# TECHNICAL REPORT

# Geochemical assessment of coal reject material

## Gemini Coal Project

***Prepared for***: **Magnetic South Pty Ltd**

LEADERS IN MINING GEOCHEMISTRY

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# 1 Introduction

## 1.1 Background

Magnetic South Pty Ltd (Magnetic South) is the project proponent and the applicant for the Mining Lease (ML) and Environmental Authority (EA) to develop the Gemini Project (the Project), a greenfield open cut mine to produce pulverised coal injection (PCI) coal and Coking Coal products for export for steel production. The Project term is anticipated to be 25 years from grant of the ML with this term including initial construction, mine operation and rehabilitation activities.

The Project is located on EPC 881 in the Bowen Basin, Central Queensland. Located 20 km east of Bluff and 6 km west of Dingo, the tenement straddles the Capricorn Highway and the Blackwater-Gladstone rail network (**Figure A1**, **Attachment A**).

The main activities associated with the Project include:

- Exploration activities continuing in order to support mine planning.
- Development of a Mine Infrastructure Area (MIA) including mine offices, bathhouse, crib rooms, warehouse/stores, workshop, fuel storage, refuelling facilities, explosives magazine and sewage, effluent and liquid waste storage.
- Construction and operation of a Coal Handling Preparation Plant (CHPP) and coal handling facilities adjacent to the MIA (including Run-of-Mine (ROM) coal, product stockpiles and reject stockpiles [coarse and fine rejects]).
- Construction and operation of a surface conveyor from the product stockpiles to a Train Load Out (TLO) facility and rail loop connecting to the Blackwater-Gladstone Branch Rail to transport product coal to coal terminals at Gladstone for export.
- Construction of access roads from the Capricorn Highway to the MIA, and to the TLO facility.
- Installation of a raw water supply pipeline to connect to the Blackwater Pipeline network.
- Construction of a 66 kV transmission line and switching/substation to connect to the existing regional network.
- Other associated minor infrastructure, plant, equipment and activities.
- Development of mine areas (open cut pits) and out-of-pit waste rock emplacements.
- Drilling and blasting of competent waste material.
- Mine operations using conventional surface mining equipment (excavators, front end loaders, rear dump trucks, dozers).
- Mining up to 1.9 Mtpa ROM Coal – average 1.8 Mtpa for an operational mine life of approximately 20 years.
- Progressive placement of waste rock (overburden/interburden) in:
  - Emplacements, adjacent to and near the open cut voids.
  - Mine voids, behind the advancing open cut mining operations.
- Progressive rehabilitation of waste rock emplacement areas and mined voids.
- Progressive establishment of soil stockpiles, laydown area and borrow pits (for road base and civil works). Material will be sourced from local quarries where required.
- Disposal of CHPP rejects (coarse and fine rejects) in out of pit waste rock emplacements, and in-pit behind the mining void.

- Progressive development of internal roads and haul roads including a causeway over Charlevue Creek to enable coal haulage and pit access.
- Development of water storage dams and sediment dams, and the installation of pumps, pipelines, and other water management equipment and structures including temporary levees, diversions and drains.

Existing local and regional infrastructure, facilities and services will be used to support Project activities. These include the SunWater water distribution network, the Aurizon rail network, Ergon's electricity network, the Capricorn Highway, and Gladstone export coal terminals.

The proposed mine will target the Rangal coal measures. Up to seven seams/plies are targeted, ranging in thickness from 0.5 m to 3.0 m. The seams are impacted by faulting and seam splitting and are typically overlain by overburden ranging in depth from 45 m to 60 m.

As part of the technical studies being completed for input into the environmental approvals process, RGS Environmental Pty Ltd (RGS) was commissioned by Magnetic South to complete a geochemical assessment of potential coal reject material at the Project.

## 1.2 Previous Studies

RGS previously completed a geochemical assessment of representative samples of mining waste materials at the Project focussing on overburden and interburden materials (RGS, 2018). The assessment found that the mining waste materials were non-acid forming (NAF), with excess acid neutralising capacity (ANC), and typically low sulfur content. Where higher sulfur was present in coal and carbonaceous siltstones, it was mainly present as non-sulfidic sulfide, and unlikely to contribute to acid generation. Overall, the mining waste materials were found to have a high factor of safety and a very low risk of acid generation. Overall, initial and ongoing surface runoff and seepage from mining waste materials represented by the samples tested was expected to be moderately alkaline and have a moderate level of salinity.

The mining waste materials contained low concentration of total metals/metalloids compared to median crustal abundance in non-mineralised soils, and most metals/metalloids were expected to be sparingly soluble at the neutral to alkaline pH of leachate from bulk mining waste materials. Dissolved metal/metalloid concentrations in surface runoff and leachate from bulk mining waste materials were predicted to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.

Mining waste materials were found to be amenable to revegetation as part of rehabilitation activities, although, it was suggested that sodic materials could require gypsum and fertiliser amendment to limit dispersion and erosion and to provide a reasonable growth medium for revegetation and rehabilitation. Rehabilitation field trials on bulk materials were recommended to be completed during the operational phase of the mine to determine the most appropriate management option for progressive rehabilitation and at mine closure.

## 1.3 Scope of work

The objective of the work program was to complete a geochemical assessment of representative samples of potential coal reject materials as part of the mine assessment and approvals process. The scope of work was developed by RGS based upon information provided to RGS by Magnetic South as well as previous site experience (RGS, 2018) and included:

- Selection of samples to best represent the coal reject materials;
- Coordination of the geochemical analysis program;
- Geochemical characterisation of the samples utilising both static and kinetic testing methods; and
- Preparation of a report to discuss the sample analysis results.

The work program was completed in accordance with relevant industry guidelines (DME, 1995, DEHP, 2013; COA, 2016a,b,c; and INAP, 2009).

## 1.4 Local geology

The project is located within the Dawson Fold Zone of the Bowen Basin. The project is focussed on the Rangal Coal Measures – Permian aged sediments consisting of siltstones, sandstone and coal seams. Up to seven seams/plies are planned to be targeted, ranging in thickness from 0.5 to 3.0 m. Typically, overburden in the project area ranges in depth from 45 m to 60 m, with varying interburden thicknesses between the seams. A representative stratigraphic column of the project area is shown in **Figure A2 (Attachment A)**.

Seams within the Rangal Coal Measures Seams (particularly the Aries, Castor and Pollux seams) commonly coalesce and split. The coal quality across the deposit is variable, but it generally described as low-volatile bituminous coal with moderate ash, sulfur and phosphorous. The geochemical assessment completed by RGS (RGS, 2018) on the overburden and interburden present at the proposed project indicated that the carbonaceous siltstone and coal material present at the site had elevated sulfur, mainly in the form of non-sulfide sulfur (ie., non-acid generating). The clay, sandstone and siltstone present showed sulfur concentrations below natural background concentration (ie., less than 0.1 %S).

# 2 Methodology

RGS personnel worked (Dr. Alan Robertson) worked closely with Magnetic South personnel and related coal quality consultants to facilitate the development of an appropriate sampling and geochemical testing plan for representative samples of coal reject materials from the Project.

## 2.1 Sample selection and preparation

The sampling methodology used to obtain representative samples of coal reject materials from the proposed Project area was undertaken in accordance with relevant guideline documents. Whilst there are no specific regulatory requirements regarding the number of samples required, existing risk-based technical guidelines for the geochemical assessment of mine rock in Australia (AMIRA, 2002; COA, 2016c) and worldwide (INAP, 2009) were used by RGS as a framework for the sampling program.

The sampling strategy was based on:

- Existing knowledge of the geology/stratigraphy and geochemistry of the site and expected low potential for any significant environmental or health impacts;
- Size of operation;
- Sample representation requirements;
- Material volumes;
- Level of confidence in predictive ability; and
- Cost.

A total of 80 coal reject samples from coal quality washability tests were provided to RGS from 14 different drill holes, which consisted of 52 coarse reject and 28 fine reject samples. The location of the drill holes in relation to the site is shown in **Figure A3** (**Attachment A**). The samples were combined into 22 composite samples by reject type and coal seam/ply (14 coarse reject samples and 8 fine reject samples). **Table 2.1** provides the number of combined samples generated for each coal seam.

**Table 2.1: Composite coal reject samples generated**

| Coal Seam | Reject Type | Number of samples |
|---|---|---|
| AR2 | Coarse | 1 |
| | Fine | 1 |
| AR3 | Coarse | 2 |
| | Fine | 1 |
| CAS | Coarse | 4 |
| | Fine | 2 |
| PLU1 | Coarse | 5 |
| | Fine | 2 |
| PLU2 | Coarse | 2 |
| | Fine | 2 |
| **Total** | | **22** |

Samples were sent to Australian Laboratory Services (ALS) in Stafford Queensland. Once received, samples were prepared by crushing (where required) and pulverising to less than 75 µm size. This method of sample preparation results in a homogenous sample, but also generates a large sample surface area in contact with the resultant assay solution. This provides a greater potential for dissolution and reaction and represents an assumed initial 'worst case' scenario for these materials.

## 2.2 Geochemical test program

A series of geochemical tests were completed on the samples. The test program was designed to assess the degree of risk from the presence and potential oxidation of sulfides, and generation and the presence/leaching of soluble metals/metalloids and salts. A detailed summary of the parameters involved in completing a static and kinetic geochemical characterisation and assessment of mine materials is provided in **Attachment B**.

### 2.2.1 Static tests

Static geochemical tests provide a 'snapshot' of the characteristics of a sample material at a single point in time. These tests were staged to screen individual samples before selecting either individual and/or composite samples for more detailed static test work.

The Acid Base Account (ABA) was used as a screening procedure whereby the acid-neutralising and acid-generating characteristics of the samples were assessed. All 22 composite samples were screened using ABA. The ABA screening included static geochemical testing for the following parameters:

- pH (1:5 w:v, sample:deionised water);
- Electrical conductivity (EC) (1:5 w:v, sample:deionised water);
- Total sulfur [Leco method]; and
- Acid neutralising capacity (ANC) [AMIRA, 2002 method].

The results of the ABA tests are discussed in **Section 3.1**. After the results of the ABA screening test were received and interpreted, a total of 13 samples were also tested for sulfide sulfur as chromium reducible sulfur (Scr) using the Australian Standard (AS 4969.7, 2008) method. The remaining 9 samples did not have sufficient sample mass remaining for Scr analysis to be carried out.

From the total sulfur (or Scr where available) and ANC results, maximum potential acidity (MPA) and net acid producing potential (NAPP) values were calculated. Where available, the MPA and NAPP of these samples were calculated using the Scr data instead of total sulfur data. The use of Scr data (for fresh samples) provides a more accurate representation of the MPA that could theoretically be generated, as acid generation primarily occurs from reactive sulfide, whereas total sulfur can include other sulfur forms such as elemental sulfur, sulfate and organic sulfur.

After the results of the initial static geochemical tests were received and reviewed, all 22 samples were used to create three composite samples – one representing coarse reject material from the Castor (CAS) and Aries (AR) seams; one representing coarse reject material from the Pollox (PLU1 and PLU2) seams; and one representing fine reject material. All the composite samples were subjected to multi-element testing at ALS. The samples were tested for:

- pH and EC (1:5 w:v, sample:deionised water);
- Major Cations (Ca, Mg, K, Na) [HCl and $HNO_3$ acid digest followed by ICP-AES/MS];
- Major Anions (Cl, $SO_4$, F) [ICP-AES/MS and PC Titrator (1:5 w:v water extracts)].
- Acidity and Alkalinity as $CaCO_3$ mg/L [PC Titrator (1:5 w:v water extracts)];
- Total metals/metalloids in solids (Al, As, B, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Th, U, V, Zn) [HCl and $HNO_3$ acid digest followed by FIMS and/or ICP-AES/MS]; and
- Soluble metals/metalloids (Al, As, B, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Th, U, V, Zn) [ICP-AES/MS and FIMS (1:5 w:v water extracts)];

The ALS test results for the static geochemical test program are provided in **Attachment E**, and summary results tables provided in **Attachment C**. The static test results are discussed in **Sections 3.1** to **3.4**.

### 2.2.2 Kinetic tests

Following receipt and interpretation of the static geochemical test results, two kinetic leach column (KLC) tests were set up at the RGS 'in house' laboratory. One KLC was set up using material from the coarse reject samples, while the second KLC was set up using material from the fine coal reject samples. The KLC tests began in May 2019 on a monthly watering and leaching cycle; and are planned to run for a period of six months until November 2019. A description of the material represented by each KLC is shown below in **Table 2.2**.

**Table 2.2: KLC material description**

| KLC Sample # | Description |
|---|---|
| KLC1 | Coarse reject |
| KLC2 | Fine reject |

Approximately 1.5 kg of each composite sample was accurately weighed and used in each of the KLC tests. Heat lamps were used daily to simulate sunshine and ensure that the KLC materials were unsaturated and subject to oxidising conditions between leaching events (this is essentially an assumed "worst case" scenario for sulfide oxidation and potential acid/salt generation). Further details and a schematic of the KLC test arrangement are provided in **Attachment B**.

All leachate samples collected from the KLC tests were assayed at ALS Brisbane for:

- pH and EC
- Acidity and alkalinity [PC Titrator]
- Dissolved metals/metalloids (Al, As, B, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, V and Zn) [ICP-AES/MS];
- Dissolved major cations (Ca, Mg, Na and K) [ICP-AES/MS]; and
- Dissolved major anions (Cl, $SO_4$) and F [ICP-AES/MS].

The ALS test results for the kinetic geochemical test program are provided in **Attachment E**, and summary results tables and trends provided in **Attachment D**. The kinetic test results are discussed in **Section 3.5**.

# 3 Results

## 3.1 ABA results

ABA test results for the 22 composite coal reject samples from the Project are presented in **Table C1** (**Attachment C**) and summarised below. The results are shown by reject type to facilitate interpretation.

### 3.1.1 pH and EC

The natural pH of the deionised water used in the pH tests is typically in the pH range of 5.0 to 6.5. The $pH_{(1:5)}$ of the 22 samples ranges from 5.1 to 8.3 (**Figure 3.1**) and has a median pH value of 7.4. The pH results indicate that the coal reject materials are typically in the pH neutral range. There does not appear to be any significant correlation between pH and reject type or coal seam/ply.

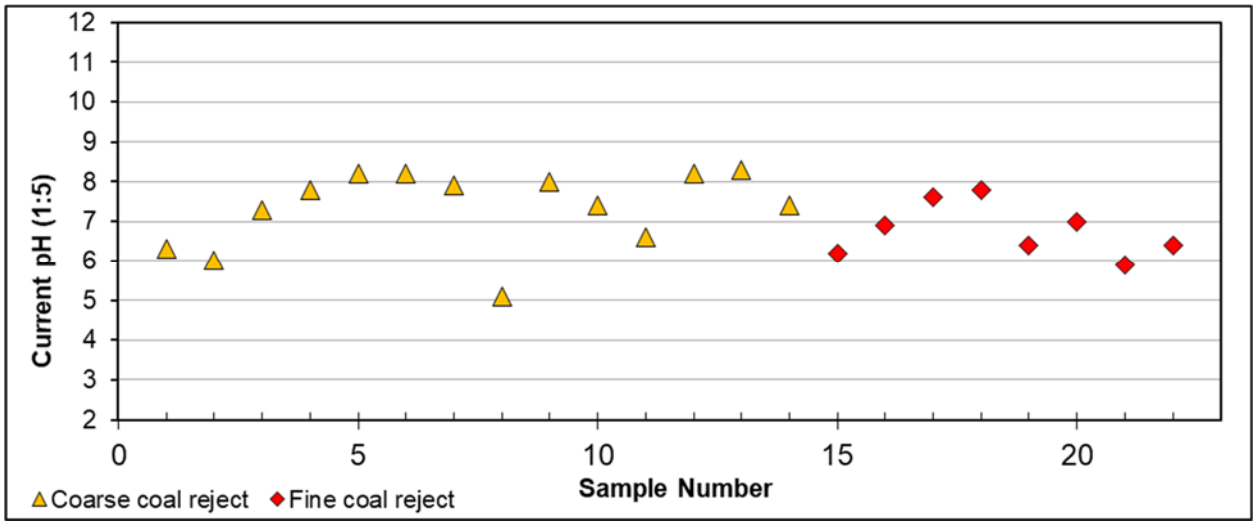


**Figure 3.1: pH results for coal reject**

The current $EC_{(1:5)}$ of the samples ranges from 398 to 1,620 µS/cm (median 774 µS/cm) (**Figure 3.2)**. There appears to be no significant correlation between EC and reject type or coal seam/ply.

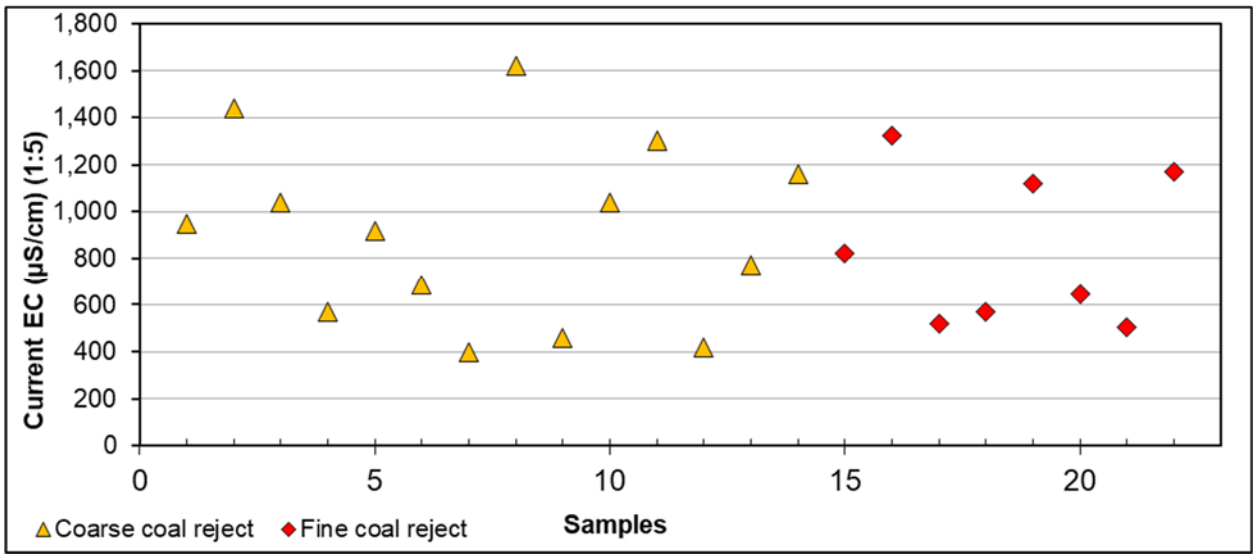


**Figure 3.2: Electrical conductivity results for coal reject**

To provide additional context, the $EC_{(1:5)}$ and $pH_{(1:5)}$ results are classified against pH and salinity criteria for mining waste materials, as defined by the Queensland DME (1995) technical guidelines for the environmental management of exploration and mining in Queensland (see **Table 3.1** below).

**Table 3.1: Salinity and pH criteria for assessment of coal reject**

| | Very Low | Low | Medium | High | Very High |
|---|---|---|---|---|---|
| **$pH_{1:5}$** | **< 4.5** | **4.5 – 5.5** | **5.5 – 7.0** | **7.0 – 9.0** (Median – 7.4) | **> 9.0** |
| **$EC_{1:5}$ (µS/cm)** | **< 150** | **150 – 450** | **450 – 900** (Median – 774) | **900 – 2,000** | **> 2,000** |

**Note:** Adapted from DME, 1995. Highlighted cells show the category corresponding to the median pH and EC values (orange shading) for the coal reject samples.

Based on the median pH and EC values, the coal reject samples tested are generally regarded as having 'high' soil pH and 'medium' salinity values.

The pH and EC tests were obtained from pulverised samples (≤ 75 µm) with a large surface area in contact with the leaching solution. This provides a greater potential for dissolution and reaction and represents an assumed initial 'worst case' scenario. It is also expected that the salinity of leachate from coal reject materials will diminish with time as salts are flushed from the sample matrix and a state of equilibrium develops. At that point, the salinity of seepage/runoff should stabilise at a lower asymptotic concentration relative to the oxidation/weathering/erosion of the materials.

### 3.1.2 Total sulfur

The total sulfur content of the samples ranges from 0.23 to 4.20 %S and has a median value of 1.03 %S, compared with the median crustal abundance value of 0.07 %S in unmineralised soils (Bowen, 1979; INAP, 2009). Materials containing greater than 0.1 %S are considered to potentially have some capacity to generate acidity. **Figure 3.3** provides the sulfur content of the sample materials and shows that most coal reject samples have a total sulfur concentration above median crustal abundance.

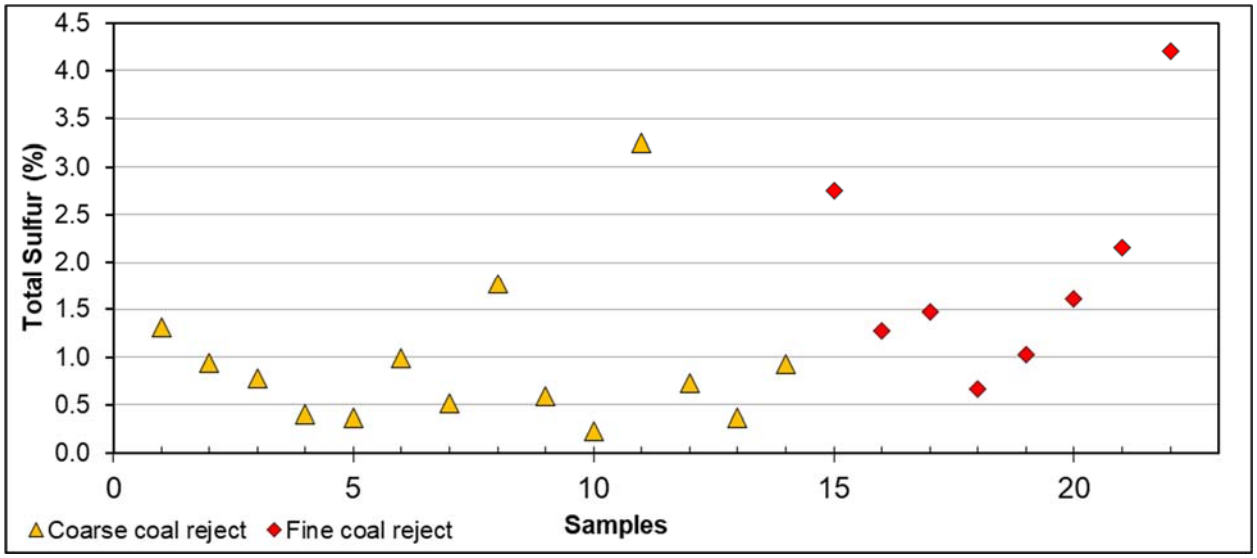


**Figure 3.3: Total sulfur results for coal reject**

### 3.1.3 Sulfide sulfur

The sulfide sulfur content for the 13 samples tested using the Scr method is illustrated in **Figure 3.4** . Sample 1 (coarse reject) and Samples 15 to 22 (fine reject) were not tested due to a lack of available sample material. The test results show a sulfide content ranging from 0.12 to 3.22 %S. The results indicate that, on average, more than half of the total sulfur content is present as sulfide sulfur (most likely pyrite/marcasite) and may have some potential to generate acidity.

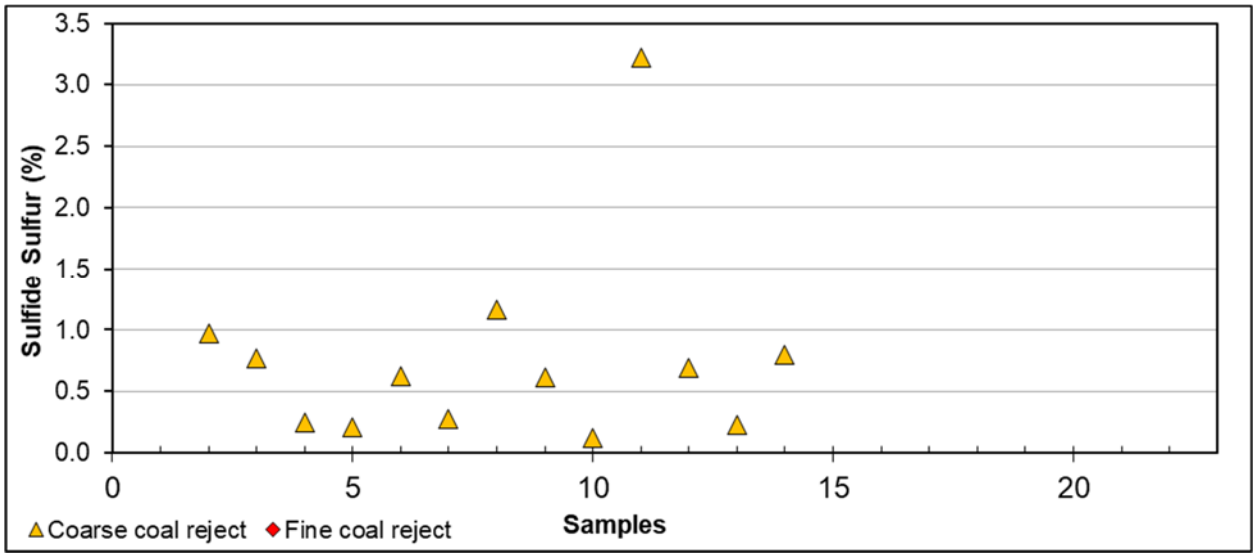


**Figure 3.4: Sulfide sulfur results for coal reject**

### 3.1.4 Maximum potential acidity

The Maximum Potential Acidity (MPA) for the reject samples ranges from 3.7 to 128.6 kg $H_2SO_4$/t, and has a median value of 31.5 kg $H_2SO_4$/t.

### 3.1.5 Acid neutralising capacity

The Acid Neutralising Capacity (ANC) for the reject samples ranges from 11.5 to 396.0 kg $H_2SO_4$/t and has a median value of 68.5 kg $H_2SO_4$/t (approximately double the median MPA).

### 3.1.6 Net acid producing potential

The Net Acid Producing Potential (NAPP) is the capacity of a sample to generate acidity (MPA) minus its capacity to neutralise acidity (ANC). The NAPP values for the reject samples range from -351.0 to 72.7 kg $H_2SO_4$/t, with a negative median value of -33.4 kg $H_2SO_4$/t (**Figure 3.5**). Sixteen (16) of the 22 coal reject samples have a negative NAPP value and six coal reject samples have a positive NAPP value.

