



ANALYTICAL REPORT



CLIENT DETAILS

Contact **Matthew Behre**
SGS Metallurgical Services
Client Address **431 Victoria Street**
Malaga
MALAGA WA 6090

Telephone **08 9209 8700**
Facsimile **08 9209 8701**
Email **Matthew.Behre@sgs.com**

Project **10850**
Order Number **(Not specified)**
Samples **9**

LABORATORY DETAILS

Manager **Said Hira**
Laboratory Address **SGS Newburn Environmental**
10 Reid Rd
Newburn WA 6105

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

SGS Reference **PE060477 R0**
Report Number **0000027103**
Date Reported **21 Sep 2011**
Date Received **02 Sep 2011**

COMMENTS

The document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(898/20210).

Total S was subcontracted to SGS Perth Minerals, 10 Reid Rd Newburn WA, NATA Accreditation Number 1936, report # WM 135224.

Kinetic NAG data attached in separate Excel document.

SIGNATORIES

Michael McKay
Inorganic Team Leader - Waters

Parameter	Units	LOR	Sample Number Sample Matrix Sample Name	PE060477.001 Pulp 45398	PE060477.002 Pulp 45410	PE060477.003 Pulp 45524	PE060477.004 Pulp 45692	PE060477.005 Pulp 45694
-----------	-------	-----	---	-------------------------------	-------------------------------	-------------------------------	-------------------------------	-------------------------------

Moisture Content Method: AN234

% Moisture	%	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
------------	---	-----	------	------	------	------	------	------

pH in soil (1:5) Method: AN101

pH	No unit	-	7.3	6.7	5.4	6.6	7.0
----	---------	---	-----	-----	-----	-----	-----

Conductivity and TDS by Calculation - Soil Method: AN106

Conductivity	µS/cm	1	110	210	210	360	210
--------------	-------	---	-----	-----	-----	-----	-----

pH in soil (1:2) Method: AN101

pH (1:2) aged	pH Units	0.1	6.8	6.2	5.3	6.6	6.8
---------------	----------	-----	-----	-----	-----	-----	-----

Conductivity (1:2) in soil Method: AN106

Conductivity (1:2) aged @ 25C*	µS/cm	1	230	490	500	830	490
--------------------------------	-------	---	-----	-----	-----	-----	-----

TCLP (Toxicity Characteristic Leaching Procedure) for Metals Method: AN006

pH 1:20	pH Units	-	7.2	6.6	5.6	6.6	7.1
pH 1:20 plus HCL	pH Units	-	1.4	1.5	1.4	1.4	1.6
Extraction Solution Used	No unit	-	1 (pH5)	1 (pH5)	1 (pH5)	1 (pH5)	1 (pH5)
Mass of Sample Used*	g	-	100	100	100	100	100
Volume of ExtractionSolution Used*	mL	-	2000	2000	2000	2000	2000
pH TCLP after 18 hours	pH Units	-	4.9	4.9	4.9	5.0	4.9

Metals in Soil (TCLP) by ICPOES Method: AN320/AN321

Arsenic, As	mg/L	0.02	<0.020	<0.020	<0.020	<0.020	<0.020
Cadmium, Cd	mg/L	0.001	<0.001	0.001	0.001	<0.001	<0.001
Chromium, Cr	mg/L	0.005	0.13	0.051	0.022	0.14	0.036
Copper, Cu	mg/L	0.005	0.014	0.014	2.3	<0.005	0.008
Lead, Pb	mg/L	0.005	<0.005	<0.005	0.007	0.015	0.005
Nickel, Ni	mg/L	0.005	0.032	0.14	0.071	0.051	0.028
Zinc, Zn	mg/L	0.01	0.11	0.45	0.22	0.21	0.20

Mercury in Soil by TCLP Extract Method: AN311/AN312

Mercury	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
---------	------	--------	---------	---------	---------	---------	---------

Total Carbon/Sulphur in soil by LECO Method: CSA06V

Sulphur*	%	0.005	0.044	0.275	0.116	1.98	0.331
Maximum Potential Acidity*	kg H2SO4/T	0.1	1.3	8.4	3.6	61	10

HCl Extractable S, Ca and Mg in Soil ICP OES Method: AN014

Acid Soluble Sulphur (SHCl)*	%w/w	0.005	0.007	0.010	0.017	0.028	0.011
------------------------------	------	-------	-------	-------	-------	-------	-------

