA25 to UA31 and larger increments of interburden material from LA21 down the profile.

453 - A chipped and cored hole of mid depth in Pit 2 (no chips were available but the majority of non coal core was available) giving;

- pH and electrical conductivity in the lower weathered profile and larger increments of interburden material,

- acid neutralising capacity and acid/base characteristics of some lower weathered strata and larger increments of interburden material in the MS42 to LS52 region (not present in Hole 456 in Pit 1),

- physical and chemical characteristics of lower weathered strata and larger increments of interburden material from LA22 down the profile, and

- geochemical characteristics of lower weathered strata, and larger increments of interburden material in the MS42 to LS52 region (not present in Hole 456 in Pit 1).

478 - A chipped and cored hole of mid to deeper depth in Pit 2 (chips and some crushed interburden samples available), giving;

- pH and electrical conductivity down the weathered profile as well as some unweathered sandstone and some of the interburden material,

- acid base characteristics of fresh sandstone overburden and some fine grained carbonaceous interburden in the UA 12 to 13 and UA23B to 24 area,

- physical and chemical characteristics of fresh sandstone overburden and some fine grained carbonaceous interburden in the UA 13 to 23B and UA 23B to 26B area, and

- geochemical characteristics of fresh sandstone overburden and fine grained carbonaceous interburden in the UA12 to 13 and UA 23B to 24 area.

480 - A chipped hole in the possible power station area (surface chips available), giving;

- acid neutralising capacity of the soil and weathered basalt in the surface 2m, and

- physical and chemical characteristics of the soil and weathered basalt in the surface 2m.

482 - A chipped and cored hole of deeper depth on the edge of Pit 3 (bulked non weathered overburden core available), giving;

- chemical and physical characteristics of fine grained unweathered overburden material.

Analysis of samples

The analysis of the samples involved four stages.

1 - pH and E.C. analysis

Initial screening of the samples by pH and E.C. analysis of all samples. This involved analysis of all samples listed in Table 1.

2 - ANC, NAPP and NAG analysis

Selected samples (49 in total) representing as broad a range of weathered and non weathered stratigraphy as available were analysed for Acid Neutralising capacity by Land Reclamation Services.

Of these samples, 36 samples representing the weathered material close to the base of weathering and the non weathered overburden and interburden material were analysed for Nett Acid Generation by reaction with peroxide as an oxygen source. (This was carried out by Land Reclamation Services.) The initial single stage digestion gave false readings of acid production due to the presence of high amounts of organic carbon or hydrocarbon materials.

The method was modified by experimentation to give a five stage digestion which classified all of the samples analysed, as non acid forming. The Nett Acid Generation method is not considered suitable for use on the types of overburden and interburden material found at Acland as use of the simple method can vastly over estimate the acid production potential of carbonaceous materials.

Due to this finding the 36 samples tested for Nett Acid Generation were also tested for Total S, SO4-S, Total C and non CO3-C by Genalysis Laboratory Services so that conventional acid/base accounting could be carried out.

3 - Chemical and physical analysis

Samples were selected (38 in total) for physical and chemical testing by the Department of Primary Industries Agricultural Chemistry Laboratories. The samples selected represented as broad a range of weathered overburden, non weathered overburden and non weathered interburden material as possible over as broad an area as this allowed within Pit 1. Where specific stratigraphy was not available within Pit 1, material was also included from holes in Pits 2 and 3.

The analysis would indicate how the materials would react as spoil material and what problems may be encountered in rehabilitation.

4 - Geochemistry (multi element composition)

Eighteen batched samples were selected representing a broad range of stratigraphy of possible waste materials to be encountered down the mining profile. These samples were submitted to Genalysis Laboratory Services for multi element scans. This analysis would indicate where elemental enrichment may cause environmental or rehabilitation problems. In all 43 elements were analysed for and reported.

3. Discussion of results

The discussion of each of the types of analyses carried out and the discussion of the results of those analyses is presented in the following sections.

3.1 Profile description and pH and E.C. analysis (initial sample screening)

The borelogs available were briefly handwritten for fully chipped holes (with no reference to stratigraphy) and were coded borelogs (referring to stratigraphy) for those holes with a cored component. The borelogs are not presented in the appendices as they are time consuming and difficult, to interpret. For ease of understanding the profile descriptions and the pH and E.C. results for the samples are presented in Table 1. The information in this table should be referred to for any more detailed descriptions of the strata present (when referring to analyses in the other tables).

The analysis results in Table 1 in general show the following:

- The non weathered material has 1:5 electrical conductivities which tend in general to be lower than the weathered materials. Some of the weathered materials would be classified as saline, while the non weathered materials are usually non saline.

- While the weathered material generally has an alkaline pH, some of the weathered or partially weathered carbonaceous materials near the base of the weathered profile may be slightly acidic (e.g. Holes 469 and 456), and occasional partings materials may have slightly acidic pH's (e.g. Holes 491, 474).

- While some sodicity is indicated by higher pH's down the profile extreme sodicity is not indicated.

Table 1. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 491

Depth (m)	Sample	Description	pH	E.C. uS/cm
0-1	chips	brown/red clayey soil	8.2	343
1-3	chips	claystone/siderite bands	7.9	895
3-5	chips	soft, fine light grey/brown sandstone	6.3	656
5-7	chips	soft, fine light grey sandstone, siderite lenses	8.9	788
7-9	chips	soft grey mudstone, carbonaceous wisps, siderite bands	8.8	964
9-11	chips	as above	8.9	809
11-13	chips	mudstone as above and soft fine grained sandstone	8.7	859
13-15	chips	moderately soft fine grained sandstone (light grey)	8.6	677
15-17	chips	weathered coal, pale pink claystone bands	7.2	1174
base of weathering at 17m				
17-19	chips	coal/claystone bands	5.5	995
19-21	chips	coal, claystone and carbonaceous mud lenses	8.8	359
21-23	chips	coal interbedded with claystone	8.1	242
23-25	chips	coal, bentonite claystone bands and carbonaceous mudstone	7.7	177
25-27	chips	coal and claystone bands and light grey siltstone	7.8	359
27-29	chips	coal, claystone lenses	8.0	353
29-31	chips	coal with carbonaceous claystone lenses	8.0	335

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 491 cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
31-33	chips	coal, interbedded with carbonaceous mudstone	7.4	162
33-35	chips	coal, mudstone and carbonaceous mudstone	8.2	343
35-37	chips	medium grey mudstone and bentonitic claystone	8.9	324
37-39	chips	carbonaceous mudstone and coal and light grey fine sandstone	8.8	318
39-41	chips	grey fine sandstone and medium siltstone	8.9	359
41-43	chips	medium grey/brown mudstone	8.9	416
43-45	chips	moderately soft, grey, fine medium sandstone	9.2	266
45-47	chips	as above	8.8	440
47-49	chips	as above	9.2	283
49-51	chips	as above, minor siderite lenses	9.2	284
51-53	chips	moderately soft interbedded sandstone and mudstone	9.1	383
53-55	chips	grey mudstone, coaly bands	9.2	326
55-57	chips	interbedded mudstone and sandstone	9.3	291
57-59	chips	medium grey/brown mudstone	8.9	418
59-60	chips	as above	9.2	325

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 496

Depth (m)	Sample	Description	pH	E.C. uS/cm
0-2	chips	soil, soft red clay and ironstone bands	8.5	393
2-4	chips	soft, light grey/brown iron stained claystone	9.0	757
4-6	chips	light brown claystone and soft fine grained grey sandstone	8.0	509
6-8	chips	0.5m ironstone band and light grey mudstone/weathered coal	8.8	543
8-10	chips	soft pink/brown/grey claystone	8.8	464
10-12	chips	light brown/yellow mudstone, coal weathered bands	8.5	424
12-14	chips	carbonaceous mud, interbedded with weathered coal	8.0	503
14-16	chips	claystone and weathered carbonaceous shale	5.9	750
16-18	chips	carbonaceous shale, claystone bands, coal lenses	4.8	1399
base of weathering at 17m				
18-20	chips	soft mudstone and bentonitic claystone	7.2	429
20-22	chips	bentonitic claystone, coal and carb mudstone bands	7.1	293
22-24	chips	coal and carbonaceous mud bands with dark grey siltstone	8.6	205
24-26	chips	dark grey siltstone, coal lenses	8.0	285
26-28	chips	fine grey sandstone, interbedded dark grey siltstone	8.1	248

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 496 cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
28-30	chips	interbedded coal and mudstone, fewer claystone bands	8.4	219
30-32	chips	coal with minor carbonaceous mudstone bands	8.5	393
32-34	chips	grey mudstone and fine grained sandstone	8.2	246
34-36	chips	brown mudstone and coaly bands	8.2	331
36-38	chips	fine medium grey sandstone and coal, with some carbonaceous mud bands	8.1	300
38-40	chips	carbonaceous mud and mudstone with coaly bands	8.2	330
40-42	chips	interbedded carbonaceous mud, coal and claystone	8.7	258
42-44	chips	light grey sandstone and siltstone	8.8	358
44-46	chips	grey sandstone and siltstone	9.1	266
46-48	chips	siltstone and carbonaceous mudstone	9.0	283
48-50	chips	interbedded, carbonaceous shale, mudstone and sandstone	8.5	508
50-52	chips	fine light grey sandstone and siltstone bands	8.5	747
52-54	chips	as above	8.6	752

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 474

Depth (m)	Sample	Description	pH	E.C. uS/cm
0-2	chips	soil	7.1	86
2-3	chips	sandstone	8.1	128
3-5	chips	claystone	8.6	132
5-7	chips	sandstone	9.1	177
7-9	chips	sandstone and siltstone	8.7	262
9-11	chips	minor siltstone, weathered coal and carbonaceous mudstone	8.2	859
11-13	chips	carbonaceous mudstone, mudstone and minor coal	7.7	1075
base of weathering at 13.3m				
13.3-13.62		coal UA 26B		
13.62-13.71	CASC05	9cm of claystone (probably to ash)	4.7	1750
13.71-13.94		coal UA 271		
13.94-14.51	CASC07	37 to 57cm of claystone/mudstone not returned as sample (analysed as coal, 0.02% total S)		
14.51-15.10		coal UA 31		
15.10-15.22	CASC09	12cm of coal and claystone (probably to ash)	4.1	726
15.22-16.13		coal UA 32		
16.13-16.27	CASC011	14cm of claystone (probably to ash)	6.5	282
16.27-16.69		coal UA 331 and UA 33		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 474 cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
16.69-17.00	CASC014	31cm of claystone not returned as sample (analysed as coal, 0.05% total S)		
17.00-19.11		coal LA 111 to LA 21		
19.11-19.27	CASC020	16cm of mudstone and carbonaceous mudstone (probably to ash)	7.3	303
19.27-20.20		coal LA 22A and LA 22B		
20.20-22.60		240cm total of mudstone, claystone and siltstone not sampled with minor (15cm) coal		
22.60-23.41		coal US 21 and MS 31		
23.41-23.78	CASC029	38cm of claystone, mudstone and carb mudstone (interburden) (minor coal)	5.3	768
23.78-24.12		coal MS 32		
24.12-24.29	CASC031A	17cm of mudstone analysed as coal, (0.10% total S)	7.8	407
24.29-24.81	CASC031	52cm of mainly carbonaceous mudstone not returned as sample (analysed as coal, 0.54% total S)		
24.81-25.93		coal MS 411 to LS 51		
25.93-26.25	CASC036	32cm of mainly mudstone	6.7	608
26.25-27.62		coal LS 521A to LS 61		
27.62-28.81		119cm of mainly mudstone and siltstone not sampled with minor coal (13cm)		
28.81-29.24		coal LS 62B		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 474 cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
29.24-31.19		195cm of mudstones and carbonceous mudstones not sampled		
31.19-31.69		coal LS 71		
31.69-31.96	CASC046	27cm of mainly claystone not returned as sample (analysed as coal, 0.02% total S)		
31.96-32.23		coal LS 72		
32.23-32.70		47cm of carb mudstone not sampled		
32.70-33.10		coal LS 73A		
33.10-33.82		72cm of carb mudstone and mudstone not sampled		
33.82-34.16		coal LS 73B		
below 34.20		over 5m of sandstones and mudstones not sampled		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 457A

Depth (m)	Sample	Description	pH	E.C. uS/cm
0-1	chips	soil,	7.5	101
1-3	chips	sandstone	8.7	199
3-5	chips	"	9.2	207
5-7	chips	"	9.2	331
7-9	chips	"	8.9	429
9-11	chips	siltstone	8.4	1426
11-13	chips	"	8.5	1150
13-15	chips	sandstone and siltstone	8.4	1070
15-17	chips	siltstone and lesser mudstone	8.4	950
17-19	chips	mudstone and siltstone	8.4	883
19-21	chips	siltstone	8.3	763
21-23	chips	siltstone and sandstone	8.6	659
base of weathering at 24.1m				
24.11-26.85		274cm of sandstone not sampled		
26.87-27.14	CACS01	27cm total of carb shale and mudstone with minor coal (4cm) not returned as sample (analysed as coal) 0.40% total S)		
27.14-27.57		coal UA 13		
27.57-27.86	CASC03	29cm of carb mudstone and shale	8.4	298
27.86-28.07		coal UA 14A		
28.07-28.51	CASC05	44cm total of mainly clay (16cm coal)	7.9	537

