

## APPENDIX 11: CHARACTERISATION OF WASTE REGOLITH – TRILOGY DEPOSIT - GRAEME CAMPBELL & ASSOCIATES (2010)

*GRAEME CAMPBELL & ASSOCIATES PTY LTD*  
*Specialists in Mine-Waste Geochemistry,*  
*& Soil-Moisture-Retention Testing*

*P.O. Box 247, Bridgetown, Western Australia 6255*  
*Phone: (61 8) 9761 2829 Fax: (61 8) 9761 2830*  
*E-mail: [gca@wn.com.au](mailto:gca@wn.com.au)*

1022

COMPANY: Tectonic Resources NL  
ATTENTION: Andrew Czerw  
FROM: Graeme Campbell  
SUBJECT: Phillips River Project: Geochemical Characterisation of  
Waste-regolith Samples (Trilogy Deposit) - Implications  
for Mine-Waste Management  
NO. PAGES (including this page): 67 DATE: 18th November 2010

---

Andy,

The testwork results obtained in this study are presented in Tables 1-4.

Details of the sampling programme are presented in Attachment I.

Details of the static-testwork methods employed are presented in Attachment II, and criteria for classifying the Acid-Formation Potential (AFP) of the waste-regolith samples are summarised in Attachment III. Copies of the laboratory reports are presented in Attachment IV.

## **1.0 TESTWORK OUTCOMES**

### **1.1 Acid-Forming Characteristics**

All samples are classified as Non-Acid Forming (NAF), due to negligible amounts of sulphide-minerals (viz. Sulphide-S values less than 0.1 %) [Table 1].

### **1.2 Multi-Element Composition**

All samples were subjected to multi-element analyses, and had contents of major- and minor-elements typically below, or close to, those recorded for soils, regoliths, and bedrocks derived from unmineralised terrain (Table 2).

The exceptions were As, Bi, Sb, Se, and B which were consistently enriched. However, the degree of enrichment was not marked. Some of the Moderate-Silica-waste-regolith samples were also enriched in Pb (viz. Pb contents up to 750 mg/kg).

---

### 1.3 Element Solubility in Water

With few exceptions, the concentrations of minor-elements in the water-extracts were typically below, or close to, the respective detection-limits (Table 3).

Isolated samples had Zn concentrations within the range 1-10 mg/L.

Samples from the 0-5m depth-interval were also typically characterised by B concentrations within the 1-5 mg/L range.

### 1.4 Element Solubility in Na<sub>2</sub>EDTA

As expected, the concentrations of Zn, Cu, and Pb – the key transition-metals associated with Trilogy mineralisation – were appreciably greater in the Na<sub>2</sub>EDTA-extracts, due to complexation. Extraction by the Na<sub>2</sub>EDTA-reagent was generally greater in the samples from the 0-5m depth-interval.

The B concentrations in the Na<sub>2</sub>EDTA-extracts were similar to those in the water-extracts.

Extraction at pH=6 with the Na<sub>2</sub>-EDTA reagent provides a broad approximation to the "pools" of minor-elements potentially available to biota (e.g. chelation from exudation of complexing organic ligands by plant-roots). The indications are that the "Bio-available-Zn-pool" may locally range up to 'of-the-order' 100-200 mg/kg (dry-solids basis), whereas the "Bio-available-pools" for Cu and Pb should generally range up to 'of-the-order' 10-20 mg/kg.

## 2.0 SUMMARY AND MANAGEMENT IMPLICATIONS

The results of this study indicate that the top 10 m (nominal) of the across the proposed Trilogy Pit should be geochemically similar. That is, over this depth-interval, all waste-regolith material should be classified as NAF, due to negligible amounts of sulphide-minerals, and only moderately enriched in As, Bi, Sb, Se, and B. The water-solubility of these minor-elements, and Zn, Cu and Pb, should be modest. Although difficult to project accurately, the "pools" of metals potentially available for uptake by plant-roots should also be modest (e.g. locally ranging up to *c.* 100 mg/kg for Zn).

Overall, waste-regolith geochemistry within the top 10 m (nominal) should be relatively insensitive to both parent-lithology, and depth. No overriding geochemical constraints are foreseen in the use of such waste-regolith materials for the containment of reactive varieties of waste-regoliths and waste-bedrocks (e.g. placement within Isolation-Cells within waste-dumps) to be produced during open-pit mining of the Trilogy Deposit.

## 3.0 CLOSURE

I trust the above is useful to your current needs.

Regards,

**Dr GD Campbell**  
**Director**

---

**TABLES**

**Table 1: Acid-Base-Analysis, Salinity and Net-Acid-Generation Results for Waste-regolith Samples**

GCA-SAMPLE NO.	CROSS-SECTION	DRILLHOLE & DOWNHOLE-INTERVAL (m)	pH-(1:2)	EC-(1:2) [mS/cm]	TOTAL-S (%)	SO <sub>4</sub> -S (%)	SULPHIDE-S (%)	TOTAL-C (%)	CO <sub>3</sub> -C (%)	ANC	NAPP	NAG	NAG-pH	AFP CATEGORY
										kg H <sub>2</sub> SO <sub>4</sub> /tonne				
<u>Laminated-Graphitic-Siltstone-waste-regolith Samples</u>														
GCA8991	5960mN	REG001, 0-5	7.6	1.5	0.08 (0.07)	nm	0.08	0.29 (0.29)	0.18	2 (2)	nc	<0.5	9.3	NAF
GCA8992		REG001, 5-10	6.4	0.89	0.02	nm	0.02	0.07	nm	1	nc	<0.5	5.9	NAF
GCA8993		REG002, 0-5	8.6	0.78	0.02	nm	0.02	0.19	nm	4	nc	<0.5	9.3	NAF
GCA8994		REG002, 5-10	5.9	0.94	0.04	nm	0.04	0.07	nm	-1	nc	<0.5	5.1	NAF
GCA8995	6080mN	REG005, 0-5	7.9	1.6	0.04	nm	0.04	0.40	0.18	15	nc	<0.5	10.2	NAF
GCA8996		REG005, 5-10	4.8	1.4	0.04	nm	0.04	0.09	nm	<1	nc	<0.5	5.4	NAF
GCA8997		REG006, 0-5	8.7	0.76	0.02	nm	0.02	0.27	0.19	30	nc	<0.5	10.3	NAF
GCA8998		REG006, 5-10	6.8	0.87	0.04	nm	0.04	0.10	nm	5	nc	<0.5	5.6	NAF
GCA8999	6200mN	REG009, 0-5	8.9	1.1	0.02	nm	0.02	0.43	0.30	22	nc	<0.5	9.8	NAF
GCA9000		REG009, 5-10	7.0	1.1	0.02	nm	0.02	0.07	nm	<1	nc	<0.5	6.4	NAF
GCA9001		REG010, 0-5	7.9 (7.8)	2.0 (1.8)	0.04	nm	0.04	0.31	0.16	19	nc	<0.5	9.8	NAF
GCA9002		REG010, 5-10	3.9	1.3	0.07	nm	0.07	0.12	nm	-1	nc	<0.5	4.6	NAF
<u>Moderate-Silica-waste-regolith Samples</u>														
GCA9003	5960mN	REG003, 0-5	7.5	1.4	0.05	nm	0.05	0.18	nm	4	nc	<0.5	8.4	NAF
GCA9004		REG003, 5-10	5.3	1.1	0.06	nm	0.06	0.08	nm	-1	nc	<0.5	5.5	NAF
GCA9005	6080mN	REG007, 0-5	8.4	1.1	0.07	nm	0.07	0.84	0.62	57	nc	<0.5	10.4	NAF
GCA9006		REG007, 5-10	7.3	1.4	0.57	-	<0.01*	0.17	nm	5	nc	<0.5	8.6	NAF
GCA9007	6200mN	REG011, 0-5	5.8	0.24	0.03	nm	0.03	0.47	0.12	1	nc	<0.5	5.6	NAF
GCA9008		REG011, 5-10	5.3	0.28	0.05	nm	0.05	0.72	0.01	-1	nc	<0.5 (1.4)	3.8 (3.8)	NAF
<u>High-Silica-waste-regolith Samples</u>														
GCA9009	5960mN	REG004, 0-5	6.6	0.96	0.03	nm	0.03	0.20	0.15	1	nc	<0.5	6.4	NAF
GCA9010		REG004, 5-10	5.4	0.50	0.01	nm	0.01	0.09	nm	-1	nc	<0.5	5.3	NAF
GCA9011	6080mN	REG008, 0-5	6.0 (6.0)	0.33 (0.29)	0.03 (0.03)	nm	0.03	0.27 (0.28)	0.08	2 (1)	nc	<0.5	6.0	NAF
GCA9012		REG008, 5-10	5.3	0.43	0.02	nm	0.02	0.10	nm	-1	nc	<0.5	5.1	NAF
GCA9013	6200mN	REG012, 0-5	5.2	0.85	0.04	nm	0.04	0.41	0.10	1	nc	<0.5	6.0	NAF
GCA9014		REG012, 5-10	4.6 (4.6)	0.49 (0.48)	0.02	nm	0.02	0.17	nm	1	nc	<0.5 (<0.5)	5.1 (5.0)	NAF

Notes:

ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential; AFP = Acid-Formation Potential; NAF = Non-Acid Forming; EC = Electrical-Conductivity;

nm = not measured; nc = not calculated.

pH-(1:2) and EC-(1:2) values correspond to pH and EC measured on sample slurries prepared with deionised-water, and a solid:solution ratio of c. 1:2 (w/w).

All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH.

Values in parentheses represent duplicates.

**N.B.** The Sulphide-S value of less than 0.01 %, and labelled with an asterisk, for sample GCA9006 corresponds to Cr(II)-Reducible-S determined by SGS (Cairns).

**Table 2: Multi-Element-Analysis Results for Waste-regolith Samples**

Note: Average-crustal abundance of elements based on Bowen (1979), and the Geochemical-Abundance Index (GAI) is based on Förstner *et al.* (1993). Refer Attachment II.

**Laminated-Graphitic-Siltstone-waste-regolith Samples (0-5 m)**

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)						AVERAGE-CRUSTAL-ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)					
	5960mN		6080mN		6200mN			5960mN		6080mN		6200mN	
	REG001, 0-5 m (GCA8991)	REG002, 0-5 m (GCA8993)	REG005, 0-5 m (GCA8995)	REG006, 0-5 m (GCA8997)	REG009, 0-5 m (GCA8999)	REG010, 0-5 m (GCA9001)		REG001, 0-5 m (GCA8991)	REG002, 0-5 m (GCA8993)	REG005, 0-5 m (GCA8995)	REG006, 0-5 m (GCA8997)	REG009, 0-5 m (GCA8999)	REG010, 0-5 m (GCA9001)
Al	8.6%	6.1%	7.9%	7.5%	8.5%	7.9%	8.2%	0	0	0	0	0	0
Fe	3.4%	2.4%	4.1%	3.3%	5.4%	5.2%	4.1%	0	0	0	0	0	0
Na	0.24%	0.15%	0.28%	0.17%	0.31%	0.33%	2.3%	0	0	0	0	0	0
K	3.1%	2.1%	2.3%	2.3%	2.4%	2.2%	2.1%	0	0	0	0	0	0
Mg	0.71%	0.32%	0.48%	0.43%	0.60%	0.37%	2.3%	0	0	0	0	0	0
Ca	0.31%	0.22%	0.65%	0.50%	0.68%	0.32%	4.1%	0	0	0	0	0	0
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.07	0	0	0	0	0	0
Cu	66	67	53	50	92	140	50	0	0	0	0	0	1
Zn	230	71	130	71	160	140	75	1	0	0	0	1	0
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	0	0	0	0	0	0
Pb	39	110	37	65	52	190	14	1	2	1	2	1	3
Cr	130	95	120	130	140	130	100	0	0	0	0	0	0
Ni	61	30	55	47	71	52	80	0	0	0	0	0	0
Co	13	5.6	18	12	31	13	20	0	0	0	0	0	0
Mn	190	92	100	150	100	72	950	0	0	0	0	0	0
Hg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0	0	0	0	0	0
Sn	3.3	2.8	3.2	3.1	3.2	3.4	2.2	0	0	0	0	0	0
Sr	77	42	63	63	129	73	370	0	0	0	0	0	0
Ba	610	420	520	610	400	740	500	0	0	0	0	0	0
Th	17	15	20	18	20	17	12	0	0	0	0	0	0
U	2.6	3.0	2.5	4.0	2.6	3.3	2.4	0	0	0	0	0	0
Tl	0.74	0.62	0.61	0.66	0.71	3.0	0.6	0	0	0	0	0	2
V	140	120	140	150	180	160	160	0	0	0	0	0	0
As	86	33	37	47	120	88	1.5	5	4	4	4	6	5
Bi	0.45	0.77	0.5	0.49	0.6	3.5	0.048	3	3	3	3	3	6
Sb	1.9	2.2	2.1	2.4	3.4	8.8	0.2	3	3	3	3	4	5
Se	0.69	0.7	1.2	1.1	1.8	1.7	0.05	3	3	4	4	5	5
Mo	3.7	2.4	4.4	2.9	4.3	6.2	1.5	1	0	1	0	1	1
B	87	82	<50	<50	120	300	10	3	2	0	0	3	4
P	99	68	<50	74	110	120	1,000	0	0	0	0	0	0
F	660	540	570	830	790	630	950	0	0	0	0	0	0

**Table 2 (Cont'd): Multi-Element-Analysis Results for Waste-regolith Samples**

**Laminated-Graphitic-Siltstone-waste-regolith Samples (5-10 m)**

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)						AVERAGE-CRUSTAL-ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)					
	5960mN		6080mN		6200mN			5960mN		6080mN		6200mN	
	REG001, 5-10 m (GCA8992)	REG002, 5-10 m (GCA8994)	REG005, 5-10 m (GCA8996)	REG006, 5-10 m (GCA8998)	REG009, 5-10 m (GCA9000)	REG010, 5-10 m (GCA9002)		REG001, 5-10 m (GCA8992)	REG002, 5-10 m (GCA8994)	REG005, 5-10 m (GCA8996)	REG006, 5-10 m (GCA8998)	REG009, 5-10 m (GCA9000)	REG010, 5-10 m (GCA9002)
Al	8.4%	6.0%	8.1%	5.9%	8.2%	5.8%	8.2%	0	0	0	0	0	0
Fe	1.9%	2.1%	7.2%	5.4%	2.8%	6.7%	4.1%	0	0	0	0	0	0
Na	0.15%	0.12%	0.18%	0.12%	0.17%	0.21%	2.3%	0	0	0	0	0	0
K	3.7%	2.5%	3.6%	2.5%	3.8%	2.4%	2.1%	0	0	0	0	0	0
Mg	0.38%	0.25%	0.39%	0.30%	0.39%	0.21%	2.3%	0	0	0	0	0	0
Ca	0.012%	0.011%	0.026%	0.024%	0.025%	0.0089%	4.1%	0	0	0	0	0	0
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.07	0	0	0	0	0	0
Cu	30	53	50	69	37	200	50	0	0	0	0	0	1
Zn	82	61	150	150	79	130	75	0	0	0	0	0	0
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	0	0	0	0	0	0
Pb	25	110	21	69	38	190	14	0	2	0	2	1	3
Cr	75	72	110	86	110	94	100	0	0	0	0	0	0
Ni	30	26	57	58	35	40	80	0	0	0	0	0	0
Co	3.7	2.7	12	11	8.6	8.4	20	0	0	0	0	0	0
Mn	67	77	94	160	68	97	950	0	0	0	0	0	0
Hg	<0.01	0.02	<0.01	<0.01	<0.01	0.02	0.05	0	0	0	0	0	0
Sn	3.9	2.9	3.6	2.7	3.9	3.4	2.2	0	0	0	0	0	0
Sr	50	31	29	70	210	54	370	0	0	0	0	0	0
Ba	680	480	650	620	630	830	500	0	0	0	0	0	0
Th	15	15	17	14	17	14	12	0	0	0	0	0	0
U	2.3	2.7	2.4	3.4	1.9	2.8	2.4	0	0	0	0	0	0
Tl	0.83	0.57	0.82	0.6	0.87	3.4	0.6	0	0	0	0	0	2
V	110	99	130	110	150	110	160	0	0	0	0	0	0
As	44	62	200	120	30	220	1.5	<b>4</b>	<b>5</b>	<b>6</b>	<b>6</b>	<b>4</b>	<b>6</b>
Bi	0.43	0.6	0.48	0.37	0.56	5.1	0.048	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>6</b>
Sb	1.8	2	1.7	2	2.8	26	0.2	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>6</b>
Se	0.4	0.2	0.9	0.67	0.55	2.7	0.05	2	1	<b>4</b>	<b>3</b>	<b>3</b>	<b>5</b>
Mo	3.9	6.3	12	11	2.7	18	1.5	1	1	2	2	0	3
B	<50	64	<50	81	110	170	10	0	2	0	2	<b>3</b>	<b>4</b>
P	79	71	89	130	240	160	1,000	0	0	0	0	0	0
F	790	570	830	830	1,300	570	950	0	0	0	0	0	0

