



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 **3**

LABORATORY DETAILS

Manager **Said Hirad**
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 **PE060287 R0**
Report Number **0000026525**
Date Reported **13 Sep 2011**
Date Received **30 Aug 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 Sulphur was subcontracted to SGS Perth Minerals, 10 Reid Rd Newburn WA, NATA Accreditation Number 1936, report # WM 134928.

SIGNATORIES

Michael McKay
Inorganic Team Leader - Waters

Ohmar David
Spectroscopy Chemist

Pamela Adams
Organic Team Leader

| Parameter | Units | LOR | Sample Number Sample Matrix Sample Name | PE060287.001 Soil NBR07 NON MAGS | PE060287.002 Soil NBR08 NON MAGS | PE060287.003 Soil NBR021 NON MAGS |
|-----------|-------|-----|---|---|---|--|
|-----------|-------|-----|---|---|---|--|

Moisture Content Method: AN234

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

pH in soil (1:5) Method: AN101

| | | | | | |
|----|---------|---|-----|-----|-----|
| pH | No unit | - | 7.2 | 7.8 | 7.7 |
|----|---------|---|-----|-----|-----|

Conductivity and TDS by Calculation - Soil Method: AN106

| | | | | | |
|--------------|-------|---|-----|-----|-----|
| Conductivity | µS/cm | 1 | 200 | 110 | 120 |
|--------------|-------|---|-----|-----|-----|

pH in soil (1:2) Method: AN101

| | | | | | |
|---------------|----------|-----|-----|-----|-----|
| pH (1:2) aged | pH Units | 0.1 | 7.0 | 7.9 | 7.8 |
|---------------|----------|-----|-----|-----|-----|

Conductivity (1:2) in soil Method: AN106

| | | | | | |
|--------------------------------|-------|---|-----|-----|-----|
| Conductivity (1:2) aged @ 25C* | µS/cm | 1 | 420 | 250 | 230 |
|--------------------------------|-------|---|-----|-----|-----|

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

| | | | | | |
|------------------------------------|----------|---|---------|---------|---------|
| pH 1:20 | pH Units | - | 7.3 | 8.1 | 8.1 |
| pH 1:20 plus HCL | pH Units | - | 1.8 | 1.8 | 1.8 |
| Extraction Solution Used | No unit | - | 1 (pH5) | 1 (pH5) | 1 (pH5) |
| Mass of Sample Used* | g | - | 100 | 100 | 100 |
| Volume of ExtractionSolution Used* | mL | - | 2000 | 2000 | 2000 |
| pH TCLP after 18 hours | pH Units | - | 5.0 | 5.1 | 5.0 |

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

| | | | | | |
|--------------|------|-------|--------|--------|--------|
| Arsenic, As | mg/L | 0.02 | <0.020 | <0.020 | <0.020 |
| Cadmium, Cd | mg/L | 0.001 | <0.001 | <0.001 | <0.001 |
| Chromium, Cr | mg/L | 0.005 | <0.005 | <0.005 | <0.005 |
| Copper, Cu | mg/L | 0.005 | 0.15 | 0.078 | 0.10 |
| Lead, Pb | mg/L | 0.005 | <0.005 | <0.005 | <0.005 |
| Nickel, Ni | mg/L | 0.005 | 0.16 | 0.028 | 0.062 |
| Zinc, Zn | mg/L | 0.01 | 0.26 | 0.16 | 0.23 |

Mercury in Soil by TCLP Extract Method: AN311/AN312

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

Total Carbon/Sulphur in soil by LECO Method: CSA06V

| | | | | | |
|----------------------------|------------|-------|------|------|------|
| Sulphur* | % | 0.005 | 1.36 | 1.98 | 1.06 |
| Maximum Potential Acidity* | kg H2SO4/T | 0.1 | 42 | 61 | 32 |

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

| | | | | | |
|------------------------------|------|-------|-------|-------|-------|
| Acid Soluble Sulphur (SHCl)* | %w/w | 0.005 | 0.028 | 0.035 | 0.024 |
|------------------------------|------|-------|-------|-------|-------|

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

| | | | | | |
|--|-------------------------|-----|-----------|-----------|-----------|
| Fizz Rating Reaction* | No unit | - | Moderate. | Moderate. | Moderate. |
| Initial Effervescence* | No unit | - | No. | No. | No. |
| Effervescence on Warming* | No unit | - | No. | No. | No. |
| Titration - Green Colouration?* | No unit | - | Yes. | Yes. | Yes. |
| Titration - Precipitate Formed?* | No unit | - | Yes. | No. | Yes. |
| ANC as % CaCO ₃ | % CaCO ₃ | 0.1 | 7.9 | 7.1 | 7.6 |
| ANC as % CaMg(CO ₃) ₂ | %w/w | 0.1 | 8.5 | 7.8 | 8.3 |
| Acid Neutralisation Capacity/Neutralisation Potential | kg CaCO ₃ /T | 1 | 79 | 71 | 76 |
| Acid Neutralisation Capacity/Neutralisation Potential kg | kg H2SO4/T | 1 | 77 | 70 | 75 |
| ANC/NP Siderite Corrected | kg CaCO ₃ /T | 1 | 79 | 71 | 76 |

| Parameter | Units | LOR | Sample Number | PE060287.001 | PE060287.002 | PE060287.003 |
|-----------|-------|-----|---------------|-------------------|-------------------|--------------------|
| | | | Sample Matrix | Soil | Soil | Soil |
| | | | Sample Name | NBR07 NON MAGS | NBR08 NON MAGS | NBR021 NON MAGS |

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

| | | | | | |
|--|--------------------------------------|---|-----------|-----------|-----------|
| ANC/NP kg H ₂ SO ₄ /t Siderite Corrected | kg H ₂ SO ₄ /T | 1 | 77 | 70 | 75 |
|--|--------------------------------------|---|-----------|-----------|-----------|