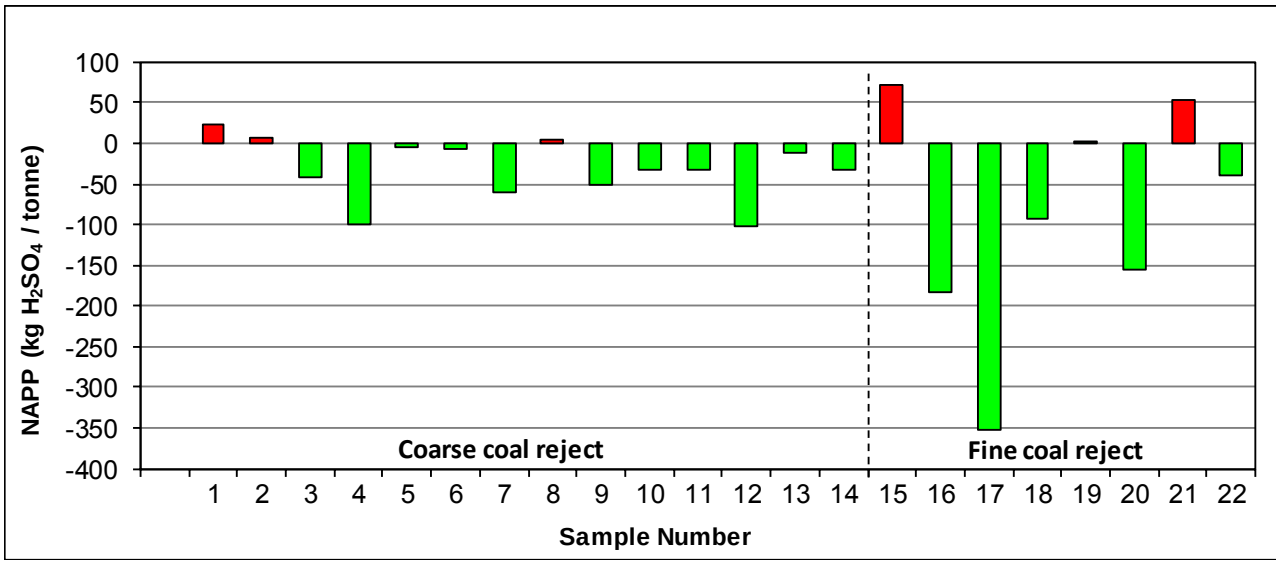


**Figure 3.5: NAPP results for coal reject**

### 3.1.7 ANC:MPA ratio

The ANC:MPA ratio of the samples ranges from 0.1 to 9.8, with a median value of 2.7. **Figure 3.6** shows a plot of the ANC versus MPA values for the samples. ANC:MPA ratio lines have been plotted on the graph to illustrate the factor of safety associated with the samples in terms of potential for generation of acid and metalliferous drainage (AMD). Generally, samples with an ANC:MPA ratio of greater than 2 are considered to represent material with a low to negligible risk of acid generation and a high factor of safety in terms of potential for AMD (COA, 2016c; INAP, 2009).

A total of 12 samples fall in the low to negligible risk categories, whilst 5 samples fall in the possible risk category, and 5 samples fall in the increased risk category.

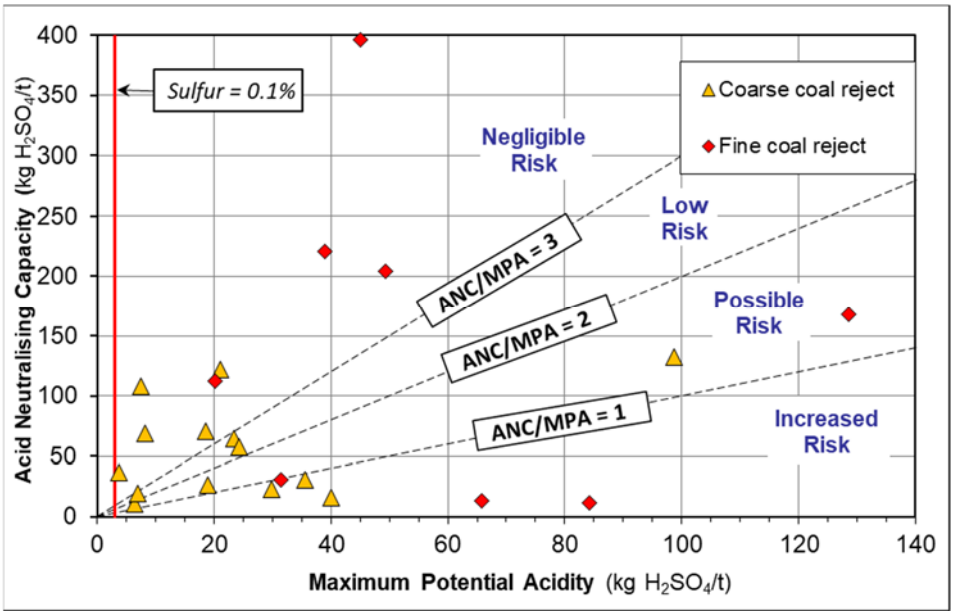


**Figure 3.6: ANC vs MPA for coal reject**

### 3.1.8 Geochemical classification

The results of the ABA testing have been used to classify the acid forming nature of the 22 coal reject samples. The classification criteria reflect Australian (COA, 2016c) and international (INAP, 2009) guidelines for the classification of mine waste materials. **Table 3.2** summarises the criteria used by RGS and gives a breakdown of the number of samples in each category.

**Table 3.2: Geochemical classification criteria for coal reject**

| Geochemical Classification | Total Sulfur[1] (%) | NAPP (kg $H_2SO_4$/t) | ANC:MPA Ratio | No. Samples (n = 22) |
|---|---|---|---|---|
| Non-Acid Forming | > 0.1 | ≤ -5 | ≥ 2 | 15 |
| Uncertain | > 0.1 | > -5 and ≤ +5 | ≥ 1 | 2 |
| Potentially Acid Forming (Low Capacity) | > 0.1 | > +5 and ≤ +10 | < 1 | 2 |
| **Potentially Acid Forming** | > 0.1 | > +10 | < 1 | 3 |

The data presented in **Table 3.2** illustrate that 15 of the 22 samples tested (68 %) are classified as non-acid forming (NAF) as a result of the excess ANC present in these samples. Two samples are classified as Uncertain and have a low NAPP value that is negative or close to zero. Two samples are classified as potentially acid forming (low capacity) (PAF-LC) and have a positive NAPP value between 5 and 10 kg $H_2SO_4$/t. Three samples are classified as PAF and have a positive NAPP value greater than 10 kg $H_2SO_4$/t .

Whilst there is no strong correlation between the reject material type or coal seam/ply source, two of the three samples classified as PAF were sourced from the AR2 seam/ply and one was sources from the PLU2 seam/ply. Whilst AR seam/plys were included in this assessment, the AR seam coal reject materials make up a small fraction of the overall total coal reject materials likely to be generated at the Project. In addition, two of the three samples classified as PAF represent fine coal reject material which again makes up a relatively small fraction of the total coal reject materials, compared to coarse coal reject materials.

It is expected that blending of the coal reject materials during co-disposal at the Project will result in a bulk coal reject material that is classified as NAF. Most coal reject materials represented by the samples tested have excess ANC and is likely to provide a significant source of buffering to any acidity generated from the small proportion of PAF materials.

## 3.2 Multi-element concentration in solids

Multi-element assays were carried out on the three composite coal reject samples described in **Section 2.2.1** to identify any elements (metals/metalloids) present in these materials at concentrations that may be of environmental concern with respect to revegetation and surface water/groundwater quality. The total metals/metalloids concentration for individual elements in these materials can be relevant for revegetation activities and/or where the potential exists for human contact (eg. if the material was to be used off-site).

The results from the multi-element tests (total metals/metalloids) are shown in **Table C2** (**Attachment C**). For comparison, guideline values from the National Environmental Protection Measure (NEPM) (NEPC, 2013) are shown for some elements. Where no guideline values are listed, none are specified in the NEPM. All major, minor and trace elements tested returned values below those listed in the NEPM for Health-Based Investigation Level – HIL (C); public open spaces - recreational land use.

## 3.3 Geochemical abundance index

Total metal/metalloid concentrations in mining waste materials can be compared to the median crustal abundance for un-mineralised soils (Bowen, 1979, COA, 2016c and INAP, 2009). The extent of enrichment is reported as the Geochemical Abundance Index (GAI), which relates the actual concentration in a sample with the median (or average) crustal abundance on a $\log_{10}$ scale. The GAI is expressed in integer increments from 0 to 6, where a GAI value of 0 indicates that the element is present at a concentration less than, or similar to, the median crustal abundance; and a GAI value of 6 indicates approximately a 100-fold enrichment above median crustal abundance (see **Table 3.3**).

**Table 3.3: Geochemical Abundance Index values and Enrichment Factors**

| GAI | Enrichment Factor | GAI | Enrichment Factor |
|---|---|---|---|
| **-** | Less than 3-fold enrichment | **4** | 24 – 48 fold enrichment |
| **1** | 3 – 6 fold enrichment | **5** | 48 – 96 fold enrichment |
| **2** | 6 – 12 fold enrichment | **6** | Greater than 96 fold enrichment |
| **3** | 12 – 24 fold enrichment | | |

As a general rule, a GAI of 3 or greater signifies enrichment that may warrant further examination. This is particularly the case with some environmentally important 'trace' elements, such as arsenic, chromium, cadmium, copper, lead, selenium and zinc, more so than with major rock-forming elements, such as aluminium, calcium, iron, manganese and sodium.

Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality or public health, but their significance should still be evaluated. While the GAI provides an indication of metals/metalloids that may be enriched relative to the global median crustal abundance, the following points should also be considered:

- The median crustal abundance varies between different literature sources, therefore affecting the calculated GAI values.
- If a sample is shown to be enriched relative to the median crustal abundance, there is no direct correlation that that sample will also leach metals/metalloids at elevated concentrations. The mobility of metals/metalloids is dependent on mineralogy, adsorption/desorption and the environment in which it occurs.
- Whilst some element concentrations can be elevated relative to the median crustal abundance, the nature of an ore deposit means the background levels are generally expected to be elevated.

Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (eg. low pH) the solubilities of common environmentally important elements such as aluminium, copper, cadmium, iron and zinc increase significantly.

**Table C3** (**Attachment C**) provides total metal/metalloid concentrations for the three composited samples described in **Section 2.2**, and is compared to median crustal abundance (GAI). The GAI results indicate that of the metals/metalloids measured, none are significantly enriched compared to median crustal abundance. Hence, further examination is not considered necessary.

The potential solubility and mobility of any metals/metalloids in the materials was investigated further through water extract tests and the results are presented in **Section 3.4**.

## 3.4 Water quality static tests

There are no specific regulatory criteria for metal/metalloid concentrations in leachate from mining waste material on mine sites in Queensland. As such, RGS has compared the multi-element results in water extracts from the selected composite samples with the Australian guideline values for livestock drinking water and aquatic freshwater eco-systems (ANZECC and ARMCANZ, 2000). These guidelines are provided for context only and are not intended to be interpreted as "maximum permissible levels" for site water storage or discharge.

It should also be recognized that direct comparison of geochemical data with guideline values can be misleading. For the purpose of this study, guideline values are only provided for broad context and should not be interpreted as arbitrary "maximum" or "trigger" values. Using sample pulps (ground to passing 75 µm) provides a high surface area to solution ratio, which encourages mineral reaction and dissolution of the solid phase. The results on screening tests on water extract solutions is assumed to represent a "worst case" scenario for initial surface runoff and seepage from mining waste materials.

The results from multi-element testing of water extracts (1:5 solid:water) from the samples are presented in **Table C4** (**Attachment C**). The pH of the water extracts ranges from pH 8.0 to 8.5 (median 8.0) and is considered to be slightly alkaline and within the range for 95 % species protection in freshwater aquatic ecosystems as set out in ANZECC and ARMCANZ (2000).

The alkalinity value in the water extract samples is dominated by bicarbonate and significantly exceeds any acidity value, such that the net alkalinity value is strongly positive. This results confirms that bulk coal reject materials represented by the samples tested have excess ANC and should provide a significant source of buffering to any acidity generated from any PAF materials.

The EC in the water extracts ranges from 593 to 1,040 µS/cm (median 865 µS/cm) and is typically moderate. The results confirm that these materials exhibit medium salinity and moderate concentrations of dissolved solids when in contact with water.

The range in concentrations for the major ions in solution in the water extracts are provided in **Table 3.4**. The concentrations for all major ions were well below the water quality guidelines for livestock drinking water.

**Table 3.4: Major ion concentrations in solution**

| Ion | Minimum (mg/L) | Maximum (mg/L) | Median (mg/L) |
|---|---|---|---|
| Calcium (Ca) | 10 | 70 | 64 |
| Magnesium (Mg) | 10 | 38 | 34 |
| Potassium (K) | 10 | 16 | 12 |
| Sodium (Na) | 52 | 108 | 92 |
| Chloride (Cl) | 22 | 44 | 38 |
| Fluoride (F) | 0.2 | 0.6 | 0.4 |
| Sulfate ($SO_4$) | 140 | 398 | 286 |

The concentration of the dissolved trace metals/metalloids tested in the water extracts is generally at or below the laboratory limit of reporting (LoR) for most samples. The exceptions are barium, manganese, molybdenum and silica, although the concentrations are below the applied water quality guideline values (ANZECC & ARMCANZ, 2000), where these exist.

Overall, the results indicate that dissolved metal/metalloid concentrations in initial surface runoff and seepage from the sample materials are unlikely to significantly impact upon the quality of surface and groundwater resources.

## 3.5 Water quality kinetic tests

As described in **Section 2.2.2** and **Attachment B**, a KLC test program is currently being completed on composite samples representing coarse reject (KLC1) and fine reject (KLC2) materials from the Project. The KLC tests are being operated following mining industry guidelines for such tests (AMIRA, 2002; COA, 2016c). The KLC tests commenced in May 2019 and are scheduled to be operated on a monthly basis for a period of six months until November 2019. To date, leachate samples from four KLC leach events have been collected and analysed over a period of three months.

The KLC test results and trends available to date are presented in **Attachment D** and summarised in this section. The leachate results from the KLC test program are presented alongside the Australian water quality guideline values for livestock drinking water quality (ANZECC & ARMCANZ, 2000). These guidelines are provided for context only and are not intended to be interpreted as "maximum permissible values" for site water storage or discharge. It should be noted that the KLC samples were used as received and have a high surface area for potential geochemical reactions. The ratio of sample to water in the KLC leach tests was approximately 3:1 (w:v); which is more concentrated then that used in the static tests (ie 1:5 w/v). Whilst arbitrary comparisons against water quality guideline concentrations can be useful in some situations and help to provide relevant context, such comparisons cannot be directly extrapolated to the field situation at the Project.

### 3.5.1 Leachate chemistry

The available KLC test results to date indicate that:

- Leachate from the KLC tests has a pH value in the range 4.90 to 7.22 over the test period. It should be noted that the pH of the deionised water used in the KLC tests over this period has a pH value ranging from 5.45 to 6.01. Apart from the first two leach events for the fine coal reject sample (KLC2), the pH of the collected KLC leachate is greater than the pH of the deionised water used in the KLC tests. These results indicate that pH values within bulk co-disposed coal reject materials are likely to be in the pH neutral range, and within the range for 95 % species protection in freshwater aquatic ecosystems as set out in ANZECC and ARMCANZ (2000).
- Leachate from the KLC tests has an EC value in the range 1,100 to 2,790 µS/cm. The EC values are generally higher in the fine reject materials (KLC2) compared to the coarse reject material (KLC1).
- The acidity value in leachate from the KLC tests over the test period is low for the coarse reject material (KLC1) and initially higher for the fine reject material (KLC 2), although the acidity value from the coarse reject material decreases by two orders of magnitude after the first two leach events. The alkalinity values in leachate from both the coarse and fine reject materials is relatively low but sufficient to create a positive net alkalinity value for the two most recent KLC leach events.
- The concentration of major ions in leachate from the KLC tests is dominated by calcium, magnesium sodium, chloride and sulfate (and bicarbonate). The calcium, magnesium and sulfate concentrations show an increasing trend over the test period whereas the sodium and chloride concentrations generally show a steady or reducing trend.
- The sulfate release rate from the KLC samples initially showed an increasing trend although the two most recent KLC leach events show a steadier concentration trend. The sulfate concentration in leachate from the KLC tests is generally greater than and less than the applied guideline value of 1,000 mg/L (ANZECC & ARMCANZ, 2000) for the fine reject material and coarse reject materials, respectively.
- The reject samples used in the KLC tests retain at least ~95.6 % of their inherent total sulfur content after three months of exposure to idealised oxidising conditions, which reflects the relatively slow rate of sulfide oxidation (and potential acid generation) for these materials.

- The KLC test samples retain at least 98.6 % of their inherent ANC value after three months of exposure to oxidising conditions, which reflects the slow release of alkalinity from these materials.
- The concentrations of trace metals/metalloids in the leachate from the KLC tests is generally low and typically below the laboratory LoR. These trace metals/metalloids are sparingly soluble at the current pH of the KLC leachate. The main exceptions to this are aluminium, cadmium, copper, manganese selenium and zinc, which can have concentrations in KLC leachate greater than the applied water quality guideline criteria for aquatic freshwater ecosystems (95 % species protection level) (ANZECC & ARMCANZ, 2000). However, all of the metals/metalloid concentrations are less than the applied livestock drinking water guideline trigger values.

### 3.5.2 Sulfide oxidation and sulfate generation rates

The sulfate generation rate results obtained for the coal reject samples used in the KLC tests have been used to determine the rate of sulfide oxidation in these materials. Most sulfate salts generated from sulfide reaction involving materials with a relatively low sulfide sulfur concentration are highly soluble, and therefore will be collected in column leachate. The dissolved sulfate (and calcium) concentrations in the KLC leachate are typically much less than the solubility limit of gypsum ($CaSO_4$), for example, which indicates that sulfate generation is not controlled by gypsum dissolution in the KLC test materials. Therefore, the sulfate concentrations and oxidation rate calculations provide reasonable estimates of these parameters and the results align well with existing static and dynamic geochemical data derived from a wide range of mine waste materials (AMIRA, 1995). The sulfate generation rate and associated sulfide oxidation rate for the two KLC tests are shown in **Table 3.5**.

**Table 3.5: Sulfate Generation and Sulfide Oxidation Rates for KLC tests on coal reject**

| KLC Sample Number | Sample Description | Sulfate Generation Rate (mg/kg/week) | Oxidation Rate (kg $O_2/m^3/s$) |
|---|---|---|---|
| KLC1 | Coarse Coal Reject | 74.1 | $3.08 \times 10^{-8}$ |
| KLC2 | Fine Coal Reject | 60.8 | $2.49 \times 10^{-8}$ |

The sulfate generation rate from the KLC samples ranges from 60.8 to 74.1 mg/kg/week indicating that the rate of sulfide oxidation is relatively low in these materials (equivalent to a sulfide oxidation rate ranging from 2.49 to 3.08 x $10^{-8}$ kg $O_2/m^3/s$). Mining waste materials with an oxidation rate in the low range (ie., less than 5 x $10^{-8}$ kg $O_2/m^3/s$) and a moderate ANC level have an increased factor of safety and are likely to generate leachate that is pH neutral and/or has a low level of acidity (AMIRA, 1995; Bennett *et al*., 2000). Hence, both the coarse and fine reject samples tested fall into this category. Overall, the KLC results reflect the range of material characteristics predicted from the static geochemical test results presented in **Section 3.1**.

Potential implications of these results with respect to the management of coal reject materials at the Project are discussed further in **Section 4.**

# 4 Discussion

## 4.1 AMD potential and management

The results of the ABA tests presented in **Section 3.1** indicate that the AMD potential of the coal reject materials is variable. As a bulk material, the coal reject materials are expected to be NAF with excess ANC, that should provide long term buffering to any acid generated. Overall, most coal reject materials have a relatively low risk of acid generation and an increased factor of safety with respect to potential AMD.

If left exposed to oxidising conditions, some of the coal reject materials with elevated total sulfur content may have the potential to generate moderately saline leachate containing an elevated concentration of sulfate. It is therefore recommended that coal reject materials are managed in a way that reduces the risk of connectivity with surface and groundwater resources. In existing Bowen Basin coal mines, this outcome is generally achieved by disposing of these materials either a dedicated co-disposal storage facility or through encapsulation within spoil storage areas, well away from the outside surface of the final rehabilitated landforms. The utilisation of spoil storage areas for coal reject disposal takes advantage of a much larger volume of NAF spoil material with excess ANC. If coal reject materials are left exposed to oxidising conditions for an extended period of time prior to encapsulation, dosing with agricultural limestone (ie. fine limestone) could be considered as a contingency measure, if warranted.

Notwithstanding the method selected for management of coal reject material, it is recommended that regular collection and monitoring of surface runoff and seepage from storage areas be completed. The potential for connectivity between coal reject materials and any surface water or groundwater resources should also be evaluated.

It is recommended that some representative samples of coal reject materials be generated and subjected to both static and kinetic geochemical testing in the future when bulk materials become available, to verify the expected geochemical nature of these materials. It is likely that the relatively small amount of coal reject material generated at the Project can be safely encapsulated within a much larger volume of NAF spoil material with excess ANC, with little risk of any adverse environmental outcomes. This strategy has successfully been employed at several coal mines within the Bowen Basin.

## 4.2 Multi-element composition and water quality

### 4.2.1 Multi-element composition and enrichment

The multi-element concentration of the metals/metalloids present in the coal reject materials are presented in **Sections 3.2** and **3.3**. The results indicate that the sample materials typically have low total metal and metalloid concentrations in solids, mostly below the laboratory limit of reporting (LoR) and all below the applied NEPC (HIL(C)) guideline for soils.

Comparison with median crustal abundance values in un-mineralised soils indicates that the coal reject materials are not significantly enriched with metals/metalloids.

### 4.2.2 Water quality

The static and kinetic geochemical test results indicate that surface runoff and seepage from coal reject materials is likely to be pH neutral and have a moderate salinity value. The pH of surface runoff and seepage from these materials is likely to fall within the range for 95 % species protection in freshwater aquatic ecosystems as set out in ANZECC and ARMCANZ (2000).

The major ion concentrations in surface runoff and seepage from coal reject materials are dominated by calcium, magnesium, sodium, sulfate, chloride (and bicarbonate). The sulfate concentration has the potential to be above the applied livestock drinking water quality guideline criterion of 1,000 mg/L.

The concentration of most trace metals/metalloids tested for water in contact with coal reject materials is generally low, typically below the laboratory LoR, and below the applied water quality guideline criteria. These

trace metals/metalloids are sparingly soluble at the current pH of coal reject materials. The main exceptions are the concentrations of aluminium, cadmium, copper, manganese selenium and zinc which can be greater than the applied water quality guideline criteria for aquatic freshwater ecosystems (95 % species protection level) (ANZECC & ARMCANZ, 2000). However, all of the metals/metalloid concentrations are less than the applied livestock drinking water guideline trigger values.

Overall, the static geochemical test results indicate that dissolved metal/metalloid concentrations in initial surface runoff and seepage from coal reject materials are unlikely to significantly impact upon the quality of surface and groundwater resources. However, some coal reject materials, if left exposed to oxidising conditions, may have the potential to generate brackish leachate containing elevated concentrations of sulfate and some metals/metalloids compared to applied water quality guideline values. Therefore, coal reject materials should be encapsulated within spoil storage areas, well away from the outside surface of the final rehabilitated landforms. If coal reject materials are left exposed to oxidising conditions for an extended period of time prior to encapsulation, dosing with agricultural limestone (ie. fine limestone) could be considered as a contingency measure, if warranted.

# 5 Conclusions and Recommendations

## 5.1 Conclusions

RGS has completed a geochemical assessment of the coal reject material at the Project. The main findings of the geochemical assessment are:

- The coal reject samples represent materials with a variety of geochemical characteristics ranging from NAF to PAF. As a bulk material, coal reject is expected to be NAF with excess ANC. Overall, most coal reject materials have a relatively low risk of acid generation and an increased factor of safety with respect to potential for AMD.
- Initial and ongoing surface runoff and seepage from coal reject materials is expected to be pH neutral and have a moderate level of salinity. The salinity of leachate from higher sulfur coal reject materials could increase over time if exposed to atmospheric conditions, due to release of sulfate through sulfide oxidation.
- Comparison with guideline values and median crustal abundance in un-mineralised soils indicates that the coal reject materials are not significantly enriched with metals/metalloids.
- Most metals/metalloids are sparingly soluble at the current pH of the leachate from coal reject materials. Dissolved metal/metalloid concentrations in surface runoff and leachate from bulk coal reject materials are expected to be relatively low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.

## 5.2 Recommendations

As a result of the geochemical assessment work completed on coal reject materials at the Project, several recommendations are provided to minimise the risk of any significant environmental harm to the immediate and downstream environment.

- Operational sampling and geochemical testing of representative samples of coal reject material should be used as required when the mine is operational to verify the findings of this report.
- Coal reject materials should be encapsulated in spoil storage areas well away from the outside surface of the final rehabilitated landforms, where there is a low risk of connectivity to surface water or groundwater resources.
- If coal reject materials are left exposed to oxidising conditions for an extended period of time prior to encapsulation, dosing with agricultural limestone (ie. fine limestone) could be considered as a contingency measure, if warranted.
- Surface water and seepage from the coal reject storage areas should be monitored to ensure that key water quality parameters remain within appropriate criteria. Water quality monitoring parameters should include pH, EC and total suspended solids (TSS) on a quarterly basis and the suite of water quality analyses described in **Table C4** (**Attachment C**) of this report opportunistically and at least on an annual basis.