**Table 2 (Cont'd): Multi-Element-Analysis Results for Waste-regolith Samples**

**Moderate-Silica- and High-Silica-waste-regolith Samples (0-5 m)**

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)						AVERAGE-CRUSTAL-ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)					
	Moderate-Silica			High-Silica				Moderate-Silica			High-Silica		
	5960mN	6080mN	6200mN	5960mN	6080mN	6200mN		5960mN	6080mN	6200mN	5960mN	6080mN	6200mN
	REG003, 0-5 m (GCA9003)	REG007, 0-5 m (GCA9005)	REG0011, 0-5 m (GCA9007)	REG004, 0-5 m (GCA9009)	REG008, 0-5 m (GCA9011)	REG0012, 0-5 m (GCA9013)		REG003, 0-5 m (GCA9003)	REG007, 0-5 m (GCA9005)	REG0011, 0-5 m (GCA9007)	REG004, 0-5 m (GCA9009)	REG008, 0-5 m (GCA9011)	REG0012, 0-5 m (GCA9013)
Al	7.7%	6.7%	3.6%	3.9%	8.2%	5%	8.2%	0	0	0	0	0	0
Fe	4.3%	6.5%	3.1%	2.8%	4.3%	2.4%	4.1%	0	0	0	0	0	0
Na	0.22%	0.25%	0.11%	0.15%	0.21%	0.15%	2.3%	0	0	0	0	0	0
K	2.0%	1.6%	0.34%	0.16%	0.24%	0.21%	2.1%	0	0	0	0	0	0
Mg	0.31%	0.50%	0.11%	0.20%	0.53%	0.15%	2.3%	0	0	0	0	0	0
Ca	0.14%	1.6%	0.023%	0.030%	0.067%	0.029%	4.1%	0	0	0	0	0	0
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.07	0	0	0	0	0	0
Cu	120	190	26	39	180	32	50	1	1	0	0	1	0
Zn	110	400	79	120	130	110	75	0	2	0	0	0	0
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	0	0	0	0	0	0
Pb	170	300	62	62	48	47	14	3	4	2	2	1	1
Cr	140	160	96	86	150	81	100	0	0	0	0	0	0
Ni	38	61	28	35	65	39	80	0	0	0	0	0	0
Co	6.7	16	4.4	5.1	8.1	5.2	20	0	0	0	0	0	0
Mn	54	88	21	27	17	18	950	0	0	0	0	0	0
Hg	<0.01	0.03	0.06	<0.01	<0.01	0.02	0.05	0	0	0	0	0	0
Sn	3.0	2.6	1.8	1.8	2.7	2.3	2.2	0	0	0	0	0	0
Sr	42	120	15	16	22	18	370	0	0	0	0	0	0
Ba	720	490	180	130	140	160	500	0	0	0	0	0	0
Th	19	25	12	9	15	8.5	12	0	0	0	0	0	0
U	3.0	4.3	1.8	1.8	2.4	1.2	2.4	0	0	0	0	0	0
Tl	0.69	0.6	0.59	0.15	0.87	0.31	0.6	0	0	0	0	0	0
V	160	250	110	110	140	86	160	0	0	0	0	0	0
As	150	99	35	26	52	18	1.5	6	5	4	4	5	3
Bi	1.7	1.9	3.2	5.0	2.5	1.5	0.048	5	5	5	6	5	4
Sb	5.2	8.9	6.3	5.1	5.4	7.8	0.2	4	5	4	4	4	5
Se	2.6	1.5	0.97	0.86	2.5	2.3	0.05	5	4	4	4	5	5
Mo	3.8	5.0	3.8	4.3	8.2	4.6	1.5	1	1	1	1	2	1
B	<50	170	<50	990	4,000	280	10	0	4	0	6	6	4
P	80	95	<50	<50	74	<50	1,000	0	0	0	0	0	0
F	750	860	140	170	600	120	950	0	0	0	0	0	0



**Table 2 (Cont'd): Multi-Element-Analysis Results for Waste-regolith Samples**

**Moderate-Silica- and High-Silica-waste-regolith Samples (5-10 m)**

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)						AVERAGE-CRUSTAL-ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)					
	Moderate-Silica			High-Silica				Moderate-Silica			High-Silica		
	5960mN	6080mN	6200mN	5960mN	6080mN	6200mN		5960mN	6080mN	6200mN	5960mN	6080mN	6200mN
	REG003, 5-10 m (GCA9004)	REG007, 5-10 m (GCA9006)	REG0011, 5-10 m (GCA9008)	REG004, 5-10 m (GCA9010)	REG008, 5-10 m (GCA9012)	REG0012, 5-10 m (GCA9014)		REG003, 5-10 m (GCA9004)	REG007, 5-10 m (GCA9006)	REG0011, 5-10 m (GCA9008)	REG004, 5-10 m (GCA9010)	REG008, 5-10 m (GCA9012)	REG0012, 5-10 m (GCA9014)
Al	7.0%	8.2%	0.54%	2.8%	4.9%	1.3%	8.2%	0	0	0	0	0	0
Fe	1.6%	4.5%	0.29%	0.92%	0.75%	0.37%	4.1%	0	0	0	0	0	0
Na	0.15%	0.25%	0.025%	0.14%	0.20%	0.051%	2.3%	0	0	0	0	0	0
K	3.0%	3.6%	0.072%	0.44%	0.21%	0.068%	2.1%	0	0	0	0	0	0
Mg	0.30%	0.36%	0.015%	0.25%	0.49%	0.33%	2.3%	0	0	0	0	0	0
Ca	0.015%	0.17%	0.0057%	0.017%	0.0071%	0.0080%	4.1%	0	0	0	0	0	0
Ag	<0.2	<0.2	0.4	0.8	<0.2	0.4	0.07	0	0	2	3	0	2
Cu	40	210	15	43	87	14	50	0	1	0	0	0	0
Zn	84	230	12	35	54	29	75	0	1	0	0	0	0
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	0	0	0	0	0	0
Pb	370	730	50	98	36	29	14	4	5	1	2	1	0
Cr	86	150	19	45	55	29	100	0	0	0	0	0	0
Ni	18	31	6	16	28	9	80	0	0	0	0	0	0
Co	1.3	4.1	1.2	1.4	1.9	1.3	20	0	0	0	0	0	0
Mn	51	67	7	10	13	5	950	0	0	0	0	0	0
Hg	0.02	0.03	0.57	0.02	0.02	0.08	0.05	0	0	3	0	0	0
Sn	3.4	3.4	1.1	1.5	2.4	1.8	2.2	0	0	0	0	0	0
Sr	65	76	9.6	52	17	16	370	0	0	0	0	0	0
Ba	750	790	150	280	190	93	500	0	0	0	0	0	0
Th	17	20	12	9.7	9.3	6.3	12	0	0	0	0	0	0
U	3.4	3.8	2.6	2	2.1	2.4	2.4	0	0	0	0	0	0
Tl	0.8	1	0.28	1	1.7	0.16	0.6	0	0	0	0	0	0
V	140	170	14	39	53	22	160	0	0	0	0	0	0
As	69	230	14	14	12	6	1.5	5	6	3	3	2	1
Bi	0.56	1.2	3.5	19	6.2	1.2	0.048	3	4	6	6	6	4
Sb	4	5.1	3.4	5.3	4.3	7.8	0.2	4	4	4	4	4	5
Se	0.44	0.83	0.47	0.72	0.28	0.28	0.05	3	3	3	3	2	2
Mo	4.1	5.3	1.2	2.6	3.6	4.1	1.5	1	1	0	0	1	1
B	64	<50	<50	3,100	4,600	<50	10	2	0	0	6	6	0
P	160	140	<50	140	55	<50	1,000	0	0	0	0	0	0
F	940	1,500	50	240	470	99	950	0	0	0	0	0	0

**Table 3: Water-Extraction-Testwork Results for Waste-regolith Samples**

Notes: All results in mg/L (*water-extract basis*), except for pH and Electrical-Conductivity (EC).  
 A solution:solid ratio of c. 2:1 (w/w) was employed in the water-extraction testwork. Refer Attachment II for further details.

**Laminated-Graphitic-Siltstone-waste-regolith Samples (0-5 m)**

ELEMENT/ PARAMETER	5960mN		6080mN		6200mN		ELEMENT/ PARAMETER	5960mN		6080mN		6200mN	
	REG001, 0-5 m (GCA8991)	REG002, 0-5 m (GCA8993)	REG005, 0-5 m (GCA8995)	REG006, 0-5 m (GCA8997)	REG009, 0-5 m (GCA8999)	REG010, 0-5 m (GCA9001)		REG001, 0-5 m (GCA8991)	REG002, 0-5 m (GCA8993)	REG005, 0-5 m (GCA8995)	REG006, 0-5 m (GCA8997)	REG009, 0-5 m (GCA8999)	REG010, 0-5 m (GCA9001)
<i>Major-Parameters</i>							<i>Minor-Ions</i>						
pH	8.3	8.9	9.1	9.0	8.7	9	Fe	0.04	0.07	0.02	0.06	4.7	<0.01
EC [µS/cm]	2,800	1,300	3,200	1,400	3,400	3,400	Cu	<0.01	<0.01	<0.01	<0.01	0.13	<0.01
							Ni	<0.01	<0.01	<0.01	<0.01	0.03	<0.01
<i>Major-Ions</i>							Zn	0.05	<0.01	<0.01	0.02	6.4	0.02
Na	530	280	690	330	910	720	Co	0.0012	0.0004	0.0007	0.0005	0.064	0.0012
K	13	7.2	13	7.1	13	16	Al	0.08	0.15	0.03	0.15	12	<0.01
Mg	28	11	42	11	78	49	Cd	0.00003	0.00003	<0.00002	0.00003	0.0067	0.00003
Ca	14	12	40	13	260	40	Pb	<0.0005	0.001	<0.0005	0.0009	0.37	0.0007
Cl	700	270	780	290	480	920	Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SO <sub>4</sub>	190	110	320	120	170	310	Hg	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
							As	0.0048	0.008	0.0062	0.0084	0.013	0.0067
							Sb	0.00065	0.00063	0.00055	0.00058	0.001	0.00056
							Bi	<0.000005	<0.000005	<0.000005	<0.000005	0.00089	<0.000005
							Se	0.012	0.012	0.016	0.014	0.021	0.018
							B	1.3	1.8	2.0	2.4	4.6	1.3
							Mo	0.0069	0.027	0.0078	0.027	0.026	0.0061
							P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
							Si	5.5	5.3	2.9	4.4	5.0	2.5
							Ag	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
							Ba	0.05	0.049	0.063	0.053	0.18	0.064
							Sr	0.21	0.15	0.43	0.17	1.9	0.44
							Tl	0.00005	0.00004	0.00003	0.00003	0.0001	0.00008
							V	<0.01	<0.01	<0.01	<0.01	0.21	<0.01
							Sn	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
							U	0.0022	0.014	0.033	0.053	0.021	0.029
							Th	0.00004	0.00006	0.000079	0.000059	0.02	0.0003
							Mn	0.11	<0.01	0.02	<0.01	0.56	0.03

**Table 3 (Cont'd): Water-Extraction-Testwork Results for Waste-regolith Samples**

**Laminated-Graphitic-Siltstone-waste-regolith Samples (5-10 m)**

ELEMENT/ PARAMETER	5960mN		6080mN		6200mN		ELEMENT/ PARAMETER	5960mN		6080mN		6200mN	
	REG001, 5-10 m (GCA8992)	REG002, 5-10 m (GCA8994)	REG005, 5-10 m (GCA8996)	REG006, 5-10 m (GCA8998)	REG009, 5-10 m (GCA9000)	REG010, 5-10 m (GCA9002)		REG001, 5-10 m (GCA8992)	REG002, 5-10 m (GCA8994)	REG005, 5-10 m (GCA8996)	REG006, 5-10 m (GCA8998)	REG009, 5-10 m (GCA9000)	REG010, 5-10 m (GCA9002)
<i>Major-Parameters</i>							<i>Minor-Ions</i>						
pH	6.8	6.7	6.3	7.7	7.3	4.5	Fe	0.05	0.05	0.03	0.02	0.04	0.34
EC [µS/cm]	1,800	1,900	2,500	1,600	1,900	2,200	Cu	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
							Ni	0.02	0.06	0.03	<0.01	<0.01	0.07
<i>Major-Ions</i>							Zn	1.1	0.62	3.0	0.07	0.04	1.5
Na	270	290	390	220	310	340	Co	0.0077	0.013	0.0086	0.0007	0.0006	0.012
K	25	24	30	24	19	36	Al	0.07	0.03	<0.01	<0.01	<0.01	0.65
Mg	23	23	34	23	15	28	Cd	0.00056	0.00008	0.00009	0.00006	0.00003	0.00011
Ca	5.7	12	17	28	4	3.2	Pb	0.0049	0.12	0.0044	0.0014	0.0006	0.045
Cl	500	530	690	390	500	630	Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SO <sub>4</sub>	84	94	150	160	120	98	Hg	0.0011	0.0003	0.0002	0.0002	<0.0001	<0.0001
							As	0.0035	0.0027	0.0032	0.0031	0.0026	0.0028
							Sb	0.0057	0.0019	0.00007	0.00008	0.00015	0.00023
							Bi	0.00024	0.000066	0.000046	<0.000005	0.000035	0.00043
							Se	0.0058	0.0059	0.0079	0.005	0.0062	0.0076
							B	0.25	0.29	0.38	0.20	0.45	0.27
							Mo	0.00054	0.00015	0.00009	0.00018	0.00015	0.00011
							P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
							Si	5.8	5.9	6.7	5.2	5.1	7.0
							Ag	0.00004	<0.00001	<0.00001	<0.00001	<0.00001	0.00003
							Ba	0.048	0.049	0.065	0.044	0.026	0.079
							Sr	0.086	0.12	0.18	0.21	0.13	0.099
							Tl	0.00005	0.00012	0.00006	0.00008	0.00006	0.00044
							V	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
							Sn	0.0006	0.0004	0.0002	0.0002	0.0002	0.0003
							U	0.000022	0.000009	0.000035	0.000032	0.000022	0.00029
							Th	0.00002	0.000013	0.000011	0.000009	0.000016	0.000024
							Mn	0.48	0.97	0.42	0.10	0.07	0.38

**Table 3 (Cont'd): Water-Extraction-Testwork Results for Waste-regolith Samples**

**Moderate-Silica- and High-Silica-waste-regolith Samples (0-5 m)**

ELEMENT/ PARAMETER	Moderate-Silica			High-Silica			ELEMENT/ PARAMETER	Moderate-Silica			High-Silica		
	5960mN	6080mN	6200mN	5960mN	6080mN	6200mN		5960mN	6080mN	6200mN	5960mN	6080mN	6200mN
	REG003, 0-5 m (GCA9003)	REG007, 0-5 m (GCA9005)	REG0011, 0-5 m (GCA9007)	REG004, 0-5 m (GCA9009)	REG008, 0-5 m (GCA9011)	REG0012, 0-5 m (GCA9013)		REG003, 0-5 m (GCA9003)	REG007, 0-5 m (GCA9005)	REG0011, 0-5 m (GCA9007)	REG004, 0-5 m (GCA9009)	REG008, 0-5 m (GCA9011)	REG0012, 0-5 m (GCA9013)
<i>Major-Parameters</i>							<i>Minor-Ions</i>						
pH	9.1	9.1	8.0	8.5	7.7	3.5	Fe	0.07	0.07	0.35	0.04	0.03	0.55
EC [ $\mu$ S/cm]	2,600	2,100	400	1,100	630	1,800	Cu	<0.01	0.03	<0.01	<0.01	<0.01	<0.01
							Ni	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<i>Major-Ions</i>							Zn	0.02	0.06	0.08	0.09	0.43	1.2
Na	570	500	91	230	130	340	Co	0.0004	0.0009	0.0008	0.002	0.0009	0.0041
K	13	11	1.0	3.8	3.9	7.9	Al	0.02	0.14	1.1	0.16	0.12	0.06
Mg	38	19	0.61	6.2	2.7	14	Cd	<0.00002	0.00003	<0.00002	<0.00002	0.00002	0.00009
Ca	39	23	0.11	2.7	1.1	3.6	Pb	0.0011	0.0014	0.0017	0.0007	<0.0005	0.0016
Cl	620	420	59	220	120	390	Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SO <sub>4</sub>	320	270	92	140	110	240	Hg	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.039
							As	0.0065	0.012	0.0015	0.0019	0.0028	0.0022
							Sb	0.00038	0.0027	0.00012	0.00042	0.0001	0.00004
							Bi	<0.000005	<0.000005	0.00002	0.00001	<0.000005	0.000084
							Se	0.014	0.015	0.0038	0.0059	0.0064	0.0093
							B	1.3	1.7	0.48	1.1	1.5	0.81
							Mo	0.0036	0.015	0.00018	0.0030	0.00023	0.00012
							P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
							Si	3.3	2.9	16	5.4	8.8	13
							Ag	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002
							Ba	0.05	0.044	0.024	0.038	0.029	0.051
							Sr	0.40	0.28	0.0039	0.052	0.024	0.092
							Tl	0.00004	0.00005	0.00002	0.00002	0.00002	0.00002
							V	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
							Sn	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0002
							U	0.014	0.057	0.00006	0.000045	0.000022	0.00022
							Th	0.00016	0.00031	0.00019	0.000052	0.000034	0.00052
							Mn	0.02	<0.01	<0.01	0.04	<0.01	0.08