Acid Neutralising Capacity or Neutralisation Potential(ANC/NP) Method: AN212

Fizz Rating Reaction*	No unit	-	nil	nil	nil	nil	nil
Initial Effervescence*	No unit	-	no	no	no	no	no
Effervescence on Warming*	No unit	-	no	no	no	no	no
Titration - Green Colouration?*	No unit	-	no	no	no	yes	no
Titration - Precipitate Formed?*	No unit	-	yes	yes	yes	yes	yes
ANC as % CaCO ₃	% CaCO ₃	0.1	<0.1	<0.1	<0.1	0.4	0.1
ANC as % CaMg(CO ₃) ₂	%w/w	0.1	<0.1	<0.1	<0.1	0.4	0.2
Acid Neutralisation Capacity/Neutralisation Potential	kg CaCO ₃ /T	1	<1.0	<1.0	<1.0	3.6	1.4
Acid Neutralisation Capacity/Neutralisation Potential kg	kg H2SO4/T	1	<1.0	<1.0	<1.0	3.5	1.4
ANC/NP Siderite Corrected	kg CaCO ₃ /T	1	<1.0	<1.0	<1.0	3.6	1.4
ANC/NP kg H ₂ SO ₄ /t Siderite Corrected	kg H2SO4/T	1	<1.0	<1.0	<1.0	3.5	1.4

Sample Number	PE060477.001	PE060477.002	PE060477.003	PE060477.004	PE060477.005
Sample Matrix	Pulp	Pulp	Pulp	Pulp	Pulp
Sample Name	45398	45410	45524	45692	45694
Parameter	Units	LOR			

Acid Neutralising Capacity or Neutralisation Potential(ANC/NP) Method: AN212 (continued)

Net Acid Generation Potential (NAGP) Method: AN215

Total Oxidisable Sulphur	kg H ₂ SO ₄ /T	0.25	1.1	8.1	3.0	60	9.8
Net Acid Production Potential	kg H ₂ SO ₄ /T	-400	0	8	4	56	8
Total Oxidisable Sulphur	%w/w	0.005	0.037	0.27	0.099	2.0	0.32

Single Addition Net Acid Generation (NAG) Method: AN216

ECox (NAG Conductivity)	µS/cm	1	37	230	73	1900	220
pHox (NAG pH)	No unit	-	5.6	3.6	4.3	2.5	5.2
NAG as kg H ₂ SO ₄ /tonne to pH 4.5	kg H ₂ SO ₄ /T	0.5	<0.5	2.2	<0.5	27	<0.5
NAG as kg H ₂ SO ₄ /tonne to pH 7	kg H ₂ SO ₄ /T	0.5	<0.5	6.2	2.1	36	1.8
NAG as kg CaCO ₃ /tonne to pH 4.5	kg CaCO ₃ /T	0.5	<0.5	2.3	<0.5	28	<0.5
NAG as kg CaCO ₃ /tonne to pH 7	kg CaCO ₃ /T	0.5	<0.5	6.3	2.1	37	1.8

Sample Number	PE060477.006	PE060477.007	PE060477.008	PE060477.009
Sample Matrix	Pulp	Pulp	Pulp	Pulp
Sample Name	45764	45769	45760	45949
Parameter	Units	LOR		

Moisture Content Method: AN234

% Moisture	%	0.5	<0.5	<0.5	<0.5	<0.5
------------	---	-----	------	------	------	------

pH in soil (1:5) Method: AN101

pH	No unit	-	7.2	6.7	7.7	5.9
----	---------	---	-----	-----	-----	-----

Conductivity and TDS by Calculation - Soil Method: AN106

Conductivity	µS/cm	1	160	170	110	230
--------------	-------	---	-----	-----	-----	-----

pH in soil (1:2) Method: AN101

pH (1:2) aged	pH Units	0.1	6.7	6.3	7.0	5.7
---------------	----------	-----	-----	-----	-----	-----

Conductivity (1:2) in soil Method: AN106

Conductivity (1:2) aged @ 25C*	µS/cm	1	390	410	270	490
--------------------------------	-------	---	-----	-----	-----	-----

TCLP (Toxicity Characteristic Leaching Procedure) for Metals Method: AN006

pH 1:20	pH Units	-	7.1	6.7	7.7	6.0
pH 1:20 plus HCL	pH Units	-	1.6	1.5	1.5	1.5
Extraction Solution Used	No unit	-	1 (pH5)	1 (pH5)	1 (pH5)	1 (pH5)
Mass of Sample Used*	g	-	100	100	100	100
Volume of ExtractionSolution Used*	mL	-	2000	2000	2000	2000
pH TCLP after 18 hours	pH Units	-	4.9	5.0	4.9	4.9

Metals in Soil (TCLP) by ICPOES Method: AN320/AN321

Arsenic, As	mg/L	0.02	<0.020	<0.020	<0.020	<0.020
Cadmium, Cd	mg/L	0.001	<0.001	<0.001	<0.001	0.001
Chromium, Cr	mg/L	0.005	0.013	0.025	0.018	0.054
Copper, Cu	mg/L	0.005	<0.005	0.092	0.007	0.25
Lead, Pb	mg/L	0.005	0.010	0.23	0.016	0.11
Nickel, Ni	mg/L	0.005	0.030	0.051	0.024	0.16
Zinc, Zn	mg/L	0.01	0.21	0.20	0.22	0.88