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 457A cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
28.51-31.26		coal UA14B to UA 23B		
31.26- 31.55	CASC015	29cm of claystone and carb mudstone sampled as non coal and not returned as sample		
31.55-32.15		coal UA 24		
32.15- 32.28	CASC017	13cm total of mainly carb mudstone and shale (2cm coal) sampled as non coal	7.8	292
32.38-32.88		coal UA 25A		
32.88- 33.00	CASC019	12cm of mainly claystone (with 5cm coal parting sampled as non coal	7.4	270
33.00-33.18		coal UA 25B		
33.18- 33.28	CASC021	10cm mainly claystone (coal parting) sampled as non coal	7.6	290
33.28-33.44		coal UA 26A		
33.44- 33.54	CASC023	5cm of dull coal and 5cm of claystone sampled as coal	7.9	283
33.54-34.20		coal UA 26B and UA 27		
34.20- 34.66	CASC027A	46cm of claystone/clay	7.4	415
34.66- 34.74	CASC027B	8cm of carbonaceous mudstone sampled as non coal	7.5	147
34.74- 36.14		coal UA 31 and UA 32		
36.14- 36.36	CASC030	22cm of carb mudstone, claystone and stony coal sampled as non coal	8.0	517
36.36- 36.70		coal UA 33		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 457A cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
36.70- 37.03	CASC032	33cm of claystone	8.7	367
37.03-37.26		coal LA 111		
37.26- 37.35	CASC034	9cm total of mainly claystone with a 2cm coal parting, sampled as non coal	8.6	484
37.35-38.31		coal LA 12 to LA 14		
38.31- 38.42	38	11cm of carb mudstone and claystone sampled as non coal	5.3	716
38.42- 39.24		coal LA 21		
39.24- 39.39	CASC040	15cm of mudstone sampled as non coal	8.6	427
39.39-39.58		coal LA 22A		
39.58- 39.81	CASC042	23cm total of mudstone with 5cm coal parting sampled as non coal	8.3	365
39.81-40.54		coal LA 22B and US 11		
40.54-42.03		149cm total of mudstone, siltstone and sandstone not sampled with minor coal (6cm)		
42.03-42.62		coal MS 31 and MS 32		
42.62- 42.75	CASC050	13cm of dull coal and claystone sampled as non coal	8.0	212
42.75-43.26		coal MS 41A		
43.26- 43.42	CASC052	16cm of mudstone with minor coal parting sampled as non coal	8.3	268
43.42-43.84		coal MS 41B		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 457A cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
43.84-44.02	CASC054	7cm of claystone and carb mudstone sampled with 11cm of dull and stony coal sampled as non coal	8.0	318
44.02-45.15		coal MS 42 and LS 51		
45.15-45.38	CASC058	23cm of mudstone	7.4	461
45.38-45.46		coal LS 52A		
45.46-45.65	CASC060	19cm total of carb mudstone with a 4cm coal parting sampled as non coal	8.6	393
45.65-46.92		coal LS 52A and LS 61		
46.92-48.40		148cm total mudstone, sandstone and siltstone with a 12cm coal band not sampled (missing)		
48.40-48.69		coal LS 62B		
48.69-49.77		108cm total of mudstone not sampled as non coal with 4cm of coal (missing)		
49.77-50.36		coal LS 71		
50.36-50.92		56cm of mudstone not sampled (missing)		
50.92-51.27		coal LS 72		
51.27-51.77		50cm total of mainly claystone and carb mudstone with 8cm of stony coal (missing)		
51.77-52.15		coal LS 73A		
52.15-52.32	CASC069	17cm mudstone sampled as non coal	8.7	369

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 457A cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
52.32-52.42		coal LS 731B (10cm)		
52.42 52.70	CASC071	28cm of mudstone sampled as non coal	8.9	343

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 456A

Depth (m)	Sample	Description	pH	E.C. uS/cm
no sample, to 20.76m,				
UA 24 above				
20.76-21.15	LRS1	claystone, mudstone and minor coal partings	4.4	481
21.15-22.31		coal UA 25 to UA 27		
22.31-22.81	LRS2	mudstone, claystone, carbonaceous shale and laterite partings	6.7	737
base of weathering at 22.6m				
22.81-26.33		coal UA 31 to LA 21		
26.33-26.59	LRS3	26cm of mudstone	9.0	234
26.61-27.37	LRS4	76cm of mainly mudstone and some siderite	8.9	291
27.37-28.51	LRS5	114cm of sandstone	8.3	248
28.51-29.56	LRS6	105cm of mudstone	8.8	244
29.56-29.92	LRS7	25cm of coal and 11cm of carbonaceous mudstone	7.4	178
29.92-31.04	LRS8	112cm total with 99cm of mudstone present and 13cm of coal missing	8.7	185
31.04-31.46	LRS9	42cm of siltstone	8.4	189
31.46-32.18	LRS10	72cm total of sandstone and siltstone	8.5	192
32.18-32.56		coal US 21		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 456A cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
32.56-33.39	LRS11	83cm of mudstone	8.3	203
33.39-33.59 mainly carb		coal MS 31 33.59-33.91 32cm total of mudstone (3cm stony coal parting) previously sampled (missing)		
33.91-35.66		coal MS 32 to MS 42		
35.66-35.99		33cm of carb mudstone previously sampled (missing)		
35.99-37.53		coal LS 51 to LS 61		
37.53-38.12	LRS12	59cm of mudstone	6.8	591
38.12-38.23		coal LS 62A (previously sampled)		
38.23-39.56	LRS13	33cm of mainly mudstone	8.1	216
39.56-39.78		coal LS 62B		
39.78-40.06	LRS14	28cm of mudstone	8.8	166
40.06-40.26		coal LS 71A		
base of probable mining				
40.26-40.53	LRS15	27cm of mudstone and carb mudstone	9.0	203
40.53-40.65		coal LS 71B previously sampled		
40.65-41.10	LRS16	45cm of claystone and carb mudstone	9.1	248
41.10-41.45		coal LS 72		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 1, Glen Rosslyn area

Hole 456A cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
41.45-41.71	LRS17	26cm of mudstone	9.0	238
41.71-42.22		coal LS 731A and LS 73A		
42.22-42.65	LRS18	43cm of mudstone (faulted)	9.1	183
42.65-42.78		coal LS 73B		
42.78-42.92	LRS19	13cm of carbonaceous mudstone and 1cm of coal	9.0	232
Below 43.0	LRS20	sandstone	6.6	436

Table 1. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 2, Glen Rosslyn area

Hole 478

Depth (m)	Sample	Description	pH	E.C. uS/cm
0-1	chips	soil	8.5	177
1-3	chips	yellow clay and ironstone with some siltstone	9.2	526
3-5	chips	sandstone	9.1	428
5-7	chips	sandstone	9.2	378
7-9	chips	weathered mudstone and siltstone	9.3	386
9-11	chips	weathered siltstone and sandstone	9.3	343
11-13	chips	weathered sandstone	9.1	360
base of weathering at 13m				
13-14	chips	fresh sandstone	8.9	267
14-14.90		fresh sandstone (not sampled)		
14.90-15.86		coal UA 11 and UA 12		
15.86-15.95	CASC04	14cm total of claystone and carb mudstone with 3cm of coal (total S 0.18%)	8.9	264
15.95-17.24		coal UA 13 to UA 141		
17.24-17.34	CASC09	10cm of carb mudstone and claystone (total S 0.13%)	9.6	305
17.34-17.47		coal UA 21		
17.47-17.60	CASC011	13cm claystone and siltstone (total S 0.09%)	9.4	303
17.60-19.21		coal UA 22 and UA 23A		
19.21-19.39	CASC015	18cm total of mainly claystone with 7cm of coal	8.8	317
19.39-19.80		coal UA 23B		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 2, Glen Rosslyn area

Hole 478 cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
19.80-19.91	CASC017	11cm total of mainly claystone and mudstone with 2cm of stony coal (total S 0.15%)	9.2	319
19.91-21.64		coal UA 24 to UA 26A		
21.64-21.77	CASC024	13cm total of mainly claystone with 4cm of stony coal (total S 0.10%)	9.0	190
21.77-22.16		coal UA 26B		
22.16-22.26	CASC026	10cm of claystone (total S 0.01%)	9.6	322
22.26-22.36		10cm coal and 9cm carb mudstone UA 271 (total S 0.69%)		
22.45-22.65		20cm of claystone not returned as sample (total S 0.19%)		
22.65-24.36		coal UA 31 to UA 321		
24.36-24.53	CASC034	17cm of claystone and lesser carb mudstone (total S 0.09%)	9.6	349
24.53-24.83		coal UA 33		
24.83-25.14		31cm of mainly claystone and lesser carb mudstone (analysed as coal and not returned as sample) (total S 0.26 and 0.03)		
25.14-27.92		coal LA 111 to US 11		
27.92-29.55		163cm of mudstone and siltstone interburden not sampled (missing)		
29.55-29.95		coal US 21		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 2, Glen Rosslyn area

Hole 478 cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
29.95-32.10		115cm of siltstone, sandstone and mudstone interburden not sampled		
32.10-32.84		coal MS31 and MS32		
32.84-34.70		186cm total of mainly mudstone and siltstone not sampled with minor coal (9cm)		
34.70-35.65		coal MS 41B and MS 42		
35.65-35.86	CASC054	21cm claystone (total S 1.60%)	9.4	594
35.86-36.05		coal LS 51		
36.05-43.12		707cm total of sandstone and mudstone not sampled with (minor coal 12cm)		
43.12-43.47		coal and carb mudstone LS 52B (total S 0.42%)		
43.47-43.58	CASC058	11cm claystone (total S 0.07%)	9.7	391
43.58-44.16		coal LS 52C and LS 61		
44.16-46.33		217cm of predominantly sandstone and mudstone not sampled		
46.33-46.44		coal LS 62A		
46.44-46.56	CASC063	12cm total of mainly mudstone and carb mudstone (minor coal, 1cm), (total S 0.07%)	9.6	221
46.56-47.02		coal LS 62B		
47.02-51.91		489cm of mudstone, claystone and siltstone with minor coal (13cm) not sampled		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 2, Glen Rosslyn area

Hole 478 cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
51.91-52.83		coal LS 711 to LS 73A		
52.83-58.00		siltstone and sandstone, not sampled		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 2, Glen Rosslyn area

Hole 453

Depth (m)	Sample	Description	pH	E.C. uS/cm
no sample, to 10.07m				
10.07-11.42	LRS21	weathered mudstone	8.4	412
11.42-12.10		calcite		
12.10-13.83	LRS22	173cm weathered mudstone	8.9	410
13.83-14.73	LRS23	90cm weathered mudstone	8.6	281
base of weathering at 14.73m				
14.73-21.33		predominantly coal with smaller partings UA 12 to UA 27		
21.33-21.81		48cm total of mainly claystone and clay with minor stony coal (5cm) previously sampled (missing)		
21.81-23.43		coal UA 31 and UA 32		
23.43-24.21		78cm total of mainly clay and mudstone with 14cm of coal (UA 33 included) previously sampled (missing)		
24.21-26.98		coal with smaller partings LA 11 to LA 22		
26.98-27.36	LRS24	38cm of mudstone and siltstone	9.0	218
27.36-27.67	LRS25	31cm of mudstone	9.1	208
27.67-28.21		coal US 21		
28.21-29.30	LRS26A	109cm of mudstone	9.1	178

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 2, Glen Rosslyn area

Hole 453 cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
29.30-30.06	LRS26B	76cm of mudstone and lesser sandstone	8.9	254
30.06-30.58	LRS27	52cm of mudstone	8.8	273
30.58-31.14		coal MS 31		
31.14-32.85	LRS28	171cm of mudstone and siltstone	9.0	237
32.85-34.38		coal MS 41A to MS 42		
probable base of mining				
34.38-35.92	LRS29	154cm of siltstone	8.9	218
35.92-36.46	LRS30	54cm of mudstone and siltstone	9.2	208
36.46-37.07	LRS31	61cm of sandstone	9.2	189
37.07-39.00	LRS32	193cm of sandstone	9.4	214
39.00-40.79	LRS33	179cm of sandstone	9.5	201
40.79-42.53	LRS34	174cm of mudstone	9.5	241
42.53-42.76	LRS35	23cm of siderite	7.9	142
42.76-43.03		27cm total of mainly carb mudstone with minor coal (1cm) previously sampled as coal (missing)		

Table 1 cont. Description, pH and electrical conductivity (1:5 basis, uS/cm) of chip and core samples from exploration drill holes in the Glen Rosslyn area

Pit 2, Glen Rosslyn area

Hole 453 cont.

Depth (m)	Sample	Description	pH	E.C. uS/cm
43.03-43.47		coal LS 52		
43.47-44.19	LRS36	72cm of mudstone	9.2	304
44.19-44.53	LRS37	34cm of carb mudstone (minor coal)	9.4	261
44.53-44.95		coal LS 62B		
44.95-47.71	LRS38	276cm of mudstone and mainly siltstone	9.5	236
47.71-48.14	LRS39	43cm of sandstone and siltstone	9.0	282
48.14-48.25	LRS40	11 cm of siderite	8.8	211
48.25-49.80	LRS41	155cm of sandstone and siltstone	9.2	250
49.80-50.70	LRS42	90cm of sandstone	9.5	228
50.70-51.70	LRS43	100cm of sandstone	9.2	244
51.70-52.22	LRS44	55cm of sandstone	9.4	202
52.22-53.15		coal (some claystone partings) LS 71 to LS 73A		
53.15-53.50	LRS45	35cm mudstone and siltstone floor	9.5	282
53.50-54.08	LRS46	58cm of mudstone and sandstone	9.6	277

3.2 Acid Neutralising Capacity, Nett Acid Producing Potential and Nett Acid Generation

A brief description of the analyses and meaning and use of the analyses is given below.

Acid Neutralising capacity - ANC

This is the measure of the buffering capacity or the inherent neutralising ability of the material (usually due to the presence of carbonate (CO3) minerals). A known amount of standardised hydrochloric acid is reacted with a known sample weight, then back titrated with standardised sodium hydroxide. The amount of acid consumed represents the inherent acid neutralising capacity of the sample and is expressed in terms of kg H2SO4 neutralised/t.