**Table 3 (Cont'd): Water-Extraction-Testwork Results for Waste-regolith Samples**

**Moderate-Silica- and High-Silica-waste-regolith Samples (5-10 m)**

ELEMENT/ PARAMETER	Moderate-Silica			High-Silica			ELEMENT/ PARAMETER	Moderate-Silica			High-Silica		
	5960mN	6080mN	6200mN	5960mN	6080mN	6200mN		5960mN	6080mN	6200mN	5960mN	6080mN	6200mN
	REG003, 5-10 m (GCA9004)	REG007, 5-10 m (GCA9006)	REG0011, 5-10 m (GCA9008)	REG004, 5-10 m (GCA9010)	REG008, 5-10 m (GCA9012)	REG0012, 5-10 m (GCA9014)		REG003, 5-10 m (GCA9004)	REG007, 5-10 m (GCA9006)	REG0011, 5-10 m (GCA9008)	REG004, 5-10 m (GCA9010)	REG008, 5-10 m (GCA9012)	REG0012, 5-10 m (GCA9014)
<i>Major-Parameters</i>							<i>Minor-Ions</i>						
pH	6.7	8.5	7	7.4	7.6	6.6	Fe	0.03	0.03	0.02	0.07	0.02	0.07
EC [µS/cm]	1,900	2,800	300	850	730	780	Cu	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
							Ni	0.02	<0.01	0.02	0.06	<0.01	0.06
<i>Major-Ions</i>							Zn	0.67	0.02	0.37	2.4	1.2	3.0
Na	290	390	47	130	110	120	Co	0.0071	0.0007	0.019	0.020	0.0071	0.035
K	21	24	2.3	7.8	5.7	4.6	Al	0.03	0.04	<0.01	0.05	<0.01	<0.01
Mg	21	38	2.4	13	8.4	9.4	Cd	0.00007	0.00005	0.00003	0.00005	0.00004	0.00007
Ca	9.5	62	1.7	2.7	4.9	1.7	Pb	0.0026	0.0051	0.0018	0.0024	0.0026	0.0037
Cl	520	720	60	240	160	220	Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SO <sub>4</sub>	120	210	21	37	53	40	Hg	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
							As	0.0023	0.0060	0.0014	0.0013	0.0014	0.0009
							Sb	0.00017	0.00064	0.00042	0.00053	0.00022	0.00010
							Bi	0.00021	0.00021	0.00014	0.00023	0.000094	0.000023
							Se	0.0055	0.0083	0.0018	0.0028	0.0023	0.0023
							B	0.33	0.09	0.05	0.75	1.1	0.13
							Mo	0.00009	0.00085	0.00007	0.00009	0.00026	0.00005
							P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
							Si	5.3	2.3	4.7	5.4	2.5	4.5
							Ag	0.00004	0.00002	<0.00001	0.00002	<0.00001	<0.00001
							Ba	0.057	0.030	0.14	0.083	0.076	0.099
							Sr	0.13	0.28	0.029	0.09	0.089	0.26
							Tl	0.00007	0.00006	0.00011	0.00011	0.0001	0.00016
							V	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
							Sn	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
							U	0.000017	0.0031	0.000039	0.00001	0.000009	0.000019
							Th	0.000012	0.00006	0.000012	0.000012	0.00001	0.000009
							Mn	0.31	0.06	0.14	0.69	0.13	0.64

**Table 4: Na<sub>2</sub>EDTA-Extraction-Testwork Results for Waste-regolith Samples**

Note: All results in mg/L (*Na<sub>2</sub>EDTA-extract basis*), except for pH.  
 A solution:solid ratio of c. 2:1 (w/w) was employed in the Na<sub>2</sub>EDTA-extraction testwork. Refer Attachment II for further details.

**Laminated-Graphitic-Siltstone-waste-regolith Samples (0-5 m)**

ELEMENT/ PARAMETER	5960mN		6080mN		6200mN		ELEMENT/ PARAMETER	5960mN		6080mN		6200mN	
	REG001, 0-5 m (GCA8991)	REG002, 0-5 m (GCA8993)	REG005, 0-5 m (GCA8995)	REG006, 0-5 m (GCA8997)	REG009, 0-5 m (GCA8999)	REG010, 0-5 m (GCA9001)		REG001, 0-5 m (GCA8991)	REG002, 0-5 m (GCA8993)	REG005, 0-5 m (GCA8995)	REG006, 0-5 m (GCA8997)	REG009, 0-5 m (GCA8999)	REG010, 0-5 m (GCA9001)
<i>Major-Parameters</i>							<i>Minor-Ions</i>						
pH	6.4	6.6	7.6	7.3	8.3	7.4	Fe	76	62	100	54	47	66
							Cu	3.2	2.5	1.2	1.1	1.2	1.7
							Ni	0.7	0.5	0.4	0.4	0.3	0.5
<i>Major-Ions</i>							Zn	68	21	40	14	62	40
K	63	56	66	58	70	62	Co	0.67	0.44	0.53	0.48	0.66	0.59
Mg	260	280	580	540	680	770	Al	79	88	92	95	110	75
Ca	250	940	2500	2700	2500	2100	Cd	0.069	0.067	0.067	0.067	0.067	0.069
							Pb	2.6	11	3.6	2.9	3.6	8.8
							Cr	0.2	0.2	0.3	0.2	<0.1	0.2
							Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
							As	0.02	0.01	0.013	0.013	0.017	0.014
							Sb	0.0012	0.0008	0.0007	0.0007	0.001	0.0009
							Bi	0.0065	0.012	0.013	0.0064	0.0092	0.075
							Se	0.02	0.011	0.026	0.022	0.029	0.033
							B	1.8	2.7	3.6	3.4	7.5	3.3
							Mo	0.025	0.034	0.004	0.0062	0.0031	0.012
							P	<1	<1	<1	<1	<1	<1
							Si	54	51	38	45	41	33
							Ag	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
							Ba	7.4	9.6	3.1	4.4	1.5	2.5
							Sr	2.7	6.3	15	15	18	12
							Tl	0.0035	0.0056	0.0017	0.0046	0.008	0.0046
							V	1.0	1.0	2.3	1.2	1.8	1.5
							Sn	0.007	0.004	<0.001	<0.001	<0.001	0.002
							U	0.021	0.011	0.0039	0.019	0.0088	0.0068
							Th	0.38	0.34	0.23	0.2	0.18	0.26
							Mn	21	9.9	4.4	7.8	5.6	5.5

**Table 4 (Cont'd): Na<sub>2</sub>EDTA-Extraction-Testwork Results for Waste-regolith Samples**

**Laminated-Graphitic-Siltstone-waste-regolith Samples (5-10 m)**

ELEMENT/ PARAMETER	5960mN		6080mN		6200mN		ELEMENT/ PARAMETER	5960mN		6080mN		6200mN	
	REG001, 5-10 m (GCA8992)	REG002, 5-10 m (GCA8994)	REG005, 5-10 m (GCA8996)	REG006, 5-10 m (GCA8998)	REG009, 5-10 m (GCA9000)	REG010, 5-10 m (GCA9002)		REG001, 5-10 m (GCA8992)	REG002, 5-10 m (GCA8994)	REG005, 5-10 m (GCA8996)	REG006, 5-10 m (GCA8998)	REG009, 5-10 m (GCA9000)	REG010, 5-10 m (GCA9002)
<i>Major-Parameters</i>							<i>Minor-Ions</i>						
pH	6.3	6.3	6.3	6.4	6.4	6.3	Fe	21	30	39	49	25	55
							Cu	1.3	0.7	0.2	0.4	0.2	0.5
<i>Major-Ions</i>							Ni	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
K	72	63	73	74	66	74	Zn	15	5.8	9.7	4.9	4.5	2.8
Mg	47	39	61	51	46	40	Co	0.067	0.047	0.024	0.037	0.023	0.02
Ca	17	25	35	72	16	5	Al	45	47	33	44	29	29
							Cd	0.059	0.058	0.061	0.056	0.057	0.057
							Pb	0.36	1.1	0.26	0.35	0.22	1.4
							Cr	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
							Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
							As	0.015	0.012	0.011	0.009	0.006	0.009
							Sb	0.0008	0.0008	0.0003	0.0004	0.0007	0.0032
							Bi	0.0021	0.0031	0.0019	0.0016	0.0017	0.033
							Se	0.008	0.009	0.012	0.008	0.008	0.011
							B	0.2	0.2	0.3	0.2	0.4	0.2
							Mo	0.015	0.027	0.011	0.018	0.0094	0.023
							P	<1	<1	<1	<1	<1	<1
							Si	32	30	22	34	27	21
							Ag	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
							Ba	3.8	4.2	4.3	7.3	3.9	7.6
							Sr	0.33	0.37	0.45	0.74	0.73	0.27
							Tl	0.0022	0.0034	0.0017	0.0037	0.0026	0.0097
							V	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
							Sn	0.005	0.003	0.003	0.004	0.003	0.005
							U	0.019	0.011	0.013	0.017	0.017	0.012
							Th	0.17	0.16	0.18	0.16	0.18	0.16
							Mn	4.6	2.4	0.8	1.0	0.7	0.6

Table 4 (Cont'd): Na<sub>2</sub>EDTA-Extraction-Testwork Results for Waste-regolith Samples

Moderate-Silica- and High-Silica-waste-regolith Samples (0-5 m)

ELEMENT/ PARAMETER	Moderate-Silica			High-Silica			ELEMENT/ PARAMETER	Moderate-Silica			High-Silica		
	5960mN	6080mN	6200mN	5960mN	6080mN	6200mN		5960mN	6080mN	6200mN	5960mN	6080mN	6200mN
	REG003, 0-5 m (GCA9003)	REG007, 0-5 m (GCA9005)	REG0011, 0-5 m (GCA9007)	REG004, 0-5 m (GCA9009)	REG008, 0-5 m (GCA9011)	REG0012, 0-5 m (GCA9013)		REG003, 0-5 m (GCA9003)	REG007, 0-5 m (GCA9005)	REG0011, 0-5 m (GCA9007)	REG004, 0-5 m (GCA9009)	REG008, 0-5 m (GCA9011)	REG0012, 0-5 m (GCA9013)
<i>Major-Parameters</i>							<i>Minor-Ions</i>						
pH	6.4	7.8	6.4	6.4	6.4	6.2	Fe	68	43	80	65	75	65
							Cu	6.8	5.6	0.8	1.5	4.8	1.1
							Ni	0.1	0.3	0.3	0.3	0.4	0.3
<i>Major-Ions</i>							Zn	31	150	20	59	72	44
K	57	72	19	33	41	40	Co	0.23	0.56	0.11	0.32	0.08	0.093
Mg	350	520	120	160	150	190	Al	100	18	56	74	110	53
Ca	690	3,600	30	110	82	89	Cd	0.068	0.073	0.07	0.07	0.067	0.07
							Pb	11	23	2.6	6.1	4	2.5
							Cr	0.3	<0.1	0.2	0.3	0.3	0.2
							Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
							As	0.012	0.027	0.004	0.007	0.005	0.005
							Sb	0.0006	0.0041	0.0007	0.0013	0.0006	0.0005
							Bi	0.059	0.026	0.065	0.17	0.043	0.014
							Se	0.024	0.053	0.012	0.021	0.019	0.018
							B	2.5	2.6	0.3	1.6	1.6	0.6
							Mo	0.013	0.0081	0.038	0.036	0.045	0.032
							P	<1	<1	<1	<1	<1	<1
							Si	48	7.2	35	41	42	30
							Ag	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
							Ba	4.4	0.8	8.4	7.7	6.4	3.6
							Sr	6.0	14	1.0	2.2	1.8	2.2
							Tl	0.0035	0.0018	0.0032	0.002	0.0021	0.0021
							V	1.0	<0.1	0.4	0.7	0.8	0.4
							Sn	0.008	<0.001	0.012	0.007	0.008	0.006
							U	0.016	0.21	0.0018	0.0068	0.0091	0.0016
							Th	0.41	0.33	0.25	0.28	0.24	0.2
							Mn	3.4	4.6	1.1	3.1	0.7	1.7



Table 4 (Cont'd): Na<sub>2</sub>EDTA-Extraction-Testwork Results for Waste-regolith Samples

Moderate-Silica- and High-Silica-waste-regolith Samples (5-10 m)

ELEMENT/ PARAMETER	Moderate-Silica			High-Silica			ELEMENT/ PARAMETER	Moderate-Silica			High-Silica		
	5960mN	6080mN	6200mN	5960mN	6080mN	6200mN		5960mN	6080mN	6200mN	5960mN	6080mN	6200mN
	REG003, 5-10 m (GCA9004)	REG007, 5-10 m (GCA9006)	REG0011, 5-10 m (GCA9008)	REG004, 5-10 m (GCA9010)	REG008, 5-10 m (GCA9012)	REG0012, 5-10 m (GCA9014)		REG003, 5-10 m (GCA9004)	REG007, 5-10 m (GCA9006)	REG0011, 5-10 m (GCA9008)	REG004, 5-10 m (GCA9010)	REG008, 5-10 m (GCA9012)	REG0012, 5-10 m (GCA9014)
<i>Major-Parameters</i>							<i>Minor-Ions</i>						
pH	6.4	6.5	6.4	6.5	6.4	6.4	Fe	27	210	23	38	21	20
							Cu	0.6	0.9	1.2	0.6	1.7	0.4
							Ni	<0.1	0.2	0.3	0.5	0.3	0.2
<i>Major-Ions</i>							Zn	5.9	15	2.8	10	21	18
K	67	74	9	19	15	10	Co	0.035	0.053	0.15	0.056	0.052	0.12
Mg	49	87	12	21	23	23	Al	31	31	9.6	25	26	17
Ca	29	270	6.9	3.7	7.6	5.4	Cd	0.059	0.058	0.059	0.057	0.058	0.057
							Pb	2.5	3.0	0.9	1.0	1.0	1.2
							Cr	<0.1	0.2	<0.1	0.2	<0.1	<0.1
							Hg	<0.001	<0.001	<0.001	<0.001	0.003	<0.001
							As	0.01	0.016	0.014	0.005	0.007	0.006
							Sb	0.0015	0.0028	0.007	0.0083	0.0024	0.0023
							Bi	0.0043	0.0074	0.20	1.3	0.17	0.014
							Se	0.010	0.012	<0.005	<0.005	0.007	0.008
							B	0.3	0.3	<0.1	1.1	1.7	<0.1
							Mo	0.015	0.022	0.034	0.064	0.039	0.032
							P	<1	<1	<1	<1	<1	<1
							Si	28	25	28	30	23	23
							Ag	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
							Ba	11	5.2	8.4	3.0	6.6	7.4
							Sr	0.62	1.8	0.33	0.32	0.52	1.3
							Tl	0.0037	0.0042	0.0036	0.003	0.0033	0.0025
							V	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
							Sn	0.004	0.018	0.015	0.01	0.009	0.004
							U	0.012	0.011	0.0069	0.0041	0.0065	0.0048
							Th	0.16	0.23	0.17	0.089	0.068	0.059
							Mn	0.9	1.9	1.1	1.1	0.6	2.1

---

**ATTACHMENT I**

**DETAILS OF SAMPLING PROGRAMME**

# TECTONIC

Unit 46/328 Albany Highway  
VICTORIA PARK WA 6100

T: 08 6250 4600

F: 08 6250 4699

E: [info@tectonic.com.au](mailto:info@tectonic.com.au)

[www.tectonic.com.au](http://www.tectonic.com.au)

## MEMORANDUM

To: \_\_\_\_\_ Type \_\_\_\_\_ Date: 27<sup>th</sup> August 2010  
From: Bruce Armstrong \_\_\_\_\_ Subject: Trilogly Regolith Characterization

Drilling at Trilogly to test the first 10m vertical regolith profile was completed in early August 2010. Twelve (REG001 to REG012) vertical rotary air blast (RAB) holes of 10m deep were drilled on three sections (5960mN, 6080mN, 6200mN), all inside the proposed pit shell. Each section drilled 2 targeting laminated graphitic siltstones (LGZ), and one each at moderate siliceous and highly siliceous rock type.

Samples were collected on 1m intervals, and assayed for Cu, Pb, Zn, Cd, As, Sb, Se, Fe, Al, Mn, S, Ca, Cr via four-acid "total" digest and ICP read at SGS Newburn, Perth. Five metre composites of at least 5kg each were collected ready for dispatch to Graeme Campbell and Associates for testing.

Review of the data, plotted in sections, has revealed the strongest pattern is Ca enrichment in the near surface (first 1m). No other depth-below-surface v metal enrichment trends are evident.

Regolith is typically 1 to 3m deep, followed by partially oxidised recognisable rock with relict laminations and mineralogy. *Laminated graphitic siltstone* and *moderately siliceous siltstone* was blade drilled (implying free digging or light blasting), whereas *highly siliceous* lithology was hammer drilled from surface (implying blasting from surface).

List of 5m composites drilled at Trilogy August 2010. Holes for regolith waste characterisation.