Net Acid Generation Potential (NAGP) Method: AN215

| | | | | | |
|-------------------------------|--------------------------------------|-------|------------|------------|------------|
| Total Oxidisable Sulphur | kg H ₂ SO ₄ /T | 0.25 | 41 | 59 | 32 |
| Net Acid Production Potential | kg H ₂ SO ₄ /T | -400 | -36 | -11 | -43 |
| Total Oxidisable Sulphur | %w/w | 0.005 | 1.3 | 1.9 | 1.0 |

Single Addition Net Acid Generation (NAG) Method: AN216

| | | | | | |
|---|--------------------------------------|-----|------------|------------|------------|
| ECox (NAG Conductivity) | μS/cm | 1 | 650 | 900 | 530 |
| pHox (NAG pH) | No unit | - | 5.8 | 4.8 | 6.3 |
| NAG as kg H ₂ SO ₄ /tonne to pH 4.5 | kg H ₂ SO ₄ /T | 0.5 | <0.5 | <0.5 | <0.5 |
| NAG as kg H ₂ SO ₄ /tonne to pH 7 | kg H ₂ SO ₄ /T | 0.5 | 4.6 | 10 | 2.0 |
| NAG as kg CaCO ₃ /tonne to pH 4.5 | kg CaCO ₃ /T | 0.5 | <0.5 | <0.5 | <0.5 |
| NAG as kg CaCO ₃ /tonne to pH 7 | kg CaCO ₃ /T | 0.5 | 4.7 | 10 | 2.0 |

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* | LB026282 | No unit | - | None. | | |
| Initial Effervescence* | LB026282 | No unit | - | No. | | |
| Effervescence on Warming* | LB026282 | No unit | - | No. | | |
| Titration - Green Colouration?* | LB026282 | No unit | - | No. | | |
| Titration - Precipitate Formed?* | LB026282 | No unit | - | No. | | |
| Acid Neutralisation Capacity/Neutralisation Potential | LB026282 | kg | 1 | | 12% | NA |
| Acid Neutralisation Capacity/Neutralisation Potential kg H ₂ SO ₄ /t | LB026282 | kg | 1 | | 12% | NA |

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

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD |
|--------------------------------|--------------|-------|-----|----|----------|
| Conductivity (1:2) aged @ 25C* | LB026227 | µS/cm | 1 | <1 | 2% |

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

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery |
|--------------|--------------|-------|-----|----|----------|---------------|
| Conductivity | LB026233 | µS/cm | 1 | <1 | 2% | 99% |

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)* | LB026284 | %w/w | 0.005 | <0.005 | 13% | 102% |

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

| Parameter | QC Reference | Units | LOR | DUP %RPD |
|-----------|--------------|-------|--------|----------|
| Mercury | LB026456 | mg/L | 0.0005 | 0% |

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

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD |
|--------------|--------------|-------|-------|--------|----------|
| Arsenic, As | LB026485 | mg/L | 0.02 | <0.020 | 0% |
| Cadmium, Cd | LB026485 | mg/L | 0.001 | <0.001 | 0% |
| Chromium, Cr | LB026485 | mg/L | 0.005 | <0.005 | 0% |
| Copper, Cu | LB026485 | mg/L | 0.005 | <0.005 | 1% |
| Lead, Pb | LB026485 | mg/L | 0.005 | <0.005 | 0% |
| Nickel, Ni | LB026485 | mg/L | 0.005 | 0.007 | 0% |
| Zinc, Zn | LB026485 | mg/L | 0.01 | <0.01 | 1% |

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

| Parameter | QC Reference | Units | LOR | DUP %RPD |
|------------|--------------|-------|-----|----------|
| % Moisture | LB026299 | % | 0.5 | 0% |

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

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD |
|---------------|--------------|----------|-----|-----|----------|
| pH (1:2) aged | LB026228 | pH Units | 0.1 | 4.4 | 3% |

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

| Parameter | QC Reference | Units | LOR | DUP %RPD | LCS %Recovery |
|-----------|--------------|---------|-----|----------|---------------|
| pH | LB026226 | No unit | - | 4% | 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) | LB026283 | µS/cm | 1 | 19 | 1% | 98% |
| pHox (NAG pH) | LB026283 | No unit | - | 5.3 | 2% | 101% |
| NAG as kg H ₂ SO ₄ /tonne to pH 4.5 | LB026283 | kg | 0.5 | <0.5 | 0% | 114% |
| NAG as kg H ₂ SO ₄ /tonne to pH 7 | LB026283 | kg | 0.5 | <0.5 | 67% | 108% |
| NAG as kg CaCO ₃ /tonne to pH 4.5 | LB026283 | kg | 0.5 | <0.5 | 0% | 114% |
| NAG as kg CaCO ₃ /tonne to pH 7 | LB026283 | kg | 0.5 | <0.5 | 67% | 108% |

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

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD |
|------------------------------------|--------------|----------|-----|---------|----------|
| pH 1:20 | LB026333 | pH Units | - | 4.3 | 0% |
| pH 1:20 plus HCL | LB026333 | pH Units | - | 1.5 | 0% |
| Extraction Solution Used | LB026333 | No unit | - | 1 (pH5) | |
| Mass of Sample Used* | LB026333 | g | - | 25 | 0% |
| Volume of ExtractionSolution Used* | LB026333 | mL | - | 500 | 0% |
| pH TCLP after 18 hours | LB026333 | pH Units | - | 5.0 | 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. | 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. | NVL | Not Validated |
| LOR | Limit of Reporting | | |
| ↑↓ | Raised or Lowered Limit of Reporting | | |

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.