Nett Acid Producing Potential - NAPP

This is measured from a combination of the ANC and measurement of total Sulphur by Leco furnace, and sulphur present as sulphate. The non sulphate sulphur level is used to calculate the maximum potential acidity that could be generated by the sample assuming that all non sulphate sulphur is present as pyrite and all pyrite is reactive.

The maximum potential acidity produced by a sample containing 1% S as pyrite is 30.6kg H2SO4/t.

The acid formed from pyrite reaction reacts to varying degrees with minerals in the rock (quantified by the ANC result).

The ANC result is taken from the maximum potential acidity that can be produced (from total non sulphate S%) and this gives the Nett Acid Producing Potential expressed in kg H2SO4 produced per ton.

This method can often over estimate acid production as it assumes;

- organic S is not significant, and
- all pyrite is reactive

Nett Acid Generation - NAG

The Nett Acid Generation or NAG is used to assess the actual acid producing potential of a sample. The test involves the addition of hydrogen peroxide as a strong oxidizing source to a known weight of finely ground sample. This oxidizes any reactive sulphide and the products of reaction in turn react with any acid neutralising capacity present.

The final pH and E.C. is measured and this indicates whether sulphides present are reactive.

Note: In the Acland samples which are carbonaceous, false acidity can be obtained from this method and a staged digestion has to be used. This is time consuming and the method is not really suitable for use on the Acland samples.

If acidic, the final reacted sample is titrated with standardised sodium hydroxide to provide a direct measure of the net amount of acid remaining in the sample after all acid forming and acid neutralising reactions have taken place (NAG).

The test provides a direct measure of the potential of a material to produce acid after a period of exposure and also provides an indication of the reactivity of the sulphide within the sample.

The results obtained from these analyses are presented in Table 2.

The results expressed in Table 2 are;

- natural pH and electrical conductivity,
- non sulphate sulphur, Acid Neutralising capacity, and Nett Acid Production Potential, and
- levels of non carbonate carbon, pH's at various stages through the NAG digestion, final electrical conductivity and pH of the NAG digestion, and NAG value.

Acid Neutralising Capacity results show significant acid neutralising capacity in;

- the upper layers of Hole 457,
- the upper 6 metres of Hole 496, and
- some of the sandstone material between MS42 and LS52 in Hole 453.

All other samples had only slight acid neutralising capacity with the exception of LRS1 which is weathered claystone, mudstone and coal above UA25 (from Hole 456) which has a naturally acidic pH and has a slightly negative acid neutralising capacity.

Non sulphate sulphur results show low levels present, with all samples analysed having 0.3% or less (or less than 10kg H_2SO_4/t if all sulphur was present as pyrite and no neutralising capacity was present).

Nett Acid Production Potential which takes into account the acid neutralising capacity present shows only very mild levels of possible acid production in some samples with a maximum level of 11kg H_2SO_4/t being detected in LRS1

(naturally acid weathered claystone, where this method would over estimate acid production as pyrite should not be present in weathered material). The next highest level calculated was 3kg H_2SO_4/t and the majority of samples had negative NAPP's.

The non carbonate carbon levels in Table 2 are used as an aid in looking at the pH's achieved in the staged NAG reaction. Where carbon levels were high the samples initially achieved very low pH's when exposed to an oxidising source. The initially low pH's later increased to neutral or near neutral levels with time and addition of more peroxide later in the digestion process. The highest NAG level recorded was 2kg H_2SO_4/t in two samples only.

<u>The initially low pH's generated in the carbonaceous samples do however have implications.</u>

The carbon may be present as organic carbon or as a hydrocarbon material. The low pH's generated (approximately 2.5) with the strong oxygen source used, are extreme and should not occur in an emplacement situation, however, pH levels of down to approximately 4 caused by the presence of organic acids from breakdown of the carbonaceous material may occur. These pH levels may affect the rate of release of and solubility of elements within the emplacement and additionally, if hydrocarbons are present some free hydrocarbon material could also be released.

Further work will be required on highly carbonaceous waste to determine the nature of the carbonaceous material and its behavior in a disposal situation. This should take the form of establishment of column leach tests with a more complete range of samples collected during the next drilling program.

It is outside of the scope of the present study to undertake this work, however, the behavior of the materials could affect disposal methods and have implications in terms of contaminated land legislation.

In addition, comparison of natural 1:5 electrical conductivity values with the NAG electrical conductivity values indicate that some additional salinity may be released, on exposure to oxygen and subsequent weathering, over that level indicated by measurement of the fresh sample. Blank values (using acid washed sand) for NAG electrical conductivity were around 100uS/cm and considering that the measurement is on an approximately 1:100 solid:water basis a reading of approximately 300 to 400uS/cm is a significant increase over that which would be expected.

Table 2. 1:5 pH and electrical conductivity, acid base account and Nett Acid Generation test results for selected samples from drill holes in the Acland area

Sample	Seam	Material	pH 1:5	E.C. 1:5 uS/cm	Tot S-SO4 %	ANC H2SO4 kg/t	NAPP H2SO4 kg/t	Non CO3 Carbon %	pH St. 2	pH St. 3	pH St. 4	pH St. 5 (NAG)	E.C. NAG uS/cm	N.A.G. H2SO4 kg/t
480 1-2		soil/w. basalt	8.1	70	-	18	-	-	-	-	-	-	-	-
457 0-3		soil/w. SS	8.1	148	-	50	-	-	-	-	-	-	-	-
457 3-9		w. SS	9.3	230	-	54	-	-	-	-	-	-	-	-
457 9-13		w. SiltS	8.7	1060	-	14	-	-	-	-	-	-	-	-
457 13-19		w. SS/SiltS/MS	8.7	890	-	37	-	-	-	-	-	-	-	-
457 19-23		w. SiltS/SS	8.6	770	-	8	-	-	-	-	-	-	-	-
496 2-6		w. CS	8.9	580	-	39	-	-	-	-	-	-	-	-
496 6-12		w. CS/MS + coal	8.9	400	-	5	-	-	-	-	-	-	-	-
496 12-16		w. carb MS/coal	6.7	580	-	3	-	-	-	-	-	-	-	-
474 2-3		w. SS	9.1	110	-	5	-	-	-	-	-	-	-	-
474 3-5		w. SS	9.1	70	-	2	-	-	-	-	-	-	-	-
474 5-9		w. SS/SiltS	9.1	150	-	4	-	-	-	-	-	-	-	-
474 9-13		w. carb MS/coal	8.2	960	-	3	-	-	-	-	-	-	-	-
456 LRS1 -21.15	above UA25	w. CS/MS +coal	4.4	481	0.3	-2	11	22.70	2.1	2.3	4.4	6.7	412	<1
456 LRS2 -22.81	UA27-31	MS/CS/carb shale	6.7	737	0.2	4	2	4.52	3.9	4.9	5.6	5.9	405	2
453 LRS21	above UA12	weathered MS	8.4	412	<0.1	12	-12	1.43	6.9	6.6	7.4	7.2	189	-
453 LRS22	" "	weathered MS	8.9	410	<0.1	9	- 9	1.27	7.5	7.2	7.9	7.4	217	-
453 LRS23	" "	weathered MS	8.6	281	<0.1	12	-12	6.80	3.4	4.3	7.6	7.1	214	-
478 13-14	above UA11	fresh SS	8.9	267	<0.1	13	-13	4.02	4.4	7.2	7.6	7.4	209	-
478 15.86-15.95	UA12-13	CS/carb MS	8.9	264	0.1	10	- 7	13.90	3.1	5.1	7.4	7.1	242	-
457 27.57-27.86	UA13-14A	carb MS/shale	8.4	298	0.3	6	3	29.10	2.5	2.4	3.1	6.7	330	<1
457 28.07-28.51	UA14A-14B	clay	7.9	537	0.3	8	1	33.00	2.4	2.7	6.8	6.9	297	<1
478 19.80-19.91	UA23B-24	CS/MS +coal	9.2	319	0.1	4	- 1	16.70	3.4	5.0	7.1	6.5	313	<1
457 32.15-32.28	UA24-25A	carb MS/shale	7.8	292	0.1	4	- 1	21.10	2.5	3.1	5.8	6.7	299	<1
456 LRS3	LA21-LA22B	MS	9.0	234	<0.1	12	-12	1.43	6.0	7.6	8.1	7.3	155	-
456 LRS4	" "	MS + siderite	8.9	291	<0.1	4	- 4	1.52	3.7	6.5	6.8	6.8	255	<1
456 LRS5	" "	SS	8.3	248	<0.1	7	- 7	1.08	7.6	8.1	8.4	7.9	215	-
456 LRS6	" "	MS	8.8	244	<0.1	7	- 7	1.11	6.8	8.1	8.2	7.8	180	-
456 LRS7	LA22B-US21	coal + carb MS	7.4	178	0.3	6	3	29.20	2.2	3.2	6.8	6.5	429	<1
456 LRS8	" "	MS	8.7	185	<0.1	6	- 6	2.46	4.0	7.5	8.2	7.6	140	-
456 LRS9	" "	SiltS	8.4	189	<0.1	5	- 5	1.83	7.3	7.7	7.9	7.4	150	-
456 LRS10	" "	SS/SiltS	8.5	192	<0.1	5	- 5	2.19	7.2	7.6	7.9	7.5	149	-
456 LRS11	US21-MS31	MS	8.3	203	<0.1	4	- 4	1.51	7.0	7.4	7.7	7.3	158	-
456 LRS12	LS61-62A	MS	6.8	591	0.1	3	0	2.01	5.3	6.8	7.2	7.1	224	-
456 LRS13	LS62A-62B	MS	8.1	216	0.1	7	- 4	1.27	3.5	4.2	6.2	6.9	185	-
456 LRS14	LS62B-71A	MS	8.8	166	<0.1	5	- 5	8.08	2.9	4.3	7.5	7.2	131	-
456 LRS15	LS71A-71B	MS/carb MS	9.0	203	<0.1	6	- 6	7.63	2.9	3.6	7.8	7.3	156	-
456 LRS16	LS71B-72	CS/carb MS	9.1	248	0.2	5	1	0.38	4.4	6.8	7.5	7.3	175	-
456 LRS17	LS72-731A	MS	9.0	238	0.2	7	- 1	13.60	2.6	3.2	7.2	7.1	231	-
456 LRS18	LS73A-73B	MS	9.1	183	<0.1	6	- 6	3.81	3.6	7.4	7.9	7.3	130	-
456 LRS19	below LS73B	carb MS	9.0	232	<0.1	6	- 6	6.63	3.2	4.3	8.0	7.8	125	-
456 LRS20	" "	SS	6.6	436	0.2	5	1	0.97	3.0	3.2	3.7	5.5	224	2
453 LRS29	MS42-LS52	SiltS	8.9	218	<0.1	5	- 5	1.91	5.3	7.6	8.0	7.8	115	-
453 LRS30	" "	MS/SiltS	9.2	208	<0.1	6	- 6	1.09	6.4	7.3	8.2	8.0	113	-
453 LRS31	" "	SS	9.2	189	<0.1	8	- 8	0.61	6.2	7.4	7.9	7.6	117	-
453 LRS32	" "	SS	9.4	214	<0.1	83	-83	0.43	7.7	8.5	8.6	8.1	198	-
453 LRS33	" "	SS	9.5	201	<0.1	43	-43	0.38	7.6	8.7	8.7	8.3	231	-
453 LRS34	" "	MS	9.5	241	<0.1	12	-12	1.55	7.2	7.7	8.3	8.1	150	-
453 LRS35	" "	siderite	7.9	142	0.2	5	1	3.78	7.1	7.3	7.7	7.5	229	-

Table 2

3.3 Chemical and physical characteristics

Thirty eight samples were selected to represent as broad a range of weathered overburden, non weathered overburden and non weathered interburden material as possible, over as broad an area as possible (within Pit 1).

These samples were submitted to the Department of Primary Industries Agricultural Chemistry Laboratories for analysis of;

- pH, electrical conductivity, Cl and SO4,
- exchangeable cations (CEC and ESP),
- particle size analysis and Rl dispersion index,
- 1/3 and 15 bar moisture contents,
- organic carbon,
- total and nitrate nitrogen,
- extractable and total phosphorus, and
- micronutrients, Cu, Zn, Mn and Fe.

The Department of Primary Industries anlayses sheets and an explanation sheet on the meaning and use of the analyses is included as Appendix 2 and this should be referred to for more information if required.

The major results for the strata analysed are shown in Table 3.

No large and consistent differences between weathered overburden, non weathered overburden and interburden were observed, with the exception that the finer grained weathered sediments in holes 457 and 496 have higher electrical conductivities and chloride contents than other strata and use of these materials as a surface or near surface medium should be avoided. In addition, these materials have relatively high exchangeable sodium percentage at 12 to 22% while most of the other strata are in the range of 5 to 14%. The fine grained weathered samples also have generally moderate to high dispersion indices.

Overall characteristics of the materials are discussed below.

In general, all strata with the exception of some of the fine grained weathered strata have low salinity and chloride contents. It is possible (Section 3.2) that additional salinity may be released from non weathered strata with weathering and in this sense either weathered sandstone or basalt material may be preferable as a near surface medium on the spoil areas.

Sodicity levels are generally moderate but do not reach the extremely high levels recorded in the Bowen Basin. The R1 dispersion indices tend to be higher in the weathered material as would be expected, and there is little difference between sandstones and finer grained sediments.

Particle size analysis varies depending on the sedimentry strata encountered, however, most strata have relatively high silt contents and surface physical conditions would be considered to be poor with exposure and weathering. In addition, clay activity ratios are often low and indicate limited shrink/swell ability.

The moisture range between 1/3bar (field capacity) and 15 bar (wilting point) tends to be between 6 and 10% for the materials examined which is much less than the 10 to 15% (and up to 20%) range for the subsoils previously examined in the area. This means that this spoil material is not a substitute for subsoil material as its use in this manner would result in lower plant available water capacities for the reinstated profiles. (Refer to Investigation of soil profile types in the EPC 513 (Acland) area for Shell Australia Coal, July 1996).