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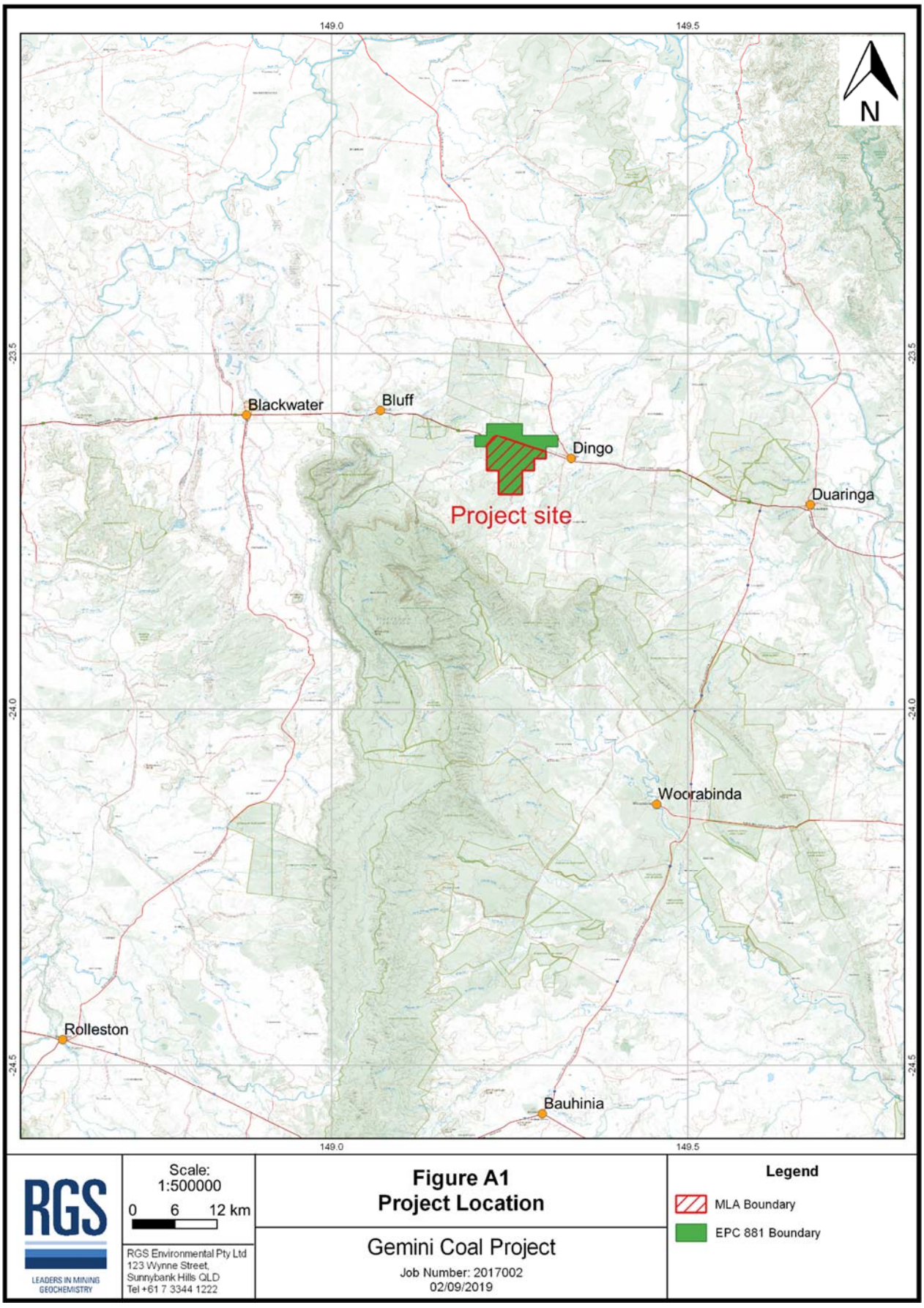
# Attachment A Figures


149.0
149.5
N
-23.5
-24.0
-24.5
Blackwater
Bluff
Dingo
Project site
Duaringa
Woorabinda
Rolleston
Bauhinia
Scale:
1:500000
0 6 12 km
RGS Environmental Pty Ltd
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Sunnybank Hills QLD
Tel +61 7 3344 1222
Figure A1
Project Location
Gemini Coal Project
Job Number: 2017002
02/09/2019
Legend
MLA Boundary
EPC 881 Boundary

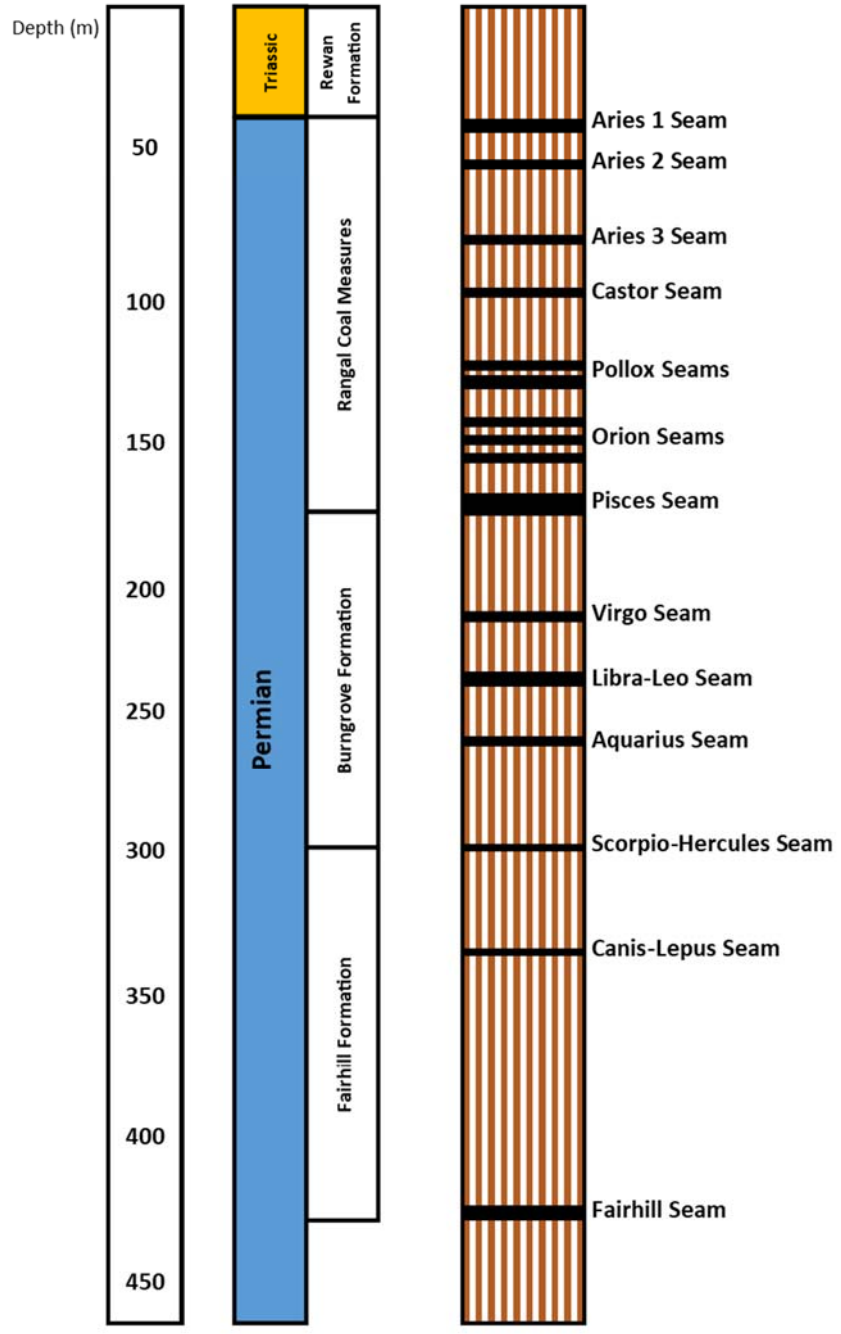


**Figure A2**

**Representative Stratigraphic Column**

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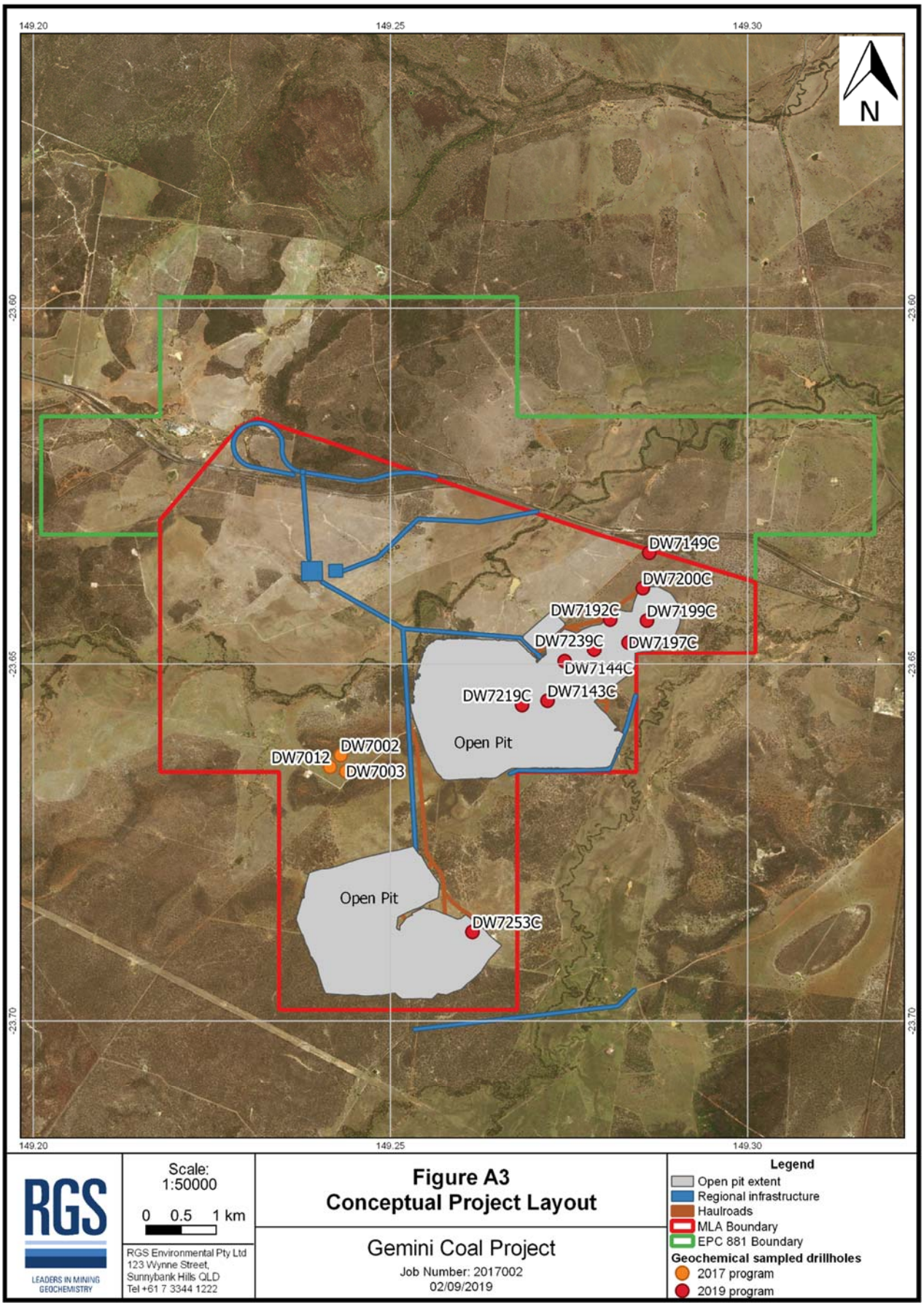
Gemini Coal Project
Job Number: 2017002
02/09/2019


149.20
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149.30
-23.60
-23.65
-23.70
N
DW7149C
DW7200C
DW7192C
DW7199C
DW7239C
DW7197C
DW7144C
DW7219C
DW7143C
Open Pit
DW7012
DW7002
DW7003
Open Pit
DW7253C
Scale:
1:50000
0 0.5 1 km
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Figure A3
Conceptual Project Layout
Gemini Coal Project
Job Number: 2017002
02/09/2019
Legend
Open pit extent
Regional infrastructure
Haulroads
MLA Boundary
EPC 881 Boundary
Geochemical sampled drillholes
2017 program
2019 program

# Attachment B Geochemical assessment methods for mining waste materials

## ACID GENERATION AND PREDICTION

Acid generation is caused by the exposure of sulfide minerals, most commonly pyrite ($FeS_2$), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum acid that could be generated by the sample by either directly determining the pyritic S content or assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \rightarrow Fe(OH)_3 + 2\ H_2SO_4$$

According to this reaction, the maximum potential acidity (MPA) of a sample containing 1%S as pyrite would be 30.6 kg $H_2SO_4$/t. The chemical components of the acid generation process consist of the above sulfide oxidation reaction and acid neutralization, which is mainly provided by inherent carbonates and to a lesser extent silicate materials. The amount and rate of acid generation is determined by the interaction and overall balance of the acid generation and neutralisation components.

### *Net Acid Producing Potential*

The net acid producing potential (NAPP) is used as an indicator of materials that may be of concern with respect to acid generation. The NAPP calculation represents the balance between the maximum potential acidity (MPA) of a sample, which is derived from the sulfide sulfur content, and the acid neutralising capacity (ANC) of the material, which is determined experimentally. By convention, the NAPP result is expressed in units of kg $H_2SO_4$/t sample. If the capacity of the solids to neutralise acid (ANC) exceeds their capacity to generate acid (MPA), then the NAPP of the material is negative. Conversely, if the MPA exceeds the ANC, the NAPP of the material is positive. A NAPP assessment involves a series of analytical tests that include:

### *Determination of pH and EC*

pH and EC measured on 1:5 w/w water extract. This gives an indication of the inherent acidity and salinity of the waste material when initially exposed in a waste emplacement area.

### *Total sulfur content and Maximum Potential Acidity (MPA)*

Total sulfur content is determined by the Leco high temperature combustion method. The total sulfur content is then used to calculate the MPA, which assumes that the entire sulfur content is present as reactive pyrite. Direct determination of the pyritic sulfur content can provide a more accurate estimate of the MPA.

### *Acid neutralising capacity (ANC)*

By addition of acid to a known weight of sample, then titration with NaOH to determine the amount of residual acid. The ANC measures the capacity of a sample to react with and neutralise acid. The ANC can be further evaluated by slow acid titration to a set end-point in the Acid Buffering Characteristic Curve (ABCC) test through calculation of the amount of acid consumed and evaluation of the resultant titration curve.

### *Net Acid Generation (NAG)*

The net acid generation (NAG) test involves the addition of hydrogen peroxide to a sample of mine rock or process residue to oxidise reactive sulfide, then measurement of pH and titration of any net acidity produced by the acid generation and neutralisation reactions occurring in the sample. A significant NAG result (*i.e.* final $NAG_{pH} < 4.5$) indicates that the sample is potentially acid forming (PAF) and the test provides a direct measure of the net amount of acid remaining in the sample after all acid generating and acid neutralising reactions have taken place. A $NAG_{pH} > 4.5$ indicates that the sample is non-acid forming (NAF). The NAG test provides a direct assessment of the potential for a material to produce acid after a period of exposure and weathering and is used to refine the results of the theoretical NAPP predictions. The NAG test can be used as a stand-alone test but is recommended that this only be considered after site specific calibration work is carried out. RGS generally avoids use the NAG test at coal mining projects as the high organic content of some materials can cause erroneous results.

## ASSESSMENT OF ELEMENT ENRICHMENT AND SOLUBILITY

In mineralised areas it is common to find a suite of enriched elements that have resulted from natural geological processes. Multi-element scans are carried out to identify any elements that are present in a material (or readily leachable from a material) at concentrations that may be of environmental concern with respect to surface water quality, revegetation and public health. The samples are generally analysed for the following elements:

| | |
|---|---|
| Major elements | Al, Ca, Fe, K, Mg, Na and S. |
| Minor elements | As, B, Cd, Co, Cr, Cu, F, Hg, Mn, Mo, Ni, Pb, Sb, Se and Zn. |

The concentration of these elements in samples can be directly compared with relevant state or national environmental and health based concentration guideline criteria to determine the level of significance. Water extracts are used to determine the immediate element solubilities under the existing sample pH conditions of the sample. The following tests are normally carried out:

### *Multi-element composition of solids.*

Multi-element composition of solid samples determined using a combination of ICP-mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

### *Multi-element composition of water extracts (1:5 sample:deionised water).*

Multi-element composition of water extracts from solid samples determined using a combination of ICP-mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

Under some conditions (*eg*. low pH) the solubility and mobility of common environmentally important elements can increase significantly. If element mobility under initial pH conditions is deemed likely and/or subsequent low pH conditions may occur, kinetic leach column test work may be completed on representative samples.

## KINETIC LEACH COLUMN TESTS

Kinetic leach column (KLC) tests can be used to provide information on the reaction kinetics of mining waste materials. The major objectives of kinetics tests are to:

- Provide time-dependent data on the kinetics and rate of acid generation and acid neutralising reactions under laboratory controlled (or onsite conditions);
- Investigate metal release and drainage/seepage quality; and
- Assess treatment options such as addition of alkaline materials.

The KLC tests simulate the weathering process that leads to acid and base generation and reaction under laboratory controlled or site conditions. The kinetic tests allow an assessment of the acid forming characteristics and indicate the rate of acid generation, over what period it will occur, and what management controls may be required.

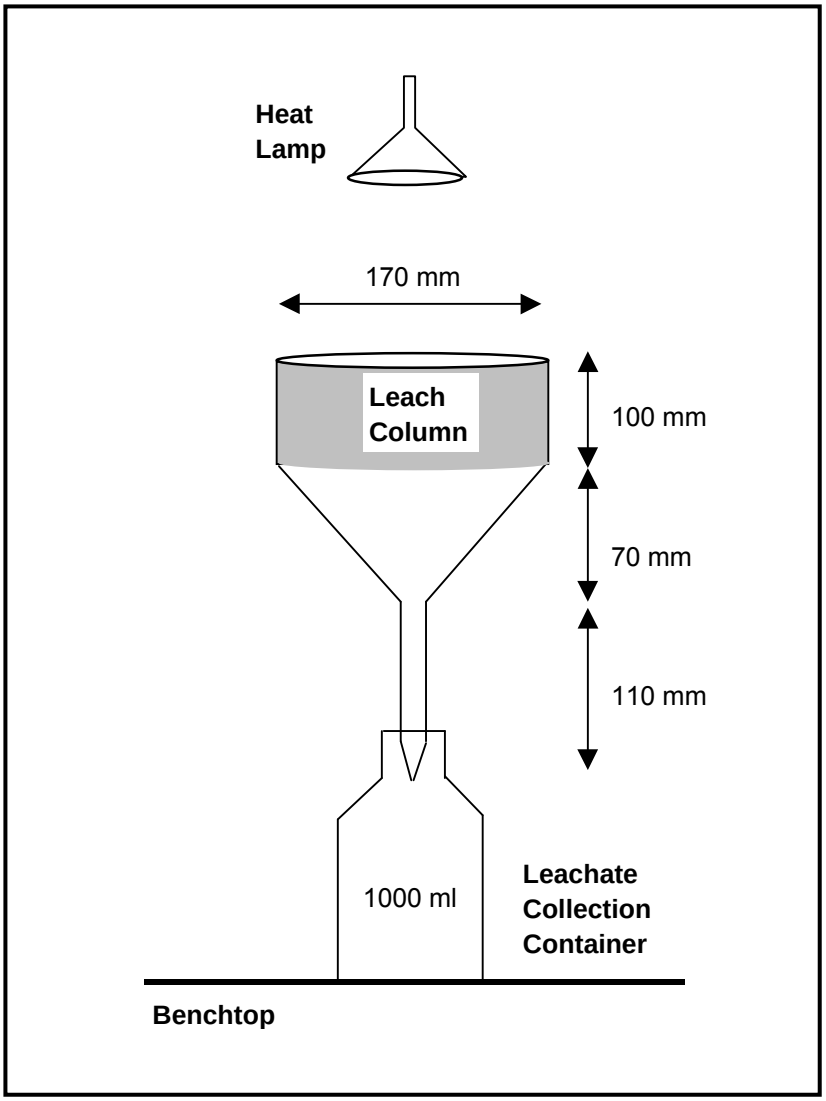
In KLC tests, water is added to a sample and the mixture allowed to leach products and by-products of acid producing and consuming reactions. Samples of leachate are then collected and analysed. Intermittent water application is applied to simulate rainfall and heat lamps are used to simulate sunshine. These tests provide real-time information and may have to continue for months or years. Monitoring includes trends in pH, sulfate, acidity or alkalinity, and metals, for example. The pH of the collected leachate simulates the acid drainage process, acidity or alkalinity levels indicate the rate of acid production and acid neutralisation, and sulfate production can be related to the rate of sulfide oxidation. Metal concentration data provides an assessment of metal solubility and leaching behaviour.

**Figure B1** shows the kinetic leach column set up used by RGS adapted from *AMIRA, 2002*. The columns are placed under heat lamps to allow the sample to dry between water additions to ensure adequate oxygen ingress into the sample material.

Approximately 2 kg of sample is accurately weighed and used in the leach columns and depending on the physical nature of the material and particle size can be used on an as-received basis (*i.e.* no crushing as with process residues) or crushed to nominal 5-10 mm particle size (as with waste rock). The sample in the column is initially leached with deionised water at a rate of about 400 ml/kg of sample and the initial leachate from the columns collected and analysed. Subsequent column leaching is carried out at a rate of about 400 ml/kg per month and again collected and analysed. The leaching rate can be varied to better simulate expected site conditions or satisfy test program data requirements. The column must be exposed to drying conditions in between watering events. The residual water content and air void content in the column can be determined by comparing the wet and dry column weights. A heat lamp is generally used above the sample during daylight hours to maintain the leach column surface temperature at about 30$^{o}$C.

**Figure B1**

**Kinetic Leach Column Setup**



# Attachment C Static geochemical results

## Table C1: Acid Base Account test results for coal reject samples

| RGS Sample No. | Sample Name | ALS Sample ID | Sample Lithology | Coal seam | pH[1] | EC[1] | Total S | $S_{CR}$[2] | MPA[2] | ANC[2] | NAPP[2] | ANC: MPA Ratio | Sample Classification[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | (µS/cm) | (%) | (%) | kg $H_2SO_4$/t | | | | |
| 1 | Sample 1 | EB1912348001 | Coarse coal reject | AR2 | 6.3 | 946 | 1.31 | | 40.1 | 16.0 | 24.1 | 0.4 | Potentially Acid Forming |
| 2 | Sample 2 | EB1912348002 | Coarse coal reject | AR3 | 6.0 | 1,440 | 0.94 | 0.97 | 29.8 | 22.6 | 7.2 | 0.8 | Potentially Acid Forming (LC) |
| 3 | Sample 3 | EB1912348003 | Coarse coal reject | AR3 | 7.3 | 1,040 | 0.78 | 0.76 | 23.4 | 64.6 | -41.2 | 2.8 | Non Acid Forming |
| 4 | Sample 4 | EB1912348004 | Coarse coal reject | CAS | 7.8 | 567 | 0.41 | 0.25 | 7.6 | 108.0 | -100.4 | 14.3 | Non Acid Forming |
| 5 | Sample 5 | EB1912348005 | Coarse coal reject | CAS | 8.2 | 919 | 0.37 | 0.21 | 6.5 | 10.7 | -4.2 | 1.7 | Uncertain |
| 6 | Sample 6 | EB1912348006 | Coarse coal reject | CAS | 8.2 | 688 | 0.99 | 0.62 | 18.9 | 26.3 | -7.4 | 1.4 | Non Acid Forming |
| 7 | Sample 7 | EB1912348007 | Coarse coal reject | CAS | 7.9 | 398 | 0.52 | 0.27 | 8.3 | 68.5 | -60.2 | 8.3 | Non Acid Forming |
| 8 | Sample 8 | EB1912348008 | Coarse coal reject | PLU1 | 5.1 | 1620 | 1.77 | 1.16 | 35.5 | 30.3 | 5.2 | 0.9 | Potentially Acid Forming (LC) |
| 9 | Sample 9 | EB1912348009 | Coarse coal reject | PLU1 | 8.0 | 456 | 0.59 | 0.61 | 18.7 | 70.1 | -51.4 | 3.8 | Non Acid Forming |
| 10 | Sample 10 | EB1912348010 | Coarse coal reject | PLU1 | 7.4 | 1040 | 0.23 | 0.12 | 3.7 | 36.3 | -32.6 | 9.8 | Non Acid Forming |
| 11 | Sample 11 | EB1912348011 | Coarse coal reject | PLU1 | 6.6 | 1300 | 3.25 | 3.22 | 98.6 | 132.0 | -33.4 | 1.3 | Non Acid Forming |
| 12 | Sample 12 | EB1912348012 | Coarse coal reject | PLU1 | 8.2 | 418 | 0.73 | 0.69 | 21.0 | 122.0 | -101.0 | 5.8 | Non Acid Forming |
| 13 | Sample 13 | EB1912348013 | Coarse coal reject | PLU2 | 8.3 | 774 | 0.37 | 0.23 | 7.0 | 19.0 | -12.0 | 2.7 | Non Acid Forming |
| 14 | Sample 14 | EB1912348014 | Coarse coal reject | PLU2 | 7.4 | 1160 | 0.92 | 0.80 | 24.4 | 57.3 | -32.9 | 2.4 | Non Acid Forming |
| 15 | Sample 15 | EB1912348015 | Fine coal reject | AR2 | 6.2 | 824 | 2.75 | | 84.2 | 11.5 | 72.7 | 0.1 | Potentially Acid Forming |
| 16 | Sample 16 | EB1912348016 | Fine coal reject | AR3 | 6.9 | 1320 | 1.27 | | 38.9 | 221.0 | -182.1 | 5.7 | Non Acid Forming |
| 17 | Sample 17 | EB1912348017 | Fine coal reject | CAS | 7.6 | 520 | 1.47 | | 45.0 | 396.0 | -351.0 | 8.8 | Non Acid Forming |
| 18 | Sample 18 | EB1912348018 | Fine coal reject | CAS | 7.8 | 570 | 0.66 | | 20.2 | 112.0 | -91.8 | 5.5 | Non Acid Forming |
| 19 | Sample 19 | EB1912348019 | Fine coal reject | PLU1 | 6.4 | 1120 | 1.03 | | 31.5 | 30.6 | 0.9 | 1.0 | Uncertain |
| 20 | Sample 20 | EB1912348020 | Fine coal reject | PLU1 | 7.0 | 647 | 1.61 | | 49.3 | 204.0 | -154.7 | 4.1 | Non Acid Forming |
| 21 | Sample 21 | EB1912348021 | Fine coal reject | PLU2 | 5.9 | 502 | 2.15 | | 65.8 | 12.9 | 52.9 | 0.2 | Potentially Acid Forming |
| 22 | Sample 22 | EB1912348022 | Fine coal reject | PLU2 | 6.4 | 1170 | 4.20 | | 128.6 | 168.0 | -39.4 | 1.3 | Non Acid Forming |

1. Current pH, EC, Alkalinity and Acidity provided for 1:5 sample:water extracts
2. Scr = Chromium Reducible Sulfur; MPA = Maximum Potential Acidity; ANC = Acid Neutralising Capacity; and NAPP = Net Acid Producing Potential.
3. Sample classification criteria detail provided in report text.

## Table C2: Multi-element test results for coal reject samples

| Parameters | Limit of Reporting | NEPC[1] Health-Based Investigation Level (HILs)-C | Composite 1 | Composite 2 | Composite 3 |
|---|---|---|---|---|---|
| | | RGS Sample Number → | Composite 1 | Composite 2 | Composite 3 |
| | | ALS Laboratory ID → | EB1912809023 | EB1912809024 | EB1912809025 |
| | | Sample ID → | Coarse-CAS/AR Composite | Coarse-PLU1/PLU2 Composite | Fine-CAS/AR Composite - Fine/PLU1/PLU2 Composite |
| **Major Cations** | | | All units mg/kg | | |
| Calcium (Ca) | 50 | - | 18,100 | 26,200 | 61,000 |
| Magnesium (Mg) | 50 | - | 3,780 | 3,950 | 5,040 |
| Potassium (K) | 50 | - | 1,490 | 1,020 | 1,230 |
| Sodium (Na) | 50 | - | 860 | 900 | 490 |
| **Major, Minor and Trace Elements** | | | All units mg/kg | | |
| Aluminium (Al) | 50 | - | 6,490 | 6,500 | 6,510 |
| Antimony (Sb) | 5 | - | <5 | <5 | <5 |
| Arsenic (As) | 5 | 300 | 21 | 34 | 17 |
| Barium (Ba) | 10 | - | 310 | 180 | 140 |
| Beryllium (Be) | 1 | - | <1 | <1 | <1 |
| Boron (B) | 50 | 20,000 | <50 | <50 | <50 |
| Cadmium (Cd) | 1 | 90 | <1 | <1 | <1 |
| Chromium (Cr) | 2 | 300 ** | 6 | 4 | 12 |
| Cobalt (Co) | 2 | 300 | 4 | 2 | 3 |
| Copper (Cu) | 5 | 17,000 | 46 | 42 | 33 |
| Iron (Fe) | 50 | - | 32,600 | 41,400 | 50,500 |
| Lead (Pb) | 5 | 600 | 15 | 11 | 10 |
| Manganese (Mn) | 5 | 19,000 | 423 | 1,160 | 1,030 |
| Mercury (Hg) | 0.1 | - | 0.1 | 0 | 0 |
| Molybdenum (Mo) | 2 | 80 | 2 | <2 | <2 |
| Nickel (Ni) | 2 | 1,200 | 7 | 5 | 7 |
| Reactive Phosphorus (P) | 0.1 | - | <0.1 | <0.1 | <0.1 |
| Selenium (Se) | 5 | 700 | <5 | <5 | <5 |
| Vanadium (V) | 5 | - | 12 | 14.0 | 13.0 |
| Zinc (Zn) | 5 | 30,000 | 44 | 52 | 45 |

Notes: < indicates less than the laboratory limit of reporting (LoR).