Mercury in Soil by TCLP Extract Method: AN311/AN312

Mercury	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005
---------	------	--------	---------	---------	---------	---------

Parameter	Units	LOR	Sample Number Sample Matrix Sample Name	PE060477.006 Pulp 45764	PE060477.007 Pulp 45769	PE060477.008 Pulp 45760	PE060477.009 Pulp 45949
-----------	-------	-----	---	-------------------------------	-------------------------------	-------------------------------	-------------------------------

Total Carbon/Sulphur in soil by LECO Method: CSA06V

Sulphur*	%	0.005	0.266	0.402	0.16	1.03
Maximum Potential Acidity*	kg H ₂ SO ₄ /T	0.1	8.1	12	4.9	32

HCl Extractable S, Ca and Mg in Soil ICP OES Method: AN014

Acid Soluble Sulphur (SHCl)*	%w/w	0.005	0.007	0.007	<0.005	0.015
------------------------------	------	-------	--------------	--------------	--------	--------------

Acid Neutralising Capacity or Neutralisation Potential(ANC/NP) Method: AN212

Fizz Rating Reaction*	No unit	-	nil	nil	nil	nil
Initial Effervescence*	No unit	-	no	no	no	no
Effervescence on Warming*	No unit	-	no	no	no	no
Titration - Green Colouration?*	No unit	-	no	no	no	no
Titration - Precipitate Formed?*	No unit	-	yes	yes	yes	yes
ANC as % CaCO ₃	% CaCO ₃	0.1	<0.1	<0.1	0.2	<0.1
ANC as % CaMg(CO ₃) ₂	%w/w	0.1	<0.1	<0.1	0.2	<0.1
Acid Neutralisation Capacity/Neutralisation Potential	kg CaCO ₃ /T	1	<1.0	<1.0	1.6	<1.0
Acid Neutralisation Capacity/Neutralisation Potential kg	kg H ₂ SO ₄ /T	1	<1.0	<1.0	1.6	<1.0
ANC/NP Siderite Corrected	kg CaCO ₃ /T	1	<1.0	<1.0	1.6	<1.0
ANC/NP kg H ₂ SO ₄ /t Siderite Corrected	kg H ₂ SO ₄ /T	1	<1.0	<1.0	1.6	<1.0

Net Acid Generation Potential (NAGP) Method: AN215

Total Oxidisable Sulphur	kg H ₂ SO ₄ /T	0.25	7.9	12	4.8	31
Net Acid Production Potential	kg H ₂ SO ₄ /T	-400	7	12	3	30
Total Oxidisable Sulphur	%w/w	0.005	0.26	0.40	0.16	1.0

Single Addition Net Acid Generation (NAG) Method: AN216

ECox (NAG Conductivity)	µS/cm	1	240	380	130	820
pHox (NAG pH)	No unit	-	3.6	3.3	4.1	2.9
NAG as kg H ₂ SO ₄ /tonne to pH 4.5	kg H ₂ SO ₄ /T	0.5	2.0	3.7	<0.5	10
NAG as kg H ₂ SO ₄ /tonne to pH 7	kg H ₂ SO ₄ /T	0.5	5.9	8.7	12	18
NAG as kg CaCO ₃ /tonne to pH 4.5	kg CaCO ₃ /T	0.5	2.1	3.8	0.5	10
NAG as kg CaCO ₃ /tonne to pH 7	kg CaCO ₃ /T	0.5	6.0	8.9	12	19

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.

Acid Neutralising Capacity or Neutralisation Potential(ANC/NP) Method: ME-(AU)-[ENV]AN212

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Fizz Rating Reaction*	LB026709	No unit	-	nil		
Initial Effervescence*	LB026709	No unit	-	no		
Effervescence on Warming*	LB026709	No unit	-	no		
Titration - Green Colouration?*	LB026709	No unit	-	no		
Titration - Precipitate Formed?*	LB026709	No unit	-	yes		
ANC as % CaCO ₃	LB026709	% CaCO ₃	0.1	<0.1		
ANC as % CaMg(CO ₃) ₂	LB026709	%w/w	0.1	<0.1		
Acid Neutralisation Capacity/Neutralisation Potential	LB026709	kg	1	<1.0	0%	NA
Acid Neutralisation Capacity/Neutralisation Potential kg H ₂ SO ₄ /t	LB026709	kg	1	<1.0	0%	NA

Conductivity (1:2) in soil Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity (1:2) aged @ 25C*	LB026714	µS/cm	1	<1	6%	NA

Conductivity and TDS by Calculation - Soil Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity	LB026715	µS/cm	1	<1	0%	98%