Hole_id	from m	to m	Lithotype	Cu ppm	Pb ppm	Zn ppm	Cd ppm	As ppm	Average		Mn ppm	S ppm	Ca ppm	Cr ppm	transported m	comments
									Sb ppm	Fe %						
REG001	0	5	LGZ	61	43	202	-	101	2	3.4	196	566	575	100	1	
	5	10	LGZ	83	29	119	-	55	0	2.0	89	123	93	74		
REG002	0	5	LGZ	73	116	81	-	48	0	2.7	131	189	1,757	81	2	
	5	10	LGZ	61	133	69	-	77	2	2.4	106	552	128	70		
REG003	0	5	Mod. Silica	121	185	103	-	143	6	4.0	62	500	1,780	113	2	
	5	10	Mod. Silica	37	422	78	-	74	3	1.8	80	521	125	73		
REG004	0	5	High Silica	46	81	151	-	34	4	3.5	54	210	347	75	1	
	5	10	High Silica	49	99	33	-	20	9	1.5	70	119	288	49		
REG005	0	5	LGZ	40	39	117	-	39	2	4.1	118	324	4,615	97	3	
	5	10	LGZ	36	25	145	-	210	3	7.4	135	359	150	89		
REG006	0	5	LGZ	49	74	93	-	60	3	3.9	160	240	7,285	103	2	
	5	10	LGZ	75	81	151	-	131	3	7.1	334	365	253	80		
REG007	0	5	Mod. Silica	173	369	400	-	110	9	6.2	96	806	13,202	136	3	
	5	10	Mod. Silica	174	867	205	-	198	5	3.7	95	4,638	706	106		proximal to ore, elevated metals: do not test?
REG008	0	5	High Silica	179	67	158	-	71	7	5.1	36	273	712	113	1	
	5	10	High Silica	76	40	48	-	18	6	1.0	40	266	512	59		
REG009	0	5	LGZ	64	53	187	-	95	2	4.9	95	223	6,181	122	3	
	5	10	LGZ	29	45	84	-	34	3	2.9	90	228	144	87		
REG010	0	5	LGZ	108	210	131	-	86	9	4.5	97	394	3,586	105	2	
	5	10	LGZ	208	246	154	-	294	37	7.9	127	633	106	86		
REG011	0	5	Mod. Silica	26	65	55	-	45	9	4.1	82	279	228	80	3	
	5	10	Mod. Silica	26	51	15	-	16	3	1.1	104	456	23	22		
REG012	0	5	High Silica	25	54	104	-	23	8	3.0	63	389	231	66	3	
	5	10	High Silica	32	29	36	-	8	8	0.7	64	194	69	22		

---

**ATTACHMENT II**

**TESTWORK METHODS**

---

## ATTACHMENT II

### TESTWORK METHODS

The testwork methods outlined below are proven approaches to 'static-testing' within the Australian, and international mining-industries (e.g. Price 2009; Stewart *et al.* 2006; AMIRA 2002; Morin and Hutt 1997).<sup>1</sup> The MEND-document prepared by Price (2009), and *c.* 10-20 years in the making by an experienced practitioner, is an invaluable source of information on testing methods on mine-waste geochemistry. There is also the Global-Acid-Rock-Drainage-Guide (GARD Guide) which is an INAP initiative (go to: [www.gardguide.com](http://www.gardguide.com)). However, in terms of comprehensiveness, structure, and clarity, the document by Price (2009) is recommended.

Part of the acid-base-account (ABA) testing, and all of the multi-element analyses, and clay-surface-chemical determinations, are carried out by Genalysis Laboratory Services Pty Ltd [GLS] (Maddington). Specialised ABA-testing is undertaken by GCA (Bridgetown), and characterisation of rock- and clay-mineralogy is carried out by Roger Townend & Associates (Malaga), and CSIRO (Bentley), respectively.

Samples are crushed to 2mm (nominal) in a jaw/rolls-crusher, and pulverised to 75µm (nominal), for specific tests, as required. These sample-splits are referred to herein as "crushings" and "pulp", respectively.

It should be noted that the testwork methods described below are routinely employed in work programmes undertaken by GCA. However, the testwork methods described are generic, and specific tests may not necessarily be undertaken in a given study.

#### 1.0 ACID-BASE-CHEMISTRY AND SALINITY TESTWORK

Acid-base chemistry and salinity are assessed by determining:

- pH and Electrical-Conductivity (EC) on sample slurries;
- Total-Sulphur (Total-S), and Sulphate-Sulphur (SO<sub>4</sub>-S);
- Acid-Neutralisation-Capacity (ANC), and CO<sub>3</sub>-C;
- Net-Acid-Producing-Potential (NAPP); and,
- Net-Acid-Generation (NAG).

Relevant details of the testwork methods employed are discussed below. Further details are presented in the laboratory reports.

---

<sup>1</sup> 'Static'-testing' corresponds to "whole-rock" analyses and tests.

---

## 1.1 pH-(1:2) and EC-(1:2) Tests

Measurements of pH and EC are performed on slurries prepared using deionised-water, and a solid:water ratio of *c.* 1:2 (w/w). The slurries are allowed to age for *c.* 24 hours, prior to measuring pH and EC.<sup>2</sup> These tests are performed on the crushings.

pH-(1:2) and EC-(1:2) values provide a measure of the inherent acidity/alkalinity and salinity.<sup>3</sup>

## 1.2 Total-S and SO<sub>4</sub>-S

Total-S is determined by Leco combustion (@ 1300 °C) with detection of evolved SO<sub>2(g)</sub> by infra-red spectroscopy. SO<sub>4</sub>-S is determined by the Na<sub>2</sub>CO<sub>3</sub>-Extraction Method (Berigari and Al-Any 1994; Lenahan and Murray-Smith 1986).<sup>4</sup> The difference between Total-S and SO<sub>4</sub>-S indicates the Sulphide-S (strictly Non-Sulphate-S) value. The Total-S and SO<sub>4</sub>-S tests are performed on pulps.

## 1.3 Acid-Consuming Properties

### 1.3.1 ANC

ANC is determined by a procedure based on that of Sobek *et al.* (1978) which is the "standard" ANC-testing method (AMIRA 2002; Morin and Hutt 1997).

Samples (as crushings) are reacted with dilute HCl for *c.* 2 hours at 80-90 °C, followed by back-titration with NaOH to a pH=7 end-point to determine the amount of acid consumed.<sup>5</sup> The simmering step for *c.* 2 hours differs from the Sobek *et al.* procedure wherein test-mixtures are heated to near boiling until reaction is deemed to be complete, followed by boiling for one minute. In terms of the dissolution of carbonate- and primary-silicate-minerals, this variation to the Sobek *et al.* method is inconsequential.

The Sobek *et al.* (1978) procedure subjects samples to both strongly-acidic conditions (e.g. pH of 1-2), and a near-boiling temperature. Provided excess acid is added, the dissolution of carbonate-minerals is near-quantitative, and traces of primary-silicates

---

<sup>2</sup> The slurries are stirred at the beginning of the testwork, and once again immediately prior to measuring pH and EC.

<sup>3</sup> The pH-(1:2) values approximate the "Abrasion-pH" values for identifying minerals in the field (e.g. Stevens and Carron 1948).

<sup>4</sup> The Na<sub>2</sub>CO<sub>3</sub>-reagent extracts SO<sub>4</sub> which occurs as soluble sulphates, and calcium sulphates (e.g. gypsum and anhydrite). It also extracts SO<sub>4</sub> sorbed to the surfaces of sesquioxides, clays and primary-silicates. However, SO<sub>4</sub> present as barytes (BaSO<sub>4</sub>) is not extracted, and SO<sub>4</sub> associated with jarositic-type and alunitic-type compounds is incompletely extracted.

<sup>5</sup> A few drops of 30 % (w/w) H<sub>2</sub>O<sub>2</sub> are added to the test mixtures as the pH=7 end-point is approached, so that Fe(II) forms released by the acid-attack of ferroan-carbonates (and -silicates) are oxidised to Fe(III) forms (which then hydrolyse to "Fe(OH)<sub>3</sub>"). This step ensures that the resulting ANC values are not unduly biased "on-the-high-side", due to the release of Fe(II) during the acid-digestion step (AMIRA 2002), provided that the ferroan-carbonate content is not excessive (e.g. siderite-C values less than 1.5 % [Stewart *et al.* 2006]).

---

also dissolve. However, at circum-neutral-pH (viz. pH 6-8) relevant to mine-waste and environmental management, the dissolution of primary-silicates is kinetically limiting (e.g. see review-monograph by White and Brantley [1995]).

In the absence of inhibiting alteration-rims, dissolution rates of mafic/felsic-silicates generally equate to H<sub>2</sub>SO<sub>4</sub>-consumption rates 'of-the-order' 10<sup>-11</sup>-10<sup>-12</sup> moles/m<sup>2</sup>/s. Accordingly, for particle-sizes within the sub-mm range, circum-neutral-dissolution rates of primary-silicates correspond to Sulphide-Oxidation Rates (SORs) 'of-the-order' 1-10 mg SO<sub>4</sub>/kg/week (= c. 0.1-1.0 kg H<sub>2</sub>SO<sub>4</sub>/tonne/year).<sup>6</sup> In practice, circum-neutral buffering through the surface-hydrolysis/dissolution of primary-silicates is therefore restricted to both particle-gradings akin to "rock-flour" (viz. sub-mm), and slow rates of sulphide-oxidation (e.g. as exhibited by "trace-sulphides" which are not atypically reactive).<sup>7</sup>

Despite aggressive-digestion conditions, the ANC values determined by the Sobek *et al.* (1978) method allow an informed "screening" of acid-consuming properties, especially when due regard is given to groundmass-mineralogy (Morin and Hutt 1997). Jambor *et al.* (2005, 2002, 2000) list 'Sobek-ANC' values for different types of primary-silicates which assists interpretation of ANC-testwork results.

That the ANC value is not an intrinsic property of a sample of geologic media, but rather the outcome of the particular ANC-testwork method employed, is shown by Morin and Hutt (2009).

### 1.3.2 CO<sub>3</sub>-C

CO<sub>3</sub>-C is the difference between the Total-C and Total-Organic-C (TOC). Total-C is measured by Leco combustion (@ 1300 °C) with detection of evolved CO<sub>2(g)</sub> by infra-red spectroscopy. TOC is determined by Leco combustion on a sub-sample which had been treated with strong HCl to decompose carbonate-minerals. Pulps are used for these determinations.

### 1.3.3 pH-Buffering Properties

pH-Buffering properties are determined via a Metrohm<sup>®</sup> 736 Titrino auto-titrator, and 0.05 M-H<sub>2</sub>SO<sub>4</sub>. Auto-titrations comprise regular addition of H<sub>2</sub>SO<sub>4</sub> to decrease the pH values of the test-suspensions (prepared using pulps) to 3.0 typically over the course of

---

<sup>6</sup> SORs of this magnitude (at circum-neutral-pH) would typically only be recorded for the oxidation of "trace-sulphides" (e.g. Sulphide-S contents less than c. 0.5 %) which are not hyper-reactive, and so excludes *inter alia* framboidal-pyrite, and marcasite.

<sup>7</sup> Primary-particle-sizes within the "rock-flour" range is a given for process-tailings-solids. In the case of mine-wastes, despite its usually small weight-based abundance, this size-fraction is invariably the main seat of geochemical-weathering reactions within waste-dumps, and thereby the main "source-term" for solute generation (e.g. Price and Kwong 1997). Such "rock-flour" occurs in two forms: that obtained via dry-sieving, and that associated with the surfaces of clasts of wide-ranging sizes, and which can only be obtained via wet-sieving.



---

c. 1 day.<sup>8</sup> Despite taking up to 1 day to complete, the H<sub>2</sub>SO<sub>4</sub>-addition rates employed in the auto-titrations are 'orders-of-magnitude' faster than the sulphide-oxidation rates typically observed under "ambient-weathering" conditions.

#### 1.4 NAPP Calculations

NAPP values are calculated from Total-S, SO<sub>4</sub>-S and ANC values, assuming that all of the Sulphide-S occurs in the form of pyrite, and/or pyrrhotite. NAPP values facilitate assessment of Acid-Formation Potential (AFP).

The complete-oxidation of pyrite (and/or marcasite) may be described by:



The complete-oxidation of pyrrhotite may be described by:



Since pyrrhotite is non-stoichiometric, expressing it as "FeS" is approximate (Janzen *et al.* 2000). Elemental-S may also be produced during pyrrhotite weathering (Nicholson and Scharer 1994), especially at low-pH. However, Elemental-S is ultimately oxidised to H<sub>2</sub>SO<sub>4</sub>.

It may be shown that, if the Sulphide-S (in %S) occurs as pyrite/pyrrhotite, then the amount of acid (in kg H<sub>2</sub>SO<sub>4</sub>/tonne) produced through complete-oxidation is given by **30.6 x %S**. That is, the same conversion-factor of 30.6 applies for both pyrite-, and pyrrhotite-oxidation.

Note: The above treatment of oxidation-reaction stoichiometry is restricted to oxidation by 'atmospheric-O<sub>2</sub>' which is the dominant oxidant at circum-neutral-pH. A different oxidation-stoichiometry applies under acidic conditions (e.g. pH less than 3-4) where soluble-Fe(III) forms prevail, and then function as the chief oxidant (e.g. Rimstidt and Newcomb 1993).

Mechanistic aspects of pyrite- and pyrrhotite-oxidation were reviewed by Rimstidt and Vaughan (2003), and Belzile *et al.* (2004), respectively.

#### 1.5 NAG Tests

The NAG Test is a direct measure of the potential for acid-production through sulphide-oxidation, and also provides an indication of the reactivity of the sulphide-minerals, and the availability of alkalinity-forms (AMIRA 2002; Miller *et al.* 1997, 1994). Since this test is performed on pulps, sulphide-grains are fully liberated, and available for reaction.

---

<sup>8</sup> In titrating to a pH=3.0 end-point, any Fe(II) released through acid attack of ferroan-carbonates and -silicates is not quantitatively oxidised to Fe(III), and subsequently hydrolysed/precipitated to "Fe(OH)<sub>3</sub>". The equivalent of c. 0.5 kg H<sub>2</sub>SO<sub>4</sub>/tonne is generally required to decrease the pH of the "solution-only" to pH=3.0. No correction is made for this "electrolyte-consumption" of H<sub>2</sub>SO<sub>4</sub>.

---

The sample is reacted with H<sub>2</sub>O<sub>2</sub> to oxidise sulphide-minerals, and allow the produced acid to react with the acid-neutralising components (chiefly carbonate-minerals). The results from NAG testwork supplement the NAPP-based assessment of AFP (Stewart *et al.* 2006; Shaw 2005; Morin and Hutt 1997).

The NAG-testing methodology used by GCA is the 'Static-NAG Test' in its "single-addition" mode, with NaOH-titration to a pH=7 end-point (AMIRA 2002; Miller *et al.* 1994, 1997). The Start-pH of the 15 % (v/v) H<sub>2</sub>O<sub>2</sub> solution (prepared from A.R.-grade H<sub>2</sub>O<sub>2</sub>) is adjusted to pH=4.5 using 0.1 M-NaOH. The boiling treatment to decompose residual, unreacted-H<sub>2</sub>O<sub>2</sub> following overnight reaction is carried out in two stages (viz. boiling for *c.* 2 hours initially, cooling and addition of 1 mL of 0.02 M-CuSO<sub>4</sub>, followed by boiling for a further *c.* 2 hours). The addition of Cu(II) catalyses the decomposition of unreacted-H<sub>2</sub>O<sub>2</sub>, and thereby prevents "positive-blank" values (McElnea and Ahern 2004; O'Shay *et al.* 1990).<sup>9</sup>

Prior to the boiling steps, the pH values of the test-suspensions are measured. Such pH values reflect buffering under ambient conditions without accelerated dissolution of groundmass-minerals through boiling. In the interpretation of NAG-testwork results, it is important to note the pH values prior to the boiling steps, especially for lithotypes characterised by "trace-sulphides" (e.g. Sulphide-S within the sub-% range), and ANC values less than *c.* 10-20 kg H<sub>2</sub>SO<sub>4</sub>/tonne (e.g. a groundmass devoid of carbonate-minerals). The rates of "peroxide-oxidation" are orders-of-magnitude faster than those of "ambient-oxidation" (viz. SORs recorded in kinetic-testing employing Weathering-Columns). If circum-neutral-pH is to prevail during NAG testwork, then the rate of acid-consumption must be proportionately faster than that for "ambient-oxidation", and is essentially restricted to buffering by reactive-carbonate-minerals (e.g. calcites, dolomites, and ankerites). This aspect must be borne in mind when interpreting NAG-testwork results, especially for samples that contain "trace-sulphides" in a carbonate-deficient groundmass.

## 2.0 MULTI-ELEMENT ANALYSES

The total content of a wide range of major- and minor-elements are determined through the use of various digestion and analytical techniques. The respective detection-limits are appropriate for environmental investigations.

Element enrichments are identified using the *Geochemical Abundance Index (GAI)*.<sup>10</sup> The GAI quantifies an assay result for a particular element in terms of the average-

---

<sup>9</sup> Where samples contain sufficient Cu(II), then Cu(II) forms will be released to solution during reaction with H<sub>2</sub>O<sub>2</sub>, especially at low-pH.

<sup>10</sup> The GAI was developed by Förstner *et al* (1993), and is defined as:

$$GAI = \log_2 [C_n / (1.5 \times B_n)]$$

where:

C<sub>n</sub> = measured content of n-th element in the sample.

B<sub>n</sub> = "background" content of the n-th element in the sample.

---

crustal-abundance of that element.<sup>11</sup> The latter corresponds to the typical composition of soils, regoliths and bedrocks derived from unmineralised terrain.

The GAI (based on a log-2 scale) is expressed in 7 integer increments (viz. 0 to 6). A GAI of 0 indicates that the content of the element is less than, or similar to, the average-crustal-abundance; a GAI of 3 corresponds to a 12-fold enrichment above the average-crustal-abundance; and so forth, up to a GAI of 6 which corresponds to a 96-fold, or greater, enrichment above average-crustal-abundances.

### 3.0 MINERALOGY AND CLAY-SURFACE CHEMISTRY

The semi-quantitative mineralogy, and clay-surface chemistry (generally restricted to waste-regoliths, oxide-ores, and/or soils), are determined using methods routinely used in geology, and soil science.

Indicative abundances of mineral fall into one of the following broad classes, viz.