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.
Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

## Table C3: Geochemical Abundance Index results for coal reject samples

| | RGS Sample Number → | | Composite 1 | Composite 2 | Composite 3 |
|---|---|---|---|---|---|
| | ALS Laboratory ID → | | EB1912809023 | EB1912809024 | EB1912809025 |
| | Sample Description → | | Coarse-CAS/AR Composite | Coarse-PLU1/PLU2 Composite | Fine-CAS/AR Composite - Fine/PLU1/PLU2 Composite |
| Parameters | Limit of Reporting | Average Crustal Abundance[1] | | | |
| **Major Elements** | all units in mg/kg | | Geochemical Abundance Index | | |
| Calcium (Ca) | 50 | 15,000 | 0 | 0 | 1 |
| Magnesium (Mg) | 50 | 5,000 | 0 | 0 | 0 |
| Potassium (K) | 50 | 14,000 | 0 | 0 | 0 |
| Sodium (Na) | 50 | 5,000 | 0 | 0 | 0 |
| **Major, Minor and Trace Elements** | all units in mg/kg | | Geochemical Abundance Index | | |
| Aluminium (Al) | 50 | 71,000 | 0 | 0 | 0 |
| Antimony (Sb) | 5 | 5 | 0 | 0 | 0 |
| Arsenic (As) | 5 | 6 | 1 | 2 | 1 |
| Barium (Ba) | 10 | 500 | 0 | 0 | 0 |
| Beryllium (Be) | 1 | 6.00 | 0 | 0 | 0 |
| Boron (B) | 50 | 100 | 0 | 0 | 0 |
| Cadmium (Cd) | 1 | 0 | 0 | 0 | 0 |
| Chromium (Cr) | 2 | 70 | 0 | 0 | 0 |
| Cobalt (Co) | 2 | 8 | 0 | 0 | 0 |
| Copper (Cu) | 5 | 30 | 0 | 0 | 0 |
| Iron (Fe) | 50 | 40,000 | 0 | 0 | 0 |
| Lead (Pb) | 5 | 35 | 0 | 0 | 0 |
| Manganese (Mn) | 5 | 1,000 | 0 | 0 | 0 |
| Mercury (Hg) | 0.1 | 0 | 0 | 1 | 0 |
| Nickel (Ni) | 2 | 50 | 0 | 0 | 0 |
| Reactive Phosphorus (P) | 0.1 | 800 | 0 | 0 | 0 |
| Selenium (Se) | 5 | 0.4 | 2 | 2 | 2 |
| Zinc (Zn) | 5 | 90 | 0 | 0 | 0 |

Notes: GAI's greater than or equal to 3 are highlighted.

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009). When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, pages 60-61.

## Table C4: Multi-Element Test results for water extracts from coal reject samples

| | | RGS Sample Number → | | Composite 1 | Composite 2 | Composite 3 |
|---|---|---|---|---|---|---|
| | | ALS Laboratory ID → | | EB1912809023 | EB1912809024 | EB1912809025 |
| | | Sample ID → | | Coarse-CAS/AR Composite | Coarse-PLU1/PLU2 Composite | Fine-CAS/AR Composite - Fine/PLU1/PLU2 Composite |
| | | Water Quality Guidelines: | | | | |
| Parameters | Limit of Reporting | Aquatic Ecosystems (freshwater)[1] | Livestock Drinking Water[2] | | | |
| pH | 0.01 pH unit | 6 to 9 | - | 8.5 | 8.0 | 8.0 |
| Electrical Conductivity | 1 µS/cm | <1,000# | 3,580^ | 593 | 1,040 | 865 |
| Carbonate Alkalinity ($mgCaCO_3/L$) | 1 mg/L | - | - | <1 | <1 | <1 |
| Bicarbonate Alkalinity ($mgCaCO_3/L$) | 1 mg/L | - | - | 3,320 | 2,960 | 13,220 |
| Total Alkalinity ($mgCaCO_3/L$) | 1 mg/L | - | - | 3,320 | 2,960 | 13,220 |
| Acidity ($mgCaCO_3/L$) | 1 mg/L | - | - | 2 | 36 | 24 |
| Net Alkalinity ($mgCaCO_3/L$) | 1 mg/L | - | - | 3,318 | 2,924 | 13,196 |
| **Major Ions** | All units mg/L | | | All units mg/L | | |
| Calcium (Ca) | 2 | - | 1,000 | 10 | 64 | 70 |
| Magnesium (Mg) | 2 | - | - | 10 | 38 | 34 |
| Potassium (K) | 2 | - | - | 12 | 10 | 16 |
| Sodium (Na) | 2 | - | - | 92 | 108 | 52 |
| Chloride (Cl) | 2 | - | - | 38 | 22 | 44 |
| Fluoride (F) | 0.2 | - | 2 | 0.6 | 0.4 | 0.2 |
| Sulfate ($SO_4$) | 2 | - | 1,000 | 140 | 398 | 286 |
| **Trace Metals/Metalloids** | All units mg/L | | | All units mg/L | | |
| Aluminium (Al) | 0.02 | 0.055 | 5 | <0.02 | <0.02 | <0.02 |
| Antimony (Sb) | 0.002 | - | - | <0.002 | <0.002 | <0.002 |
| Arsenic (As) (trivalent) | 0.002 | 0.024 ** | 0.5 | 0.002 | <0.002 | <0.002 |
| Barium (Ba) | 0.002 | - | - | 0.026 | 0.022 | 0.022 |
| Beryllium (Be) | 0.002 | - | - | <0.002 | <0.002 | <0.002 |
| Boron (B) | 0.2 | 0.37 | 5 | <0.2 | <0.2 | <0.2 |
| Cadmium (Cd) | 0.002 | 0.0002 | 0.01 | <0.002 | <0.002 | <0.002 |
| Chromium (Cr) | 0.002 | 0.001 (hex)* | 1 (total) | <0.002 | <0.002 | <0.002 |
| Cobalt (Co) | 0.002 | - | - | <0.002 | <0.002 | <0.002 |
| Copper (Cu) | 0.002 | 0.0014 | 1 | <0.002 | <0.002 | <0.002 |
| Iron (Fe) | 0.2 | - | - | <0.2 | <0.2 | <0.2 |
| Lead (Pb) | 0.002 | 0.0034 | 0.1 | <0.002 | <0.002 | <0.002 |
| Manganese (Mn) | 0.002 | 1.90 | - | 0.004 | 0.588 | 0.094 |
| Mercury (Hg) | 0.0001 | 0.0001 | 0.002 | <0.0001 | <0.0001 | <0.0001 |
| Molybdenum (Mo) | 0.002 | - | 0.15 | 0.036 | 0.004 | 0.010 |
| Nickel (Ni) | 0.002 | 0.011 | 1 | <0.002 | <0.002 | <0.002 |
| Selenium (Se) | 0.02 | 0.011 | 0.02 | <0.02 | <0.02 | <0.02 |
| Silica (Si) | 0.2 | - | - | 5.0 | 4.8 | 5.2 |
| Thorium (Th) | 0.002 | - | - | <0.002 | <0.002 | <0.002 |
| Uranium (U) | 0.002 | - | - | <0.002 | <0.002 | <0.002 |
| Vanadium (V) | 0.02 | - | - | <0.02 | <0.02 | <0.02 |
| Zinc (Zn) | 0.01 | 0.008 | 20 | <0.01 | <0.01 | <0.01 |

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.

1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)

2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water.

* Cr (VI) = hexavalent. ** 0.013 mg/Lfor pentavalent Arsenic (V).

# for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

# Attachment D Kinetic geochemical results

**Gemini Coal Project**

**KLC1 (Coarse Coal reject)**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Weight (kg)** | 1.53 | **Total S (%)** | 0.94 | **ANC** | 56 | |
| **pH (1:5)** | 7.3 | **Scr (%)** | 0.65 | **NAPP** | -27.2 | |
| **EC (µS/cm)** | 912 | **MPA** | 28.8 | **ANC:MPA** | 1.9 | |

| **Date** | | | | **23-May-19** | **25-Jun-19** | **22-Jul-19** | **27-Aug-19** | **24-Sep-19** | **29-Oct-19** | **26-Nov-19** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Number of Weeks** | | | | **0** | **4** | **9** | **13** | **17** | **22** | **26** |
| **Leach Number** | | | | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **ALS Laboratory Number** | | | | EB1913182001 | EB1916404001 | EB1918950001 | EB1922372001 | | | |
| **Volume On (L)** | | | | 1.0 | 1.0 | 1.0 | 1.0 | | | |
| **Volume Off (L)** | | | | 0.552 | 0.565 | 0.577 | 0.621 | | | |
| **Cum. Volume (L)** | | | | 0.55 | 1.12 | 1.69 | 2.31 | | | |
| **Pore Volumes** | | | | 0.4 | 0.8 | 1.3 | 1.7 | | | |
| **pH (RGS Measurement)** | | | | 6.34 | 5.84 | 6.83 | 6.96 | | | |
| **pH (ALS Measurement)** | | | | 6.61 | 5.88 | 6.90 | 6.83 | | | |
| **pH (deionised water used in test)** | | | | 5.73 | 5.45 | 5.46 | 6.01 | | | |
| **EC (RGS Measurement) (µS/cm)** | | | | 1,100 | 2,312 | 1,711 | 1,822 | | | |
| **EC (ALS Measurement) (µS/cm)** | | | | 1,110 | 2,410 | 1,860 | 1,820 | | | |
| **Acidity (mg/L)*** | | | | 5 | 15 | 1 | 2 | | | |
| **Alkalinity (mg/L)*** | | | | 13 | 3 | 7 | 8 | | | |
| **Net Alkalinity (mg/L)*** | | | | 8 | -12 | 6 | 6 | | | |
| **Major Ions (mg/L)** | **LoR** | **WQ Guidelines#** **Aquatic Ecosystem (freshwater)[1]** | **WQ Guidelines#** **Livestock Drinking Water[2]** | | | | | | | |
| **Calcium (Ca)** | 1 | - | 1,000 | 34 | 83 | 75 | 98 | | | |
| **Potassium (K)** | 1 | - | - | 5 | 6 | 4 | 7 | | | |
| **Magnesium (Mg)** | 1 | - | - | 31 | 120 | 84 | 98 | | | |
| **Sodium (Na)** | 1 | - | - | 164 | 337 | 215 | 212 | | | |
| **Chloride (Cl)** | 1 | - | - | 41 | 83 | 51 | 42 | | | |
| **Fluoride (F)** | 0.1 | - | 2 | 0.2 | 0.1 | 0.2 | 0.2 | | | |
| **Sulfate ($SO_4$)** | 1 | - | 1,000 | 451 | 1,140 | 846 | 861 | | | |
| **Trace metals/ metalloids** | **LoR** | | | All units mg/L | | | | | | |
| **Aluminium (Al)** | 0.01 | 0.055 | 5 | <0.01 | <0.01 | <0.01 | <0.01 | | | |
| **Arsenic (As)** | 0.001 | 0.024 | 0.5 | <0.001 | <0.001 | <0.001 | 0.001 | | | |
| **Boron (B)** | 0.05 | - | 5 | 0.12 | 0.06 | 0.06 | 0.07 | | | |
| **Cadmium (Cd)** | 0.0001 | 0.0002 | 0.01 | 0.0003 | 0.0005 | 0.0002 | 0.0003 | | | |
| **Cobalt (Co)** | 0.001 | - | 1 | 0.025 | 0.035 | 0.008 | 0.012 | | | |
| **Chromium (Cr)** | 0.001 | 0.001 | 1 | <0.001 | <0.001 | <0.001 | <0.001 | | | |
| **Copper (Cu)** | 0.001 | 0.0014 | 1 | <0.001 | <0.001 | <0.001 | <0.001 | | | |
| **Iron (Fe)** | 0.05 | - | - | 1.81 | 4.6 | <0.05 | <0.05 | | | |
| **Manganese (Mn)** | 0.001 | 1.9 | - | 4.85 | 2.55 | 1.06 | 1.04 | | | |
| **Molybdenum (Mo)** | 0.001 | - | 0.15 | <0.001 | <0.001 | 0.002 | 0.002 | | | |
| **Nickel (Ni)** | 0.001 | - | 1 | 0.022 | 0.029 | 0.006 | 0.013 | | | |
| **Lead (Pb)** | 0.001 | 0.0034 | 0.1 | <0.001 | <0.001 | <0.001 | <0.001 | | | |
| **Antimony (Sb)** | 0.001 | - | - | <0.001 | <0.001 | <0.001 | <0.001 | | | |
| **Selenium (Se)** | 0.01 | 0.011 | 0.02 | <0.01 | 0.02 | 0.01 | 0.01 | | | |
| **Vanadium** | 0.01 | - | - | <0.01 | <0.01 | <0.01 | <0.01 | | | |
| **Zinc (Zn)** | 0.005 | 0.008 | 20 | 0.020 | 0.048 | 0.011 | 0.023 | | | |
| **Total Anions** | | | | 10.8 | 26.1 | 19.2 | 19.3 | | | |
| **Total Cations** | | | | 11.5 | 28.8 | 20.1 | 22.4 | | | |
| **Ionic Balance** | | | | 3.15 | 4.9 | 2.34 | 7.41 | | | |
| **Calculations**** | | | | | | | | | | |
| **$SO_4$ Release Rate** | | | | 162 | 420 | 318 | 349 | | | |
| **Cumulative $SO_4$ Release** | | | | 162 | 582 | 318 | 667 | | | |
| **Ca Release Rate** | | | | 12.2 | 30.6 | 28.2 | 39.7 | | | |
| **Cumulative Ca Release** | | | | 12.2 | 42.8 | 28.2 | 67.9 | | | |
| **Mg Release Rate** | | | | 11.2 | 44.2 | 31.6 | 39.7 | | | |
| **Cumulative Mg Release** | | | | 11.2 | 55.3 | 31.6 | 71.3 | | | |
| **Residual ANC (%)** | | | | 99.9 | 99.4 | 99.1 | 98.6 | | | |
| **Residual Sulfur (%)** | | | | 99.4 | 97.9 | 96.8 | 95.6 | | | |
| **$SO_4$/(Ca+Mg) molar ratio** | | | | 2.2 | 1.7 | 1.7 | 1.4 | | | |

< indicates less than the limit of reporting. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
** $SO_4$, Ca and Mg release rates calculated in mg/kg/flush.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity.
MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.
# ANZECC & ARMCANZ (2000). 1. Trigger values for aquatic ecosystems. 2. Livestock Drinking Water Levels.

**Gemini Coal Project**

**KLC2 (Fine Coal Reject)**

| | | | | | |
|---|---|---|---|---|---|
| **Weight (kg)** | 1.54 | **Total S (%)** | 1.89 | **ANC** | 144.5 |
| **pH (1:5)** | 6.80 | **Scr (%)** | 1.70 | **NAPP** | -86.6 |
| **EC (µS/cm)** | 834 | **MPA** | 57.9 | **ANC:MPA** | 2.5 |

| **Date** | | | | **23-May-19** | **25-Jun-19** | **22-Jul-19** | **27-Aug-19** | **24-Sep-19** | **29-Oct-19** | **26-Nov-19** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Number of Weeks** | | | | **0** | **4** | **9** | **13** | **17** | **22** | **26** |
| **Leach Number** | | | | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **ALS Laboratory Number** | | | | EB1913182002 | EB1916404002 | EB1918950002 | EB1922372002 | | | |
| **Volume On (L)** | | | | 1.0 | 1.0 | 1.0 | 1.0 | | | |
| **Volume Off (L)** | | | | 0.332 | 0.328 | 0.346 | 0.332 | | | |
| **Cum. Volume (L)** | | | | 0.33 | 0.66 | 1.01 | 1.34 | | | |
| **Pore Volumes** | | | | 0.2 | 0.5 | 0.7 | 1.0 | | | |
| **pH (RGS Measurement)** | | | | 5.31 | 4.90 | 7.22 | 6.84 | | | |
| **pH (ALS Measurement)** | | | | 5.15 | 4.75 | 7.18 | 6.65 | | | |
| **pH (deionised water used in test)** | | | | 5.73 | 5.45 | 5.46 | 6.01 | | | |
| **EC (RGS Measurement) (µS/cm)** | | | | 2,098 | 2,319 | 2,790 | 2,380 | | | |
| **EC (ALS Measurement) (µS/cm)** | | | | 2,090 | 2,420 | 3,030 | 2,450 | | | |
| **Acidity (mg/L)*** | | | | 101 | 110 | 2 | 2 | | | |
| **Alkalinity (mg/L)*** | | | | 4 | <1 | 13 | 9 | | | |
| **Net Alkalinity (mg/L)*** | | | | -97 | -110 | 11 | 7 | | | |
| **Major Ions (mg/L)** | **LoR** | **WQ Guidelines#** **Aquatic Ecosystem (freshwater)[1]** | **Livestock Drinking Water[2]** | | | | | | | |
| **Calcium (Ca)** | 1 | - | 1,000 | 110 | 202 | 234 | 292 | | | |
| **Potassium (K)** | 1 | - | - | 8 | 7 | 8 | 14 | | | |
| **Magnesium (Mg)** | 1 | - | - | 68 | 126 | 161 | 134 | | | |
| **Sodium (Na)** | 1 | - | - | 252 | 190 | 260 | 156 | | | |
| **Chloride (Cl)** | 1 | - | - | 259 | 141 | 261 | 95 | | | |
| **Fluoride (F)** | 0.1 | - | 2 | <0.1 | <0.1 | 0.2 | 0.2 | | | |
| **Sulfate ($SO_4$)** | 1 | - | 1,000 | 726 | 1,240 | 1,500 | 1,300 | | | |
| **Trace metals/ metalloids** | **LoR** | | | All units mg/L | | | | | | |
| **Aluminium (Al)** | 0.01 | 0.055 | 5 | 0.12 | 0.07 | <0.01 | <0.01 | | | |
| **Arsenic (As)** | 0.001 | 0.024 | 0.5 | 0.001 | <0.001 | <0.001 | <0.001 | | | |
| **Boron (B)** | 0.05 | - | 5 | 0.13 | 0.13 | 0.05 | 0.12 | | | |
| **Cadmium (Cd)** | 0.0001 | 0.0002 | 0.01 | 0.0006 | 0.0013 | 0.0001 | 0.0008 | | | |
| **Cobalt (Co)** | 0.001 | - | 1 | 0.085 | 0.097 | 0.006 | 0.039 | | | |
| **Chromium (Cr)** | 0.001 | 0.001 | 1 | <0.001 | <0.001 | <0.001 | <0.001 | | | |
| **Copper (Cu)** | 0.001 | 0.0014 | 1 | 0.005 | 0.011 | <0.001 | <0.001 | | | |
| **Iron (Fe)** | 0.05 | - | - | 44.5 | 53.6 | <0.05 | 0.34 | | | |
| **Manganese (Mn)** | 0.001 | 1.9 | - | 4.10 | 5.38 | 1.67 | 2.61 | | | |
| **Molybdenum (Mo)** | 0.001 | - | 0.15 | <0.001 | <0.001 | 0.001 | <0.001 | | | |
| **Nickel (Ni)** | 0.001 | - | 1 | 0.096 | 0.083 | 0.006 | 0.039 | | | |
| **Lead (Pb)** | 0.001 | 0.0034 | 0.1 | <0.001 | <0.001 | <0.001 | <0.001 | | | |
| **Antimony (Sb)** | 0.001 | - | - | <0.001 | <0.001 | <0.001 | <0.001 | | | |
| **Selenium (Se)** | 0.01 | 0.011 | 0.02 | 0.02 | 0.01 | 0.02 | <0.01 | | | |
| **Vanadium** | 0.01 | - | - | <0.01 | <0.01 | <0.01 | <0.01 | | | |
| **Zinc (Zn)** | 0.005 | 0.008 | 20 | 0.27 | 0.281 | 0.007 | 0.075 | | | |
| **Total Anions** | | | | 22.5 | 29.8 | 38.8 | 29.9 | | | |
| **Total Cations** | | | | 22.2 | 28.9 | 36.4 | 32.7 | | | |
| **Ionic Balance** | | | | 0.56 | 1.54 | 3.2 | 4.5 | | | |
| **Calculations**** | | | | | | | | | | |
| **$SO_4$ Release Rate** | | | | 157 | 265 | 338 | 281 | | | |
| **Cumulative $SO_4$ Release** | | | | 157 | 422 | 760 | 1041 | | | |
| **Ca Release Rate** | | | | 23.8 | 43.1 | 52.7 | 63.2 | | | |
| **Cumulative Ca Release** | | | | 23.8 | 66.9 | 119.7 | 182.8 | | | |
| **Mg Release Rate** | | | | 14.7 | 26.9 | 36.3 | 29.0 | | | |
| **Cumulative Mg Release** | | | | 14.7 | 41.6 | 77.9 | 106.9 | | | |
| **Residual ANC (%)** | | | | 99.9 | 99.8 | 99.6 | 99.4 | | | |
| **Residual Sulfur (%)** | | | | 99.7 | 99.3 | 98.7 | 98.2 | | | |
| **$SO_4$/(Ca+Mg) molar ratio** | | | | 1.4 | 1.3 | 1.3 | 1.1 | | | |

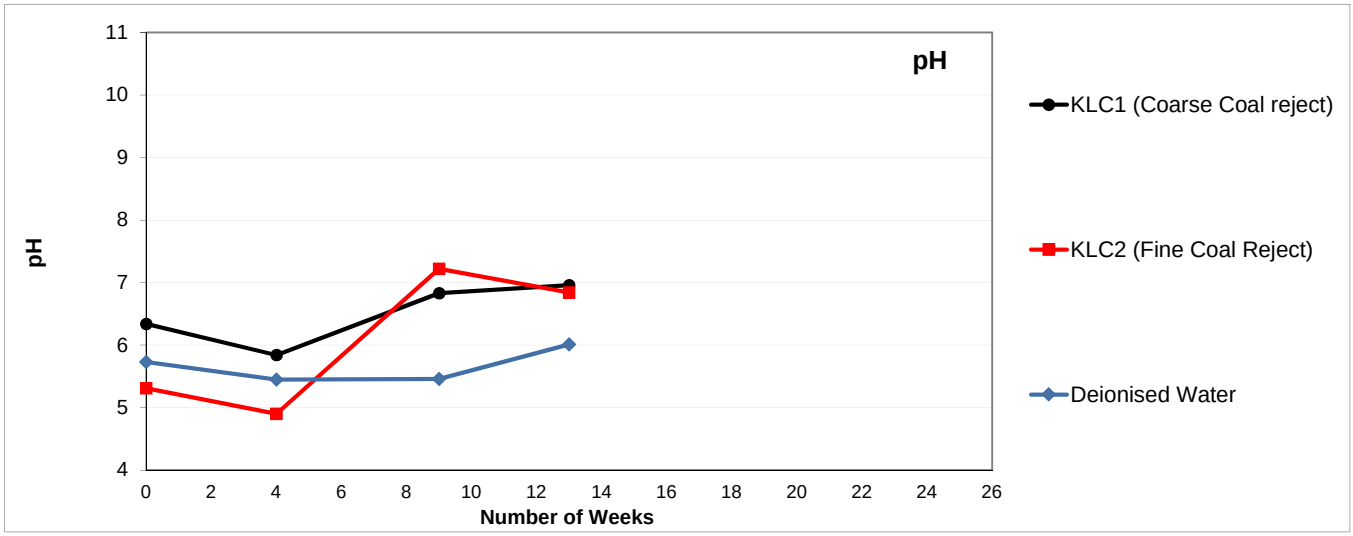
< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L

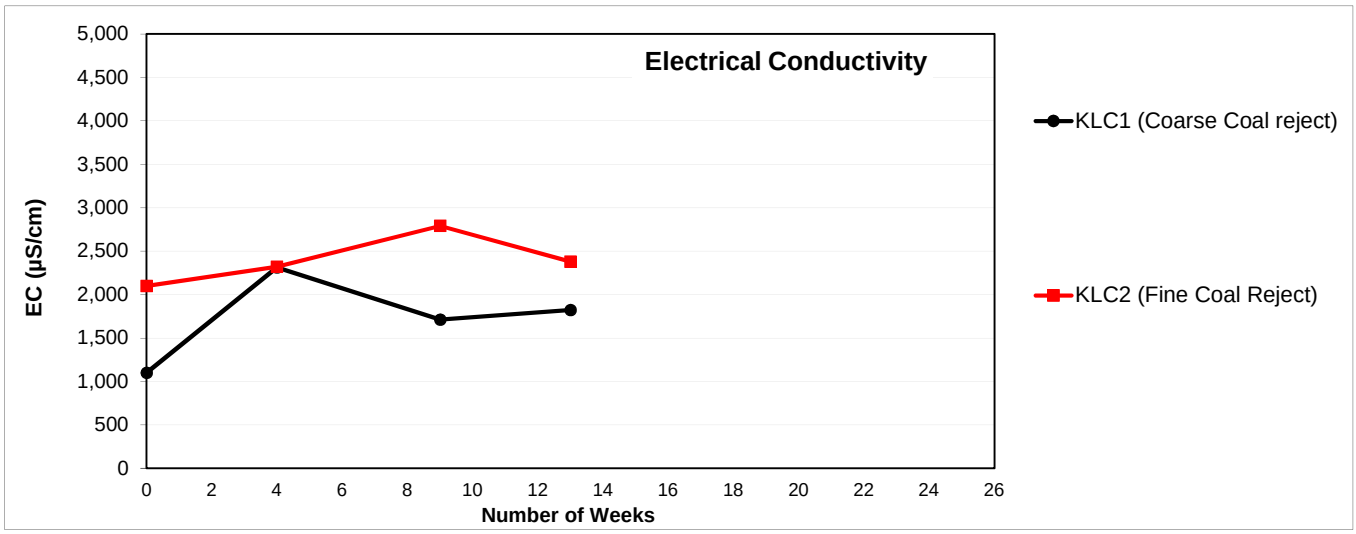
** $SO_4$, Ca and Mg release rates calculated in mg/kg/flush.

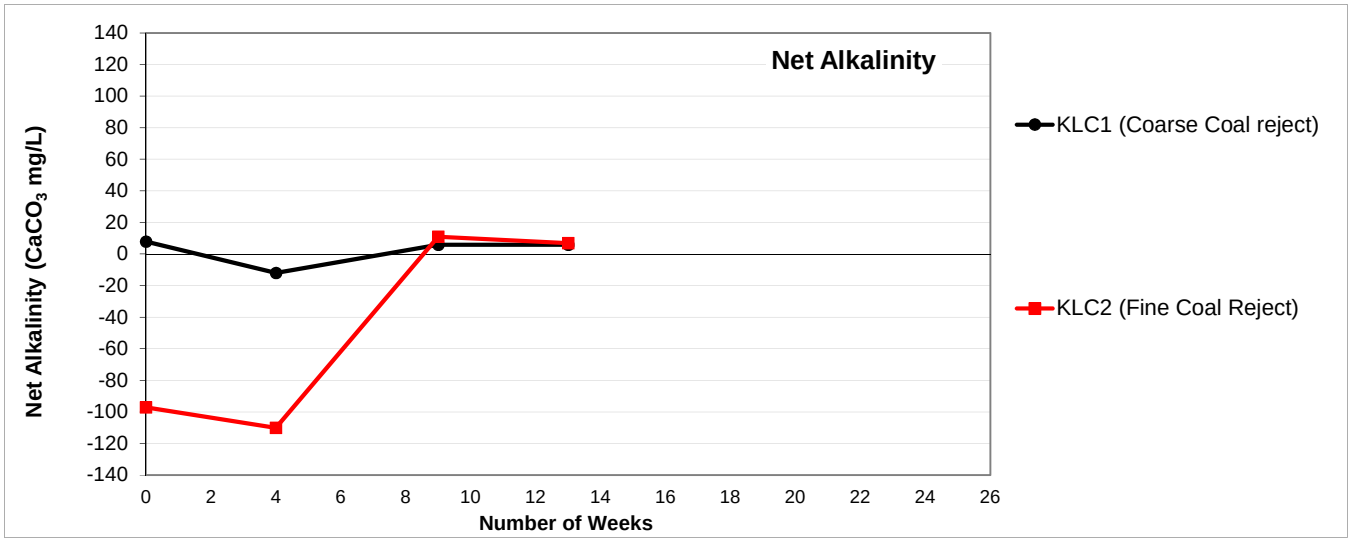
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity.