Nutritionally the materials have adequate levels of calcium and magnesium with low levels of potassium in some of the weathered sediments (particularly sandstone). Sulphate levels appear adequate in all strata.

Levels of extactable phosphorus are low but are higher than would be expected while total phosphorus levels are low to moderate (when considered as subsoil strata). Some reasonable levels of nitrate nitrogen are present in some of the weathered strata, with very low levels in the non weathered material. Levels of total nitrogen are low to moderate.

Micronutrient levels vary between strata, however, deficiencies of manganese, and lesser zinc and iron are indicated in occasional isolated strata. This is unlikely to be of any consequence with an adequate depth of topsoil replacement and rehabilitation.

Table 3. Chemical and physical characteristics of batched overburden samples from drill holes in the Acland area (Holes and approximate depth of sampling shown)

Sample (+approx depth)	Seam	Material	pH 1:5	E.C. 1:5 uS/cm	Cl ug/g	SO4 ug/g	E.S.P. %	Ca/Mg	R1	CS %	FS %	S %	C %	CEC meq	CEC/ clay	1/3bar %H20	15bar %H20	K meq	Ca meq	Mg meq	Extr P ug/g	Tot P %	NO3 ug/g	Tot N %
Weathered overburden																								
480 1-2		soil/w. basalt	8.1	70	24	20	3	1.36	0.83	41	28	17	15	23	1.53	18	10	0.13	12.1	8.9	8	0.217	1	0.02
457 1-9		w. SS	9.3	230	108	26	13	1.71	0.60	23	38	17	22	10	0.45	17	9	0.06	7.0	4.1	4	0.039	8	0.01
457 9-13		w. SiltS	8.7	1060	1465	98	22	1.34	0.30	6	47	17	29	8	0.28	21	11	0.09	5.1	3.8	<1	0.046	10	0.02
457 13-19		w. SS/SiltS/MS	8.7	890	1106	113	12	1.37	0.66	6	35	22	36	15	0.42	24	15	0.13	8.3	6.1	2	0.036	12	0.02
457 19-23		w. SiltS/SS	8.6	770	706	139	8	1.22	0.68	1	32	28	40	21	0.53	26	16	0.19	11.7	9.6	1	0.015	8	0.02
496 2-6		w. CS	8.9	580	431	104	19	0.40	0.72	4	47	20	29	10	0.34	20	12	0.16	2.6	6.4	12	0.036	13	0.02
496 6-12		w.CS/MS + coal	8.9	400	478	11	16	0.43	0.84	5	14	27	53	18	0.34	29	18	0.21	3.8	8.9	5	0.033	3	0.02
496 12-16		w. carb MS/coal	6.7	580	370	178	12	0.59	0.70	8	9	20	60	28	0.47	35	19	0.13	6.0	10.2	7	0.018	10	0.09
456 21-23	UA25-31	MS/CS/carb shale	5.1	530	146	347	4	0.23	0.25	31	8	11	46	26	0.56	17	12	0.18	2.5	10.9	2	0.023	4	0.18
474 2-3		w.SS	9.1	110	22	6	6	1.12	0.57	16	36	19	28	10	0.36	19	11	0.06	5.9	5.2	2	0.018	4	0.01
474 3-5		w.SS	9.1	70	31	5	14	1.01	0.73	9	44	21	25	8	0.32	21	11	0.04	4.2	4.2	3	0.031	4	0.01
474 5-9		w.SS/SiltS	9.1	150	125	15	27	0.92	0.76	13	35	24	29	7	0.24	21	12	0.05	3.2	3.5	5	0.029	4	0.01
453	above UA12	weathered MS	8.6	320	248	51	10	0.54	0.73	9	10	47	31	16	0.39	23	13	0.29	5.9	11.0	6	0.060	1	0.08
Non weathered overburden																								
478 13-14	above UA11	fresh SS	8.9	200	91	63	12	0.47	0.71	12	41	14	29	9	0.31	17	10	0.19	3.3	7.0	2	0.021	1	0.05
482 ?		MS/carb MS	8.8	160	11	38	1	0.81	0.64	-	18	36	42	14	0.33	22	14	0.34	6.7	8.2	3	0.042	1	0.05
Interburden																								
456 26-27	LA21-22B	MS	8.9	250	103	71	6	0.47	0.76	3	3	40	52	14	0.27	24	15	0.36	3.8	8.0	1	0.019	1	0.05
456 27-28	" "	SS	8.5	210	75	87	8	0.49	0.63	3	50	16	31	6	0.19	19	11	0.22	2.2	4.4	2	0.017	1	0.03
456 28-31	LA21-US21	MS some coal	8.7	170	49	73	6	0.50	0.64	12	16	29	39	11	0.28	20	13	0.32	3.4	6.9	4	0.035	1	0.11
456 31-32	LA22B-US21	SS/SiltS	8.7	160	43	54	5	0.54	0.55	1	44	25	29	9	0.31	19	11	0.27	2.7	5.3	2	0.069	1	0.05
456 32-38	US21-LS62A	MS	7.9	380	65	223	5	0.61	0.45	13	17	29	39	9	0.23	20	12	0.26	3.7	6.0	4	0.028	1	0.05
456 38-40	LS62A-71A	MS	8.7	160	42	53	5	0.83	0.49	7	19	38	37	10	0.27	19	12	0.28	5.8	6.9	5	0.014	1	0.11
456 40-41	LS71A-72	carb MS/MS/CS	9.0	200	68	44	5	0.68	0.47	13	16	18	50	20	0.40	24	15	0.34	8.1	11.8	5	0.012	1	0.07
456 41-43	LS72-LS73B	MS/carb MS	9.0	170	47	43	5	0.83	0.44	11	6	36	42	15	0.36	21	13	0.37	7.1	8.5	4	0.013	1	0.14
478 17-19	UA141-23B	CS some coal	9.1	260	103	62	10	0.68	0.46	24	15	8	49	27	0.55	22	16	0.28	10.3	15.2	5	0.012	1	0.11
478 20-22	UA23B-26B	CS some coal	9.0	210	93	55	9	0.73	0.46	25	13	10	46	25	0.54	21	15	0.28	8.9	12.2	7	0.020	1	0.14
457 27-29	UA13-14B	carb MS/clay	8.6	290	174	89	6	1.10	0.81	48	16	6	26	18	0.69	20	14	0.18	8.2	7.4	3	0.010	1	0.33
453 27-28	LA22-US21	MS/SiltS	9.0	180	38	41	10	1.60	0.52	3	31	29	38	10	0.26	20	12	0.31	6.3	3.9	4	0.017	1	0.05
453 28-31	US21-MS31	MS minor SS	9.0	200	20	61	10	1.76	0.44	1	32	36	31	11	0.35	19	11	0.65	7.1	4.0	3	0.017	1	0.05
453 31-33	MS31-41A	MS/SiltS	9.1	190	27	44	10	2.06	0.40	5	26	33	34	14	0.41	21	12	0.37	8.5	4.1	7	0.026	1	0.06
453 34-36	MS42-LS52	Silt S/MS	9.3	170	7	44	11	2.78	0.31	5	32	32	31	14	0.45	16	10	0.34	8.4	3.0	7	0.012	1	0.04
453 36-39	" "	SS	9.6	170	10	19	11	2.71	0.47	25	37	12	34	12	0.50	15	9	0.25	8.2	3.0	7	0.047	1	0.02
453 39-41	" "	SS	9.7	170	14	16	11	2.86	0.45	22	43	9	24	15	0.63	16	8	0.22	8.9	3.1	<1	0.061	1	0.01
453 41-43	"	SS	9.6	180	5	16	11	3.22	0.39	17	15	28	38	15	0.39	17	10	0.38	8.8	2.7	<1	0.043	1	0.07
453 43-45	LS52-62B	MS/carb MS	9.2	280	8	45	13	4.05	0.28	1	14	37	49	21	0.43	23	14	0.52	13.3	3.3	<1	0.036	1	0.04
453 45-48	LS62B-71	MS/SiltS	9.6	210	1	16	14	4.39	0.48	-	29	36	42	17	0.53	20	11	0.44	10.9	2.5	2	0.024	1	0.03
453 48-50	" "	SS/SiltS	9.5	210	<1	41	14	4.06	0.45	21	40	18	24	11	0.46	15	8	0.28	7.8	1.9	<1	0.079	1	0.03
453 50-52	" "	SS	9.6	190	4	22	14	4.50	0.49	24	37	14	24	12	0.50	16	9	0.23	9.0	2.0	<1	0.044	1	0.02
453 53-54	below LS73A	MS/SS/SiltS	9.7	250	3	18	15	6.13	0.46	1	33	31	35	22	0.63	23	12	0.44	14.7	2.4	<1	0.013	1	0.04

Table 3

3.4 Geochemistry

Eighteen batched samples were selected representing a broad range of stratigraphy of possible waste materials to be encountered down the mining profile. These samples were submitted to Genalysis Laboratory services for mult element scans. The results sheets from Genalysis are presented in Appendix 3.

The samples were considered to represent strata in order of stratigraphy as follows.

A 457, 0-3m	soil and sandstone
B 457, 3-9m	weathered sandstone
C 457, 9-13m	weathered siltstone
D 457, 13-19m	weathered sandstone, siltstone and mudstone
E 457, 19-23m	weathered siltstone and sandstone
F 478, 13-14m	fresh sandstone, above UA11
G 478, 15.9m	fresh claystone and carb. mudstone, UA12-13
H 457, app 28m	fresh carb. mudstone shale and clay, UA13-14B
I 478, 19.8m	fresh claystone, mudstone and coal, UA23B-24
J 457, 32.2m	fresh carb. mudstone and shale, UA24-25A
K 456, 21m	weathered claystone, mudstone and coal, above UA25
L 456, 22.5m	weathered mudstone, claystone and carb. shale, UA27-31
M 456, 26-32m	fresh mixed interburden sediments, LA21-US21
N 456, 33m	fresh mudstone, US21-MS31
O 453, 34-43m	fresh sandstone, siltstone and mudstone, MS42-LS51
P 456, 37-40m	fresh mudstone, LS61-LS71A
Q 456, 40-43m	fresh mudstone and carb. mudstone, LS71A-73B
R 456, 43m	fresh carb mudstone, floor below 73B

This materials list should be referred to in considering the analysis results in Tables 4a to 4c.

Table 4a shows the absolute levels obtained along with the average crustal abundance levels (Bowen 1979).

Table 4b shows the level in comparison to the average crustal abundance (enrichment factor).

Table 4c shows the absolute levels of some metals of environmental significance in comparison to levels for which ANZEEC has guidelines for soils warrenting further investigation.

Elemental enrichment

The results in Table 4b show enrichment of some elements, these being As, Bi, Cd, Cs, S, and Se in some strata with slight enrichment of Hg and Zn in isolated strata.

As a general rule investigation would not be warrented unless the levels approached approximately 5 to 10 times average crustal abundance. This level of enrichment includes the elements listed.

In regards to cadmium, the levels encountered are close to the detection limits and in verbal communication with Genalysis Laboratory Services they indicated that as these levels are so close to detection limits, these levels may or may not be present. Alternatively, cadmium may have been picked up from galvanised material used in sample preparation (galvanising tends to be around 500ppm cadmium) however, this is considered unlikely as zinc levels would be higher if this was the case.

In regard to caesium only one high level was detected in floor material and it is considered unlikely that this material will be encountered in mining operations as it is unlikely they will extend to this depth. Its presence should be bourn in mind.

The significance of sulphur enrichment has been previously discussed in Section 3.2 and the levels present are not considered high.

ANZEEC guidelines

Table 4c shows soil levels beyond which ANZECC considers further investigation is necessary and levels which are present in the material tested. ANZECC only has levels for some elements.

In Sample L which is weathered mudstone, claystone and carbonaceous shale from the UA27-31 area, levels of manganese and zinc are above threshold investigation levels and levels of arsenic are close to investigation levels.

In Sample P which is fresh mudstone from the LS61-LS71A area, levels of arsenic and copper are above threshold investigation levels.

Also in sample R which is fresh carbonaceous mudstone from the floor below 73B levels of zinc are close to investigation levels.

Levels for selenium are enriched above normal levels (Table 4b) and an ANZECC level is not available. The level given by the DME is 3mg/g which is above the levels present (Table 4a), however, some European literature suggests that for pasture reclamation, the level should be 0.1mg/kg to avoid Se accumulation in pastures which may pose a risk to grazing stock. Replacement of the full overlying soil profile as required for reinstatement of cropping should avoid the possibility of this complication arising.