- |   |           |                   |
|---|-----------|-------------------|
| • | dominant  | greater than 50 % |
| • | major     | 20-50 %           |
| • | minor     | 10-20 %           |
| • | accessory | 2-10 %            |
| • | trace     | less than 2 %     |

Randomly- and preferentially-oriented specimens are prepared, and variously treated with sodium-hexametaphosphate (dispersant), ethylene-glycol, and heating, to quantify non-expansive, and expansive (e.g. smectites), varieties of clay-minerals.

The Effective-Cation-Exchange Capacity (eCEC), and suite of Exchangeable-Cations, are determined by different methods for samples (as crushings) of non-calcareous and calcareous materials (Rengasamy and Churchman 1999). In both cases, soluble-salts are initially removed via pre-washing using a "mixed-organic-solvent" (viz. ethylene-glycol and ethanol). Method 15A2 in Rayment and Higginson (1992) is then employed for non-calcareous samples to determine eCEC, and Exchangeable-Sodium Percentage (ESP). In the case of calcareous samples, a method based on that described by Pierce and Morris (2004) is used, and prevents the dissolution of carbonate-minerals (e.g. calcites and dolomites).<sup>12</sup> After the initial pre-washing step above, extraction is carried out with 1 M-NH<sub>4</sub>Cl buffered at pH=8.5 in an ethanolic-aqueous solution. Without such precautions to suppress dissolution of carbonate-minerals, the eCEC is biased "on-the-high-side", and ESP biased "on-the-low-side". Depending on the abundance and nature of the carbonate-minerals, the magnitude of this bias can be marked.

---

<sup>11</sup> The average-crustal-abundances of the elements for the GAI calculations are based on the values listed in Bowen (1979).

<sup>12</sup> The procedure described by Pierce and Morris (2004) is closely related to that originally developed by Tucker (1974).

---

## 4.0 SOLUBILITY OF MAJOR/MINOR-ELEMENTS

### 4.1 Water-Extraction Testwork

Water-Extraction Testwork on the crushings is performed via the bottle-roll technique, and using deionised-water. The test-slurries have a solid:solution ratio of *c.* 1:2 (w/w), and are bottle-rolled for *c.* 1 day before being left to "still-stand" for *c.* 1 day to allow suspended mineral-fines to settle. The resulting supernatants are decanted, vacuum-filtered (0.45µm-membrane), and preserved, as appropriate, for specific analyses. Where required, centrifuging at *c.* 4,000 G for 30 minutes is undertaken to expedite solid-solution separation for vacuum-filtration. The Water-Extraction Testwork is performed in the GCA-Testing Laboratory.

### 4.2 Na<sub>2</sub>EDTA-Extraction Testwork

Na<sub>2</sub>EDTA-Extraction Testwork (at pH=6) is carried out on the crushings, based on the method described by Clayton and Tiller (1979). The test-slurries have a solid:solution ratio of *c.* 1:2 (w/w), and are bottle-rolled for *c.* 7 days. This testwork provides a measure of the "metal-pool" potentially available for uptake by biota (e.g. absorption by plant roots).

## 5.0 REFERENCES

- AMIRA International Ltd, 2002, "ARD Test Handbook", Prepared by Ian Wark Research Institute, and Environmental Geochemistry International Pty Ltd
- Belzile N, Chen Y-W, Cai M-F and Li Y, 2004, "A Review on Pyrrhotite Oxidation", *Journal of Geochemical Exploration*, **84**:65-76
- Berigari MS and Al-Any FMS, 1994, "Gypsum Determination in Soils by Conversion to Water-Soluble Sodium Sulfate", *Soil Science Society of America Journal*, **58**:1624-1627
- Bowen HJM, 1979, "Environmental Chemistry of the Elements", Academic Press, New York
- Clayton PM and Tiller KG, 1979, "A Chemical Method for the Determination of the Heavy Metal Content of Soils In Environmental Studies", Division of Soils, Technical Paper No. 41, CSIRO
- Förstner U, Ahlf W and Calmano W, 1993, "Sediment Quality Objectives and Criteria Development in Germany", *Water Science & Technology*, **28**:307-316
- Jambor JL, Dutrizac JE and Chen TT, 2000, "Contribution of Specific Minerals to the Neutralization Potential in Static Tests", pp. 551-565 in "Proceedings from the Fifth International Conference on Acid Rock Drainage", Volume I, Denver
- Jambor JL, Dutrizac JE, Groat LA and Raudsepp M, 2002, "Static Tests of Neutralization Potentials of Silicate and Aluminosilicate Minerals", *Environmental Geology*, **43**:1-17
- Jambor JL, Dutrizac JE and Raudsepp M, 2005, "Neutralization Potentials of Some Common and Uncommon Rocks, and Some Pitfalls in NP Measurements", in "Challenges in the Prediction of Drainage Chemistry", Proceedings of the 12th Annual British Columbia – MEND ML/ARD Workshop
- Janzen MP, Nicholson RV and Schärer JM, 2000, "Pyrrhotite Reaction Kinetics: Reaction Rates for Oxidation by Oxygen, Ferric Iron, and for Nonoxidative Dissolution", *Geochimica et Cosmochimica Acta*, **64**:1511-1522
- Jerz JK and Rimstidt JD, 2004, "Pyrite Oxidation in Moist Air", *Geochimica et Cosmochimica Acta*, **68**:701-714
- Lenahan WC and Murray-Smith R de L, 1986, "Assay and Analytical Practice in the South African Mining Industry", The South African Institute of Mining and Metallurgy Monograph Series M6, Johannesburg
- McElnea AE and Ahern CR, 2004, "Peroxide pH (pH<sub>ox</sub>), Titratable Peroxide Acidity (TPA) and Excess Acid Neutralising Capacity (ANC<sub>E</sub>) – Method Codes 23B, 23G and 23Q", Chapter 3 in "Acid

- 
- Sulfate Soils Laboratory Methods Guidelines", Eds Ahern CR, McElnea AE and Sullivan LA, Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland
- Miller SD, Jeffery JJ and Donohue TA, 1994, "Developments in Predicting and Management of Acid Forming Mine Wastes in Australia and Southeast Asia", pp. 177-184 in "Proceedings of the International Land Reclamation and Mine Drainage Conference and Third International Conference on the Abatement of Acidic Drainage", Pittsburgh
- Miller S, Robertson A and Donohue T, 1997, "Advances in Acid Drainage Prediction Using the Net Acid Generation (NAG) Test", pp. 535-547 in "Proceedings of the Fourth International Conference on Acid Rock Drainage", Vancouver
- Morin KA and Hutt NM, 1997, "Environmental Geochemistry of Minesite Drainage: Practical Theory and Case Studies", MDAG Publishing, Vancouver
- Morin KA and Hutt NM, 2009, "On the Nonsense of Arguing the Superiority of an Analytical Method for Neutralization Potential", Mine Drainage Assessment Group (MDAG), Internet Case Study #32 (go to: [www.mdag.com](http://www.mdag.com))
- Nicholson RV and Scharer JM, 1994, "Laboratory Studies of Pyrrhotite Oxidation Kinetics", pp. 14-30 in Alpers CN and Blowes DW (eds), "Environmental Geochemistry of Sulfide Oxidation", ACS Symposium Series 550, American Chemical Society, Washington D.C.
- O'Shay T, Hossner LR and Dixon JB, 1990, "A Modified Hydrogen Peroxide Method for Determination of Potential Acidity in Pyritic Overburden", *Journal of Environmental Quality*, **19**:778-782
- Pierce CG and Morris S, 2004, "Comparison of Extraction Techniques for Measuring Exchangeable Cations in Calcareous Soils", *Australian Journal of Soil Research*, **42**:301-311
- Price W, 2009, "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials", MEND Report 1.20.1
- Price W and Kwong YTJ, 1997, "Waste Rock Weathering, Sampling and Analysis: Observations from the British Columbia Ministry of Employment and Investment Database", pp. 31-45 in "Proceedings of the Fourth International Conference on Acid Rock Drainage", Vancouver
- Rayment GE and Higginson FR, 1992, "Australian Laboratory Handbook of Soil and Water Chemical Methods", Inkata Press, Melbourne
- Rengasamy P and Churchman GJ, 1999, "Cation Exchange Capacity, Exchangeable Cations and Sodicity", Chapter 9, pp. 147-170 in Peverill KI, Sparrow LA, and Reuter DJ (eds), "Soil Analysis: An Interpretation Manual", CSIRO Publishing, Collingwood
- Rimstidt JD and Vaughan DJ, 2003, "Pyrite Oxidation: A State-of-the-Art Assessment of Reaction Mechanism", *Geochimica et Cosmochimica Acta*, **67**:873-880
- Shaw S, 2005, "Case Studies and Subsequent Guidelines for the Use of the Static NAG Procedure", Presentation A.4 in "Proceedings of the 12th Annual British Columbia – MEND ML/ARD Workshop on "Challenges in the Prediction of Drainage Chemistry", November 30 to December 1, 2005, Vancouver, British Columbia
- Sobek AA, Schuller WA, Freeman JR and Smith RM, 1978, "Field and Laboratory Methods Applicable to Overburdens and Minesoils", EPA-600/2-78-054
- Stevens RE and Carron MK, 1948, "Simple Field Test for Distinguishing Minerals by Abrasion pH", *American Mineralogist*, **33**:31-49
- Stewart WA, Miller SD and Smart R, 2006, "Advances in Acid Rock Drainage (ARD) Characterisation of Mine Wastes", pp. 2098-2117 in "Proceedings from the Seventh International Conference on Acid Rock Drainage", St. Louis, Missouri
- Tucker BM, 1974, "Laboratory Procedures for Cation Exchange Measurements on Soils", Division of Soils Technical Paper No. 23, CSIRO, Melbourne
- White AF and Brantley SL (eds.), 1995, "Chemical Weathering Rates of Silicate Minerals", Reviews in Mineralogy, Volume 31, Mineralogical Society of America, Washington, D.C.

---

**ATTACHMENT III**

**ACID-FORMATION POTENTIAL (AFP):**

**CALCULATED PARAMETERS AND CLASSIFICATION CRITERIA**

---

## ATTACHMENT III

### ACID-FORMATION POTENTIAL (AFP):

#### CALCULATED PARAMETERS AND CLASSIFICATION CRITERIA

Notes: The geochemically-based parameters, and AFP-classification criteria, indicated below apply equally to samples of mine-wastes (e.g. waste-regoliths and waste-bedrocks), low-grade-ores, and process-tailings-solids. The generic descriptor "test-sample" is employed below.

#### 1.0 CALCULATED PARAMETERS

Maximum-Potential-Acidity (MPA) values (in kg H<sub>2</sub>SO<sub>4</sub>/tonne) of test-samples are typically calculated by multiplying the Sulphide-S values (in %) by 30.6. The multiplication-factor of 30.6 reflects both the reaction stoichiometry for the complete-oxidation of pyrite, by O<sub>2</sub> to "Fe(OH)<sub>3</sub>" and H<sub>2</sub>SO<sub>4</sub>, and the different weight-based units of %, and kg H<sub>2</sub>SO<sub>4</sub>/tonne.

Net-Acid-Producing-Potential (NAPP) values (in kg H<sub>2</sub>SO<sub>4</sub>/tonne) are calculated from the corresponding MPA and Acid-Neutralisation-Capacity (ANC) values (i.e. NAPP = MPA - ANC).

#### 2.0 CLASSIFICATION CRITERIA

In terms of AFP, test-samples may be classified into one of the following categories, viz.

- Non-Acid Forming (NAF)
- Potentially-Acid Forming (PAF)

There are **no** unifying, "standard" criteria for classifying the AFP of test-samples (e.g. Price 2009; AMIRA 2002), and reflects the diversity of sulphide- and gangue-mineral assemblages within (un)mineralised-lithotypes of varying weathering- and alteration-status. Rather, criteria for classifying AFP may need to be tailored to deposit-specific geochemistry, mineralogy, and site-specific climate.

The AFP-classification criteria often employed at mining-operations worldwide are:

- **NAF:** Sulphide-S < 0.3 %. For Sulphide-S ≥ 0.3 %, both a negative NAPP value, and an ANC/MPA ratio ≥ 2.0
- **PAF:** For Sulphide-S ≥ 0.3 %, any positive-NAPP value; negative-NAPP value with an ANC/MPA ratio < 2.0

---

In assessing AFP, lithotypes from hard-rock mines with Sulphide-S values less than 0.3 % are unlikely to acidify (e.g. pH less than 4-5) through sulphide-oxidation. This position holds especially where the groundmass hosting the "trace-sulphides" is not simply quartz, soil-clays, and/or sesquioxides (Price *et al.* 1997), and where the sulphide-minerals are not hyper-reactive varieties (e.g. framboidal-pyrite). A "cut-off" of 0.3 % for Sulphide-S also accords with the findings of kinetic-testing, since the late-1980s, by Dr. Graeme Campbell for test-samples of diverse mineralogy in terms of sulphide-weathering dynamics, and solubility behaviour.

The risk posed by PAF-lithotypes during the active-mine-life is governed primarily by the duration of the lag-phase (i.e. the period during which sulphide-oxidation occurs, but acidification does not develop, due to circum-neutral buffering by gangue-phases [chiefly reactive-carbonate-minerals]).<sup>1</sup> Although the duration of the lag-phase for mine-wastes at field-scale cannot be accurately predicted *a priori*, estimates may still be needed to identify threshold exposure-times for the safe handling of PAF-lithotypes. Lag-phase duration may be estimated via kinetic-testing (viz. Weathering-Columns), and consideration of the moisture/aeration/thermal-regimes of exposed (i.e. uncovered) mine-wastes under the site's climatic conditions. In the absence of results from kinetic-testing, experience permits "first-pass" estimates of sulphide-oxidation rates and lag-phase duration to be made from the results of static-testing, and thereby classify PAF-lithotypes into **PAF-[Short-Lag]** and **PAF-[Long-Lag]** sub-categories. Such "first-pass" estimations are necessarily provisional, and subject to revision, in the light of the outcomes of kinetic-testing, and field observations.

### 3.0 REFERENCES

- AMIRA International Ltd, 2002, "ARD Test Handbook", Prepared by Ian Wark Research Institute, and Environmental Geochemistry International Pty Ltd
- Price W, 2009, "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials", MEND Report 1.20.1
- Price WA, Morin K and Hutt N, 1997, "Guidelines for the Prediction of Acid Rock Drainage and Metal Leaching for Mines in British Columbia: Part II. Recommended Procedures for Static and Kinetic Testing", pp. 15-30 in "Proceedings of the Fourth International Conference on Acid Rock Drainage", Volume I, Vancouver

---

<sup>1</sup> SO<sub>4</sub> is still produced by sulphide-oxidation during the lag-phase, and appreciable amounts of soluble-forms of certain minor-elements (e.g. Ni and As) may be released at circum-neutral-pH during lag-phase weathering. However, in the latter case, the mine-wastes would need to be sufficiently enriched in Total-Ni and Total-As to begin with.