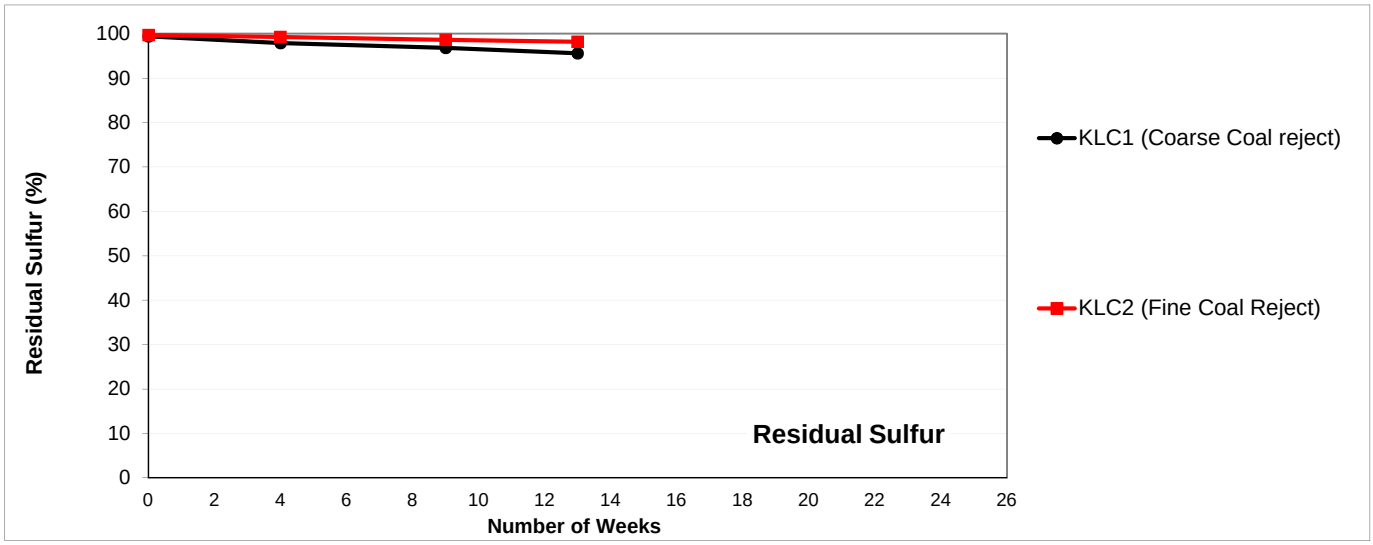
MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

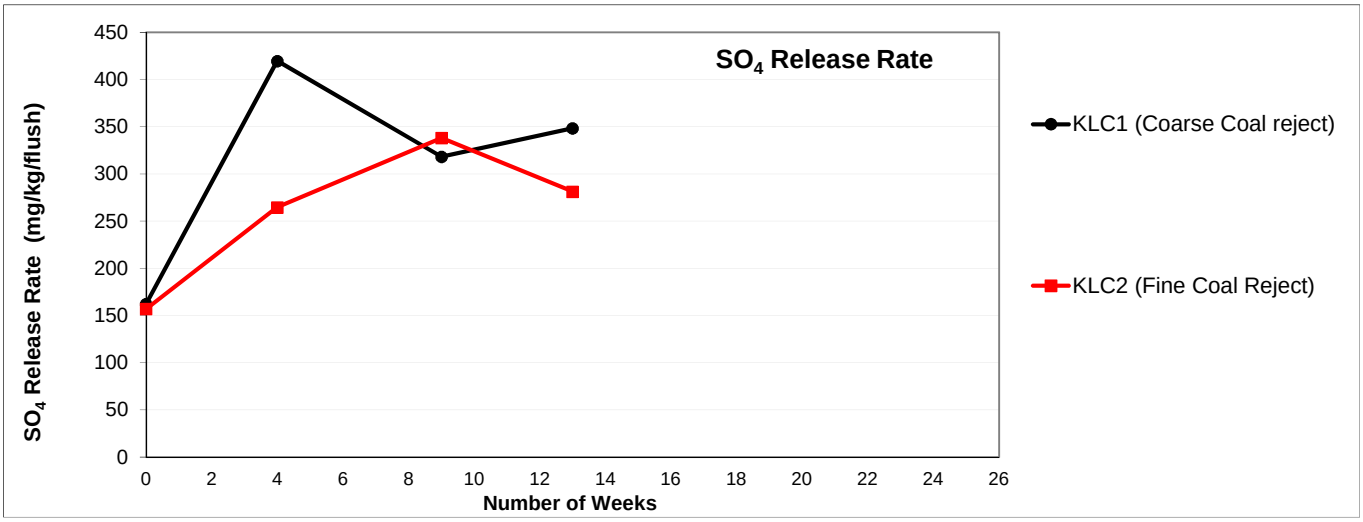
# ANZECC & ARMCANZ (2000). 1. Trigger values for aquatic ecosystems. 2. Livestock Drinking Water Levels.

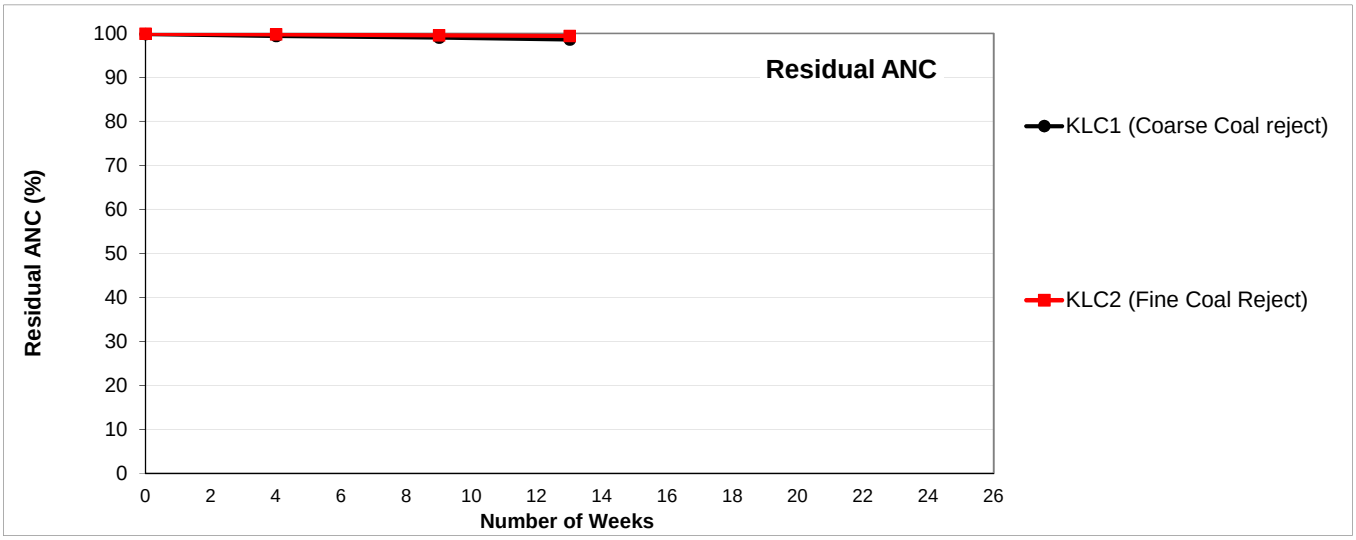

pH
pH
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)
Deionised Water

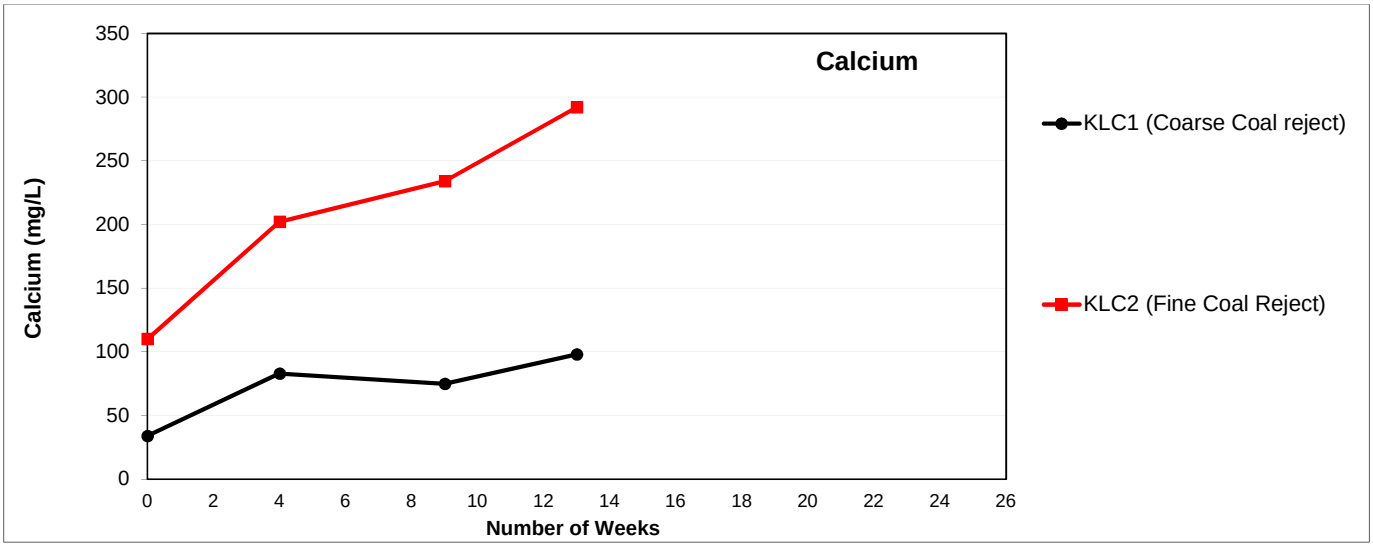

Electrical Conductivity
EC (µS/cm)
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

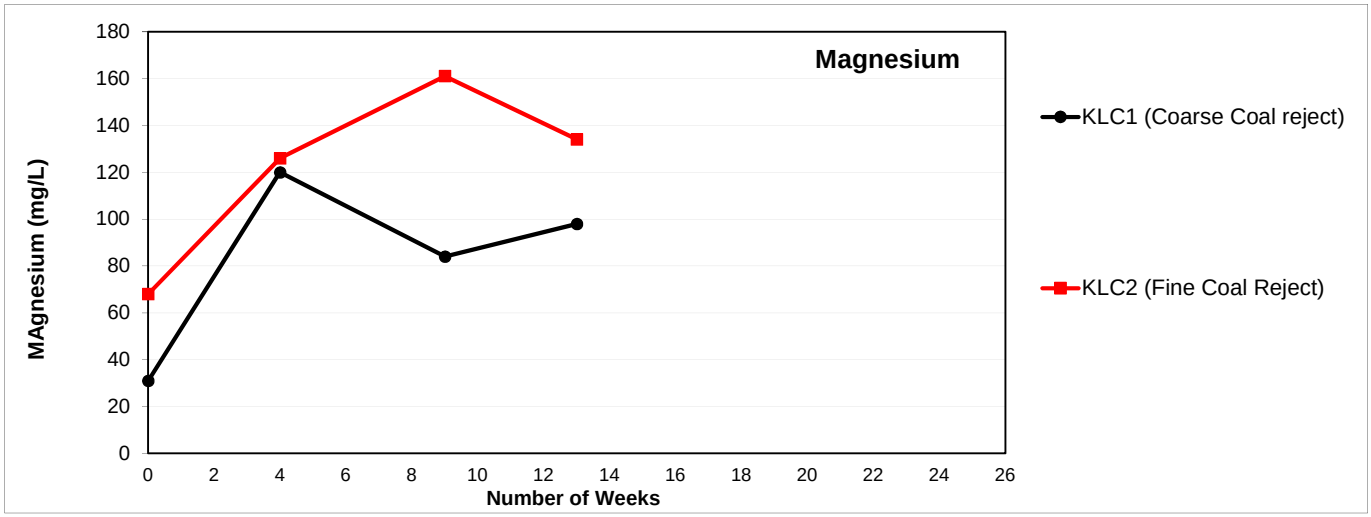

Net Alkalinity
Net Alkalinity (CaCO3 mg/L)
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

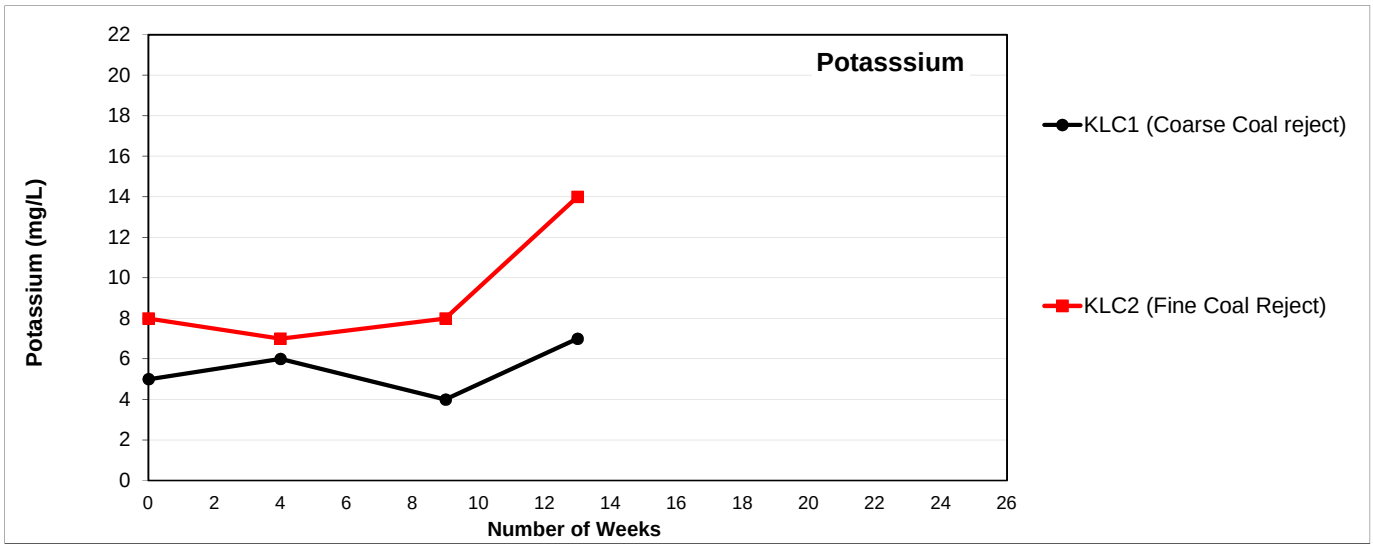

Residual Sulfur (%)
Residual Sulfur
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

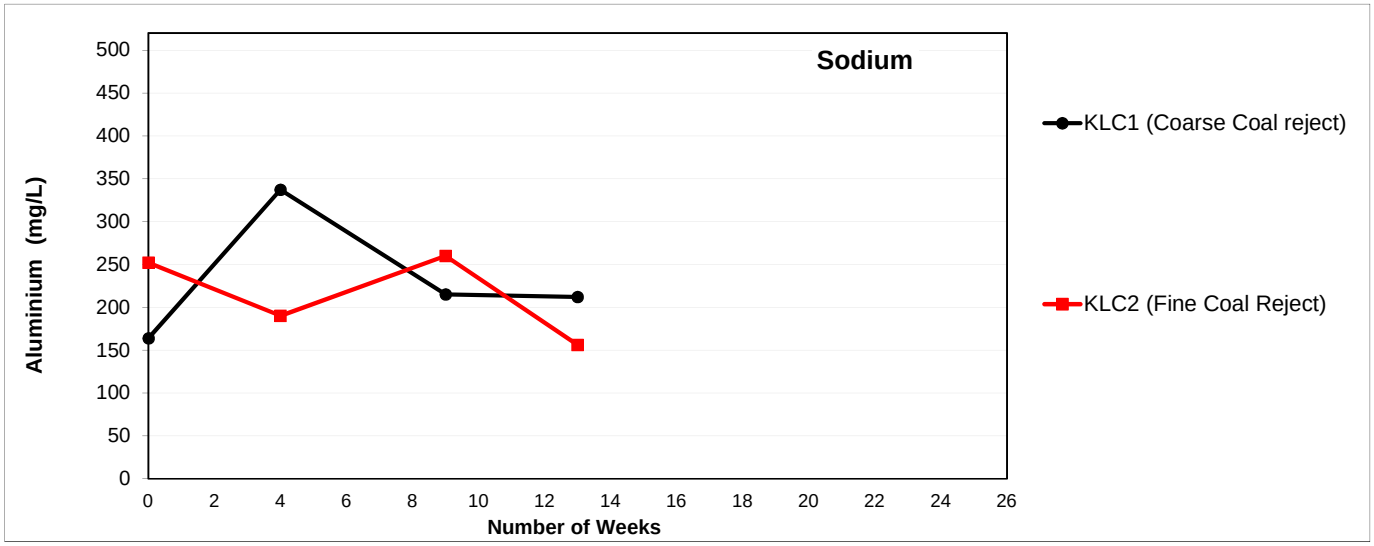

SO4 Release Rate (mg/kg/flush)
SO4 Release Rate
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

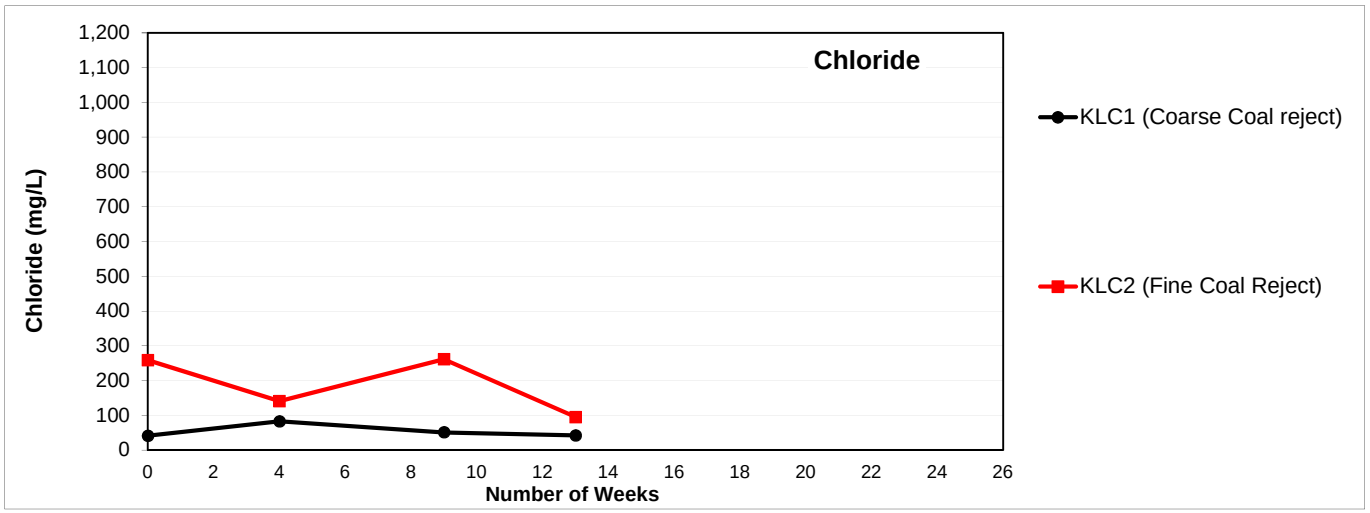

Residual ANC (%)
Residual ANC
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

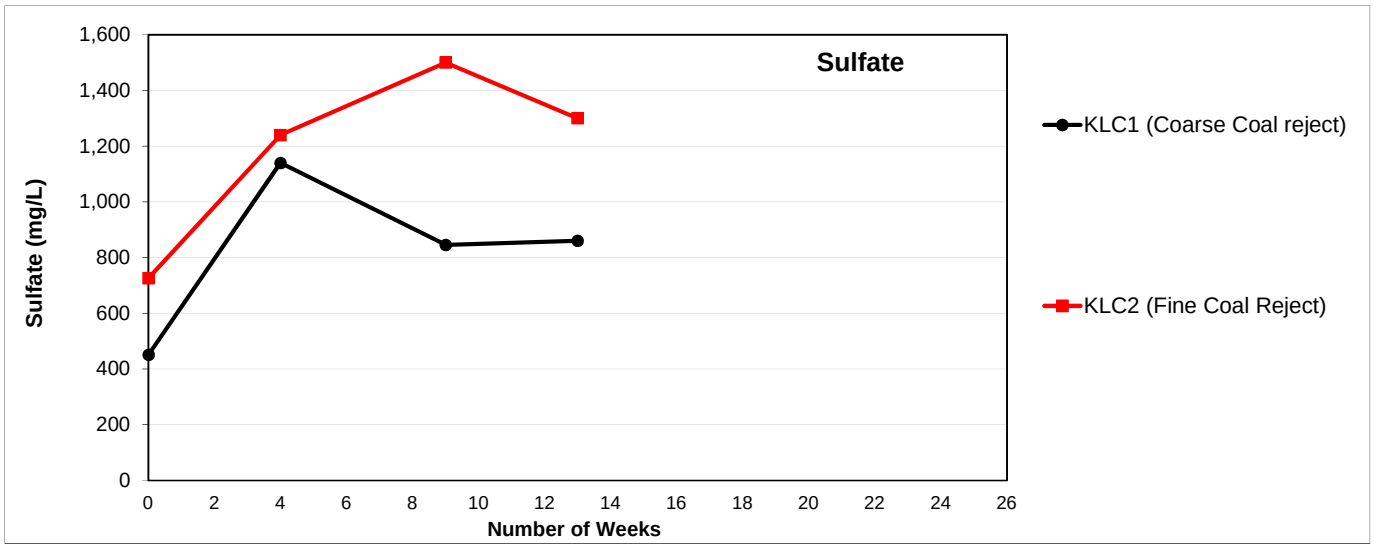

Calcium
Calcium (mg/L)
350
300
250
200
150
100
50
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

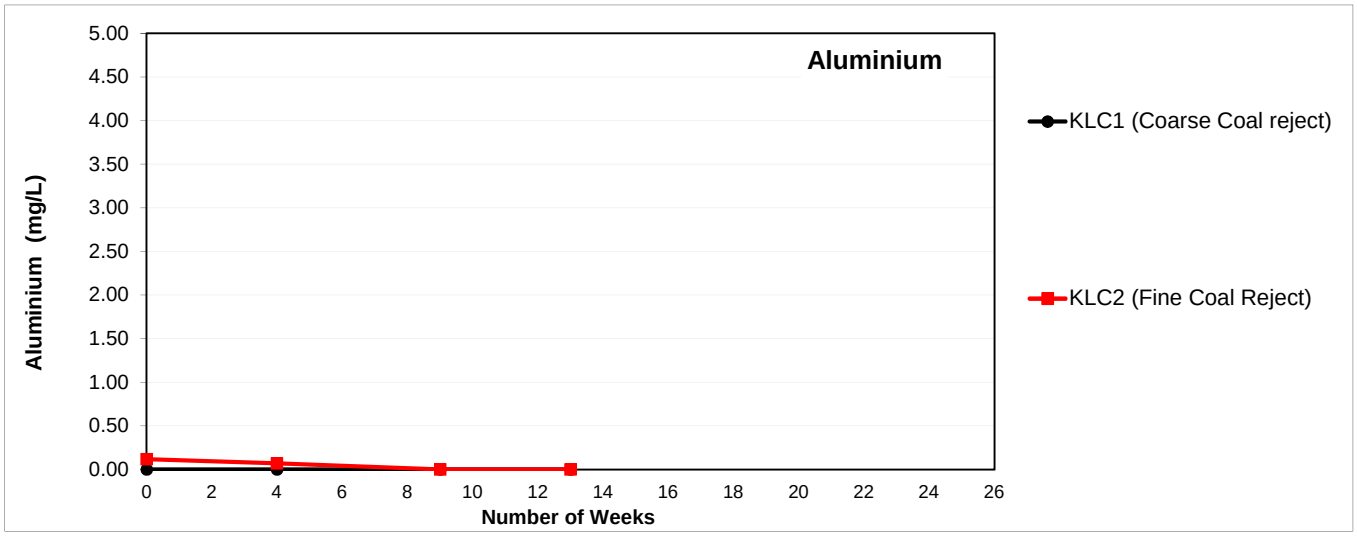

Magnesium
MAgnesium (mg/L)
180
160
140
120
100
80
60
40
20
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

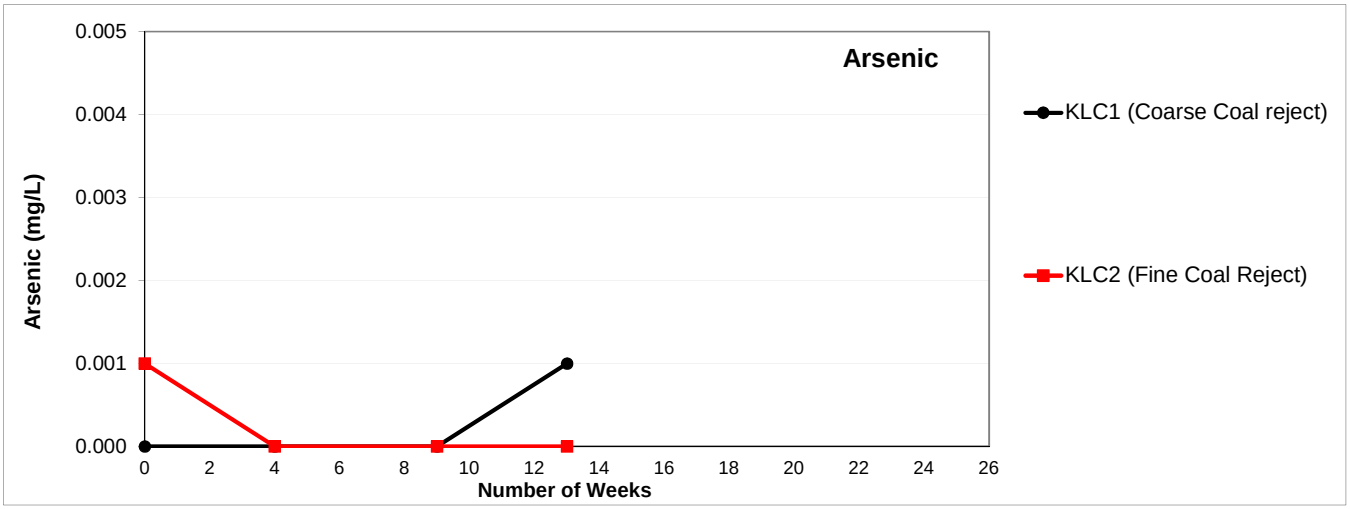

Potasssium
Potassium (mg/L)
22
20
18
16
14
12
10
8
6
4
2
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