Table 4a. Geochemistry (multi element composition) of batched overburden samples from drill holes in the Acland area (holes and approximate depth of sampling shown)

Element	Average Crustal Abundance	Concentration in samples mg/kg except where otherwise shown																	
		A 457 0-3	B 457 3-9	C 457 9-13	D 457 13-19	E 457 19-23	F 478 13-14	G 478 15.9	H 457 app28	I 478 19.8	J 457 32.2	K 456 21	L 456 22.5	M 456 26-32	N 456 33	O 453 34-43	P 456 37-40	Q 456 40-43	R 456 43
Ag	0.07	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.2	0.2	<0.1
Al%	8.20%	7.2	7.4	8.4	9.4	10.6	8.8	12.0	9.4	12.5	9.4	9.2	10.8	9.8	9.0	10.0	10.4	11.2	9.6
As	1.5	7.0	8.0	13.0	4.5	1.5	2.5	1.0	0.5	<0.5	<0.5	0.5	17.0	4.5	4.0	3.5	34.0	3.0	<0.5
B	10	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Ba	500	700	540	560	520	410	410	180	500	210	155	135	135	370	340	460	295	230	700
Be	2.6	1.0	1.3	1.5	1.6	1.4	1.3	0.9	1.1	0.9	1.2	2.8	1.9	1.7	1.5	1.4	1.5	1.4	1.7
Bi	0.048	0.1	<0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.1	0.2	0.2	0.2	0.3	0.2	0.1	0.4	0.4	0.4
Ca%	4.1%	2.0%	2.7%	0.6%	1.5%	0.4%	0.1%	0.1%	0.2%	0.3%	0.1%	0.1%	0.2%	0.2%	0.2%	1.4%	0.1%	0.2%	0.2%
Cd	0.11	0.4	0.8	0.4	0.4	0.4	0.6	0.6	0.6	0.8	0.6	0.6	0.6	0.8	0.6	0.4	0.6	0.6	0.8
Ce	68	46	42	47	50	44	46	58	60	54	56	58	46	60	62	46	60	66	54
Co	20	30	15	27	13	10	7	4	6	3	2	8	42	12	8	10	10	11	4
Cr	100?	34	14	22	26	24	16	2	6	2	4	6	6	30	28	22	32	20	34
Cs	3	4.0	2.4	3.6	7.0	9.0	4.4	1.4	1.8	1.4	1.2	0.6	1.0	8.0	5.8	5.0	9.2	9.4	13.5
Cu	50	24	21	29	27	27	13	20	43	25	33	33	32	40	34	25	88	29	47
F	950	200	150	200	250	250	150	250	200	300	200	150	400	350	300	250	300	350	350
Fe%	4.1%	2.3%	2.1%	2.0%	3.0%	2.3%	1.3%	0.5%	0.4%	1.6%	0.2%	0.2%	13.0%	2.6%	5.0%	2.8%	2.2%	1.7%	0.9%
Ga	18	18	16	18	22	24	19	34	22	29	24	24	29	25	21	23	24	25	27
Hg	0.05	0.04	0.03	0.04	0.04	0.07	0.05	0.13	0.10	0.05	0.04	0.12	0.20	0.07	0.05	0.04	0.07	0.06	0.11
K%	2.10%	1.1%	1.3%	1.6%	1.5%	1.4%	0.9%	0.3%	0.3%	0.3%	0.1%	0.3%	0.3%	1.3%	1.1%	1.2%	1.2%	0.8%	1.3%
La	32	24	19	22	24	21	21	24	26	24	25	24	21	27	28	21	28	31	26
Li	20	15	13	15	21	25	24	31	36	34	31	30	34	23	23	20	20	26	21
Mg%	2.30%	0.4%	0.3%	0.3%	0.4%	0.5%	0.3%	0.3%	0.3%	0.4%	0.1%	0.2%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Mn	950	320	410	300	640	200	102	20	10	150	9	22	3200	230	310	520	120	62	29
Mo	1.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	2.5	2.0	1.5	2.0	2.5	1.0	1.0	0.5	2.0	1.0	0.5
Na%	2.30%	0.5%	0.7%	0.8%	0.5%	0.3%	0.4%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.6%	0.1%	0.1%	0.1%
Ni	80?	25	13	21	22	17	8	9	10	5	8	11	20	18	12	15	17	16	11
P	1000	300	420	440	440	160	200	100	100	260	100	100	340	400	440	460	180	140	140
Pb	14	14	24	22	22	22	18	44	26	30	30	26	30	26	42	18	34	34	22
Rb	90	55	49	64	70	68	42	13	11	10	7	9	11	78	68	58	80	54	92
S%	0.026%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	0.1%	0.3%	0.2%	0.2%	0.3%	0.4%	0.1%	0.1%	<0.1%	0.2%	0.1%	0.1%
Sb	0.2	0.6	0.4	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.2	0.4	0.4	0.4	0.2	0.4	0.4	0.4
Se	0.05	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	0.4	0.2	0.2	0.2	0.6	0.2	0.2	0.2	0.4	0.4	0.4
Si%	27.7%	28.0%	33.0%	33.0%	31.0%	32.0%	32.0%	19.0%	19.0%	20.0%	19.5%	13.0%	17.0%	28.5%	29.0%	28.5%	30.0%	28.0%	28.5%
Sn	2.2	3	1	2	2	2	2	4	2	4	2	2	2	3	2	2	2	3	3
Sr	370	115	125	116	120	92	86	92	84	102	52	52	54	94	98	320	112	106	150
Th	12	8.5	6.0	7.0	8.6	9.0	7.0	10.2	8.4	4.8	7.6	9.6	11.2	10.4	9.8	7.2	10.0	14.0	10.2
Ti	5600	4600	3800	4200	4600	5200	4200	3800	3600	7400	3900	5200	6200	5200	5000	4200	4800	3900	4300
Tl	0.6	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.5	0.1	0.5	0.1	0.2	0.2	0.1
U	2.4	1.7	1.4	1.6	1.9	2.1	1.7	2.8	2.2	2.2	2.5	2.9	2.9	2.7	2.5	1.8	2.4	4.0	2.3
V	160	100	96	110	108	98	80	32	60	48	56	96	90	130	125	106	120	88	150
W	1	2	1	1	1	1	1	1	2	2	1	1	1	2	2	1	<2	2	1
Zn	75	85	82	116	88	88	80	84	92	58	23	52	330	120	118	100	120	72	165
Zr	190	200	106	114	125	160	125	165	155	180	94	250	116	155	150	94	145	150	160

Q 456 40-43	R 456 43
3.0	<0.5
0.6	0.8
20	34
29	47
0.06	0.11
62	29
16	11
34	22
0.4	0.4
3	3
72	165

Table 4a

Table 4b. Elemental enrichment factors of batched overburden samples from drill holes in the Acland area (holes and approximate depth of sampling shown)

Element	A 457 0-3	B 457 3-9	C 457 9-13	D 457 13-19	E 457 19-23	F 478 13-14	G 478 15.9	H 457 app28	I 478 19.8	J 457 32.2	K 456 21	L 456 22.5	M 456 26-32	N 456 33	O 453 34-43	P 456 37-40	Q 456 40-43	R 456 43
Ag	1	1	1	1	1	1	3	1	1	1	1	1	1	3	1	3	3	1
Al	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1
As	5	5	9	3	1	2	1	<1	<1	<1	<1	11	3	3	2	23	2	<1
B	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ba	1	1	1	1	1	1	<1	1	<1	<1	<1	<1	1	1	1	1	<1	1
Be	<1	1	1	1	1	1	<1	<1	<1	<1	1	1	1	1	1	1	1	1
Bi	2	<2	2	2	2	2	6	4	2	4	4	4	6	4	3	8	8	8
Ca	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cd	4	7	4	4	4	5	5	5	7	5	5	5	7	5	4	5	5	7
Ce	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Co	2	1	1	1	<1	<1	<1	<1	<1	<1	<1	2	1	<1	<1	<1	1	<1
Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cs	1	1	1	2	3	1	<1	1	<1	<1	<1	<1	3	2	2	3	3	5
Cu	<1	<1	1	1	1	<1	<1	1	1	1	1	1	1	1	1	1	1	1
F	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fe	1	1	1	1	1	<1	<1	<1	<1	<1	<1	3	1	1	1	1	<1	<1
Ga	1	1	1	1	1	1	2	1	2	1	1	2	1	1	1	1	1	2
Hg	1	1	1	1	1	1	2	2	1	1	2	4	1	1	1	1	1	2
K	1	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	1	1	1	1	<1	1
La	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Li	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1
Mg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mn	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	3	<1	<1	<1	<1	<1	<1
Mo	<1	<1	<1	<1	<1	<1	1	2	1	1	1	2	1	1	<1	1	1	<1
Na	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pb	1	2	2	2	2	1	3	2	2	2	2	2	2	3	1	2	2	2
Rb	1	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	1	1	1	1	1	1
S	1	1	1	1	1	3	5	11	8	6	12	14	3	4	1	6	5	4
Sb	3	2	3	2	2	2	2	2	2	2	6	2	2	2	1	2	2	2
Se	4	<4	<4	<4	<4	<4	8	8	4	4	4	12	4	4	4	8	8	8
Si	1	1	1	1	1	1	1	1	1	1	<1	1	1	1	1	1	1	1
Sn	1	<1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1
Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
Th	1	1	1	1	1	1	1	1	<1	1	1	1	1	1	1	1	1	1
Ti	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tl	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1
U	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
V	1	1	1	1	1	1	<1	<1	<1	<1	1	1	1	1	1	1	1	1
W	2	1	1	1	1	1	1	2	2	1	1	1	2	2	1	2	2	1
Zn	1	1	2	1	1	1	1	1	1	<1	1	4	2	2	1	2	1	2
Zr	1	1	1	1	1	1	1	1	1	<1	1	1	1	1	<1	1	1	1

Table 4c. Comparison of ANZECC 1992 levels for soils warrenting further investigation, and element levels of batched overburden samples from drill holes in the Acland area (holes and approximate depth of sampling shown)

Element	ANZECC soil levels	ANZECC health levels	A 457 0-3	B 457 3-9	C 457 9-13	D 457 13-19	E 457 19-23	F 478 13-14	G 478 15.9	H 457 app28	I 478 19.8	J 457 32.2	K 456 21	L 456 22.5	M 456 26-32	N 456 33	O 453 34-43	P 456 37-40	Q 456 40-43	R 456 43
As	20	100	7.0	8.0	13.0	4.5	1.5	2.5	1.0	0.5	<0.5	<0.5	0.5	17.0	4.5	4.0	3.5	34.0	3.0	<0.5
Cd	3	20	0.4	0.8	0.4	0.4	0.4	0.6	0.6	0.6	0.8	0.6	0.6	0.6	0.8	0.6	0.4	0.6	0.6	0.8
Cr	50	-	34	14	22	26	24	16	2	6	2	4	6	6	30	28	22	32	20	34
Cu	60	-	24	21	29	27	27	13	20	43	25	33	33	32	40	34	25	88	29	47
Hg	1	-	0.04	0.03	0.04	0.04	0.07	0.05	0.13	0.10	0.05	0.04	0.12	0.20	0.07	0.05	0.04	0.07	0.06	0.11
Mn	500	-	320	410	300	640	200	102	20	10	150	9	22	3200	230	310	520	120	62	29
Ni	60	-	25	13	21	22	17	8	9	10	5	8	11	20	18	12	15	17	16	11
Pb	300	300	14	24	22	22	22	18	44	26	30	30	26	30	26	42	18	34	34	22
Sb	20	-	0.6	0.4	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.2	0.4	0.4	0.4	0.2	0.4	0.4	0.4
Sn	50	-	3	1	2	2	2	2	4	2	4	2	2	2	3	2	2	2	3	3
Zn	200	-	85	82	116	88	88	80	84	92	58	23	52	330	120	118	100	120	72	165

Agricultural Chemistry Laboratory Analytical Information Management System

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FINAL RESULTS REPORT
Investigative and Miscellaneous Samples

Printed: 10-FEB-97

Lbno	Rl	Depth	Prof	Description	Zn 1 mg/kg	Mn 1 mg/kg	ADHC 1 %	C. Sand 1 %	F. Sand 1 %	Silt 1 %	Clay 1 %	1/3 Bar 1 %	15 Bar 1 %	Rl 1 .	P 3 %	K 3 %
189	0	.21-.23	453		16.00	8.70	1.63	9	10	37	41	23	13	.73	.060	1.420
190	0	.24-.25	453		25.00	.11	.91	3	31	29	38	20	12	.52	.017	1.580
191	0	.26-.27	453		33.00	-BQ-	1.06	1	32	36	31	19	11	.44	.017	1.660
192	0	0-.28	453		16.00	.07	1.62	5	26	33	34	21	12	.40	.026	1.580
193	0	.29-.30	453		25.00	.02	1.32	5	32	32	31	16	10	.31	.012	1.460
194	0	.31-.32	453		17.00	.68	.96	25	37	12	24	15	9	.47	.047	1.150
195	0	0-.33	453		11.00	.86	1.31	22	43	9	24	16	8	.45	.061	.834
196	0	.34-.35	453		15.00	.88	1.47	17	15	28	38	17	10	.39	.043	1.620
197	0	.36-.37	453		15.00	.53	1.94	1	14	37	49	23	14	.28	.036	1.700
198	0	0-.38	453		13.00	1.40	1.67	-BQ-	29	36	32	20	11	.48	.024	1.760
199	0	.39-.41	453		18.00	6.10	1.11	21	40	18	24	15	8	.45	.079	1.430
200	0	.42-.44	453		16.00	1.30	1.01	24	37	14	24	16	9	.49	.044	1.130
201	0	.45-.46	453		22.00	.66	2.40	1	33	31	35	23	12	.46	.013	1.540
202	0	.01-.02	456		24.00	63.00	2.35	31	8	11	46	17	12	.25	.023	.403
203	0	.03-.04	456		30.00	.92	1.37	3	3	40	52	24	15	.76	.019	1.490
204	0	0-.05	456		47.00	1.20	.80	3	50	16	31	19	11	.63	.017	1.370
205	0	.06-.08	456		31.00	.50	1.52	12	16	29	39	20	13	.64	.035	1.410
206	0	.09-.10	456		39.00	1.00	1.01	1	44	25	29	19	11	.55	.069	1.400
207	0	.11-.12	456		37.00	1.70	1.31	13	17	29	39	20	12	.45	.028	1.410
208	0	.13-.14	456		26.00	.45	1.27	7	19	38	37	19	12	.49	.014	1.180
209	0	.15-.16	456		16.00	.27	2.30	13	16	18	50	24	15	.47	.012	.475
210	0	.17-.19	456		17.00	.19	2.40	11	6	36	42	21	13	.44	.013	1.230
211	0	.01-.09	457		.91	2.80	.91	23	38	17	22	17	9	.60	.039	1.500
212	0	.09-.13	457		3.80	2.50	.96	6	47	17	29	21	11	.30	.046	1.730
213	0	.13-.19	457		2.30	3.10	1.57	6	35	22	36	24	15	.66	.036	1.510
214	0	.19-.23	457		7.50	2.10	2.40	1	32	28	40	26	16	.68	.015	1.350
215	0	.03-.05	457		17.00	1.30	2.14	48	16	6	26	20	14	.81	.010	.334
216	0	.02-.03	474		.17	.44	1.47	16	36	19	28	19	11	.57	.018	1.220
217	0	.03-.05	474		.24	.21	.86	9	44	21	25	21	11	.73	.031	1.240
218	0	.05-.09	474		1.40	.68	.86	13	35	24	29	21	12	.76	.029	.924
219	0	.13-.14	478		4.30	.76	1.01	12	41	14	29	17	10	.71	.021	.937
220	0	.09-.15	478		15.00	2.00	3.36	24	15	8	49	22	16	.46	.012	.295
221	0	.17-.24	478		11.00	2.30	2.82	25	13	10	46	21	15	.46	.020	.247
222	0	.01-.02	480		11.00	10.00	2.51	41	28	17	15	18	10	.83	.217	1.450
223	0	482			19.00	5.00	2.65	-BQ-	18	36	42	22	14	.64	.042	1.340
224	0	.02-.06	496		.34	2.20	.91	4	47	20	29	20	12	.72	.036	1.460
225	0	.06-.12	496		1.80	.71	1.73	5	14	27	53	29	18	.84	.033	.869
226	0	.12-.16	496		17.00	6.60	2.09	8	9	20	60	35	19	.70	.018	.188