---

**ATTACHMENT IV**

**LABORATORY REPORTS**



**Dr G Campbell**  
 CAMPBELL, GRAEME and ASSOCIATES  
 PO Box 247  
 BRIDGETOWN WA 6255

**JOB INFORMATION**

JOB CODE	143/1013622
No. of SAMPLES	24
CLIENT O/N	GCA 1022
PROJECT	Phillips River Trilogy
STATE	pulp
DATE RECEIVED	30/9/2010
DATE COMPLETED	25/10/2010

**LEGEND**

- X = Less than Detection Limit
- N/R = Sample Not Received
- \* = Result Checked
- ( ) = Result still to come
- I/S = Insufficient Sample for Analysis
- E6 = Result X 1,000,000
- UA = Unable to Assay
- > = Value beyond Limit of Method

The samples were received as pulps

**Results of analysis on:**

Element		S	S-SO4	C	TOC+C	C-CO3
Method		Ind/IR	Na2CO3/GR	Ind/IR	HotAcidInd/IR	/CALC
Detection		0.01	0.01	0.01	0.01	0.01
Units		%	%	%	%	%
Sample Name						
Control Blank		X		X		
GCA8991		0.08		0.29	0.11	0.18
GCA8991	check	0.07		0.29		
GCA8992		0.02		0.07		
GCA8993		0.02		0.19		
GCA8994		0.04		0.07		
GCA8995		0.04		0.4	0.12	0.18
GCA8996		0.04		0.09		
GCA8997		0.02		0.27	0.08	0.19
GCA8998		0.04		0.1		
GCA8999		0.02		0.43	0.13	0.3
GCA9000		0.02		0.07		
GCA9001		0.04		0.31	0.15	0.16
GCA9002		0.07		0.12		
GCA9003		0.05		0.18		
GCA9004		0.06		0.08		
GCA9005		0.07		0.84	0.22	0.62
GCA9006		0.57	0.38	0.17		
GCA9007		0.03		0.47	0.35	0.12
GCA9008		0.05		0.72	0.71	0.01
GCA9009		0.03		0.2	0.15	0.15
GCA9010		0.01		0.09		
GCA9011		0.03		0.27	0.19	0.08
GCA9011	check	0.03		0.28		
GCA9012		0.02		0.1		
GCA9013		0.04		0.41	0.31	0.1
GCA9014		0.02		0.17		
OREAS 93		0.76		0.12		
SO-2		0.03		4.52		
S_SO4_A			0.59			
PD-1			4.26			
S_SO4_B			1.33			

1. The C, S results were determined from the pulverised portion
2. The Carbon and Sulphur was determined according to Genalysis method number MPL\_W043
3. S-SO4 was determined by precipitation of BaSO4 according to Genalysis method number ENV\_W039
4. TOC+C (acid insoluble carbon compounds and elemental carbon) by a C&S analyser after removal of carbonates and soluble organic carbon according to Genalysis method number MPL\_W046. This method is not covered by the NATA scope of accreditation

**Results of analysis on:**

sample name		Fizz Rate	volume HCl	HCl M	NaOH M	Colour Change	ANC soln pH	pH Drop	ANC (kgH <sub>2</sub> SO <sub>4</sub> /t)
GCA8991		0	8	0.507	0.196	N	1.3		2
GCA8991	check	0	8	0.507	0.196	N	1.6		2
GCA8992		0	8	0.507	0.196	N	1.3		1
GCA8993		0	8	0.507	0.196	N	1.5		4
GCA8994		0	8	0.507	0.196	N	1.5		-1
GCA8995		1	8	0.507	0.196	N	1.3		15
GCA8996		0	8	0.507	0.196	N	1.5		0
GCA8997		1	8	0.507	0.196	N	1.2		30
GCA8998		0	8	0.507	0.196	N	1.6		5
GCA8999		1	8	0.507	0.196	N	1.2		22
GCA9000		0	8	0.507	0.196	N	1.5		0
GCA9001		1	8	0.507	0.196	N	1.7		19
GCA9002		0	8	0.507	0.196	N	1.6		-1
GCA9003		0	8	0.507	0.196	N	1.6		4
GCA9004		0	8	0.507	0.196	N	1.6		-1
GCA9005		1	8	0.507	0.196	N	1.2		57
GCA9006		1	8	0.507	0.196	N	1.6		5
GCA9007		0	8	0.507	0.196	N	1.6		1
GCA9008		0	8	0.507	0.196	N	1.5		-1
GCA9009		0	8	0.507	0.196	N	1.6		1
GCA9010		0	8	0.507	0.196	N	1.6		-1
GCA9011		0	8	0.507	0.196	N	1.6		2
GCA9011	check	0	8	0.507	0.196	N	1.6		1
GCA9012		0	8	0.507	0.196	N	1.3		-1
GCA9013		0	8	0.507	0.196	N	1.5		1
GCA9014		0	8	0.507	0.196	N	1.5		1

**Notes:**

1. ANC was determined on 2g of the -2mm portion. Acid concentrations are as stated.
2. Colour change: Y indicates the appearance of a green colouration as the pH=7 endpoint was approached. N no change. Two drops of hydrogen peroxide are added to each sample as the endpoint is approached to oxidise any ferrous iron
3. pH drop : Result reported when the pH drops to a value below 4 on addition of peroxide
4. This procedure according to Genalysis method number ENV\_W035

**NATA ENDORSED DOCUMENT****Company Accreditation Number 3244**

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

NATA Signatory: Ann Evers

**Ann Evers**

Date: 25/10/2010



This document is issued in accordance with  
NATA accreditation requirements.

**Dr G Campbell**

CAMPBELL, GRAEME and ASSOCIATES  
 PO Box 247  
 BRIDGETOWN WA 6255

**JOB INFORMATION**

JOB CODE	143/1014446
No. of SAMPLES	1
CLIENT O/N	GCA 1022
PROJECT	Phillips River Trilogy
STATE	pulp
DATE RECEIVED	13/10/2010
DATE COMPLETED	29/10/2010

**LEGEND**

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
()	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

The samples were received as pulps

**Results of analysis on:**

Element		S-SO4	S-SO4
Method		Na2CO3/GR	S71/OE
Detection		0.01	0.01
Units		%	%
Sample Name			
Control Blank		0.01	X
GCA9006		0.36	0.35
GCA9006	check	0.3	0.37
PD-1		4.24	
PD-1			4.1
S_SO4_A		0.58	
S_SO4_B		1.32	

1. S-SO4 was determined by precipitation of BaSO4 according to Genalysis method number ENV\_W039 and by HCl digestion followed by determination of S in solution by OES.(S71/OE)  
 Genalysis method codes: MPL\_W045 and ICP\_W004

**NATA ENDORSED DOCUMENT**  
**Company Accreditation Number 3244**

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

NATA Signatory: Ann Evers

***Ann Evers***

Date: 29/10/2010



This document is issued in accordance with  
NATA accreditation requirements.

## CLIENT DETAILS

Contact **Graeme Campbell**  
 Client **Graeme Campbell & Associates Pty Ltd**  
 Address **PO Box 247  
 BRIDGETOWN WA 6255**

Telephone **0897 612 829**  
 Facsimile **0897 612 830**  
 Email **gca@wn.com.au**

Project **GCA Job No 1022**  
 Order Number **1022**  
 Samples **1**

## LABORATORY DETAILS

Manager **Said Hirad**  
 Laboratory **SGS Newburn Environmental**  
 Address **10 Reid Rd  
 Newburn WA 6104**

Telephone **(08) 9373 3500**  
 Facsimile **(08) 9373 3556**  
 Email **au.environmental.perth@sgs.com**

SGS Reference **PE053394 R0**  
 Report Number **0000009012**  
 Date Reported **02 Nov 2010**


## COMMENTS

The document is issued in accordance with NATA's accreditation requirements.  
 Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(898).

## SIGNATORIES



**Jeremy Truong**  
 Inorganics Co-ordinator



**Kurt Blackman**  
 Inorganic Team Leader - Soils



# ANALYTICAL REPORT

PE053394 R0

Sample Number PE053394.001  
Sample Matrix Pulp  
Sample Name GCA 9006

Parameter Units LOR

**Chromium Reducible Sulphur (CRS) Method: AN217**

Parameter	Units	Value	LOR
Chromium Reducible Sulphur (Scr)	%	0.005	<0.005
Chromium Reducible Sulphur (Scr)	moles H+/T	5	<5
Chromium Reducible Sulphur (Scr)	kg H2SO4/T	0.25	<0.25



MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula: *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

**Chromium Reducible Sulphur (CRS) Method: ME-(AU)-[ENV]AN217**

Parameter	QC Reference	Units	LOR	MB
Chromium Reducible Sulphur (Scr)	LB008283	%	0.005	<0.005
Chromium Reducible Sulphur (Scr)	LB008283	moles	5	<5
Chromium Reducible Sulphur (Scr)	LB008283	kg	0.25	<0.25

METHOD

METHODOLOGY SUMMARY

FOOTNOTES

IS	Insufficient sample for analysis.	QFH	QC result is above the upper tolerance
LNR	Sample listed, but not received.	QFL	QC result is below the lower tolerance
*	This analysis is not covered by the scope of accreditation.	-	The sample was not analysed for this analyte
^	Performed by outside laboratory.		
LOR	Limit of Reporting		
↑↓	Raised or Lowered Limit of Reporting		

Samples analysed as received.  
Solid samples expressed on a dry weight basis.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here:  
<http://www.au.sgs.com/sgs-mp-au-env-qu-022-qa-qc-plan-en-09.pdf>

This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at [http://www.sgs.com/terms\\_and\\_conditions.htm](http://www.sgs.com/terms_and_conditions.htm). The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

This report must not be reproduced, except in full.

*Laboratory Report*

**pH-(1:2) & EC-(1:2) TESTWORK**

<b>SAMPLE NO.</b>	<b>SAMPLE WEIGHT (g)</b>	<b>SAMPLE + DEION.-W WEIGHT (g)</b>	<b>pH-(1:2)</b>	<b>EC-(1:2) (µS/cm)</b>
GCA8991	30.0	60.0	7.6	1,500
GCA8992	30.0	60.0	6.4	890
GCA8993	30.0	60.0	8.6	780
GCA8994	30.0	60.0	5.9	940
GCA8995	30.0	60.0	7.9	1,600
GCA8996	30.0	60.0	4.8	1,400
GCA8997	30.0	60.0	8.7	760
GCA8998	30.0	60.0	6.8	870
GCA8999	30.0	60.0	8.9	1,100
GCA9000	30.0	60.0	7.0	1,010
GCA9001	30.0	60.0	7.9	2,000
GCA9001-1	30.0	60.0	7.8	1,800
GCA9002	30.0	60.0	3.9	1,300
GCA9003	30.0	60.0	7.5	1,400
GCA9004	30.0	60.0	5.3	1,040
GCA9005	30.0	60.0	8.4	1,040
GCA9006	30.0	60.0	7.3	1,400
GCA9007	30.0	60.0	5.8	240
GCA9008	30.0	60.0	5.3	280
GCA9009	30.0	60.0	6.6	960
GCA9010	30.0	60.0	5.4	500
GCA9011	30.0	60.0	6.0	330
GCA9011-1	30.0	60.0	6.0	290
GCA9012	30.0	60.0	5.3	430
GCA9013	30.0	60.0	5.2	850
GCA9014	30.0	60.0	4.6	490
GCA9014-1	30.0	60.0	4.6	480

**Note:** EC = Electrical-Conductivity.

Testwork performed on the as-supplied 'pulp' samples (nominal -75 µm).

pH-(1:2) and EC-(1:2) values correspond to pH and EC values of suspensions with a solid:solution ratio of c. 1:2 (w/w) prepared using deionised-water.

Drift in pH-glass-electrode less than 0.1 pH unit between commencement, and completion, of testwork.

Drift in EC-electrode less than 5 µS/cm between commencement, and completion, of testwork.

Testwork performed in a constant-temperature room (viz. 21 +/- 2-3 °C).

**Dr GD Campbell**  
**17th September 2010**

Laboratory Report

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	Comments	pH of Test Mixture Before Boiling Step	Test Mixture After Boiling Step		Titre [0.1 M-NaOH] (mL)	NAG (kg H <sub>2</sub> SO <sub>4</sub> /tonne)
				pH	EC (µS/cm)		
GCA8991	3.0	No observed reaction	6.7	9.3	120	-	<0.5
GCA8992	3.0	No observed reaction	5.5	5.9	54	0.20	<0.5
GCA8993	3.0	No observed reaction	6.6	9.3	68	-	<0.5
GCA8994	3.0	No observed reaction	5.2	5.1	53	0.20	<0.5
GCA8995	3.0	No observed reaction	7.0	10.2	180	-	<0.5
GCA8996	3.0	No observed reaction	5.0	5.4	71	0.30	<0.5
GCA8997	3.0	No observed reaction	7.1	10.3	140	-	<0.5
GCA8998	3.0	No observed reaction	5.3	5.6	50	0.30	<0.5
GCA8999	3.0	No observed reaction	7.3	9.8	140	-	<0.5
GCA9000	3.0	No observed reaction	5.6	6.4	61	0.20	<0.5
GCA9001	3.0	No observed reaction	6.9	9.8	170	-	<0.5
GCA9002	3.0	No observed reaction	4.4	4.6	71	0.30	<0.5
GCA9003	3.0	No observed reaction	6.5	8.4	82	-	<0.5
GCA9004	3.0	No observed reaction	5.1	5.5	58	0.30	<0.5
GCA9005	3.0	No observed reaction	7.3	10.4	250	-	<0.5
GCA9006	3.0	No observed reaction	6.6	8.6	130	-	<0.5
GCA9007	3.0	No observed reaction	4.5	5.6	38	0.30	<0.5
GCA9008	3.0	Reaction peaked overnight	3.6	3.8	51	0.40	<0.5
GCA9008-1	3.0	Reaction peaked overnight	3.6	3.8	53	0.80	1.4
BLANK1	3.0	No observed reaction	5.8	7.3	34	-	<0.5

**Notes:** Test conditions based on those described by Miller *et al.* (1997), and AMIRA (2002) for the 'Static-NAG-Test' in its "Single-Additon-Mode". The pH of the 15 % (v/v) H<sub>2</sub>O<sub>2</sub> solution was adjusted to 4.5 using 0.1 M-NaOH prior to commencing the NAG Tests. Following an overnight-reaction period, the test-mixtures were boiled for *c.* 2 hours. Then, after allowing the test-mixtures to cool, *c.* 1.0 mL of 0.016 M-CuSO<sub>4</sub> solution was added, and the test-mixtures again boiled for *c.* 2 hours. The addition of Cu(II) catalyses the decomposition of any residual, unreacted-H<sub>2</sub>O<sub>2</sub> in the test-mixtures (McElnea and Ahern 2004; O'Shay *et al.* 1990). K-Feldspar was employed for the Blank.

Dr GD Campbell  
27th October 2010

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	Comments	pH of Test Mixture Before Boiling Step	Test Mixture After Boiling Step		Titre [0.1 M-NaOH] (mL)	NAG (kg H <sub>2</sub> SO <sub>4</sub> /tonne)
				pH	EC (µS/cm)		
GCA9009	3.0	No observed reaction	5.1	6.4	40	0.20	<0.5
GCA9010	3.0	No observed reaction	4.8	5.3	32	0.20	<0.5
GCA9011	3.0	No observed reaction	4.8	6.0	34	0.20	<0.5
GCA9012	3.0	No observed reaction	4.7	5.1	33	0.40	<0.5
GCA9013	3.0	No observed reaction	4.4	6.0	54	0.20	<0.5
GCA9014	3.0	No observed reaction	4.5	5.1	33	0.20	<0.5
GCA9014-1	3.0	No observed reaction	4.5	5.0	31	0.10	<0.5
BLANK2	3.0	No observed reaction	5.8	7.3	37	-	<0.5

**Notes:** Test conditions based on those described by Miller *et al.* (1997), and AMIRA (2002) for the 'Static-NAG-Test' in its "Single-Additon-Mode". The pH of the 15 % (v/v) H<sub>2</sub>O<sub>2</sub> solution was adjusted to 4.5 using 0.1 M-NaOH prior to commencing the NAG Tests. Following an overnight-reaction period, the test-mixtures were boiled for *c.* 2 hours. Then, after allowing the test-mixtures to cool, *c.* 1.0 mL of 0.016 M-CuSO<sub>4</sub> solution was added, and the test-mixtures again boiled for *c.* 2 hours. The addition of Cu(II) catalyses the decomposition of any residual, unreacted-H<sub>2</sub>O<sub>2</sub> in the test-mixtures (McElnea and Ahern 2004; O'Shay *et al.* 1990). K-Feldspar was employed for the Blank.

**Dr GD Campbell**  
**27th October 2010**

# ANALYTICAL REPORT

**Dr G. CAMPBELL**  
**CAMPBELL, GRAEME and ASSOCIATES**  
 PO Box 247  
 BRIDGETOWN, W.A. 6255  
 AUSTRALIA

## JOB INFORMATION

JOB CODE : 143.0/1013621  
 No. of SAMPLES : 24  
 No. of ELEMENTS : 32  
 CLIENT O/N : GCA 1022 (Job 1 of 1)  
 SAMPLE SUBMISSION No. :  
 PROJECT : Phillips River, Trilogy  
 STATE : Ex-Pulp  
 DATE RECEIVED : 30/09/2010  
 DATE COMPLETED : 28/10/2010  
 DATE PRINTED : 28/10/2010  
 PRIMARY LABORATORY : Genalysis Main Laboratory

## LEGEND

X = Less than Detection Limit  
 N/R = Sample Not Received  
 \* = Result Checked  
 ( ) = Result still to come  
 I/S = Insufficient Sample for Analysis  
 E6 = Result X 1,000,000  
 UA = Unable to Assay  
 > = Value beyond Limit of Method  
 OV = Value over-range for Package

## MAIN OFFICE AND LABORATORY

15 Davison Street, Maddington 6109, Western Australia  
 PO Box 144, Gosnells 6990, Western Australia  
 Tel: +61 8 9251 8100 Fax: +61 8 9251 8110  
 Email: [genalysis@intertek.com](mailto:genalysis@intertek.com)  
 Web Page: [www.genalysis.com.au](http://www.genalysis.com.au)

## KALGOORLIE SAMPLE PREPARATION DIVISION

12 Keogh Way, Kalgoorlie 6430, Western Australia  
 Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

## ADELAIDE LABORATORY

11 Senna Road, Wingfield, 5013, South Australia  
 Tel: +61 8 8162 9714 Fax: +61 8 8349 7444

## JOHANNESBURG LABORATORY

43 Malcolm Moodie Crescent,  
 Jet Park, Gauteng, South Africa 1459  
 Tel: +27 11 552 8149 Fax: +27 11 552 8248

## TOWNSVILLE LABORATORY

9-23 Kelli Street, Mt St John, Bohle, Queensland, Australia 4818  
 Tel: +61 7 4774 3655 Fax: +61 7 4774 4692

## SAMPLE DETAILS

### **DISCLAIMER**

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

Genalysis Laboratory Services Pty Ltd disclaims any liability, legal or otherwise, for any inferences implied from this report relating to either the origin of, or the sampling technique employed in the collection of, the submitted samples.

### **SIGNIFICANT FIGURES**

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

**Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.**

## SAMPLE STORAGE DETAILS

### **GENERAL CONDITIONS**

#### **SAMPLE STORAGE OF SOLIDS**

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of \$3.30 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at \$100.00 per cubic metre.

#### **SAMPLE STORAGE OF SOLUTIONS**

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

## NOTES

\*\*\* NATA ENDORSED DOCUMENT \*\*\*\*

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The 24 samples, as listed in the report, were received as being 'Mine-Waste' which had been dried, mixed, crushed and pulverised as per job reference 143.0/1011983.