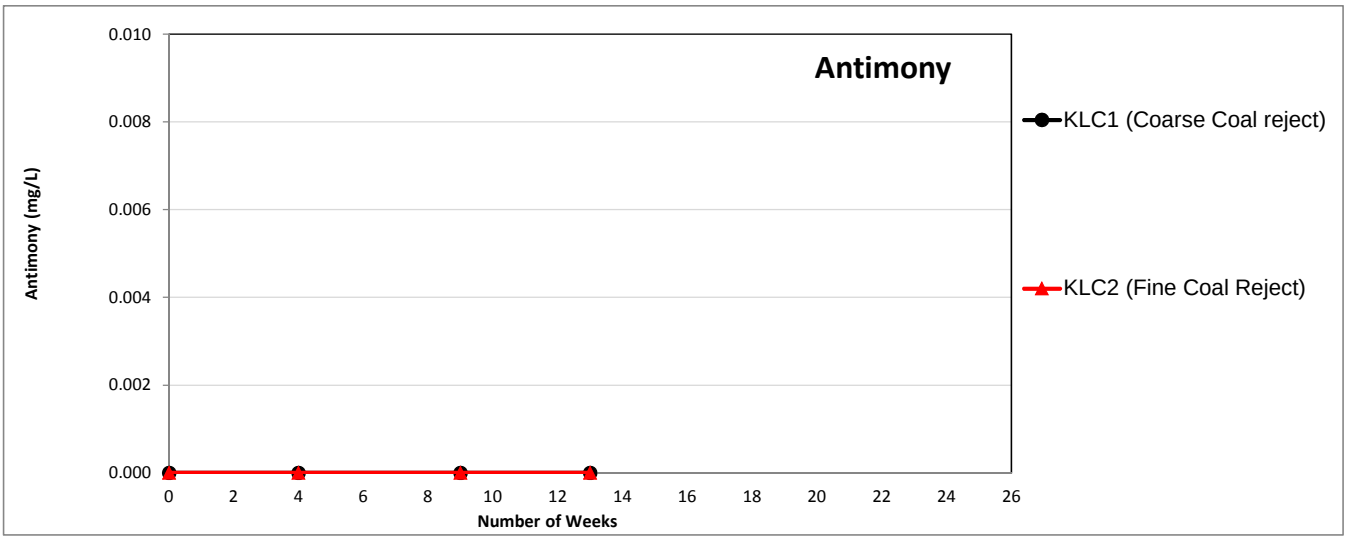

Sodium
Aluminium (mg/L)
500
450
400
350
300
250
200
150
100
50
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

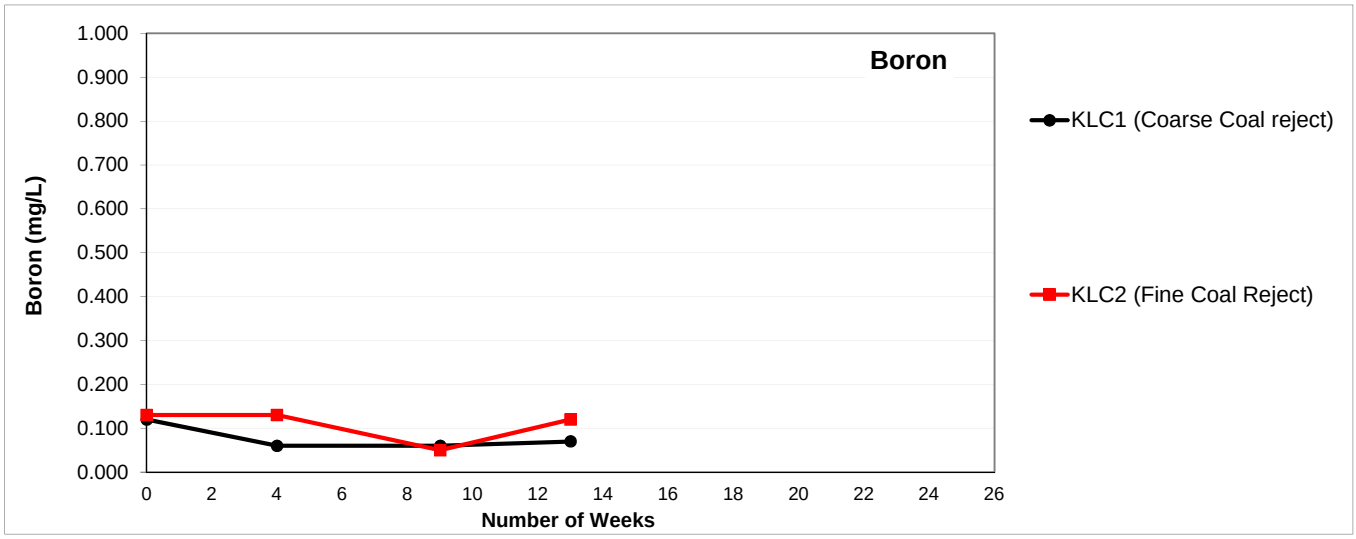

Chloride
Chloride (mg/L)
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

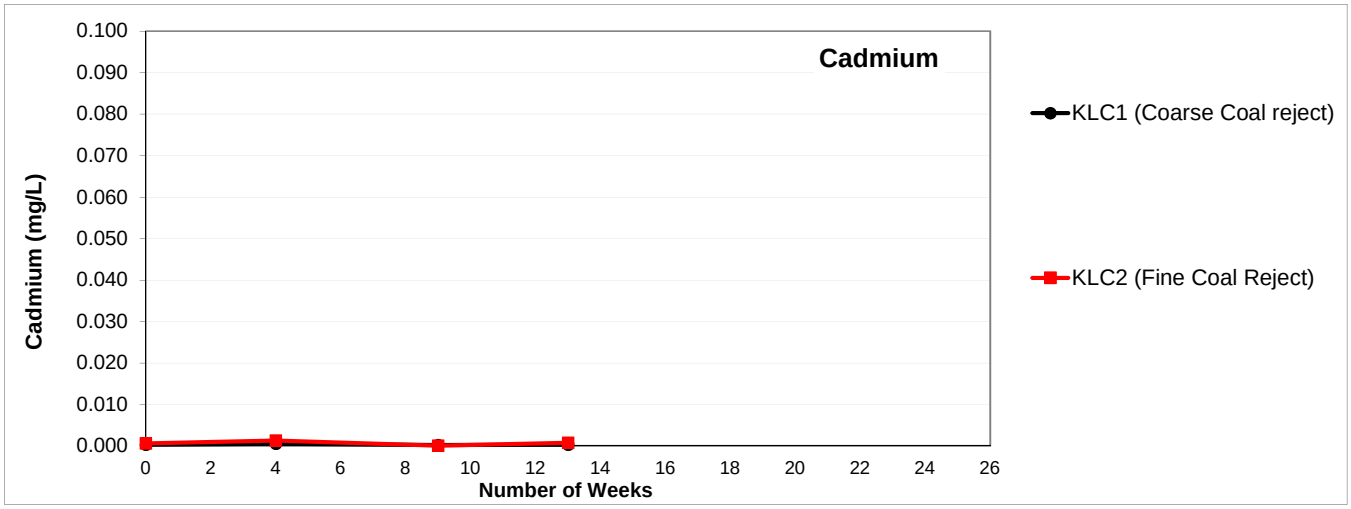

Sulfate
Sulfate (mg/L)
1,600
1,400
1,200
1,000
800
600
400
200
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