Agricultural Chemistry Laboratory Analytical Information Management System

Printed: 10-FEB-97

Reference: SOI96/716

FINAL RESULTS REPORT
Investigative and Miscellaneous Samples

Labno	Rl	Depth	Prof	Description	Analyte ..... Method #	S 3 %	OC 1 %	N 1 %	Al 1 meq/100g	Ex Acid 1 meq/100g	Fe 1 mg/kg	ESP 1 %
10189	0	.21-.23	453			.064	1.90	.08			8.30	10
10190	0	.24-.25	453			.071	1.80	.05			7.90	10
10191	0	.26-.27	453			.066	1.50	.05			11.00	10
10192	0	0-.28	453			.062	1.60	.06			26.00	10
10193	0	.29-.30	453			.055	1.30	.04			8.90	11
10194	0	.31-.32	453			.039	.50	.02			17.00	11
10195	0	0-.33	453			.026	.45	.01			20.00	11
10196	0	.34-.35	453			.085	1.80	.07			25.00	11
10197	0	.36-.37	453			.087	1.05	.04			22.00	13
10198	0	0-.38	453			.040	.85	.03			20.00	14
10199	0	.39-.41	453			.046	1.05	.03			32.00	14
10200	0	.42-.44	453			.040	.85	.02			42.00	14
10201	0	.45-.46	453			.050	1.15	.04			18.00	15
10202	0	.01-.02	456			.318	5.65	.18	.20	.20	25.00	4
10203	0	.03-.04	456			.066	1.15	.05			7.30	6
10204	0	0-.05	456			.073	1.20	.03			17.00	8
10205	0	.06-.08	456			.115	2.85	.11			8.60	6
10206	0	.09-.10	456			.067	1.55	.05			18.00	5
10207	0	.11-.12	456			.114	1.65	.05			19.00	5
10208	0	.13-.14	456			.099	2.20	.11			7.70	5
10209	0	.15-.16	456			.066	2.50	.07			5.30	5
10210	0	.17-.19	456			.101	3.80	.14			6.80	5
10211	0	.01-.09	457			.024	.40	.01			2.60	13
10212	0	.09-.13	457			.033	.50	.02			1.80	22
10213	0	.13-.19	457			.032	.40	.02			2.40	12
10214	0	.19-.23	457			.035	.50	.02			2.60	8
10215	0	.03-.05	457			.361	5.50	.33			4.50	6
10216	0	.02-.03	474			.019	.25	.01			1.10	6
10217	0	.03-.05	474			.015	.25	.01			1.00	14
10218	0	.05-.09	474			.017	.30	.01			1.10	27
10219	0	.13-.14	478			.098	1.95	.05			6.60	12
10220	0	.09-.15	478			.122	2.40	.11			13.00	10
10221	0	.17-.24	478			.136	3.10	.14			14.00	9
10222	0	.01-.02	480			.016	.45	.02			17.00	5
10223	0	482				.044	1.30	.05			17.00	1
10224	0	.02-.06	496			.028	.35	.02			4.90	19
10225	0	.06-.12	496			.017	.35	.02			2.10	16
10226	0	.12-.16	496			.060	3.10	.09			106.00	12

Agricultural Chemistry Laboratory Analytical Information Management System

Reference: SOIL96/716

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FINAL RESULTS REPORT
Investigative and Miscellaneous Samples

Methods Used to Analyse Samples

Analyte	#	Method	Reprod %	Quant	Unit	Name	Method Description	Drying Conditions
PH	1	IEC-S4A1	5	.1	-	pH	Aqueous 1:5, electrode	Air dry
EC	1	IEC-S3A1	7	.01	mS/cm	Electrical conductivity	Electrical conductivity	Air dry
CL	1	IEC-S5A2	10.4	6	mg/kg	Chloride	Aqueous, 1:5 soil:water	Air dry
NO3-N	1	IEC-S7B1	15	.65	mg/kg	Nitrate nitrogen	Aqueous 1:5, colorimetry	Air dry
P	1	IEC-S9B2	20	1	mg/kg	Phosphorus	.5M NaHCO3 extr. colorimetry	Air dry
SO4-S	1	IEC-S10B3	11.5	.6	mg/kg	Sulfate sulfur	.01M Ca(H2PO4)2 extr. ICP	Air dry
CA	1	IEC-S15C1	10	.18	meq/100g	Calcium	Exch. alcoholic NH4Cl pH 8.5	Air dry
MG	1	IEC-S15C1	8.7	.31	meq/100g	Magnesium	Exch. alcoholic NH4Cl pH 8.5	Air dry
NA	1	IEC-S15C1	6.8	.091	meq/100g	Sodium	Exch. alcoholic NH4Cl pH 8.5	Air dry
K	1	IEC-S15C1	6.8	.015	meq/100g	Potassium	Exch. alcoholic NH4Cl pH 8.5	Air dry
CEC	2	IEC-S15C1	5	1	meq/100g	Cation Exchange Capacity	Cation exch. capacity pH 8.5	Air dry
CU	1		6	.1	mg/kg	Copper	.005M DTPA extractable, ICP	Air dry
ZN	1		6	.1	mg/kg	Zinc	.005M DTPA extractable, ICP	Air dry
MN	1		6	1	mg/kg	Manganese	.005M DTPA extractable, ICP	Air dry
ADMC	1	IEC-S2A1	5	.4	%	Air dry moisture content	Air dry moisture content	Air dry
CS	1		5	1	%	Coarse Sand fraction	Coarse sand fraction	Air dry
FS	1		5	1	%	Fine Sand Fraction	Fine sand fraction	Air dry
SIL	1		5	1	%	Silt fraction	Silt fraction	Air dry
CLA	1		5	1	%	Clay fraction	Clay fraction	Air dry
BAR1/3	1		5	1	%	Third bar	1/3 Bar, pressure plate	Air dry
BAR15	1		7	.3	%	15 Bar	15 Bar, pressure plate	24 H @ 105 degrees celsius
R1	1	IEC-S2Z1	6	.3	%	Dispersion ratio	Aqu. Silt+Clay/Total Silt+Clay	24 H @ 105 degrees celsius
P	3		6.1	.1	-	Phosphorus	Total P pressed powder, XRF	Air dry
K	3		3.5	.001	%	Potassium	Total K pressed powder, XRF	65 degrees
S	3		12.2	.003	%	Sulfur	Total S pressed powder, XRF	65 degrees
OC	1	IEC-S6A1	5	.002	%	Organic Carbon	Organic Carbon, colorimetry	65 degrees
N	1	IEC-S7A2	6	.01	%	Nitrogen	Total N, kjeldahl, colorimetry	Air dry
AL	1		8	.2	%	Aluminium	Exchangeable Aluminium	Air dry
ACID	1		8	.5	meq/100g	Exchangeable acidity	Exchangeable acidity	Air dry
FE	1		6	.5	meq/100g	Iron	.005M DTPA extractable, ICP	Air dry
ESP	1		5	3	mg/kg	Exchangeable Na %	Exchangeable Na %	Air dry
				.3	%			

NATA Signatories

IEC-S10B3 : D.E. Baker
IEC-S10B3 : G.F. Haydon
IEC-S10B3 : I.J. Grant
IEC-S15C1 : D.E. Baker
IEC-S15C1 : I.J. Grant
IEC-S2A1 : D.E. Baker
IEC-S2A1 : I.J. Grant
IEC-S2Z1 : D.E. Baker
IEC-S2Z1 : I.J. Grant
IEC-S3A1 : D.E. Baker
IEC-S3A1 : I.J. Grant
IEC-S4A1 : D.E. Baker
IEC-S4A1 : I.J. Grant
IEC-S5A2 : D.E. Baker
IEC-S5A2 : I.J. Grant
IEC-S6A1 : D.E. Baker
IEC-S6A1 : I.J. Grant
IEC-S7A2 : D.E. Baker
IEC-S7A2 : I.J. Grant
IEC-S7B1 : D.E. Baker
IEC-S7B1 : I.J. Grant
IEC-S9B2 : D.E. Baker
IEC-S9B2 : I.J. Grant

Agricultural Chemistry Laboratory Analytical Information Management System

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FINAL RESULTS REPORT
Investigative and Miscellaneous Samples

Explanation of Status Codes in Report

Status	Description
BQ	Below limit of quantitation

Manager
Agricultural Chemistry

* The analytical and test results are for the sample(s) received by the laboratory.

Appendix 3. Analysis sheets from Genalysis Laboratory Services showing results of multi element testing (Table 4a)

ANALYSIS

ELEMENTS	Li	Be	B	F	Na	Mg	Al	Si	P	S	K
UNITS	ppm	ppm	ppm	ppm	ppm	%	%	%	ppm	%	%
DETECTION	0.1	0.1	50	50	20	0.01	0.01	0.1	20	0.005	0.01
METHOD	A/MS	A/MS	D/OES	DH/SIE	A/OES	D/OES	D/OES	D/OES	A/OES	/LECO	D/OES
SAMPLE NUMBERS											
1 A	15.0	1.0	X	200	4800	0.37	7.20	28.0	300	0.020	1.06
2 B	12.5	1.3	X	150	7200	0.31	7.40	33.0	420	0.015	1.25
3 C	15.0	1.5	X	200	7600	0.33	8.40	33.0	440	0.025	1.55
4 D	20.5	1.6	X	250	4500	0.39	9.40	31.0	440	0.025	1.45
5 E	24.5	1.4	X	250	2650	0.48	10.60	32.0	160	0.030	1.35
6 F	24.0	1.3	X	150	4300	0.30	8.80	32.0	200	0.075	0.88
7 G	31.0	0.9	X	250	740	0.32	12.00	19.0*	100	0.135	0.32
8 H	36.0	1.1	X	200	600	0.27	9.40	19.0*	100	0.280	0.26
9 I	34.0	0.9	X	300	900	0.44	12.50	20.0*	260	0.205	0.28
10 J	31.0	1.2	X	200	520	0.11	9.40	19.5*	100	0.155	0.12
11 K	29.5	2.8	X	150	520	0.15	9.20	13.0*	100	0.310	0.27
12 L	34.0	1.9	X	400	480	0.45	10.80	17.0*	340	0.360	0.31
13 M	23.0	1.7	X	350	640	0.40	9.80	28.5	400	0.090	1.25
14 N	22.5	1.5	X	300	560	0.38	9.00	29.0	440	0.095	1.14
15 O	19.5	1.4	X	250	6000	* 0.43	10.00	28.5	460	* 0.035	1.18
16 P	19.5	1.5	X	300	740	0.38	10.40	30.0	180	0.160	1.20
17 Q	26.0	1.4	X	350	560	0.41	11.20	28.0	140	0.135	0.80
18 R	21.0	1.7	X	350	680	0.41	9.60	28.5*	140	0.095	1.25
Ch.0001(A)	15.0	1.5	X	250	5000	0.38	7.60	31.0	320	0.020	1.14
STD: LECO1										5.600	
STD: MRG1				200							
STD: SY3			100			1.60	5.80	27.5			3.40
STD: SY3					2.90%				2200		
STD: SY3	96.0	24.0									
STD: AE0-6											
STD: AE0-6											
STD: HgSTD											
STD: SY3											

ANALYSIS

ELEMENTS	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga
UNITS	ppm	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
DETECTION	10	0.01	2	2	1	0.01	1	1	1	1	1
METHOD	A/OES	D/OES	A/OES	A/OES	A/OES	D/OES	A/MS	A/OES	A/OES	A/OES	A/MS
SAMPLE NUMBERS											
1 A	2.00%	0.46	100	34	320	2.25	30	25	24	85	18
2 B	2.65%	0.38	96	14	410	2.05	15	13	21	82	16
3 C	6400	0.42	110	22	300	1.95	27	21	29	116	18
4 D	1.50%	0.46	108	26	640	3.00	13	22	27	88	22
5 E	4100	0.52	98	24	200	2.25	10	17	27	88	24
6 F	1450	0.42	80	16	102	1.25	7	8	13	80	19
7 G	1350	0.38	32	2	20	0.54*	4	9	20	84	34
8 H	2300	0.36	60	6	10	0.35*	6	10	43	92	22
I	2800	0.74	48	2	150	1.55*	3	5	25	58	29
10 J	860	0.39	56	4	9	0.17*	2	8	33	23	24
11 K	1000	0.52	96	6	22	0.20*	8	11	33	52	24
12 L	2300	0.62	90	6	3200	13.00*	42	20	32	330	29
13 M	2050	0.52	130	30	230	2.55	12	18	40	120	25
14 N	2150	0.50	125	28	310	5.00	8	12	34	118	21
15 O	1.40%*	0.42	106	22	520	* 2.80	10	15	25	100	23
16 P	1450	0.48	120	32	120	2.15	10	17	88	120	24
17 Q	2000	0.39	88	20	62	1.70	11	16	29	72	25
18 R	1850	0.43	150	34	29	0.86*	4	11	47	165	27
Ch.0001(A	2.20%	0.46	110	34	285	2.30	31	26	23	74	19
STD: LECO1											
STD: MRG1											
STD: SY3		0.09				4.50					
STD: SY3	5.60%		48	6	2400			10	20	240	
STD: SY3							11				28
STD: AE0-6											
STD: AE0-6											
STD: HgSTD											
STD: SY3											