The results have been determined according to Genalysis methods codes :  
Digestions : MPL\_W001 (A/), SL\_W007 (BP/), ENV\_W012 (DH/SIE), MPL\_W011 (D/), MPL\_W008 (CM/).  
Analytical Finishes: ICP\_W004 (/OES), ICP\_W003 (/MS) and AAS\_W008 (/AAS).

The results included the assay of blanks and international reference standards OREAS 45P,STSD-2,AMIS0076 and Genalysis in-house standards OREAS 97.01 and HgSTD-3.

The results are expressed as parts per million or percent by mass in the dried and prepared material.

NATA Signatory: A Evers  
Chief Chemist

Date: 28th October 2010

This document is issued in accordance with NATA's accreditation requirements.





**ANALYSIS**

ELEMENTS	Cu	F	Fe	Hg	K	Mg	Mn	Mo	Na	Ni
UNITS	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION LIMIT	1	50	0.01	0.01	20	20	1	0.1	20	1
DIGEST	A/	DH/	D/	CM/	A/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	OES	SIE	OES	CVAP	OES	OES	OES	MS	OES	OES
SAMPLE NUMBERS										
0001 GCA8991	66	654	3.31	X	3.01%	7105	183	3.7	2338	61
0002 GCA8992	30	786	1.85	X	3.66%	3786	67	3.9	1429	30
0003 GCA8993	67	540	2.38	0.01	2.07%	3162	92	2.4	1485	30
0004 GCA8994	53	568	2.09	0.02	2.44%	2456	77	6.3	1138	26
0005 GCA8995	53	567	4.08	X	2.24%	4781	100	4.4	2742	55
0006 GCA8996	50	822	7.20	X	3.53%	3898	94	11.9	1731	57
0007 GCA8997	50	821	3.23	X	2.28%	4262	141	2.9	1690	47
0008 GCA8998	69	821	5.39	0.01	2.50%	2981	160	10.1	1199	58
0009 GCA8999	92	786	5.40	X	2.34%	5912	100	4.3	3086	71
0010 GCA9000	37	1281	2.79	X	3.70%	3837	68	2.7	1623	35
0011 GCA9001	133	623	5.19	X	2.16%	3693	72	6.2	3229	52
0012 GCA9002	196	568	6.64	0.02	2.37%	2024	97	17.9	2090	40
0013 GCA9003	117	750	4.24	0.01	1.94%	3047	54	3.8	2145	38
0014 GCA9004	40	940	1.54	0.02	2.92%	2934	51	4.1	1487	18
0015 GCA9005	187	860	6.47	0.03	1.58%	4981	88	5.0	2420	61
0016 GCA9006	205	1458	4.43	0.03	3.57%	3581	67	5.3	2458	31
0017 GCA9007	26	134	3.05	0.06	3400	1046	21	3.8	1038	28
0018 GCA9008	15	50	0.29	0.57	714	149	7	1.2	244	6
0019 GCA9009	39	164	2.80	0.01	1547	1999	27	4.3	1411	35
0020 GCA9010	43	236	0.92	0.02	4356	2447	10	2.6	1308	16
0021 GCA9011	177	593	4.23	0.01	2334	5244	17	8.2	2026	65
0022 GCA9012	87	468	0.75	0.02	2060	4818	13	3.6	1919	28
0023 GCA9013	32	115	2.39	0.02	2024	1436	18	4.6	1446	39
0024 GCA9014	14	99	0.37	0.08	676	323	5	4.1	510	9

**CHECKS**

0001 GCA8991	64	717	3.35	X	2.96%	6904	179	3.7	2273	60
0002 GCA9011	173	540	4.19	0.01	2221	5313	17	8.0	1970	64

**STANDARDS**

0001 AMIS0076	87				4027	3147	378	8.7	912	203
0002 HgSTD-3				0.41						
0003 OREAS 45P			19.01							
0004 OREAS 97.01										
0005 STSD-2		1027								

**BLANKS**

0001 Control Blank	1	56	X	X	X	X	X	X	X	X
0002 Control Blank										
0003 Control Blank				X						



**ANALYSIS**

ELEMENTS	V	Zn
UNITS	ppm	ppm
DETECTION LIMIT	2	1
DIGEST	A/	A/
ANALYTICAL FINISH	OES	OES

## SAMPLE NUMBERS

0001 GCA8991	136	228
0002 GCA8992	106	82
0003 GCA8993	120	71
0004 GCA8994	99	61
0005 GCA8995	135	122
0006 GCA8996	122	147
0007 GCA8997	142	71
0008 GCA8998	105	148
0009 GCA8999	180	160
0010 GCA9000	148	79
0011 GCA9001	158	139
0012 GCA9002	109	128
0013 GCA9003	159	103
0014 GCA9004	132	84
0015 GCA9005	244	395
0016 GCA9006	161	226
0017 GCA9007	107	79
0018 GCA9008	14	12
0019 GCA9009	109	112
0020 GCA9010	39	35
0021 GCA9011	134	130
0022 GCA9012	53	54
0023 GCA9013	86	109
0024 GCA9014	22	29

## CHECKS

0001 GCA8991	133	216
0002 GCA9011	132	129

## STANDARDS

0001 AMIS0076	18	460
0002 HgSTD-3		
0003 OREAS 45P		
0004 OREAS 97.01		
0005 STSD-2		

## BLANKS

0001 Control Blank	X	2
0002 Control Blank		
0003 Control Blank		

**ANALYSIS**

ELEMENTS	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION LIMIT	0.2	50	2	50	0.1	0.01	50	0.1	0.1	5
DIGEST	A/	A/	A/	D/	A/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	MS	OES	MS	OES	MS	MS	OES	MS	MS	OES
<b>BLANKS</b>										
0004 Control Blank				X						
0005 Acid Blank	X	X	X		X	0.03	X	X	X	X
0006 Acid Blank				X						

**ANALYSIS**

ELEMENTS	Cu	F	Fe	Hg	K	Mg	Mn	Mo	Na	Ni
UNITS	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION LIMIT	1	50	0.01	0.01	20	20	1	0.1	20	1
DIGEST	A/	DH/	D/	CM/	A/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	OES	SIE	OES	CVAP	OES	OES	OES	MS	OES	OES
BLANKS										
0004 Control Blank			X							
0005 Acid Blank	X				X	X	X	X	X	X
0006 Acid Blank			X							



## ANALYSIS

ELEMENTS	V	Zn
UNITS	ppm	ppm
DETECTION LIMIT	2	1
DIGEST	A/	A/
ANALYTICAL FINISH	OES	OES

### BLANKS

---

0004 Control Blank

0005 Acid Blank	X	1
-----------------	---	---

---

0006 Acid Blank

---



## METHOD CODE DESCRIPTION

- A/MS** Genalysis Main Laboratory  
Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Mass Spectrometry.
- A/OES** Genalysis Main Laboratory  
Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.
- BP/MS** Genalysis Main Laboratory  
Aqua-Regia digest followed by Precipitation and Concentration. Specific for Selenium. Analysed by Inductively Coupled Plasma Mass Spectrometry.
- D/OES** Genalysis Main Laboratory  
Sodium peroxide fusion (Zirconium crucibles) and Hydrochloric acid to dissolve the melt. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.
- DH/SIE** Genalysis Main Laboratory  
Alkaline fusion (Nickel crucible) specific for Fluorine. Analysed by Specific Ion Electrode.
- CM/CVAP** Genalysis Main Laboratory  
Low temperature Perchloric acid digest specific for Mercury. Analysed by Cold Vapour Generation Atomic Absorption Spectrometry.



**Dr G Campbell**  
 CAMPBELL, GRAEME and ASSOCIATES PTY LTD  
 PO Box 247  
 BRIDGETOWN WA 6255

**JOB INFORMATION**

JOB CODE	143/1014074
No. of SAMPLES	38
CLIENT O/N	GCA 1022
PROJECT	Phillips River Trilogy
STATE	Water extracts
DATE RECEIVED	6/10/2010
DATE COMPLETED	1/11/2010

**LEGEND**

- X = Less than Detection Limit
- N/R = Sample Not Received
- \* = Result Checked
- () = Result still to come
- I/S = Insufficient Sample for Analysis
- E6 = Result X 1,000,000
- UA = Unable to Assay
- > = Value beyond Limit of Method

A range of solutions/slurries were received  
 The slurries were centrifuged and filtered to obtain clear solutions a split of each was acidified with nitric acid

The pH, EC and Cl of each "raw" sample was measured Genalysis method codes ENV-W001, ENV-W002, ENV-W013

The nitric acid dosed filtered solutions were analysed for the requested element suite by ICPOES and ICPMS Genalysis method code (ICP\_W004, ICP\_W003)

**Results of analysis on:**

Element		Cl	EC	pH
Method		/COL	/METER	/METER
Detection		2	0.01	0.1
Units		mg/l	mS/cm	NONE
Sample Name				
Control Blank				
GCA8991 RAW		695	2.78	8.3
GCA8992 RAW		500	1.73	6.8
GCA8992 RAW	check	480	1.75	6.9
GCA8993 RAW		270	1.26	8.9
GCA8994 RAW		525	1.87	6.7
GCA8995 RAW		780	3.14	9.1
GCA8996 RAW		690	2.46	6.3
GCA8997 RAW		290	1.4	9
GCA8998 RAW		385	1.57	7.7
GCA8999 RAW		480	3.37	8.7
GCA9000 RAW		500	1.81	7.3
GCA9001 RAW		915	3.34	9
GCA9002 RAW		630	2.17	4.5
GCA9003 RAW		620	2.57	9.1
GCA9004 RAW		515	1.85	6.7
GCA9005 RAW		420	2.01	9.1
GCA9006 RAW		715	2.71	8.5
GCA9007 RAW		59	0.4	8
GCA9008 RAW		60	0.3	7
GCA9009 RAW		213	1.02	8.5
GCA9010 RAW		235	0.85	7.4
GCA9011 RAW		115	0.63	7.7
GCA9012 RAW		156	0.73	7.6
GCA9013 RAW		390	1.73	3.5
GCA9014 RAW		214	0.78	6.6

Element	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
Method	/MS	/OES	/MS	/OES	/MS	/MS	/OES	/MS	/MS	/OES
Detection	0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02	0.1	0.01
Units	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l	mg/l
Sample Name										
Control Blank	X	X	X	X	X	X	X	X	X	X
GCA8991 HNO3	X	0.08	4.8	1.26	49.48	X	13.21	0.03	1.2	X
GCA8992 HNO3	0.04	0.07	3.5	0.25	47.74	0.236	5.68	0.56	7.7	X
GCA8993 HNO3	X	0.15	8	1.76	48.54	X	11.68	0.03	0.4	X
GCA8994 HNO3	0.01	0.03	2.7	0.29	48.74	0.066	11.24	0.08	12.2	X
GCA8995 HNO3	X	0.03	6.2	1.96	62.28	X	39.51	X	0.7	X
GCA8996 HNO3	0.01	0.01	3.2	0.38	64.13	0.046	16.49	0.09	8.6	X
GCA8997 HNO3	X	0.15	8.4	2.35	52.81	X	12.73	0.03	0.5	X
GCA8998 HNO3	0.01	X	3.1	0.2	43.95	X	27.73	0.06	0.7	X
GCA8999 HNO3	X	11.25	12.6	4.53	176.26	0.885	259.53	6.62	63.8	0.01
GCA9000 HNO3	0.01	0.01	2.6	0.45	25.2	0.035	3.95	0.03	0.6	X
GCA9001 HNO3	X	X	6.7	1.22	63.78	X	39.82	0.03	1.2	X
GCA9002 HNO3	0.03	0.65	2.8	0.27	78.28	0.424	3.11	0.11	11.1	X
GCA9003 HNO3	X	0.02	6.5	1.24	49.44	X	38.92	X	0.4	X
GCA9004 HNO3	0.04	0.03	2.3	0.33	56.17	0.208	9.43	0.07	7.1	X
GCA9005 HNO3	X	0.14	12	1.61	43.42	X	22.14	0.03	0.9	X
GCA9006 HNO3	0.02	0.04	6	0.09	29.09	0.209	61.56	0.05	0.7	X
GCA9007 HNO3	X	1.06	1.5	0.48	23.63	0.02	0.11	X	0.8	X
GCA9008 HNO3	X	0.01	1.4	0.05	134.48	0.132	1.67	0.03	18.9	X
GCA9009 HNO3	X	0.16	1.9	1.07	37.71	0.01	2.62	X	2	X
GCA9010 HNO3	0.02	0.05	1.3	0.75	82.34	0.226	2.65	0.05	19.2	X
GCA9011 HNO3	X	0.12	2.8	1.48	28.03	X	1.04	0.02	0.9	X
GCA9012 HNO3	X	0.01	1.4	1.09	75.21	0.094	4.86	0.04	7.1	X
GCA9013 HNO3	0.02	0.06	2.2	0.81	50.82	0.084	3.6	0.09	4.1	X
GCA9014 HNO3	X	X	0.9	0.13	98.12	0.023	1.69	0.07	34.6	X
BLANK-(WET)	0.07	0.01	0.2	0.02	2.13	0.121	0.11	0.08	0.3	X
DW-(WET)	0.02	X	X	X	0.74	0.039	0.06	0.03	X	X
Alcoa-High3-MS	20.43		108.4		22.61	19.476		21.59	1088.4	
AlcoaHi2-OES		50.48		19.31			964.64			20.28
Control Blank	X	X	0.2	0.01	0.16	X	0.03	X	0.1	X
Control Blank	X	X	X	X	0.19	X	X	X	X	X

Element	Cu	Fe-Sol	Hg	K	Mg	Mn	Mo	Na	Ni	P
Method	/OES	/OES	/MS	/OES	/OES	/OES	/MS	/OES	/OES	/OES
Detection	0.01	0.01	0.1	0.1	0.01	0.01	0.05	0.1	0.01	0.1
Units	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
Sample Name										
Control Blank	X	X	X	X	X	X	X	X	X	X
GCA8991 HNO3	X	0.04	0.1	12.8	27.15	0.11	6.9	524.3	X	X
GCA8992 HNO3	X	0.05	1.1	24.4	22.7	0.48	0.54	266.7	0.02	X
GCA8993 HNO3	X	0.07	X	7.2	10.01	X	26.47	274.8	X	X
GCA8994 HNO3	X	0.05	0.3	24	22.07	0.97	0.15	284	0.06	X
GCA8995 HNO3	X	0.02	X	12.9	41.5	0.02	7.79	684.7	X	X
GCA8996 HNO3	X	0.03	0.2	29.1	33.12	0.42	0.09	388.2	0.03	X
GCA8997 HNO3	X	0.06	X	7.1	10.86	X	26.87	320.7	X	X
GCA8998 HNO3	X	0.02	0.2	23.8	22.84	0.1	0.18	216.8	X	X
GCA8999 HNO3	0.13	4.69	X	12.9	77.74	0.56	25.35	906.4	0.03	X
GCA9000 HNO3	X	0.04	0.1	18.7	14.94	0.07	0.15	305	X	X
GCA9001 HNO3	X	0.01	X	15.3	48.2	0.03	6.02	717.8	X	X
GCA9002 HNO3	0.02	0.34	0.1	35.4	27.98	0.38	0.11	339.8	0.07	X
GCA9003 HNO3	X	0.07	X	12.6	37.56	0.02	3.6	561.1	X	X
GCA9004 HNO3	X	0.03	X	20.8	20.39	0.31	0.09	286.2	0.02	X
GCA9005 HNO3	0.03	0.07	X	10.3	18.82	X	14.92	496.2	X	X
GCA9006 HNO3	X	0.03	0.2	23.1	37.91	0.06	0.85	389.1	X	X
GCA9007 HNO3	X	0.35	X	1	0.61	X	0.18	90.5	X	X
GCA9008 HNO3	X	0.02	X	2.3	2.37	0.14	0.07	46.3	0.02	X
GCA9009 HNO3	X	0.04	X	3.8	6.13	0.04	2.94	226	X	X
GCA9010 HNO3	X	0.07	X	7.8	12.01	0.69	0.09	126	0.06	X
GCA9011 HNO3	X	0.03	X	3.9	2.62	X	0.23	127	X	X
GCA9012 HNO3	X	0.02	0.1	5.7	8.31	0.13	0.26	102.1	0.01	X
GCA9013 HNO3	0.01	0.55	38.2	7.9	13.68	0.08	0.12	330.5	X	X
GCA9014 HNO3	X	0.07	X	4.6	9.31	0.64	0.05	116.2	0.06	X
BLANK-(WET)	X	0.01	X	0.1	0.07	X	X	0.8	X	X
DW-(WET)	X	X	X	X	X	X	X	X	X	X
Alcoa-High3-MS			21.6				21.43			
AlcoaHi2-OES	2.68	95.9		481.8	203.68	19.58		1883.3	20.23	50
Control Blank	X	X	0.7	X	X	X	0.06	X	X	X
Control Blank	X	X	0.4	X	X	X	X	0.1	X	X