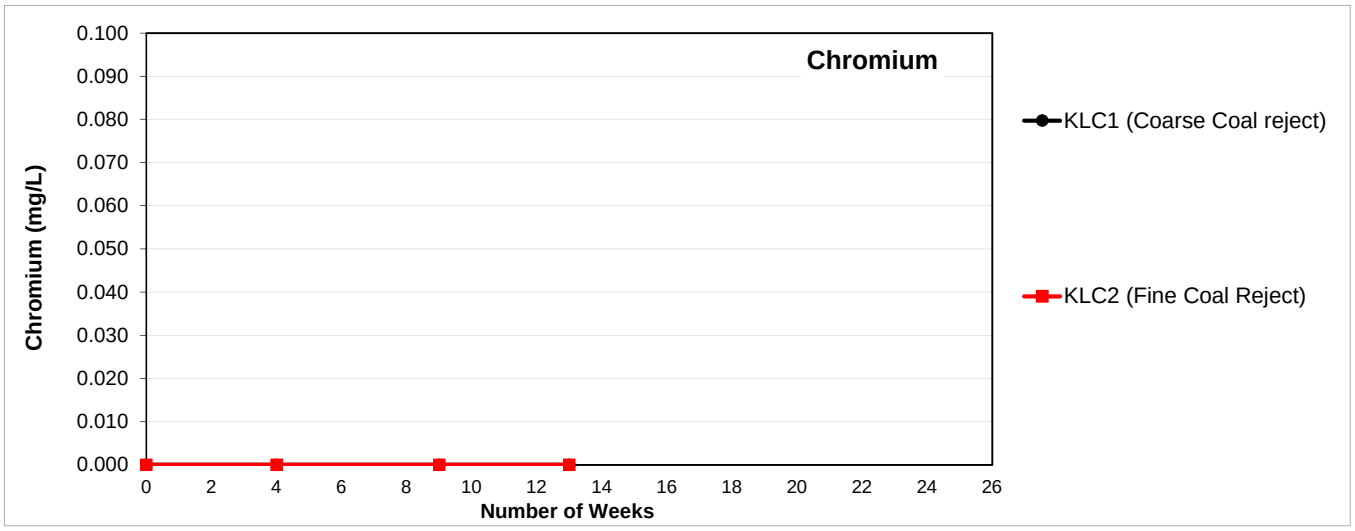

Aluminium
Aluminium (mg/L)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

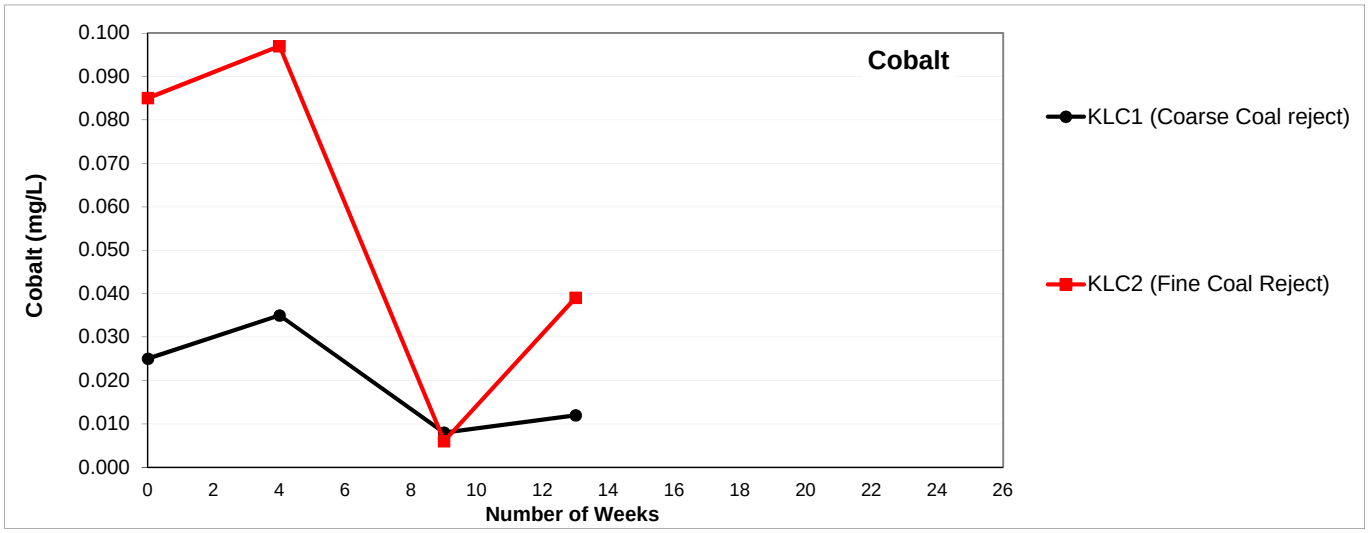

Arsenic
Arsenic (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

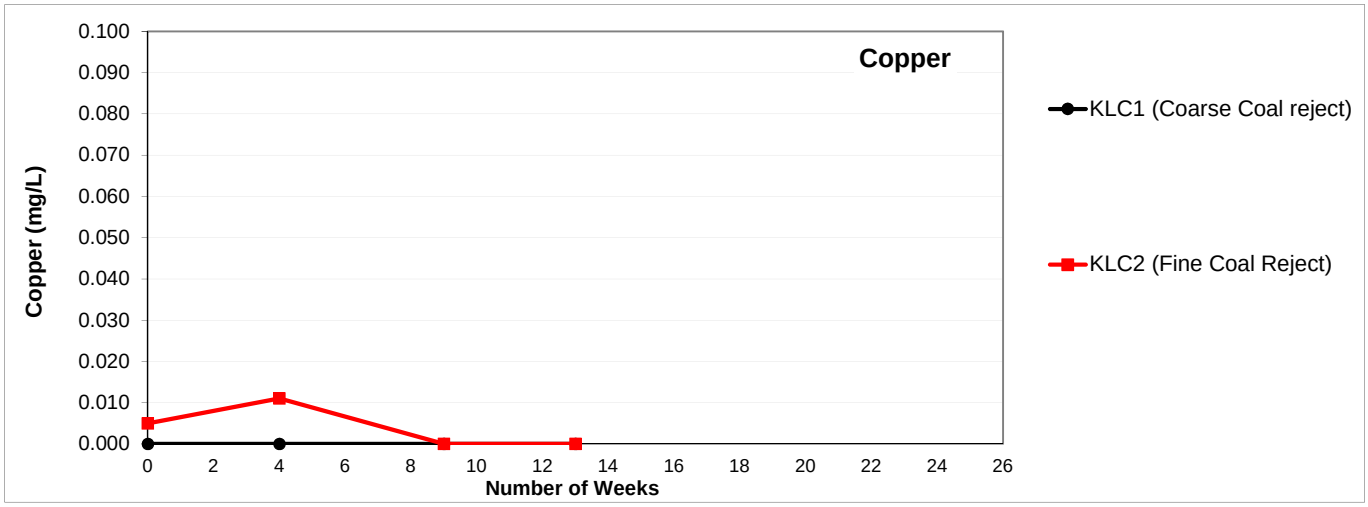

Antimony
Antimony (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

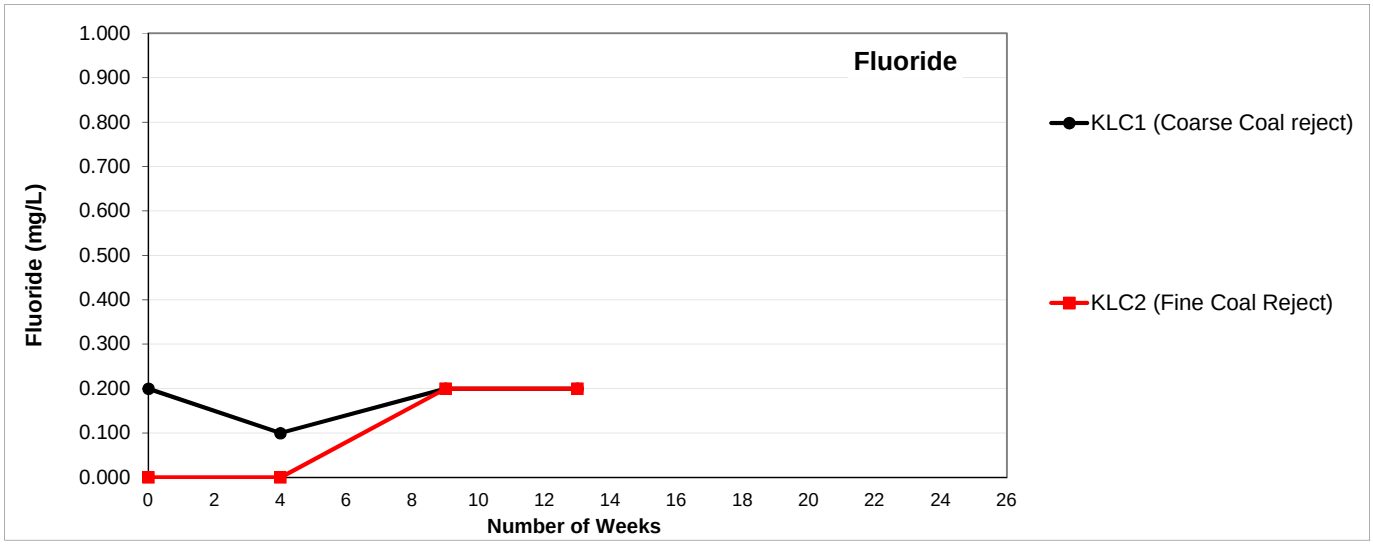

Boron
Boron (mg/L)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

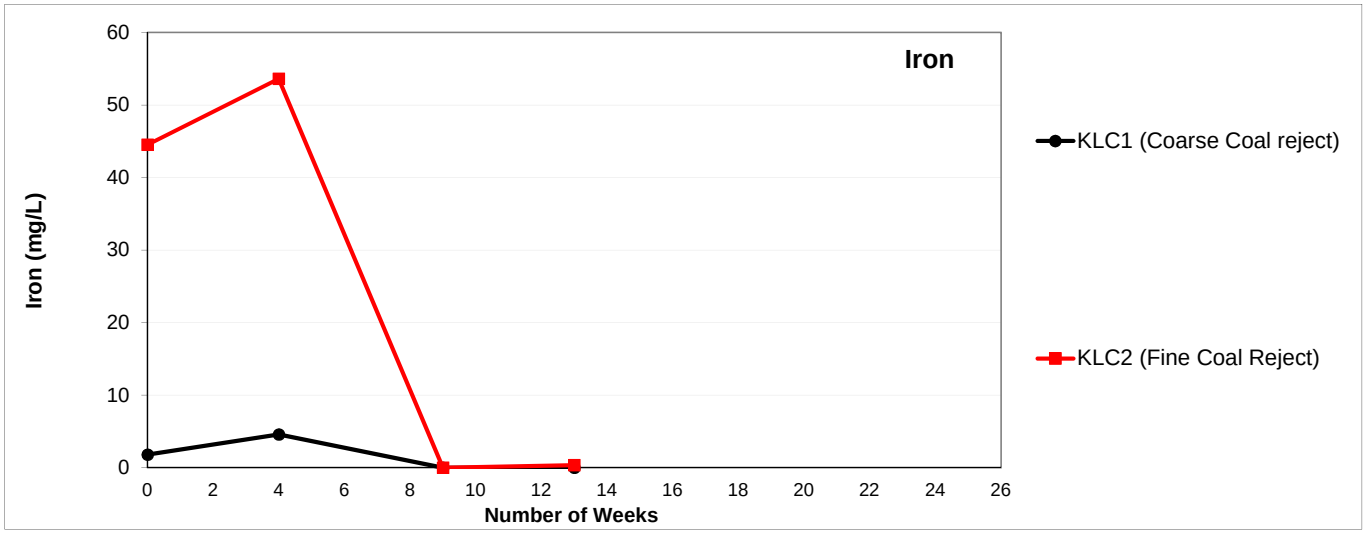

Cadmium
Cadmium (mg/L)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

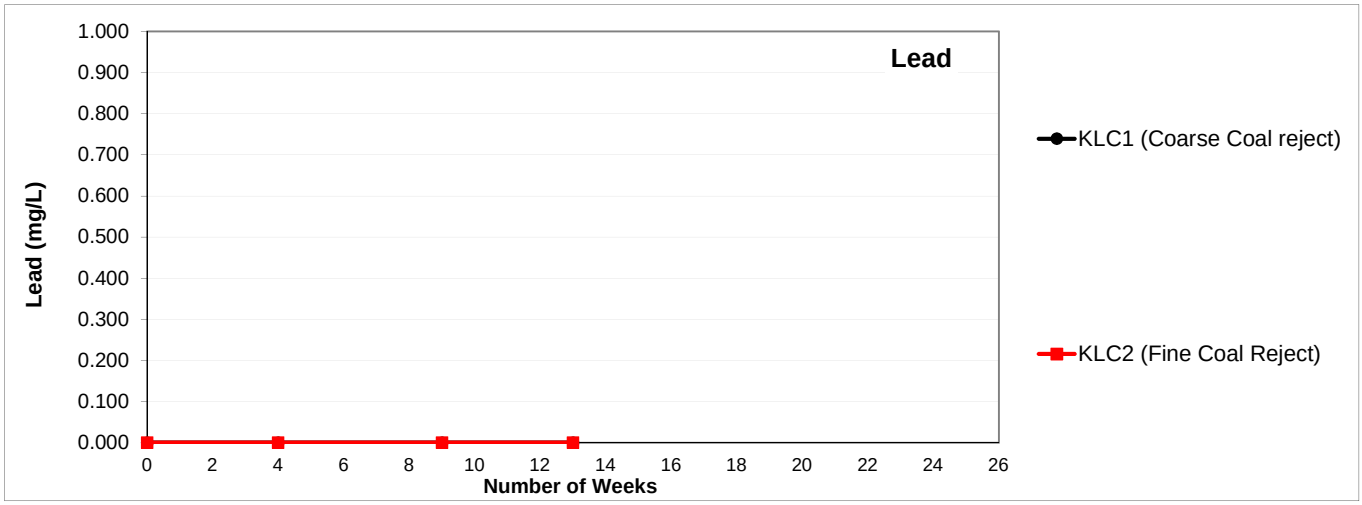

Chromium
Chromium (mg/L)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

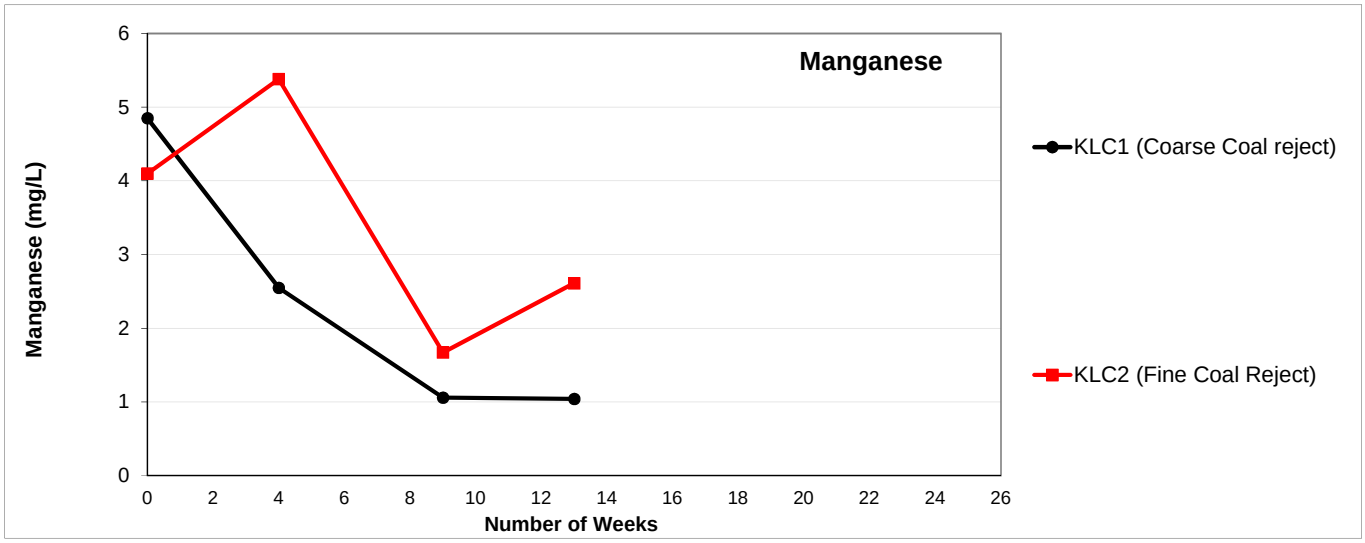

Cobalt
Cobalt (mg/L)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

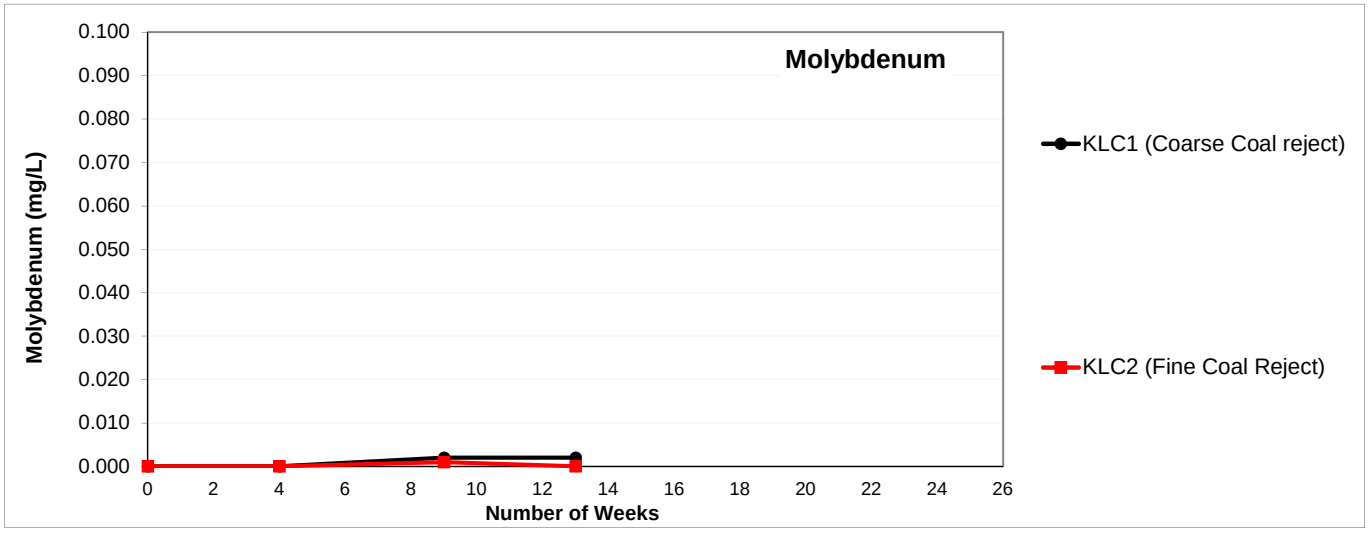

Copper
Copper (mg/L)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

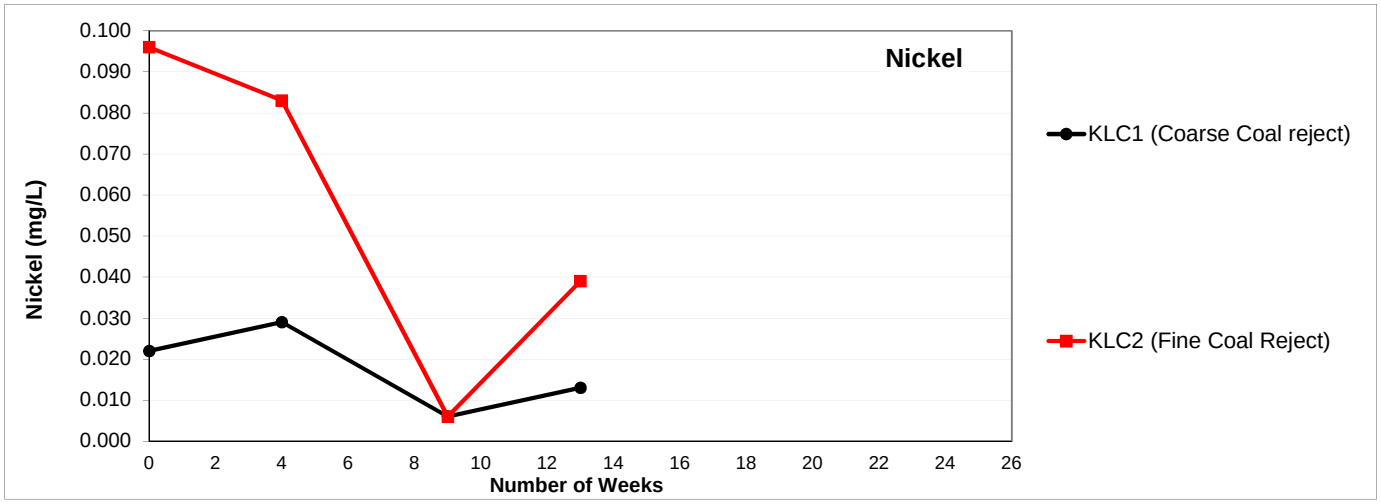

Fluoride
Fluoride (mg/L)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

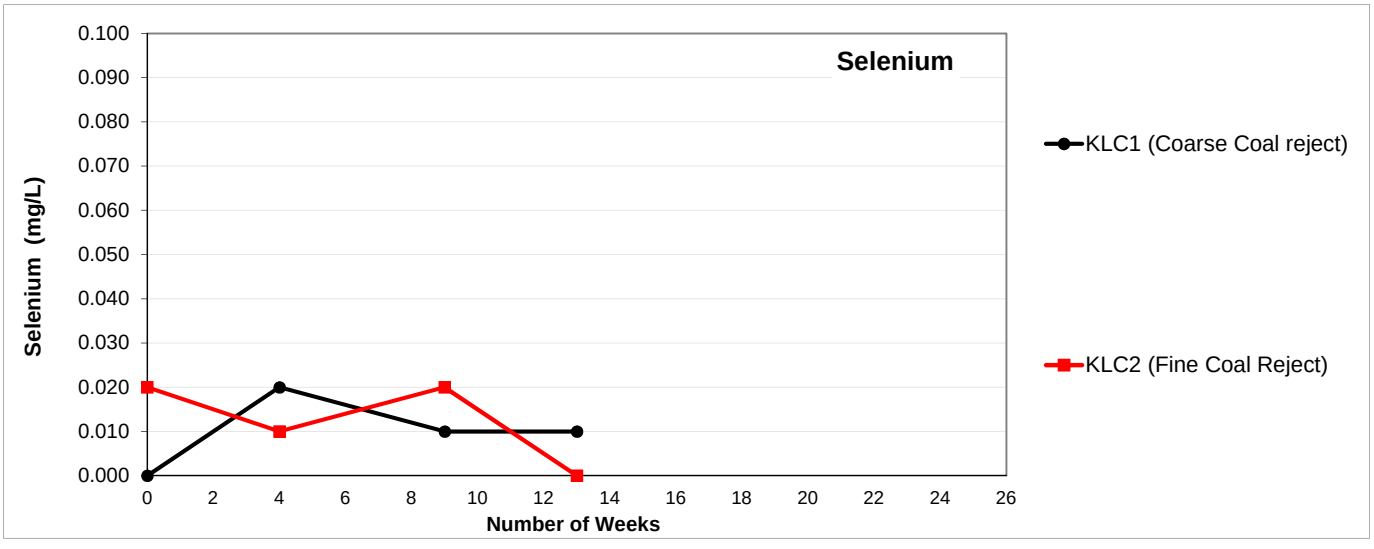

Iron
Iron (mg/L)
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

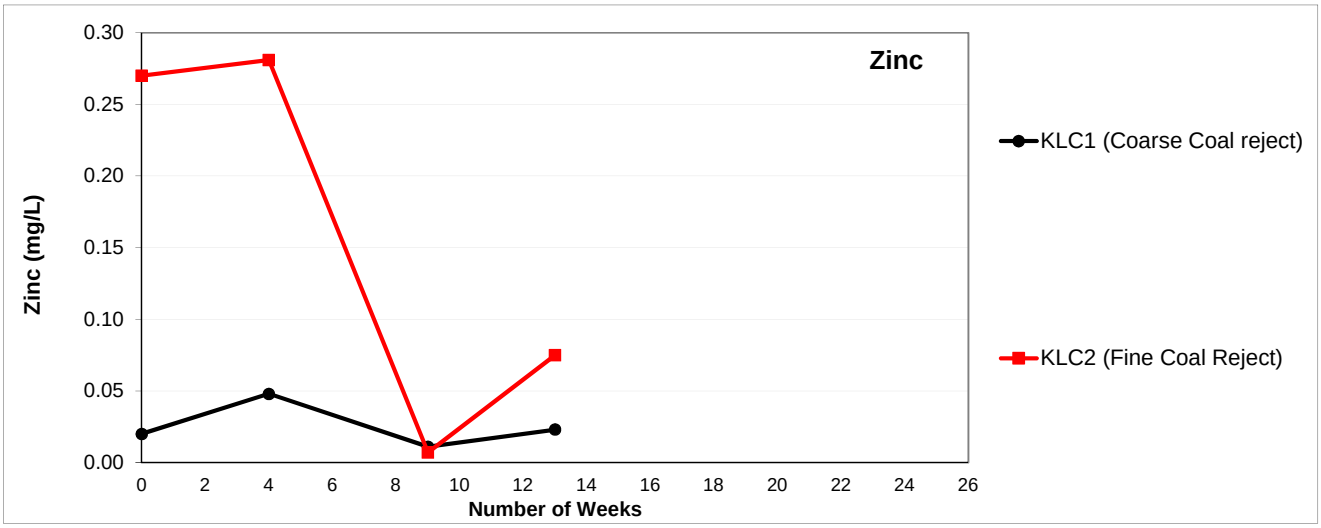

Lead
Lead (mg/L)
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)


Manganese
Manganese (mg/L)
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)


Molybdenum
Molybdenum (mg/L)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)


Nickel
Nickel (mg/L)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)


Selenium
Selenium (mg/L)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)


Zinc
Zinc (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Number of Weeks
KLC1 (Coarse Coal reject)
KLC2 (Fine Coal Reject)

# Attachment E ALS laboratory results

ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB1912348** | Page | : 1 of 7 |
| Client | : **RGS ENVIRONMENTAL PTY LTD** | Laboratory | : Environmental Division Brisbane |
| Contact | : MR ALAN ROBERTSON | Contact | : Customer Services EB |
| Address | : PO Box 3091<br>SUNNYBANK SOUTH QLD, AUSTRALIA 4109 | Address | : 2 Byth Street Stafford QLD Australia 4053 |
| Telephone | : +61 07 3344 1222 | Telephone | : +61-7-3243 7222 |
| Project | : 2017002 Dingo west | Date Samples Received | : 15-May-2019 14:30 |
| Order number | : 2017002 | Date Analysis Commenced | : 15-May-2019 |
| C-O-C number | : ---- | Issue Date | : 22-May-2019 13:08 |
| Sampler | : MARY MACELROY | | |
| Site | : ---- | | |
| Quote number | : EN/222 | | |
| No. of samples received | : 23 | | |
| No. of samples analysed | : 23 | | |

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

**Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.**

## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Kim McCabe | Senior Inorganic Chemist | Brisbane Acid Sulphate Soils, Stafford, QLD |
| Kim McCabe | Senior Inorganic Chemist | Brisbane Inorganics, Stafford, QLD |
| Satishkumar Trivedi | Senior Acid Sulfate Soil Chemist | Brisbane Acid Sulphate Soils, Stafford, QLD |

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA031 (Saturated Paste pH): NATA accreditation does not cover the performance of this service.
- EA032 (Saturated Paste EC): NATA accreditation does not cover the performance of this service.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | | Client sample ID | Composite 1 | Composite 2 | Composite 3 | Composite 4 | Composite 5 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 |
| Compound | CAS Number | LOR | Unit | | EB1912348-001 | EB1912348-002 | EB1912348-003 | EB1912348-004 | EB1912348-005 |
| | | | | | Result | Result | Result | Result | Result |
| **EA009: Nett Acid Production Potential** | | | | | | | | | |
| Net Acid Production Potential | ---- | 0.5 | kg H2SO4/t | | 24.1 | 6.2 | -40.7 | -95.4 | 0.6 |
| **EA013: Acid Neutralising Capacity** | | | | | | | | | |
| ANC as H2SO4 | ---- | 0.5 | kg H2SO4 equiv./t | | 16.0 | 22.6 | 64.6 | 108 | 10.7 |
| ANC as CaCO3 | ---- | 0.1 | % CaCO3 | | 1.6 | 2.3 | 6.6 | 11.0 | 1.1 |
| Fizz Rating | ---- | 0 | Fizz Unit | | 1 | 1 | 2 | 2 | 1 |
| **EA031: pH (saturated paste)** | | | | | | | | | |
| ø pH (Saturated Paste) | ---- | 0.1 | pH Unit | | 6.3 | 6.0 | 7.3 | 7.8 | 8.2 |
| **EA032: Electrical Conductivity (saturated paste)** | | | | | | | | | |
| ø Electrical Conductivity (Saturated Paste) | ---- | 1 | µS/cm | | 946 | 1440 | 1040 | 567 | 919 |
| **ED042T: Total Sulfur by LECO** | | | | | | | | | |
| Sulfur - Total as S (LECO) | ---- | 0.01 | % | | 1.31 | 0.94 | 0.78 | 0.41 | 0.37 |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | | Client sample ID | Composite 6 | Composite 7 | Composite 8 | Composite 9 | Composite 10 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 |
| Compound | CAS Number | LOR | Unit | | EB1912348-006 | EB1912348-007 | EB1912348-008 | EB1912348-009 | EB1912348-010 |
| | | | | | Result | Result | Result | Result | Result |
| **EA009: Nett Acid Production Potential** | | | | | | | | | |
| Net Acid Production Potential | ---- | 0.5 | kg H2SO4/t | | 4.0 | -52.6 | 23.9 | -52.0 | -29.3 |
| **EA013: Acid Neutralising Capacity** | | | | | | | | | |
| ANC as H2SO4 | ---- | 0.5 | kg H2SO4 equiv./t | | 26.3 | 68.5 | 30.3 | 70.1 | 36.3 |
| ANC as CaCO3 | ---- | 0.1 | % CaCO3 | | 2.7 | 7.0 | 3.1 | 7.1 | 3.7 |
| Fizz Rating | ---- | 0 | Fizz Unit | | 1 | 2 | 1 | 2 | 1 |
| **EA031: pH (saturated paste)** | | | | | | | | | |
| ø pH (Saturated Paste) | ---- | 0.1 | pH Unit | | 8.2 | 7.9 | 5.1 | 8.0 | 7.4 |
| **EA032: Electrical Conductivity (saturated paste)** | | | | | | | | | |
| ø Electrical Conductivity (Saturated Paste) | ---- | 1 | µS/cm | | 688 | 398 | 1620 | 456 | 1040 |
| **ED042T: Total Sulfur by LECO** | | | | | | | | | |
| Sulfur - Total as S (LECO) | ---- | 0.01 | % | | 0.99 | 0.52 | 1.77 | 0.59 | 0.23 |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Client sample ID | Composite 11 | Composite 12 | Composite 13 | Composite 14 | Composite 15 |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 |
| Compound | CAS Number | LOR | Unit | EB1912348-011 | EB1912348-012 | EB1912348-013 | EB1912348-014 | EB1912348-015 |
| | | | | Result | Result | Result | Result | Result |
| **EA009: Nett Acid Production Potential** | | | | | | | | |
| Net Acid Production Potential | ---- | 0.5 | kg H2SO4/t | -32.6 | -99.7 | -7.7 | -29.1 | 72.6 |
| **EA013: Acid Neutralising Capacity** | | | | | | | | |
| ANC as H2SO4 | ---- | 0.5 | kg H2SO4 equiv./t | 132 | 122 | 19.0 | 57.3 | 11.5 |
| ANC as CaCO3 | ---- | 0.1 | % CaCO3 | 13.5 | 12.5 | 1.9 | 5.8 | 1.2 |
| Fizz Rating | ---- | 0 | Fizz Unit | 2 | 2 | 1 | 2 | 1 |
| **EA031: pH (saturated paste)** | | | | | | | | |
| ø pH (Saturated Paste) | ---- | 0.1 | pH Unit | 6.6 | 8.2 | 8.3 | 7.4 | 6.2 |
| **EA032: Electrical Conductivity (saturated paste)** | | | | | | | | |
| ø Electrical Conductivity (Saturated Paste) | ---- | 1 | µS/cm | 1300 | 418 | 774 | 1160 | 824 |
| **ED042T: Total Sulfur by LECO** | | | | | | | | |
| Sulfur - Total as S (LECO) | ---- | 0.01 | % | 3.25 | 0.73 | 0.37 | 0.92 | 2.75 |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | | Client sample ID | Composite 16 | Composite 17 | Composite 18 | Composite 19 | Composite 20 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 |
| Compound | CAS Number | LOR | Unit | | EB1912348-016 | EB1912348-017 | EB1912348-018 | EB1912348-019 | EB1912348-020 |
| | | | | | Result | Result | Result | Result | Result |
| **EA009: Nett Acid Production Potential** | | | | | | | | | |
| Net Acid Production Potential | ---- | 0.5 | kg H2SO4/t | | -182 | -351 | -91.8 | 0.9 | -155 |
| **EA013: Acid Neutralising Capacity** | | | | | | | | | |
| ANC as H2SO4 | ---- | 0.5 | kg H2SO4 equiv./t | | 221 | 396 | 112 | 30.6 | 204 |
| ANC as CaCO3 | ---- | 0.1 | % CaCO3 | | 22.5 | 40.4 | 11.5 | 3.1 | 20.8 |
| Fizz Rating | ---- | 0 | Fizz Unit | | 3 | 4 | 2 | 1 | 3 |
| **EA031: pH (saturated paste)** | | | | | | | | | |
| ø pH (Saturated Paste) | ---- | 0.1 | pH Unit | | 6.9 | 7.6 | 7.8 | 6.4 | 7.0 |
| **EA032: Electrical Conductivity (saturated paste)** | | | | | | | | | |
| ø Electrical Conductivity (Saturated Paste) | ---- | 1 | µS/cm | | 1320 | 520 | 570 | 1120 | 647 |
| **ED042T: Total Sulfur by LECO** | | | | | | | | | |
| Sulfur - Total as S (LECO) | ---- | 0.01 | % | | 1.27 | 1.47 | 0.66 | 1.03 | 1.61 |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Client sample ID | Composite 21 | Composite 22 | pH and EC - DI Water | ---- | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | ---- | ---- |
| Compound | CAS Number | LOR | Unit | EB1912348-021 | EB1912348-022 | EB1912348-023 | -------- | -------- |
| | | | | Result | Result | Result | ---- | ---- |
| **EA002: pH 1:5 (Soils)** | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **----** | **----** | **5.1** | **----** | **----** |
| **EA009: Nett Acid Production Potential** | | | | | | | | |
| **Net Acid Production Potential** | ---- | 0.5 | kg H2SO4/t | **52.9** | **-39.5** | **----** | **----** | **----** |
| **EA010: Conductivity (1:5)** | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **----** | **----** | <1 | **----** | **----** |
| **EA013: Acid Neutralising Capacity** | | | | | | | | |
| **ANC as H2SO4** | ---- | 0.5 | kg H2SO4 equiv./t | **12.9** | **168** | **----** | **----** | **----** |
| **ANC as CaCO3** | ---- | 0.1 | % CaCO3 | **1.3** | **17.1** | **----** | **----** | **----** |
| **Fizz Rating** | ---- | 0 | Fizz Unit | **1** | **3** | **----** | **----** | **----** |
| **EA031: pH (saturated paste)** | | | | | | | | |
| **ø pH (Saturated Paste)** | ---- | 0.1 | pH Unit | **5.9** | **6.4** | **----** | **----** | **----** |
| **EA032: Electrical Conductivity (saturated paste)** | | | | | | | | |
| **ø Electrical Conductivity (Saturated Paste)** | ---- | 1 | µS/cm | **502** | **1170** | **----** | **----** | **----** |
| **ED042T: Total Sulfur by LECO** | | | | | | | | |
| **Sulfur - Total as S (LECO)** | ---- | 0.01 | % | **2.15** | **4.20** | **----** | **----** | **----** |

ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB1913397** | Page | : 1 of 5 |
| Client | : **RGS ENVIRONMENTAL PTY LTD** | Laboratory | : Environmental Division Brisbane |
| Contact | : MR ALAN ROBERTSON | Contact | : Customer Services EB |
| Address | : PO Box 3091<br>SUNNYBANK SOUTH QLD, AUSTRALIA 4109 | Address | : 2 Byth Street Stafford QLD Australia 4053 |
| Telephone | : +61 07 3344 1222 | Telephone | : +61-7-3243 7222 |
| Project | : 2017002 Dingo west | Date Samples Received | : 24-May-2019 17:30 |
| Order number | : | Date Analysis Commenced | : 29-May-2019 |
| C-O-C number | : ---- | Issue Date | : 29-May-2019 13:28 |
| Sampler | : AMANDA CLEMENTS | | |
| Site | : ---- | | |
| Quote number | : EN/222 | | |
| No. of samples received | : 15 | | |
| No. of samples analysed | : 15 | | |

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

**Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.**

## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Ben Felgendrejeris | Senior Acid Sulfate Soil Chemist | Brisbane Acid Sulphate Soils, Stafford, QLD |

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | | Client sample ID | Composite 2 | Composite 3 | Composite 4 | Composite 5 | Composite 6 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 24-May-2019 00:00 | 24-May-2019 00:00 | 24-May-2019 00:00 | 24-May-2019 00:00 | 24-May-2019 00:00 |
| Compound | CAS Number | LOR | Unit | | EB1913397-001 | EB1913397-002 | EB1913397-003 | EB1913397-004 | EB1913397-005 |
| | | | | | Result | Result | Result | Result | Result |
| **EA026 : Chromium Reducible Sulfur** | | | | | | | | | |
| **Chromium Reducible Sulphur** | ---- | 0.005 | % | | **0.973** | **0.763** | **0.247** | **0.211** | **0.618** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Client sample ID | Composite 7 | Composite 8 | Composite 9 | Composite 10 | Composite 11 |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 24-May-2019 00:00 | 24-May-2019 00:00 | 24-May-2019 00:00 | 24-May-2019 00:00 | 24-May-2019 00:00 |
| Compound | CAS Number | LOR | Unit | EB1913397-006 | EB1913397-007 | EB1913397-008 | EB1913397-009 | EB1913397-010 |
| | | | | Result | Result | Result | Result | Result |
| **EA026 : Chromium Reducible Sulfur** | | | | | | | | |
| **Chromium Reducible Sulphur** | ---- | 0.005 | % | **0.270** | **1.16** | **0.609** | **0.121** | **3.22** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | | Client sample ID | Composite 12 | Composite 13 | Composite 14 | KLC1 | KLC2 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 24-May-2019 00:00 | 24-May-2019 00:00 | 24-May-2019 00:00 | 24-May-2019 00:00 | 24-May-2019 00:00 |
| Compound | CAS Number | LOR | Unit | | EB1913397-011 | EB1913397-012 | EB1913397-013 | EB1913397-014 | EB1913397-015 |
| | | | | | Result | Result | Result | Result | Result |
| **EA026 : Chromium Reducible Sulfur** | | | | | | | | | |
| **Chromium Reducible Sulphur** | ---- | 0.005 | % | | **0.686** | **0.229** | **0.796** | **0.651** | **1.70** |

ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB1912809** | Page | : 1 of 6 |
| Client | : **RGS ENVIRONMENTAL PTY LTD** | Laboratory | : Environmental Division Brisbane |
| Contact | : MR ALAN ROBERTSON | Contact | : Customer Services EB |
| Address | : PO Box 3091<br>SUNNYBANK SOUTH QLD, AUSTRALIA 4109 | Address | : 2 Byth Street Stafford QLD Australia 4053 |
| Telephone | : +61 07 3344 1222 | Telephone | : +61-7-3243 7222 |
| Project | : 2017002 Dingo west | Date Samples Received | : 20-May-2019 16:41 |
| Order number | : | Date Analysis Commenced | : 04-Jun-2019 |
| C-O-C number | : ---- | Issue Date | : 07-Jun-2019 15:51 |
| Sampler | : ---- | | |
| Site | : ---- | | |
| Quote number | : EN/222 | | |
| No. of samples received | : 26 | | |
| No. of samples analysed | : 4 | | |

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Mark Hallas | Senior Inorganic Chemist | Brisbane Inorganics, Stafford, QLD |
| Tom Maloney | Senior Inorganic Chemist | Brisbane Acid Sulphate Soils, Stafford, QLD |
| Tom Maloney | Senior Inorganic Chemist | Brisbane Inorganics, Stafford, QLD |

## General Comments

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED037 (Alkalinity): NATA accreditation does not cover the performance of this service.
- ED038 (Acidity): NATA accreditation does not cover the performance of this service.

## Analytical Results

| Sub-Matrix: PULP (Matrix: SOIL) | | | | Client sample ID | Coarse-CAS/AR Composite | Coarse-PLU1/PLU2 Composite | Fine-CAS/AR Composite - Fine/PLU1/PLU2 Composite | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | EB1912809-023 | EB1912809-024 | EB1912809-025 | -------- | -------- |
| | | | | | Result | Result | Result | ---- | ---- |
| **ED037: Alkalinity** | | | | | | | | | |
| Total Alkalinity as CaCO3 | ---- | 1 | mg/kg | | 16600 | 14800 | 66100 | ---- | ---- |
| Bicarbonate Alkalinity as CaCO3 | 71-52-3 | 1 | mg/kg | | 16600 | 14800 | 66100 | ---- | ---- |
| Carbonate Alkalinity as CaCO3 | 3812-32-6 | 1 | mg/kg | | <5 | <5 | <5 | ---- | ---- |
| **ED038A: Acidity** | | | | | | | | | |
| Acidity | ---- | 1 | mg/kg | | 12 | 178 | 119 | ---- | ---- |
| **ED040S : Soluble Sulfate by ICPAES** | | | | | | | | | |
| Sulfate as SO4 2- | 14808-79-8 | 10 | mg/kg | | 700 | 1990 | 1430 | ---- | ---- |
| Silica | 7631-86-9 | 1 | mg/kg | | 25 | 24 | 26 | ---- | ---- |
| **ED045G: Chloride by Discrete Analyser** | | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | | 190 | 110 | 220 | ---- | ---- |
| **ED093S: Soluble Major Cations** | | | | | | | | | |
| Calcium | 7440-70-2 | 10 | mg/kg | | 50 | 320 | 350 | ---- | ---- |
| Magnesium | 7439-95-4 | 10 | mg/kg | | 50 | 190 | 170 | ---- | ---- |
| Sodium | 7440-23-5 | 10 | mg/kg | | 460 | 540 | 260 | ---- | ---- |
| Potassium | 7440-09-7 | 10 | mg/kg | | 60 | 50 | 80 | ---- | ---- |
| **ED093T: Total Major Cations** | | | | | | | | | |
| Sodium | 7440-23-5 | 50 | mg/kg | | 860 | 900 | 490 | ---- | ---- |
| Potassium | 7440-09-7 | 50 | mg/kg | | 1490 | 1020 | 1230 | ---- | ---- |
| Calcium | 7440-70-2 | 50 | mg/kg | | 18100 | 26200 | 61000 | ---- | ---- |
| Magnesium | 7439-95-4 | 50 | mg/kg | | 3780 | 3950 | 5040 | ---- | ---- |
| **EG005(ED093)S : Soluble Metals by ICPAES** | | | | | | | | | |
| Boron | 7440-42-8 | 1 | mg/kg | | <1 | <1 | <1 | ---- | ---- |
| Iron | 7439-89-6 | 1 | mg/kg | | <1 | <1 | <1 | ---- | ---- |
| **EG005(ED093)T: Total Metals by ICP-AES** | | | | | | | | | |
| Aluminium | 7429-90-5 | 50 | mg/kg | | 6490 | 6500 | 6510 | ---- | ---- |
| Antimony | 7440-36-0 | 5 | mg/kg | | <5 | <5 | <5 | ---- | ---- |
| Arsenic | 7440-38-2 | 5 | mg/kg | | 21 | 34 | 17 | ---- | ---- |
| Barium | 7440-39-3 | 10 | mg/kg | | 310 | 180 | 140 | ---- | ---- |
| Beryllium | 7440-41-7 | 1 | mg/kg | | <1 | <1 | <1 | ---- | ---- |
| Boron | 7440-42-8 | 50 | mg/kg | | <50 | <50 | <50 | ---- | ---- |
| Cadmium | 7440-43-9 | 1 | mg/kg | | <1 | <1 | <1 | ---- | ---- |
| Chromium | 7440-47-3 | 2 | mg/kg | | 6 | 4 | 12 | ---- | ---- |

## Analytical Results

| Sub-Matrix: PULP (Matrix: SOIL) | | | | Client sample ID | Coarse-CAS/AR Composite | Coarse-PLU1/PLU2 Composite | Fine-CAS/AR Composite - Fine/PLU1/PLU2 Composite | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | EB1912809-023 | EB1912809-024 | EB1912809-025 | -------- | -------- |
| | | | | | Result | Result | Result | ---- | ---- |
| **EG005(ED093)T: Total Metals by ICP-AES - Continued** | | | | | | | | | |
| **Cobalt** | 7440-48-4 | 2 | mg/kg | | **4** | **2** | **3** | ---- | ---- |
| **Copper** | 7440-50-8 | 5 | mg/kg | | **46** | **42** | **33** | ---- | ---- |
| **Iron** | 7439-89-6 | 50 | mg/kg | | **32600** | **41400** | **50500** | ---- | ---- |
| **Lead** | 7439-92-1 | 5 | mg/kg | | **15** | **11** | **10** | ---- | ---- |
| **Manganese** | 7439-96-5 | 5 | mg/kg | | **423** | **1160** | **1030** | ---- | ---- |
| **Molybdenum** | 7439-98-7 | 2 | mg/kg | | **2** | <2 | <2 | ---- | ---- |
| **Nickel** | 7440-02-0 | 2 | mg/kg | | **7** | **5** | **7** | ---- | ---- |
| **Selenium** | 7782-49-2 | 5 | mg/kg | | <5 | <5 | <5 | ---- | ---- |
| **Vanadium** | 7440-62-2 | 5 | mg/kg | | **12** | **14** | **13** | ---- | ---- |
| **Zinc** | 7440-66-6 | 5 | mg/kg | | **44** | **52** | **45** | ---- | ---- |
| **EG020S: Soluble Metals by ICPMS** | | | | | | | | | |
| **Arsenic** | 7440-38-2 | 0.01 | mg/kg | | **0.01** | <0.01 | <0.01 | ---- | ---- |
| **Selenium** | 7782-49-2 | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 | ---- | ---- |
| **Barium** | 7440-39-3 | 0.01 | mg/kg | | **0.13** | **0.11** | **0.11** | ---- | ---- |
| **Beryllium** | 7440-41-7 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Cadmium** | 7440-43-9 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Cobalt** | 7440-48-4 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Chromium** | 7440-47-3 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Thorium** | 7440-29-1 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Copper** | 7440-50-8 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Manganese** | 7439-96-5 | 0.01 | mg/kg | | **0.02** | **2.94** | **0.47** | ---- | ---- |
| **Molybdenum** | 7439-98-7 | 0.01 | mg/kg | | **0.18** | **0.02** | **0.05** | ---- | ---- |
| **Nickel** | 7440-02-0 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Lead** | 7439-92-1 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Antimony** | 7440-36-0 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Uranium** | 7440-61-1 | 0.01 | mg/kg | | <0.01 | <0.01 | <0.01 | ---- | ---- |
| **Zinc** | 7440-66-6 | 0.05 | mg/kg | | <0.05 | <0.05 | <0.05 | ---- | ---- |
| **Vanadium** | 7440-62-2 | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 | ---- | ---- |
| **Aluminium** | 7429-90-5 | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 | ---- | ---- |
| **EG035S: Soluble Mercury by FIMS** | | | | | | | | | |
| **Mercury** | 7439-97-6 | 0.0005 | mg/kg | | <0.0005 | <0.0005 | <0.0005 | ---- | ---- |
| **EG035T: Total Recoverable Mercury by FIMS** | | | | | | | | | |