ANALYSIS

ELEMENTS	As	Se	Rb	Sr	Zr	Mo	Ag	Cd	Sn	Sb	Te
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	0.5	0.2	0.2	0.1	1	0.5	0.1	0.1	1	0.2	0.2
METHOD	BX/MS	AP/MS	A/MS	A/MS	A/MS	A/MS	BX/AAS	BX/AAS	A/MS	A/MS	BX/MS
SAMPLE NUMBERS											
1 A	7.0	0.2	55.0	115.0	200	0.5	X	0.4	3	0.6	X
2 B	8.0	X	49.0	125.0	106	0.5	X	0.8	1	0.4	X
3 C	13.0	X	64.0	116.0	114	0.5	X	0.4	2	0.6	X
4 D	4.5	X	70.0	120.0	125	0.5	X	0.4	2	0.4	X
5 E	1.5	X	68.0	92.0	160	0.5	X	0.4	2	0.4	X
6 F	2.5	X	42.0	86.0	125	0.5	X	0.6	2	0.4	X
7 G	1.0	0.4	13.0	92.0	165	1.0	0.2	0.6	4	0.4	X
8 H	0.5	0.4	11.0	84.0	155	2.5	X	0.6	2	0.4	X
9 I	X	0.2	10.4	102.0	180	2.0	X	0.8	4	0.4	X
10 J	X	0.2	7.0	52.0	94	1.5	X	0.6	2	0.4	0.2
11 K	0.5	0.2	8.6	52.0	250	2.0	X	0.6	2	1.2	X
12 L	17.0	0.6	11.2	54.0	116	2.5	X	0.6	2	0.4	0.4
13 M	4.5	0.2	78.0	94.0	155	1.0	X	0.8	3	0.4	0.2
14 N	4.0	0.2	68.0	98.0	150	1.0	0.2	0.6	2	0.4	0.2
15 O	3.5	0.2	58.0	320.0	94	0.5	X	0.4	2	0.2	0.2
16 P	34.0	0.4	80.0	112.0	145	2.0	0.2	0.6	2	0.4	0.2
17 Q	3.0	0.4	54.0	106.0	150	1.0	0.2	0.6	3	0.4	X
18 R	X	0.4	92.0	150.0	160	0.5	X	0.8	3	0.4	X
Ch.0001(A)	5.5	X	62.0	112.0	205	0.5	X	0.4	2	0.4	X
STD: LECO1											
STD: MRG1											
STD: SY3											
STD: SY3											
STD: SY3			216.0	320.0	340	1.0			6	0.4	
STD: AE0-6							1.0	2.0			
STD: AE0-6	240.0										8.6
STD: HgSTD											
STD: SY3		X									

ANALYSIS

ELEMENTS	Cs	Ba	La	Ce	W	Hg	Tl	Pb	Bi	Th	U
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	0.2	1	0.1	0.1	1	0.01	0.05	2	0.1	0.1	0.1
METHOD	A/MS	A/MS	A/MS	A/MS	A/MS	C*CVAP	BX/MS	A/MS	BX/MS	A/MS	A/MS
SAMPLE NUMBERS											
1 A	4.0	700	24.0	46.0	2	0.04	0.20	14	0.1	8.5	1.7
2 B	2.4	540	19.0	42.0	1	0.03	0.10	24	X	6.0	1.4
3 C	3.6	560	21.5	47.0	1	0.04	0.15	22	0.1	7.0	1.6
4 D	7.0	520	23.5	50.0	1	0.04	0.10	22	0.1	8.6	1.9
5 E	9.0	410	20.5	44.0	1	0.07	0.10	22	0.1	9.0	2.1
6 F	4.4	410	20.5	46.0	1	0.05	0.10	18	0.1	7.0	1.7
7 G	1.4	180	24.0	58.0	1	0.13	0.05	44	0.3	10.2	2.8
8 H	1.8	500	26.0	60.0	2	0.10	0.20	26	0.2	8.4	2.2
9 I	1.4	210	24.0	54.0	2	0.05	0.10	30	0.1	4.8	2.2
10 J	1.2	155	25.0	56.0	1	0.04	0.15	30	0.2	7.6	2.5
11 K	0.6	135	23.5	58.0	1	0.12	0.10	26	0.2	9.6	2.9
12 L	1.0	135	21.0	46.0	1	0.20	0.50	30	0.2	11.2	2.9
13 M	8.0	370	26.5	60.0	2	0.07	0.10	26	0.3	10.4	2.7
14 N	5.8	340	28.0	62.0	2	0.05	0.05	42	0.2	9.8	2.5
15 O	5.0	460	20.5	46.0	1	0.04	0.10	18	0.1	7.2	1.8
16 P	9.2	295	27.5	60.0	2	0.07	0.20	34	0.4	10.0	2.4
17 Q	9.4	230	31.0	66.0	2	0.06	0.15	34	0.4	14.0	4.0
18 R	13.5	700	25.5	54.0	1	0.11	0.10	22	0.4	10.2	2.3
Ch.0001(A	4.0	640	22.0	48.0	1	0.03	0.15	20	0.1	7.0	1.5
STD: LECO1											
STD: MRG1											
STD: SY3											
STD: SY3											
STD: SY3	2.8	440	1300.0	2250.0	3			140		1000.0	660.0
STD: AE0-6											
STD: AE0-6									19.5		
STD: HgSTD						0.32					
STD: SY3											

METHOD CODE DESCRIPTIONS

A/MS
Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids.
Analysed by Inductively Coupled Plasma Mass Spectrometry.

D/OES
Sodium peroxide fusion (Zirconium crucibles) and Hydrochloric acid to disolve the melt
Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

DH/SIE
Alkaline fusion (Nickel crucible) specific for Fluorine.
Analysed by Specific Ion Electrode.

A/OES
Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids.
Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

/LECO
LECO Analyser.

BX/MS
Modified Aqua-Regia digest for low detection of indicator elements.
Analysed by Inductively Coupled Plasma Mass Spectrometry.

AP/MS
Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids followd by Precipitation and Concentration.
Specific for Selenium.
Analysed by Inductively Coupled Plasma Mass Spectrometry.

BX/AAS
Modified Aqua-Regia digest for low detection of indicator elements.
Analysed by Flame Atomic Absorption Spectrometry.

C*CVAP
Modified Perchloric acid digest.
Analysed by Cold Vapour Generation Atomic Absorption Spectrometry.

4. General conclusions and recommendations

Different aspects of the results of investigation of the samples available and the analyses carried out are presented below.

pH and electrical conductivity

- The non weathered material has 1:5 electrical conductivities which tend in general to be lower than the weathered materials. Some of the weathered materials would be classified as saline, while the non weathered materials are usually non saline.

- While the weathered material generally has an alkaline pH, some of the weathered or partially weathered carbonaceous materials near the base of the weathered profile may be slightly acidic (e.g. Holes 469 and 456), and occasional partings materials may have slightly acidic pH's (e.g. Holes 491, 474).

- While some sodicity is indicated by higher pH's down the profile extreme sodicity is not indicated.

Acid production aspects

- Acid neutralising capacity results show significant acid neutralising capacity in;
  - the upper weathered layers of hole 457
  - the upper 6 metres (weathered) of Hole 496, and
  - some of the sandstone material (fresh) between MS42 and LS52 in Hole 453

- All other samples had only slight acid neutralising capacity with the exception of LRS1 which is weathered claystone, mudstone and coal above UA25 (from Hole 456) which has a naturally acidic pH and has a slightly negative acid neutralising capacity.

- Levels of non sulphate sulphur are low with a maximum of 0.3% being encountered.

- Nett Acid Production Potential calculations show only very mild acid production levels in occasional samples (levels which would not be regarded as significant), the majority of samples having slightly negative values.

- Nett Acid Generation values using a staged reaction gave a maximum NAG of 2kg H_2SO_4/t, a level which is considered insignificant.

- The simple Nett Acid Generation test is not suitable for the Acland waste material as high carbon levels in the form of organic material or hydrocarbon materials can give misleading acid generation results with pH's of 2.5 being achieved.

- Further work is required on a more complete range of samples after the next drilling program to determine the behavior of the carbonaceous waste in a disposal situation. This work should take the form of column leach tests with monitoring for release of enriched elements (at possibly reduced pH's) and hydrocarbon material.

- Even weathered carbonaceous waste requires examination as Sample LRS1 for example which had an initial pH of 4.4 and no acid neutralising capacity, achieved a pH of 2.1 during the NAG reaction and a final pH of 6.7 after completion of the staged reaction (Table 2). The initial pH present indicates that the weathering of carbonaceous material could cause low pH's and affect solubilities of elements present.

- Although initial salinity of non weathered material is low, additional salinity may be released on weathering.

Chemical and physical characteristics

- Finer grained weathered sediments appear to have higher salinities than other strata and relatively high exchangeable sodium percentages and use of these materials as a surface or near surface medium should be avoided.

- The majority of strata have low salinity and moderate sodicity in their fresh state, but have high silt contents and relatively low clay activity ratios, and with exposure and weathering the production of poor surface physical conditions is likely. Nutritionally the materials are reasonable for spoil materials, with phosphorus and nitrogen and in some cases potassium being the major requirements.

- The spoil materials hold less plant available moisture than the subsoils of the surrounding soil profiles and so their use as a subsoil would result in lower plant available water capacities in the reinstated cropping profiles and therefore reduced land capability or suitability. The full depth of soil profiles needs to be replaced.

Geochemistry

- In comparison to crustal abundance levels, there is some enrichment (not highly enriched) of the elements As, Bi, Cd, Cs, S, and Se in some strata, with slight enrichment of Hg and Zn in isolated strata. These elements

need to be taken into account in column leach tests to assess their mobility in an emplacement situation.

- Levels of manganese and zinc are above ANZECC levels in weathered mudstone, carbonaceous shale and and claystone from the UA27-31 area (and arsenic is high), and levels of arsenic and copper are also above investigation levels in fresh mudstone from the LS61-LS71A area.

- While reinstatement of a full soil profile for cropping may may alleviate the majority of these concerns at the surface, column leach tests are required to determine the significance of these metals and the organic carbon or hydrocarbon materials present in terms of contaminated land legislation.

Summary

The recommendation of the most acceptable material for near surface material for rehabilitation is difficult in the light of the requirement for more work.

The materials investigated which were associated with the Acland deposit do not appear to have a potential for acid generation from pyrite oxidation. However, there may be a potential for generation of acidic conditions within the waste dump through oxidation of organic carbon materials and production of organic acids. (Alternatively, some hydrocarbon materials may be released.)

This reduction in pH may affect solubilities of some of the enriched elements within the waste materials (As, Bi, Cd, S and Se with lesser Cs, Hg and Zn). Further work utilising column leach studies needs to be carried out on a more complete range of samples after the next drilling program to determine the behaviour of these wastes in an emplacement situation and to predict drainage quality.

Fine grained weathered sediments should be avoided as near surface rehabilitation media (higher salinity) particularly if carbonaceous, and the best material available, (without knowledge of the results of the leach studies) appears to be the weathered sandstone material.

The weathered sandstone, however, appears to have elevated levels of As, Cd and Se (although not to levels markedly higher than other strata available). The benefits of this material are that it appears to have reasonable acid neutralising capacity, and has low salinity. The material does however have low moisture holding capacity and the full soil profile will have to be reinstated to hold adequate moisture to reinstate land capability. This will also help to alleviate plant associated problems from the enrichment of As, Cd and Se in the underlying strata.

Appendix 1. Analysis sheets from Genalysis Laboratory Services relating to data used in Table 2.

ANALYSIS

ELEMENTS	S-Tot	S-SO4	S-S2-	C-Tot	TOC+C
UNITS	%	%	%	%	%
DETECTION	0.005	0.01	0.1	0.005	0.01
METHOD	/LECO	X/OES	/CALC	/LECO	X/LECO
SAMPLE NUMBERS					
1 01	0.355	0.03	0.3	22.700	22.70
2 02	0.240	0.04	0.2	5.170	4.52
3 03	0.040	0.01	X	1.640	1.43
4 04	0.055	0.02	X	1.570	1.27
5 05	0.100	0.02	X	6.800	6.80
6 06	0.070	0.01	X	4.190	4.02
7 07	0.180	0.01	0.1	13.900	13.90
8 08	0.335	0.01	0.3	29.100	29.10
9 09	0.315	0.01	0.3	33.000	33.00
10 10	0.150	0.01	0.1	16.700	16.70
11 11	0.180	X	0.1	21.100	21.10
12 12	0.045	0.01	X	1.450	1.43
13 13	0.105	0.01	X	1.850	1.52
14 14	0.075	0.02	X	1.760	1.08
15 15	0.065	0.02	X	1.300	1.11
16 16	0.380	0.01	0.3	29.200	29.20
17 17	0.075	0.01	X	2.490	2.46
18 18	0.075	0.02	X	2.460	1.83
19 19	0.065	0.01	X	2.340	2.19
20 20	0.095	0.01	X	2.610	1.51
21 21	0.225	0.07	0.1	2.800	2.01
22 22	0.205	0.01	0.1	1.340	1.27
23 23	0.095	0.01	X	8.090	8.08
24 24	0.100	0.01	X	7.630	7.63
25 25	0.220	X	0.2	1.060	0.38
26 26	0.240	0.01	0.2	13.600	13.60
27 27	0.050	0.01	X	3.880	3.81
28 28	0.110	0.02	X	6.790	6.63
29 29	0.310	0.07	0.2	0.975	0.97
30 30	0.060	0.01	X	1.930	1.91
31 31	0.040	0.01	X	1.140	1.09
32 32	0.035	0.01	X	0.635	0.61
33 33	0.030	0.01	X	1.420	0.43
34 34	0.020	X	X	0.815	0.38
35 35	0.040	0.01	X	1.620	1.55
36 36	0.250	0.01	0.2	11.500	3.78
Ch.0001(01)	0.350	0.03	0.3	32.800	22.80
Ch.0026(26)	0.235	0.01	0.2	13.700	13.70
STD: PD-1		4.30			
STD: LECO7	5.770			11.600	

ANALYSIS

ELEMENTS	S-Tot	S-SO4	S-S2-	C-Tot	TOC+C
UNITS	%	%	%	%	%
DETECTION	0.005	0.01	0.1	0.005	0.01
METHOD	/LECO	X/OES	/CALC	/LECO	X/LECO
SAMPLE NUMBERS					
STD: LECO7					9.32

METHOD CODE DESCRIPTIONS

/LECO
LECO Analyser.