Element	Pb	S	Sb	Se	Si	Sn	SO4	Sr	Th	Tl
Method	/MS	/OES	/MS	/MS	/OES	/MS	/CALC	/MS	/MS	/MS
Detection	0.5	0.1	0.01	0.5	0.05	0.1	0.3	0.02	0.005	0.01
Units	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	ug/l
Sample Name										
Control Blank	X	X	0.01	X	X	X	X	X	X	X
GCA8991 HNO3	X	62.5	0.65	11.7	5.46	X	187.3	206	0.04	0.05
GCA8992 HNO3	4.9	27.9	0.57	5.8	5.71	0.6	83.4	85.13	0.02	0.05
GCA8993 HNO3	1	35	0.63	11.1	5.29	X	104.9	147.6	0.06	0.04
GCA8994 HNO3	111.2	31.2	0.19	5.9	5.86	0.4	93.5	119.25	0.013	0.12
GCA8995 HNO3	X	105.3	0.55	15.3	2.84	X	315.3	429.03	0.079	0.03
GCA8996 HNO3	4.4	49.2	0.07	7.9	6.68	0.2	147.5	176.74	0.011	0.06
GCA8997 HNO3	0.9	40	0.58	13.6	4.35	X	119.8	160.4	0.059	0.03
GCA8998 HNO3	1.4	52	0.08	5	5.19	0.2	155.7	200.05	0.009	0.08
GCA8999 HNO3	367.2	54.2	1	20.5	4.96	X	162.5	1850.26	19.728	0.1
GCA9000 HNO3	0.6	37.2	0.15	6.2	5.02	0.2	111.5	120.77	0.016	0.06
GCA9001 HNO3	0.7	101.1	0.56	17.1	2.43	X	302.8	439.88	0.298	0.08
GCA9002 HNO3	44.3	32.5	0.23	7.6	6.92	0.3	97.4	98.73	0.024	0.44
GCA9003 HNO3	1.1	106.7	0.38	13.7	3.3	0.2	319.6	392.42	0.159	0.04
GCA9004 HNO3	2.6	36.8	0.17	5.5	5.23	0.2	110.2	129.15	0.012	0.07
GCA9005 HNO3	1.4	87.9	2.63	15	2.83	X	263.2	278.7	0.301	0.05
GCA9006 HNO3	5.1	67.2	0.64	8.3	2.25	0.2	201.3	274.24	0.06	0.06
GCA9007 HNO3	1.7	30.4	0.12	3.8	15.76	X	91.1	3.88	0.187	0.02
GCA9008 HNO3	1.8	6.9	0.42	1.8	4.68	0.2	20.5	28.81	0.012	0.11
GCA9009 HNO3	0.7	43.7	0.42	5.9	5.32	X	131	51.4	0.052	0.02
GCA9010 HNO3	2.4	12.1	0.53	2.8	5.37	0.2	36.1	89.4	0.012	0.11
GCA9011 HNO3	X	33.6	0.1	6.4	8.78	X	100.6	23.33	0.034	0.02
GCA9012 HNO3	2.6	17.5	0.22	2.3	2.42	0.2	52.5	88.59	0.01	0.1
GCA9013 HNO3	1.6	78.4	0.04	9.3	12.81	0.2	234.8	91.26	0.517	0.02
GCA9014 HNO3	3.7	13.2	0.1	2.3	4.43	0.2	39.7	259.78	0.009	0.16
BLANK-(WET)	1.8	X	0.14	X	X	0.4	X	1.93	X	X
DW-(WET)	1.1	X	0.01	X	X	0.2	X	0.12	X	X
Alcoa-High3-MS	19.8		22	109.6		21.6		1023.01	21.794	19.65
AlcoaHi2-OES		254.7			93.32		763.1			
Control Blank	X	X	X	X	X	X	X	0.14	0.008	0.13
Control Blank	X	X	X	X	X	X	X	0.63	X	0.03

Element	U	V	Zn
Method	/MS	/OES	/OES
Detection	0.005	0.01	0.01
Units	ug/l	mg/l	mg/l
Sample Name			
Control Blank	X	X	X
GCA8991 HNO3	2.122	X	0.05
GCA8992 HNO3	0.022	X	1.09
GCA8993 HNO3	13.968	X	0.01
GCA8994 HNO3	0.009	X	0.62
GCA8995 HNO3	32.75	X	0.01
GCA8996 HNO3	0.035	X	2.99
GCA8997 HNO3	52.592	X	0.02
GCA8998 HNO3	0.032	X	0.07
GCA8999 HNO3	20.071	0.21	6.32
GCA9000 HNO3	0.022	X	0.04
GCA9001 HNO3	28.598	X	0.02
GCA9002 HNO3	0.29	X	1.45
GCA9003 HNO3	13.493	X	0.02
GCA9004 HNO3	0.017	X	0.67
GCA9005 HNO3	56.759	X	0.06
GCA9006 HNO3	3.055	X	0.02
GCA9007 HNO3	0.06	X	0.08
GCA9008 HNO3	0.039	X	0.37
GCA9009 HNO3	0.045	X	0.09
GCA9010 HNO3	0.01	X	2.36
GCA9011 HNO3	0.022	X	0.43
GCA9012 HNO3	0.009	X	1.2
GCA9013 HNO3	0.212	X	1.17
GCA9014 HNO3	0.019	X	2.97
BLANK-(WET)	0.007	X	0.03
DW-(WET)	X	X	X
Alcoa-High3-MS	20.788		
AlcoaHi2-OES		20.25	20.47
Control Blank	0.005	X	X
Control Blank	0.056	X	0.01

**NATA ENDORSED DOCUMENT****Company Accreditation Number 3244**

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

NATA Signatory: Ann Evers

Ann Evers

Date: 1/11/10



This document is issued in accordance with NATA accreditation requirements.

**Dr G Campbell**

CAMPBELL, GRAEME and ASSOCIATES PTY LTD  
 PO Box 247  
 BRIDGETOWN WA 6255

**JOB INFORMATION**

JOB CODE	143/1014562
No. of SAMPLES	48
CLIENT O/N	GCA 1022
PROJECT	Phillips River Trilogy
STATE	Na <sub>2</sub> EDTA extracts
DATE RECEIVED	21/10/2010
DATE COMPLETED	1/11/2010

**LEGEND**

X = Less than Detection Limit  
 N/R = Sample Not Received  
 \* = Result Checked  
 ( ) = Result still to come  
 I/S = Insufficient Sample for Analysis  
 E6 = Result X 1,000,000  
 UA = Unable to Assay  
 > = Value beyond Limit of Method

A range of solutions/slurries were received

The slurries were centrifuged and filtered to obtain clear solutions a split of each was acidified with nitric acid

The pH of each "raw" sample was measured Genalysis method codes ENV-W001, ENV-W002, ENV-W013

The nitric acid dosed filtered solutions were analysed for the requested element suite by ICPOES and ICPMS  
 Genalysis method code (ICP\_W004, ICP\_W003)



**Results of analysis on:**

Element		pH
Method		/METER
Detection		0.1
Units		NONE
Sample Name		
Control Blank		
GCA8991 Raw		6.4
GCA8992 Raw		6.3
GCA8992 Raw	check	6.3
GCA8993 Raw		6.6
GCA8994 Raw		6.3
GCA8995 Raw		7.6
GCA8996 Raw		6.3
GCA8997 Raw		7.3
GCA8998 Raw		6.4
GCA8999 Raw		8.3
GCA9000 Raw		6.4
GCA9001 Raw		7.4
GCA9002 Raw		6.3
GCA9003 Raw		6.4
GCA9004 Raw		6.4
GCA9005 Raw		7.8
GCA9006 Raw		6.5
GCA9007 Raw		6.4
GCA9008 Raw		6.4
GCA9009 Raw		6.4
GCA9010 Raw		6.5
GCA9011 Raw		6.4
GCA9012 Raw		6.4
GCA9013 Raw		6.2
GCA9014 Raw		6.4

Element	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
Method	/MS	/OES	/MS	/OES	/MS	/MS	/OES	/MS	/MS	/OES
Detection	0.1	0.1	0.001	0.1	0.5	0.05	0.1	0.2	0.001	0.1
Units	ug/l	mg/l	mg/l	mg/l	ug/l	ug/l	mg/l	ug/l	mg/l	mg/l
Sample Name										
Control Blank	X	0.4	0.001	X	X	X	X	X	X	X
GCA8991 HNO3	X	78.6	0.02	1.8	7384.5	6.48	242.3	68.6	0.67	0.2
GCA8992 HNO3	X	44.4	0.015	0.2	3777.8	2.01	16.4	58.8	0.067	0.1
GCA8993 HNO3	X	87.6	0.01	2.7	9506.3	11.62	938.7	66.6	0.435	0.2
GCA8994 HNO3	X	46.5	0.012	0.2	4103.5	3.07	24.5	57.3	0.047	X
GCA8995 HNO3	X	92	0.013	3.6	3004.4	12.51	2434.7	66.9	0.524	0.3
GCA8996 HNO3	X	32.9	0.011	0.3	4260.1	1.9	34.5	60.1	0.024	X
GCA8997 HNO3	X	94.7	0.013	3.4	4391.3	6.31	2639.6	66.8	0.479	0.2
GCA8998 HNO3	X	43.9	0.009	0.2	7285.8	1.54	72	55.2	0.037	X
GCA8999 HNO3	X	109.6	0.017	7.5	1433.1	9.14	2469.6	66.4	0.655	0.1
GCA9000 HNO3	X	29	0.006	0.4	3895.3	1.67	15.9	56.8	0.023	X
GCA9001 HNO3	X	74.6	0.014	3.3	2482.3	74.16	2006	68.5	0.582	0.2
GCA9002 HNO3	X	28.6	0.009	0.2	7551.8	32.02	5	56.3	0.02	X
GCA9003 HNO3	X	99.2	0.012	2.5	4386.9	58.48	688.8	67.4	0.228	0.3
GCA9004 HNO3	X	30.3	0.01	0.3	10350	4.25	28.9	58.7	0.035	X
GCA9005 HNO3	X	17.6	0.027	2.6	791.3	25.78	3565.3	72.2	0.558	X
GCA9006 HNO3	X	30.2	0.016	0.3	5120.9	7.33	261.4	57.6	0.053	0.2
GCA9007 HNO3	X	55.6	0.004	0.3	8343.7	64.75	29.7	69.6	0.104	0.2
GCA9008 HNO3	X	9.6	0.014	X	8356.6	194.1	6.9	58.6	0.15	0.1
GCA9009 HNO3	X	73.3	0.007	1.6	7659.1	168.8	101.9	69.8	0.311	0.3
GCA9010 HNO3	X	24.8	0.005	1.1	2916.8	1255.92	3.7	56.8	0.055	0.2
GCA9011 HNO3	X	104.8	0.005	1.6	6323.6	42.5	81.1	66.1	0.08	0.3
GCA9012 HNO3	X	25.7	0.007	1.7	6562.9	168.55	7.6	57.4	0.052	0.1
GCA9013 HNO3	X	52.1	0.005	0.6	3549.9	13.85	89	69.2	0.093	0.2
GCA9014 HNO3	X	16.4	0.006	X	7351.3	13.84	5.4	56	0.118	X
AlcoaHi2-OES		47.2		19.6			988.4			20.6
Alcoa-High3-MS	20.4		0.113		22.4	20.11		21.2	1.044	
GLS blank	X	0.2	0.001	X	X	X	X	X	X	X

Element	Cu	Fe-Sol	Hg	K	Mg	Mn	Mo	Ni	P	Pb
Method	/OES	/OES	/MS	/OES	/OES	/OES	/MS	/OES	/OES	/MS
Detection	0.1	0.1	1	1	0.1	0.1	0.5	0.1	1	0.005
Units	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
Sample Name										
Control Blank	X	X	X	1	X	X	X	X	X	X
GCA8991 HNO3	3.2	75.7	X	63	253.8	20.4	24.9	0.7	X	2.522
GCA8992 HNO3	1.3	20.7	X	72	46.9	4.6	14.1	0.1	X	0.358
GCA8993 HNO3	2.5	61.1	X	56	275.2	9.9	33.8	0.5	X	10.107
GCA8994 HNO3	0.7	29.9	X	63	39	2.4	26.5	0.2	X	1.013
GCA8995 HNO3	1.2	100	X	66	576.3	4.4	4	0.4	X	3.528
GCA8996 HNO3	0.2	38.2	X	73	60.3	0.8	10.6	X	X	0.255
GCA8997 HNO3	1.1	53.3	X	58	533.1	7.8	6.2	0.4	X	2.9
GCA8998 HNO3	0.4	48.9	X	74	51	1	17.2	0.1	X	0.341
GCA8999 HNO3	1.2	46.1	X	70	670.3	5.6	3.1	0.3	X	3.561
GCA9000 HNO3	0.2	24.2	X	66	45.2	0.7	9.4	X	X	0.218
GCA9001 HNO3	1.7	65.9	X	62	768.4	5.5	11.2	0.5	X	8.797
GCA9002 HNO3	0.5	54.2	X	74	39.4	0.6	22.5	X	X	1.318
GCA9003 HNO3	6.8	67.5	X	57	348.6	3.4	12.9	0.1	X	10.396
GCA9004 HNO3	0.6	26.3	X	67	48.8	0.9	14.3	X	X	2.43
GCA9005 HNO3	5.6	42.9	X	72	511.6	4.6	8.1	0.3	X	22.441
GCA9006 HNO3	0.9	206.3	X	74	86.2	1.9	21.5	0.2	X	2.914
GCA9007 HNO3	0.8	80	X	19	119.7	1.1	37.8	0.3	X	2.584
GCA9008 HNO3	1.2	22.1	1	9	11.8	1.1	33.2	0.3	X	0.895
GCA9009 HNO3	1.5	65	X	33	159.3	3.1	35.1	0.3	X	6.019
GCA9010 HNO3	0.6	37.2	X	19	20.7	1.1	63.8	0.5	X	0.943
GCA9011 HNO3	4.8	74.8	X	41	142.4	0.7	44.3	0.4	X	3.967
GCA9012 HNO3	1.7	20.7	3	15	22.3	0.6	38.1	0.3	X	0.958
GCA9013 HNO3	1.1	64.4	X	40	188.2	1.7	31.6	0.3	X	2.436
GCA9014 HNO3	0.4	19.6	X	10	22.7	2.1	31.3	0.2	X	1.197
AlcoaHi2-OES	2.8	100.1		505	206.5	20.4		20.5	50	
Alcoa-High3-MS			20				20			0.022
GLS blank	X	X	X	1	X	X	X	X	X	X

Element	Sb	Se	Si	Sn	Sr	Th	Tl	U	V	Zn
Method	/MS	/MS	/OES	/MS	/MS	/MS	/MS	/MS	/OES	/OES
Detection	0.1	0.005	0.5	1	0.2	0.05	0.1	0.05	0.1	0.1
Units	ug/l	mg/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l
Sample Name										
Control Blank	X	X	X	X	0.2	X	X	X	X	X
GCA8991 HNO3	1.2	0.02	53.7	7	2642.3	375.05	3.5	20.18	1	67.3
GCA8992 HNO3	0.8	0.008	31.3	5	328.6	165.38	2.2	18.31	X	14.6
GCA8993 HNO3	0.8	0.011	50.8	4	6268.5	330.14	5.6	10.26	1	20.5
GCA8994 HNO3	0.8	0.009	30	3	365.1	152.02	3.4	10.93	X	5.8
GCA8995 HNO3	0.7	0.026	37.5	1	14033.5	227.91	1.7	3.9	2.3	39.7
GCA8996 HNO3	0.3	0.012	21.2	3	449.8	173.52	1.7	12.92	X	9.7
GCA8997 HNO3	0.7	0.022	44.2	1	14032.9	194.43	4.6	18.22	1.2	13.8
GCA8998 HNO3	0.4	0.008	33.1	4	731.9	154.29	3.7	16.44	X	4.9
GCA8999 HNO3	1	0.029	41	X	17788.9	176.68	0.8	8.79	1.8	61.2
GCA9000 HNO3	0.7	0.008	26.4	3	726	176.63	2.6	16.3	X	4.5
GCA9001 HNO3	0.9	0.033	32.3	2	11340.2	255.14	4.6	6.8	1.5	39.2
GCA9002 HNO3	3.2	0.011	20.4	5	265	155.87	9.7	11.59	X	2.8
GCA9003 HNO3	0.6	0.024	47.8	8	5900.5	400.49	3.5	15.06	1	30.6
GCA9004 HNO3	1.5	0.01	27.2	4	618.9	150.31	3.7	11.14	X	5.9
GCA9005 HNO3	4.1	0.053	7.2	X	13119.1	329.57	1.8	206.5	X	145.7
GCA9006 HNO3	2.8	0.012	25	18	1713.5	222.1	4.2	10.02	0.1	14.9
GCA9007 HNO3	0.7	0.012	35	12	977.8	240.5	3.2	1.74	0.4	19.7
GCA9008 HNO3	7	0.005	27.1	15	326.6	168.02	3.6	6.88	X	2.8
GCA9009 HNO3	1.3	0.021	40.3	7	2121	274.06	2	6.74	0.7	58.7
GCA9010 HNO3	8.3	X	29.9	10	312.7	88.91	3	4.02	X	10
GCA9011 HNO3	0.6	0.019	41.3	8	1749.7	237.38	2.1	9.02	0.8	71.4
GCA9012 HNO3	2.4	0.007	22.7	9	519.4	67.03	3.3	6.46	X	20.5
GCA9013 HNO3	0.5	0.018	29.7	6	2116.1	193.79	1.2	1.6	0.4	43.6
GCA9014 HNO3	2.3	0.008	22.2	4	1240.9	58.8	2.5	4.77	X	17.8
AlcoaHi2-OES			105.1						20.6	20.8
Alcoa-High3-MS	21.5	0.116		21	1043	19.48	20.1	20.57		
GLS blank	X	X	X	X	0.2	X	X	X	X	X

**NATA ENDORSED DOCUMENT**  
**Company Accreditation Number 3244**

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

NATA Signatory: Ann Evers

Ann Evers

Date: 1/11/10



This document is issued in accordance with  
 NATA accreditation requirements.