HCl Extractable S, Ca and Mg in Soil ICP OES Method: ME-(AU)-[ENV]AN014

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Acid Soluble Sulphur (SHCl)*	LB026711	%w/w	0.005	<0.005	4%	88%

Mercury in Soil by TCLP Extract Method: ME-(AU)-[ENV]AN311/AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD
Mercury	LB027023	mg/L	0.0005	<0.0005	0%

Metals in Soil (TCLP) by ICPOES Method: ME-(AU)-[ENV]AN320/AN321

Parameter	QC Reference	Units	LOR	DUP %RPD
Arsenic, As	LB027019	mg/L	0.02	0%
Cadmium, Cd	LB027019	mg/L	0.001	0%
Chromium, Cr	LB027019	mg/L	0.005	4%
Copper, Cu	LB027019	mg/L	0.005	1%
Lead, Pb	LB027019	mg/L	0.005	9%
Nickel, Ni	LB027019	mg/L	0.005	2%
Zinc, Zn	LB027019	mg/L	0.01	1%

Moisture Content Method: ME-(AU)-[ENV]AN234

Parameter	QC Reference	Units	LOR	DUP %RPD
% Moisture	LB026665	%	0.5	0 - 1%

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.

pH in soil (1:2) Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH (1:2) aged	LB026714	pH Units	0.1	5.9	1%	NA

pH in soil (1:5) Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH	LB026715	No unit	-	6.2	1%	100%

Single Addition Net Acid Generation (NAG) Method: ME-(AU)-[ENV]AN216

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
ECox (NAG Conductivity)	LB026710	µS/cm	1	25	4%	99%
pHox (NAG pH)	LB026710	No unit	-	5.9	1%	101%
NAG as kg H ₂ SO ₄ /tonne to pH 4.5	LB026710	kg	0.5	<0.5	0%	113%
NAG as kg H ₂ SO ₄ /tonne to pH 7	LB026710	kg	0.5	5.2	1%	110%
NAG as kg CaCO ₃ /tonne to pH 4.5	LB026710	kg	0.5	<0.5	0%	113%
NAG as kg CaCO ₃ /tonne to pH 7	LB026710	kg	0.5	5.3	1%	110%

TCLP (Toxicity Characteristic Leaching Procedure) for Metals Method: ME-(AU)-[ENV]AN006

Parameter	QC Reference	Units	LOR	MB	DUP %RPD
pH 1:20	LB026716	pH Units	-	5.6	1%
pH 1:20 plus HCL	LB026716	pH Units	-	1.4	3%
Extraction Solution Used	LB026716	No unit	-	1 (pH5)	
Mass of Sample Used*	LB026716	g	-	1000	0%
Volume of ExtractionSolution Used*	LB026716	mL	-	2000	0%
pH TCLP after 18 hours	LB026716	pH Units	-	4.9	0%

METHOD

METHODOLOGY SUMMARY

AN002	Into a glass bottle or plastic jar weigh 20g of air-dried or as received sample, and add 100mL distilled water. If suspensions are prepared on different sample weights, ensure that the 1:5 soil to water ratio is maintained.
AN004	Soils, sediments and sludges are pulverised using an LM2 ringmill. The dry sample is pulverised to a particle size of >90% passing through a -75µm sieve.
AN014	This method is for the determination of soluble sulphate (SO ₄ -S) by extraction with hydrochloric acid. Sulphides should not react and would normally be expelled. Sulphur is determined by ICP.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H ⁺ .
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2520 B.
AN106	Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity.
AN212	Samples are initially evaluated to determine the strength of reagents needed using a 'fizz' test. Samples are then subjected to an excess of hydrochloric acid followed by alkaline back titration to pH 7. Results are expressed in kg H ₂ SO ₄ /tonne or Kg CaCO ₃ /tonne after correction for moisture content if applicable.
AN215	This is purely a calculation based on results obtained from Total Sulphur, Sulphate Method, and Acid Neutralisation Capacity Method (ME-(AU)-[ENV]AN212).
AN216	Pulverised sub-sample of a waste rock or an as received sample of filter cake, soil or sludge is subjected to an oxidising digest with hydrogen peroxide. The pH and EC of the NAG suspension is recorded at various stages in the digest. The acid produced (if any) is titrated using standardised NaOH to pH 7.0. NAG results are reported to 0.5 kg H ₂ SO ₄ /tonne.
AN234	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN311/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN320/AN321	Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components.
AN320/AN321	Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B.

FOOTNOTES

IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
*	This analysis is not covered by the scope of accreditation.
^	Performed by outside laboratory.
LOR	Limit of Reporting
↑↓	Raised or Lowered Limit of Reporting

QFH	QC result is above the upper tolerance
QFL	QC result is below the lower tolerance
-	The sample was not analysed for this analyte
NVL	Not Validated

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

Some totals may not appear to add up because the total is rounded after adding up the raw values.

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. 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.