X/OES
Client Specified Digestion or Extraction.
Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

/CALC
Results Determined by calculation from other reported data.

X/LECO
Client Specified Digestion or Extraction.
LECO Analyser.

Appendix 2. Explanatory notes for interpretation of soil analysis results and analysis sheets from the Department of Primary Industries Agricultural Chemistry Laboratories

Explanatory notes - soil and spoil analysis

pH is measured on a 1:5 solid:water extract and indicates acidity or alkalinity, which influences nutrient availability or toxicity. Very high pH's above 8.5 often indicate a very high sodicity and associated physical problems. The accepted range for plant growth is considered to be 5.5 to 8.5.

E.C. is electrical conductivity of the soil or spoil solution measured on a 1:5 solid:water extract. It indicates the salinity of the growth medium. Different plants can tolerate different levels of salinity however levels over 600uS/cm are considered to be quite saline. The appraisal generally depends in the selection of the most hospitable media available.

In this report all results are quoted on a 1:5 basis, however, for conversion to a saturated extract value, multiplication by 6.4 is the accepted value for soils while for spoils the factor tends to be 8 to 9 due to the lower incidence of large pores.

Cl is the concentration of chloride in the 1:5 solid:water extract and high levels of chloride are generally associated with high levels of salinity. Depending on the species of plant being grown levels above 200 to 600ug/g are generally undesirable.

Extr. P indicates the level of phosphate available for plant growth. The extraction is carried out with a weak bicarbonate solution. Levels of less than 11ug/g are considered very low and usually limiting to crops while levels of 30ug/g are considered non limiting for plant growth, however very few Australian soils ever contain these levels.

Tot. P is the total phosphorus content of the soil which averages 550ppm for surface soils and 380ppm for subsoils for Australian soils.

NO3 indicates the level of nitrogen available for plant growth in the soil solution. The analysis is carried out on a 1:5 solid:water extract and ignores other nitrogen forms which may be present. Levels of 20 to 30ug/g are considered non limiting for plant growth in soils, however few Australian soils ever contain these levels.

Tot. N is the total nitrogen content of of the soil and Queensland soils usually lie within the range 0.05 to 0.2%. Values less than 0.1% may indicate potential problems of availability for plant growth.

SO4 indicates the level of sulphate available for plant growth in the soil solution. The extraction is carried out with a CaHPO4 solution. A level of 15 is considered non limiting for plant growth. In certain situations where some pyrite oxidation has occurred levels may be present which are far in excess of plant requirements.

Exchangeable cations Ca, Mg, Na and K are measured in milliequivalents per 100g of soil by alcoholic extraction and as well as indicating nutrient status of these elements indicates physical soil properties, by the use of relationships which take into account the relative abundance of Na, Mg and Ca on the exchange complex.

Non limiting levels for plant growth are considered to be:

K - 0.2-0.3meq/100g
Ca - 2.0meq/100g
Mg - 1.0-2.0meq/100g

Zn, Cu, Mn, and Fe are extracted with a D.T.P.A. solution and the levels indicate the availability of these nutrients for plant growth.

Non limiting levels for plant growth are considered to be:
Fe - 2.5-4.5ug/g
Mn - 2ug/g above pH 6
Cu - 0.1ug/g on acid soils, and 0.4ug/g on alkaline soils
Zn - 0.2-0.5ug/g on acid soils, and 0.8ug/g on alkaline soils

Although soil tests may indicate micronutrient deficiency, these deficiencies rarely become evident in the field (except under irrigated conditions) due to the greater limitations of major nutrients. Toxicities of these elements, especially Mn may be a problem under acidic conditions.

CEC is the cation exchange capacity of the soil and indicates its ability to hold nutrients. Leaching of cations used in plant growth can become a problem in a soil with a very low cation exchange capacity (eg. 5). The analysis is also used in the calculation of soil exchangeable sodium percentage.

E.S.P. is the exchangeable sodium percentage of the soil and is the percentage of the cation exchange capacity which is taken up by sodium. The measurement is an indication of how prone the soil is to dispersion by rainfall and resultant structural problems.

An E.S.P. of less than 6 has generally been acceptable for conventional soils however some workers consider that a level of 3 is a better value to indicate a sodic soil for surface soils in Queensland. Soils with E.S.P. levels of 6 to 14 are considered as sodic and likely to have resultant structural problems, while soils with levels above 14 are strongly sodic.

Ca/Mg is used to express the relative proportions of calcium and magnesium on the exchange complex. The two elements are competetive in their nutritional characteristics so that an excess of one may cause a shortage of another (even though it may be adequate in absolute terms). An imbalance of Mg, however, may promote dispersion in soils with a low exchangeable sodium percentage. Soils with Ca/Mg ratios of <2 should be regarded with suspicion.

CEC/clay% indicates in general terms the type of clay which is present in the soil or spoil. For kaolinite CEC/clay is <0.2, for non expanding clays or illites CEC/clay is 0.3-0.5 and for montmorillonite or expanding clays the ratio is >0.8. The soils generally contain a variety of clay types however so the results are only indicative.

R1 dispersion ratio is obtained by comparing the proportion of the clay and silt fraction which is dispersed in water with shaking, with the amount of clay and silt in the soil which is obtained with conventional particle size analysis (using calgon and shaking).

In soils levels below 0.6 generally indicate a stable soil, while levels between 0.6 and 0.8 indicate some problems may be present and levels above 0.8 indicate that the soil is unstable and dispersive.

Particle size analysis is the proportions of the individual fractions which make up the soil or spoil. It is expressed as the percentage of coarse sand, fine sand, silt and clay in the soil or spoil. This gives the soil texture and an indication of the ability of the soil or spoil to hold water for plant growth.

An additional use of particle size analysis is to provide an indication of whether the soil or spoil may have poor infiltration and hydraulic conductivity, the rules are however by no means defined.

The soil fraction which promotes aggregation is the clay fraction. For pure sands pores are large, while for a pure non aggregated clay pores will be very small. For mixtures of sand, silt and clay the finer particles will pack into pores created by the larger particles, reducing porosities until the pores are full. Minimum porosity of non aggregated soils occurs when the clay content is 30 to 40%. If there is a high percentage of fine sand and silt in the soil the soils can be unstable to rapid wetting if organic matter levels are low. The silt sized particles are more disruptive to aggregation and maintenance of hydraulic conductivity.

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FINAL RESULTS REPORT
Investigative and Miscellaneous Samples

Subject: Land Reclamation Services
Officer: D.E. Baker
Senior Chemist
Indooroopilly

Category: Miscellaneous
Date registered: 11-OCT-96
Number of samples: 38
Number of profiles: 8

Labno	Rl	Depth	Analyte ..... Method # ..... Prof Description	pH 1 -	EC 1 mS/cm	Cl 1 mg/kg	NO3-N 1 mg/kg	P 1 mg/kg	SO4-S 1 mg/kg	Ca 1 meq/100g	Mg 1 meq/100g	Na 1 meq/100g	K 1 meq/100g	CEC 2 meq/100g	Cu 1 mg/kg
10189	0	.21-.23	453												
10190	0	.24-.25	453	8.60	.32	248.000	1.00	6.00	51.00	5.89	11.00	1.55	.29	16.00	3.20
10191	0	.26-.27	453	9.00	.18	38.000	1.00	4.00	41.00	6.26	3.91	1.00	.31	10.00	3.90
10192	0	0-.28	453	9.00	.20	20.000	1.00	3.00	61.00	7.10	4.03	1.09	.65	11.00	4.30
10193	0	.29-.30	453	9.10	.19	27.000	1.00	7.00	44.00	8.51	4.14	1.37	.37	14.00	3.30
10194	0	.31-.32	453	9.30	.17	7.000	1.00	7.00	44.00	8.41	3.03	1.56	.34	14.00	3.60
10195	0	0-.33	453	9.60	.17	10.000	1.00	7.00	19.00	8.20	3.03	1.35	.25	12.00	1.40
10196	0	.34-.35	453	9.70	.17	14.000	1.00	-BQ-	16.00	8.93	3.12	1.61	.22	15.00	1.20
10197	0	.36-.37	453	9.60	.18	5.000	1.00	-BQ-	16.00	8.77	2.72	1.69	.38	15.00	1.90
10198	0	0-.38	453	9.20	.28	8.000	1.00	-BQ-	45.00	13.30	3.28	2.65	.52	21.00	8.40
10199	0	.39-.41	453	9.60	.21	1.000	1.00	2.00	16.00	10.88	2.48	2.39	.44	17.00	2.30
0200	0	.42-.44	453	9.50	.21	-BQ-	1.00	-BQ-	41.00	7.75	1.91	1.56	.28	11.00	1.90
0201	0	.45-.46	453	9.60	.19	4.000	1.00	-BQ-	22.00	9.00	2.00	1.69	.23	12.00	.98
0202	0	.01-.02	456	9.70	.25	3.000	1.00	-BQ-	18.00	14.65	2.39	3.25	.44	22.00	4.00
0203	0	.03-.04	456	5.10	.53	146.000	4.00	2.00	347.00	2.53	10.89	1.15	.18	26.00	5.20
0204	0	0-.05	456	8.90	.25	103.000	1.00	1.00	71.00	3.78	7.99	.85	.36	14.00	12.00
0205	0	.06-.08	456	8.50	.21	75.000	1.00	2.00	87.00	2.17	4.40	.48	.22	6.00	2.30
0206	0	.09-.10	456	8.70	.17	49.000	1.00	4.00	73.00	3.40	6.85	.69	.32	11.00	7.20
0207	0	.11-.12	456	8.70	.16	43.000	1.00	2.00	54.00	2.86	5.33	.49	.27	9.00	3.20
0208	0	.13-.14	456	7.90	.38	65.000	1.00	4.00	223.00	3.67	5.99	.44	.26	9.00	7.00
0209	0	.15-.16	456	8.70	.16	42.000	1.00	5.00	53.00	5.75	6.94	.47	.28	10.00	5.90
0210	0	.17-.19	456	9.00	.20	68.000	1.00	5.00	44.00	8.07	11.81	.98	.34	20.00	3.50
0211	0	.01-.09	457	9.00	.17	47.000	1.00	4.00	43.00	7.09	8.50	.81	.37	15.00	5.50
0212	0	.09-.13	457	9.30	.23	108.000	8.00	4.00	26.00	6.98	4.07	1.28	.06	10.00	.91
0213	0	.13-.19	457	8.70	1.06	1465.000	10.00	-BQ-	98.00	5.06	3.77	1.74	.09	8.00	3.10
0214	0	.19-.23	457	8.70	.89	1106.000	12.00	2.00	113.00	8.33	6.06	1.85	.13	15.00	2.30
0215	0	.03-.05	457	8.60	.77	706.000	8.00	1.00	139.00	11.67	9.56	1.64	.19	21.00	4.60
0216	0	.02-.03	474	8.60	.29	174.000	1.00	3.00	89.00	8.17	7.43	1.06	.18	18.00	6.50
0217	0	.03-.05	474	9.10	.11	22.000	4.00	2.00	6.00	5.87	5.24	.55	.06	10.00	.20
0218	0	.05-.09	474	9.10	.07	31.000	4.00	3.00	5.00	4.23	4.20	1.15	.04	8.00	.24
0219	0	.13-.14	478	9.10	.15	125.000	4.00	5.00	15.00	3.24	3.53	1.87	.05	7.00	1.50
0220	0	.09-.15	478	8.90	.20	91.000	1.00	2.00	63.00	3.30	6.97	1.08	.19	9.00	.75
0221	0	.17-.24	478	9.10	.26	103.000	1.00	5.00	62.00	10.33	15.22	2.63	.28	27.00	3.20
0222	0	.01-.02	480	9.00	.21	93.000	1.00	7.00	55.00	8.87	12.22	2.14	.28	25.00	4.50
0223	0	482		8.10	.07	24.000	1.00	8.00	20.00	12.12	8.90	.67	.13	23.00	1.20
0224	0	.02-.06	496	8.80	.16	11.000	1.00	3.00	38.00	6.68	8.21	.20	.34	14.00	3.60
0225	0	.06-.12	496	8.90	.58	431.000	13.00	12.00	104.00	2.57	6.38	1.94	.16	10.00	.62
226	0	.12-.16	496	8.90	.40	478.000	3.00	5.00	11.00	3.83	8.89	2.96	.21	18.00	3.10
				6.70	.58	370.000	10.00	7.00	178.00	6.02	10.20	3.32	.13	28.00	5.40