## Analytical Results

| Sub-Matrix: PULP (Matrix: SOIL) | | | | Client sample ID | Coarse-CAS/AR Composite | Coarse-PLU1/PLU2 Composite | Fine-CAS/AR Composite - Fine/PLU1/PLU2 Composite | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 15-May-2019 00:00 | 15-May-2019 00:00 | 15-May-2019 00:00 | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | EB1912809-023 | EB1912809-024 | EB1912809-025 | -------- | -------- |
| | | | | | Result | Result | Result | ---- | ---- |
| **EG035T: Total Recoverable Mercury by FIMS - Continued** | | | | | | | | | |
| **Mercury** | 7439-97-6 | 0.1 | mg/kg | | **0.1** | **0.2** | **0.1** | **----** | **----** |
| **EK040S: Fluoride Soluble** | | | | | | | | | |
| **Fluoride** | 16984-48-8 | 1 | mg/kg | | **3** | **2** | **1** | **----** | **----** |
| **EK071G: Reactive Phosphorus as P by discrete analyser** | | | | | | | | | |
| **Reactive Phosphorus as P** | 14265-44-2 | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 | **----** | **----** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | | Client sample ID | pH and EC of deionised water | ---- | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 15-May-2019 00:00 | ---- | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | EB1912809-026 | -------- | -------- | -------- | -------- |
| | | | | | Result | ---- | ---- | ---- | ---- |
| **EA002: pH 1:5 (Soils)** | | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | | **5.5** | **----** | **----** | **----** | **----** |
| **EA010: Conductivity (1:5)** | | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | | <1 | **----** | **----** | **----** | **----** |

ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB1915057** | Page | : 1 of 2 |
| Client | : **AUSTAR GOLD LTD** | Laboratory | : Environmental Division Brisbane |
| Contact | : ALAN @ RGS | Contact | : Customer Services EB |
| Address | : Level 8 46 Edward Street<br>Brisbane QLD 4000 | Address | : 2 Byth Street Stafford QLD Australia 4053 |
| Telephone | : ---- | Telephone | : +61-7-3243 7222 |
| Project | : ---- | Date Samples Received | : 11-Jun-2019 13:53 |
| Order number | : | Date Analysis Commenced | : 15-Jun-2019 |
| C-O-C number | : ---- | Issue Date | : 17-Jun-2019 11:14 |
| Sampler | : ---- | | |
| Site | : ---- | | |
| Quote number | : EN/333 | | |
| No. of samples received | : 5 | | |
| No. of samples analysed | : 5 | | |

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

**Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.**

## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Kim McCabe | Senior Inorganic Chemist | Brisbane Acid Sulphate Soils, Stafford, QLD |

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

## Analytical Results

| Sub-Matrix: **PULP** (Matrix: **SOIL**) | | | Client sample ID | **Coarse-CAS/AR Composite** | **Coarse-PLU1/PLU2 Composite** | **Fine-CAS/AR Composite/Fine-PLU1/ PLU2 Composite** |
|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 20-May-2019 00:00 | 20-May-2019 00:00 | 20-May-2019 00:00 |
| *Compound* | *CAS Number* | *LOR* | *Unit* | **EB1915057-001** | **EB1915057-002** | **EB1915057-003** |
| | | | | Result | Result | Result |
| **EA002: pH 1:5 (Soils)** | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **8.5** | **8.0** | **8.0** |
| **EA010: Conductivity (1:5)** | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **593** | **1040** | **865** |

ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB1913182** | Page | : 1 of 4 |
| Client | : **RGS ENVIRONMENTAL PTY LTD** | Laboratory | : Environmental Division Brisbane |
| Contact | : MS AMANDA CLEMENTS | Contact | : Customer Services EB |
| Address | : PO Box 3091<br>SUNNYBANK SOUTH QLD, AUSTRALIA 4109 | Address | : 2 Byth Street Stafford QLD Australia 4053 |
| Telephone | : ---- | Telephone | : +61-7-3243 7222 |
| Project | : 2017002 Dingo West | Date Samples Received | : 23-May-2019 15:40 |
| Order number | : | Date Analysis Commenced | : 24-May-2019 |
| C-O-C number | : ---- | Issue Date | : 29-May-2019 09:12 |
| Sampler | : ---- | | |
| Site | : ---- | | |
| Quote number | : EN/222 | | |
| No. of samples received | : 2 | | |
| No. of samples analysed | : 2 | | |

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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- Analytical Results

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## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Kim McCabe | Senior Inorganic Chemist | Brisbane Inorganics, Stafford, QLD |

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Client sample ID | KLC 1 | KLC 2 | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 23-May-2019 00:00 | 23-May-2019 00:00 | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | EB1913182-001 | EB1913182-002 | -------- | -------- | -------- |
| | | | | Result | Result | ---- | ---- | ---- |
| **EA005P: pH by PC Titrator** | | | | | | | | |
| pH Value | ---- | 0.01 | pH Unit | **6.61** | **5.15** | ---- | ---- | ---- |
| **EA010P: Conductivity by PC Titrator** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | **1110** | **2090** | ---- | ---- | ---- |
| **ED037P: Alkalinity by PC Titrator** | | | | | | | | |
| Hydroxide Alkalinity as CaCO3 | DMO-210-001 | 1 | mg/L | <1 | <1 | ---- | ---- | ---- |
| Carbonate Alkalinity as CaCO3 | 3812-32-6 | 1 | mg/L | <1 | <1 | ---- | ---- | ---- |
| Bicarbonate Alkalinity as CaCO3 | 71-52-3 | 1 | mg/L | **13** | **4** | ---- | ---- | ---- |
| Total Alkalinity as CaCO3 | ---- | 1 | mg/L | **13** | **4** | ---- | ---- | ---- |
| **ED038A: Acidity** | | | | | | | | |
| Acidity as CaCO3 | ---- | 1 | mg/L | **5** | **101** | ---- | ---- | ---- |
| **ED041G: Sulfate (Turbidimetric) as SO4 2- by DA** | | | | | | | | |
| Sulfate as SO4 - Turbidimetric | 14808-79-8 | 1 | mg/L | **451** | **726** | ---- | ---- | ---- |
| **ED045G: Chloride by Discrete Analyser** | | | | | | | | |
| Chloride | 16887-00-6 | 1 | mg/L | **41** | **259** | ---- | ---- | ---- |
| **ED093F: Dissolved Major Cations** | | | | | | | | |
| Calcium | 7440-70-2 | 1 | mg/L | **34** | **110** | ---- | ---- | ---- |
| Magnesium | 7439-95-4 | 1 | mg/L | **31** | **68** | ---- | ---- | ---- |
| Sodium | 7440-23-5 | 1 | mg/L | **164** | **252** | ---- | ---- | ---- |
| Potassium | 7440-09-7 | 1 | mg/L | **5** | **8** | ---- | ---- | ---- |
| **EG020F: Dissolved Metals by ICP-MS** | | | | | | | | |
| Aluminium | 7429-90-5 | 0.01 | mg/L | <0.01 | **0.12** | ---- | ---- | ---- |
| Antimony | 7440-36-0 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Arsenic | 7440-38-2 | 0.001 | mg/L | <0.001 | **0.001** | ---- | ---- | ---- |
| Cadmium | 7440-43-9 | 0.0001 | mg/L | **0.0003** | **0.0006** | ---- | ---- | ---- |
| Chromium | 7440-47-3 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Cobalt | 7440-48-4 | 0.001 | mg/L | **0.025** | **0.085** | ---- | ---- | ---- |
| Copper | 7440-50-8 | 0.001 | mg/L | <0.001 | **0.005** | ---- | ---- | ---- |
| Lead | 7439-92-1 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Manganese | 7439-96-5 | 0.001 | mg/L | **4.85** | **4.10** | ---- | ---- | ---- |
| Molybdenum | 7439-98-7 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Nickel | 7440-02-0 | 0.001 | mg/L | **0.022** | **0.096** | ---- | ---- | ---- |
| Selenium | 7782-49-2 | 0.01 | mg/L | <0.01 | **0.02** | ---- | ---- | ---- |
| Vanadium | 7440-62-2 | 0.01 | mg/L | <0.01 | <0.01 | ---- | ---- | ---- |
| Zinc | 7440-66-6 | 0.005 | mg/L | **0.020** | **0.270** | ---- | ---- | ---- |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Client sample ID | KLC 1 | KLC 2 | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 23-May-2019 00:00 | 23-May-2019 00:00 | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | EB1913182-001 | EB1913182-002 | -------- | -------- | -------- |
| | | | | | Result | Result | ---- | ---- | ---- |
| **EG020F: Dissolved Metals by ICP-MS - Continued** | | | | | | | | | |
| **Boron** | 7440-42-8 | 0.05 | mg/L | | **0.12** | **0.13** | **----** | **----** | **----** |
| **Iron** | 7439-89-6 | 0.05 | mg/L | | **1.81** | **44.5** | **----** | **----** | **----** |
| **EK040P: Fluoride by PC Titrator** | | | | | | | | | |
| **Fluoride** | 16984-48-8 | 0.1 | mg/L | | **0.2** | <0.1 | **----** | **----** | **----** |
| **EN055: Ionic Balance** | | | | | | | | | |
| ø **Total Anions** | ---- | 0.01 | meq/L | | **10.8** | **22.5** | **----** | **----** | **----** |
| ø **Total Cations** | ---- | 0.01 | meq/L | | **11.5** | **22.2** | **----** | **----** | **----** |
| ø **Ionic Balance** | ---- | 0.01 | % | | **3.15** | **0.56** | **----** | **----** | **----** |

ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB1916404** | Page | : 1 of 4 |
| Client | : **RGS ENVIRONMENTAL PTY LTD** | Laboratory | : Environmental Division Brisbane |
| Contact | : MS AMANDA CLEMENTS | Contact | : Customer Services EB |
| Address | : PO Box 3091<br>SUNNYBANK SOUTH QLD, AUSTRALIA 4109 | Address | : 2 Byth Street Stafford QLD Australia 4053 |
| Telephone | : ---- | Telephone | : +61-7-3243 7222 |
| Project | : 2017002 Dingo west | Date Samples Received | : 25-Jun-2019 14:50 |
| Order number | : 2017002 | Date Analysis Commenced | : 26-Jun-2019 |
| C-O-C number | : ---- | Issue Date | : 02-Jul-2019 14:44 |
| Sampler | : MARY MACILROY | | |
| Site | : ---- | | |
| Quote number | : EN/222 | | |
| No. of samples received | : 2 | | |
| No. of samples analysed | : 2 | | |

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| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Kim McCabe | Senior Inorganic Chemist | Brisbane Inorganics, Stafford, QLD |

## General Comments

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Client sample ID | KLC 1 | KLC 2 | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 25-Jun-2019 00:00 | 25-Jun-2019 00:00 | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | EB1916404-001 | EB1916404-002 | -------- | -------- | -------- |
| | | | | Result | Result | ---- | ---- | ---- |
| **EA005P: pH by PC Titrator** | | | | | | | | |
| pH Value | ---- | 0.01 | pH Unit | **5.88** | **4.75** | ---- | ---- | ---- |
| **EA010P: Conductivity by PC Titrator** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | **2410** | **2420** | ---- | ---- | ---- |
| **ED037P: Alkalinity by PC Titrator** | | | | | | | | |
| Hydroxide Alkalinity as CaCO3 | DMO-210-001 | 1 | mg/L | <1 | <1 | ---- | ---- | ---- |
| Carbonate Alkalinity as CaCO3 | 3812-32-6 | 1 | mg/L | <1 | <1 | ---- | ---- | ---- |
| Bicarbonate Alkalinity as CaCO3 | 71-52-3 | 1 | mg/L | **3** | <1 | ---- | ---- | ---- |
| Total Alkalinity as CaCO3 | ---- | 1 | mg/L | **3** | <1 | ---- | ---- | ---- |
| **ED038A: Acidity** | | | | | | | | |
| Acidity as CaCO3 | ---- | 1 | mg/L | **15** | **110** | ---- | ---- | ---- |
| **ED041G: Sulfate (Turbidimetric) as SO4 2- by DA** | | | | | | | | |
| Sulfate as SO4 - Turbidimetric | 14808-79-8 | 1 | mg/L | **1140** | **1240** | ---- | ---- | ---- |
| **ED045G: Chloride by Discrete Analyser** | | | | | | | | |
| Chloride | 16887-00-6 | 1 | mg/L | **83** | **141** | ---- | ---- | ---- |
| **ED093F: Dissolved Major Cations** | | | | | | | | |
| Calcium | 7440-70-2 | 1 | mg/L | **83** | **202** | ---- | ---- | ---- |
| Magnesium | 7439-95-4 | 1 | mg/L | **120** | **126** | ---- | ---- | ---- |
| Sodium | 7440-23-5 | 1 | mg/L | **337** | **190** | ---- | ---- | ---- |
| Potassium | 7440-09-7 | 1 | mg/L | **6** | **7** | ---- | ---- | ---- |
| **EG020F: Dissolved Metals by ICP-MS** | | | | | | | | |
| Aluminium | 7429-90-5 | 0.01 | mg/L | <0.01 | **0.07** | ---- | ---- | ---- |
| Antimony | 7440-36-0 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Arsenic | 7440-38-2 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Cadmium | 7440-43-9 | 0.0001 | mg/L | **0.0005** | **0.0013** | ---- | ---- | ---- |
| Chromium | 7440-47-3 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Copper | 7440-50-8 | 0.001 | mg/L | <0.001 | **0.011** | ---- | ---- | ---- |
| Cobalt | 7440-48-4 | 0.001 | mg/L | **0.035** | **0.097** | ---- | ---- | ---- |
| Nickel | 7440-02-0 | 0.001 | mg/L | **0.029** | **0.083** | ---- | ---- | ---- |
| Lead | 7439-92-1 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Zinc | 7440-66-6 | 0.005 | mg/L | **0.048** | **0.281** | ---- | ---- | ---- |
| Manganese | 7439-96-5 | 0.001 | mg/L | **2.55** | **5.38** | ---- | ---- | ---- |
| Molybdenum | 7439-98-7 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Selenium | 7782-49-2 | 0.01 | mg/L | **0.02** | **0.01** | ---- | ---- | ---- |
| Vanadium | 7440-62-2 | 0.01 | mg/L | <0.01 | <0.01 | ---- | ---- | ---- |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Client sample ID | KLC 1 | KLC 2 | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 25-Jun-2019 00:00 | 25-Jun-2019 00:00 | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | EB1916404-001 | EB1916404-002 | -------- | -------- | -------- |
| | | | | | Result | Result | ---- | ---- | ---- |
| **EG020F: Dissolved Metals by ICP-MS - Continued** | | | | | | | | | |
| **Boron** | 7440-42-8 | 0.05 | mg/L | | **0.06** | **0.13** | **----** | **----** | **----** |
| **Iron** | 7439-89-6 | 0.05 | mg/L | | **4.60** | **53.6** | **----** | **----** | **----** |
| **EK040P: Fluoride by PC Titrator** | | | | | | | | | |
| **Fluoride** | 16984-48-8 | 0.1 | mg/L | | **0.1** | <0.1 | **----** | **----** | **----** |
| **EN055: Ionic Balance** | | | | | | | | | |
| ø **Total Anions** | ---- | 0.01 | meq/L | | **26.1** | **29.8** | **----** | **----** | **----** |
| ø **Total Cations** | ---- | 0.01 | meq/L | | **28.8** | **28.9** | **----** | **----** | **----** |
| ø **Ionic Balance** | ---- | 0.01 | % | | **4.90** | **1.54** | **----** | **----** | **----** |

ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB1918950** | Page | : 1 of 4 |
| Client | : **RGS ENVIRONMENTAL PTY LTD** | Laboratory | : Environmental Division Brisbane |
| Contact | : MS AMANDA CLEMENTS | Contact | : Customer Services EB |
| Address | : PO Box 3091<br>SUNNYBANK SOUTH QLD, AUSTRALIA 4109 | Address | : 2 Byth Street Stafford QLD Australia 4053 |
| Telephone | : ---- | Telephone | : +61-7-3243 7222 |
| Project | : 2017002 Dingo west | Date Samples Received | : 22-Jul-2019 03:05 |
| Order number | : 2017002 | Date Analysis Commenced | : 23-Jul-2019 |
| C-O-C number | : ---- | Issue Date | : 30-Jul-2019 11:19 |
| Sampler | : MARY MACELROY | | |
| Site | : ---- | | |
| Quote number | : EN/222 | | |
| No. of samples received | : 2 | | |
| No. of samples analysed | : 2 | | |

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This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Kim McCabe | Senior Inorganic Chemist | Brisbane Inorganics, Stafford, QLD |

## General Comments

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Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Client sample ID | KLC 1 | KLC 2 | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 22-Jul-2019 00:00 | 22-Jul-2019 00:00 | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | EB1918950-001 | EB1918950-002 | -------- | -------- | -------- |
| | | | | Result | Result | ---- | ---- | ---- |
| **EA005P: pH by PC Titrator** | | | | | | | | |
| pH Value | ---- | 0.01 | pH Unit | **6.90** | **7.18** | ---- | ---- | ---- |
| **EA010P: Conductivity by PC Titrator** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | **1860** | **3030** | ---- | ---- | ---- |
| **ED037P: Alkalinity by PC Titrator** | | | | | | | | |
| Hydroxide Alkalinity as CaCO3 | DMO-210-001 | 1 | mg/L | <1 | <1 | ---- | ---- | ---- |
| Carbonate Alkalinity as CaCO3 | 3812-32-6 | 1 | mg/L | <1 | <1 | ---- | ---- | ---- |
| Bicarbonate Alkalinity as CaCO3 | 71-52-3 | 1 | mg/L | **7** | **13** | ---- | ---- | ---- |
| Total Alkalinity as CaCO3 | ---- | 1 | mg/L | **7** | **13** | ---- | ---- | ---- |
| **ED038A: Acidity** | | | | | | | | |
| Acidity as CaCO3 | ---- | 1 | mg/L | **1** | **2** | ---- | ---- | ---- |
| **ED041G: Sulfate (Turbidimetric) as SO4 2- by DA** | | | | | | | | |
| Sulfate as SO4 - Turbidimetric | 14808-79-8 | 1 | mg/L | **846** | **1500** | ---- | ---- | ---- |
| **ED045G: Chloride by Discrete Analyser** | | | | | | | | |
| Chloride | 16887-00-6 | 1 | mg/L | **51** | **261** | ---- | ---- | ---- |
| **ED093F: Dissolved Major Cations** | | | | | | | | |
| Calcium | 7440-70-2 | 1 | mg/L | **75** | **234** | ---- | ---- | ---- |
| Magnesium | 7439-95-4 | 1 | mg/L | **84** | **161** | ---- | ---- | ---- |
| Sodium | 7440-23-5 | 1 | mg/L | **215** | **260** | ---- | ---- | ---- |
| Potassium | 7440-09-7 | 1 | mg/L | **4** | **8** | ---- | ---- | ---- |
| **EG020F: Dissolved Metals by ICP-MS** | | | | | | | | |
| Aluminium | 7429-90-5 | 0.01 | mg/L | <0.01 | <0.01 | ---- | ---- | ---- |
| Antimony | 7440-36-0 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Arsenic | 7440-38-2 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Cadmium | 7440-43-9 | 0.0001 | mg/L | **0.0002** | **0.0001** | ---- | ---- | ---- |
| Chromium | 7440-47-3 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Copper | 7440-50-8 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Cobalt | 7440-48-4 | 0.001 | mg/L | **0.008** | **0.006** | ---- | ---- | ---- |
| Nickel | 7440-02-0 | 0.001 | mg/L | **0.006** | **0.006** | ---- | ---- | ---- |
| Lead | 7439-92-1 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Zinc | 7440-66-6 | 0.005 | mg/L | **0.011** | **0.007** | ---- | ---- | ---- |
| Manganese | 7439-96-5 | 0.001 | mg/L | **1.06** | **1.67** | ---- | ---- | ---- |
| Molybdenum | 7439-98-7 | 0.001 | mg/L | **0.002** | **0.001** | ---- | ---- | ---- |
| Selenium | 7782-49-2 | 0.01 | mg/L | **0.01** | **0.02** | ---- | ---- | ---- |
| Vanadium | 7440-62-2 | 0.01 | mg/L | <0.01 | <0.01 | ---- | ---- | ---- |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Client sample ID | KLC 1 | KLC 2 | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 22-Jul-2019 00:00 | 22-Jul-2019 00:00 | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | EB1918950-001 | EB1918950-002 | -------- | -------- | -------- |
| | | | | | Result | Result | ---- | ---- | ---- |
| **EG020F: Dissolved Metals by ICP-MS - Continued** | | | | | | | | | |
| **Boron** | 7440-42-8 | 0.05 | mg/L | | **0.06** | **0.05** | **----** | **----** | **----** |
| **Iron** | 7439-89-6 | 0.05 | mg/L | | <0.05 | <0.05 | **----** | **----** | **----** |
| **EK040P: Fluoride by PC Titrator** | | | | | | | | | |
| **Fluoride** | 16984-48-8 | 0.1 | mg/L | | **0.2** | **0.2** | **----** | **----** | **----** |
| **EN055: Ionic Balance** | | | | | | | | | |
| ø **Total Anions** | ---- | 0.01 | meq/L | | **19.2** | **38.8** | **----** | **----** | **----** |
| ø **Total Cations** | ---- | 0.01 | meq/L | | **20.1** | **36.4** | **----** | **----** | **----** |
| ø **Ionic Balance** | ---- | 0.01 | % | | **2.34** | **3.20** | **----** | **----** | **----** |

ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB1922372** | Page | : 1 of 4 |
| Client | : **RGS ENVIRONMENTAL PTY LTD** | Laboratory | : Environmental Division Brisbane |
| Contact | : MS VERONICA CANALES | Contact | : Customer Services EB |
| Address | : | Address | : 2 Byth Street Stafford QLD Australia 4053 |
| Telephone | : +61 07 3344 1222 | Telephone | : +61-7-3243 7222 |
| Project | : Dingo West Template | Date Samples Received | : 27-Aug-2019 15:20 |
| Order number | : | Date Analysis Commenced | : 27-Aug-2019 |
| C-O-C number | : 3548 | Issue Date | : 03-Sep-2019 16:56 |
| Sampler | : CARSTEN EMRICH | | |
| Site | : Dingo West Template L4 | | |
| Quote number | : BN/1234/19 | | |
| No. of samples received | : 2 | | |
| No. of samples analysed | : 2 | | |

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

**Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.**

## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Kim McCabe | Senior Inorganic Chemist | Brisbane Inorganics, Stafford, QLD |

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Client sample ID | KLC-1 | KLC-2 | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 27-Aug-2019 12:37 | 27-Aug-2019 12:38 | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | EB1922372-001 | EB1922372-002 | -------- | -------- | -------- |
| | | | | Result | Result | ---- | ---- | ---- |
| **EA005P: pH by PC Titrator** | | | | | | | | |
| pH Value | ---- | 0.01 | pH Unit | **6.83** | **6.65** | ---- | ---- | ---- |
| **EA010P: Conductivity by PC Titrator** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | **1820** | **2450** | ---- | ---- | ---- |
| **ED037P: Alkalinity by PC Titrator** | | | | | | | | |
| Hydroxide Alkalinity as CaCO3 | DMO-210-001 | 1 | mg/L | <1 | <1 | ---- | ---- | ---- |
| Carbonate Alkalinity as CaCO3 | 3812-32-6 | 1 | mg/L | <1 | <1 | ---- | ---- | ---- |
| Bicarbonate Alkalinity as CaCO3 | 71-52-3 | 1 | mg/L | **8** | **9** | ---- | ---- | ---- |
| Total Alkalinity as CaCO3 | ---- | 1 | mg/L | **8** | **9** | ---- | ---- | ---- |
| **ED038A: Acidity** | | | | | | | | |
| Acidity as CaCO3 | ---- | 1 | mg/L | **2** | **2** | ---- | ---- | ---- |
| **ED041G: Sulfate (Turbidimetric) as SO4 2- by DA** | | | | | | | | |
| Sulfate as SO4 - Turbidimetric | 14808-79-8 | 1 | mg/L | **861** | **1300** | ---- | ---- | ---- |
| **ED045G: Chloride by Discrete Analyser** | | | | | | | | |
| Chloride | 16887-00-6 | 1 | mg/L | **42** | **95** | ---- | ---- | ---- |
| **ED093F: Dissolved Major Cations** | | | | | | | | |
| Calcium | 7440-70-2 | 1 | mg/L | **98** | **292** | ---- | ---- | ---- |
| Magnesium | 7439-95-4 | 1 | mg/L | **98** | **134** | ---- | ---- | ---- |
| Sodium | 7440-23-5 | 1 | mg/L | **212** | **156** | ---- | ---- | ---- |
| Potassium | 7440-09-7 | 1 | mg/L | **7** | **14** | ---- | ---- | ---- |
| **EG020F: Dissolved Metals by ICP-MS** | | | | | | | | |
| Aluminium | 7429-90-5 | 0.01 | mg/L | <0.01 | <0.01 | ---- | ---- | ---- |
| Antimony | 7440-36-0 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Arsenic | 7440-38-2 | 0.001 | mg/L | **0.001** | <0.001 | ---- | ---- | ---- |
| Cadmium | 7440-43-9 | 0.0001 | mg/L | **0.0003** | **0.0008** | ---- | ---- | ---- |
| Chromium | 7440-47-3 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Copper | 7440-50-8 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Cobalt | 7440-48-4 | 0.001 | mg/L | **0.012** | **0.039** | ---- | ---- | ---- |
| Nickel | 7440-02-0 | 0.001 | mg/L | **0.013** | **0.039** | ---- | ---- | ---- |
| Lead | 7439-92-1 | 0.001 | mg/L | <0.001 | <0.001 | ---- | ---- | ---- |
| Zinc | 7440-66-6 | 0.005 | mg/L | **0.023** | **0.075** | ---- | ---- | ---- |
| Manganese | 7439-96-5 | 0.001 | mg/L | **1.04** | **2.61** | ---- | ---- | ---- |
| Molybdenum | 7439-98-7 | 0.001 | mg/L | **0.002** | <0.001 | ---- | ---- | ---- |
| Selenium | 7782-49-2 | 0.01 | mg/L | **0.01** | <0.01 | ---- | ---- | ---- |
| Vanadium | 7440-62-2 | 0.01 | mg/L | <0.01 | <0.01 | ---- | ---- | ---- |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Client sample ID | KLC-1 | KLC-2 | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 27-Aug-2019 12:37 | 27-Aug-2019 12:38 | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | EB1922372-001 | EB1922372-002 | -------- | -------- | -------- |
| | | | | | Result | Result | ---- | ---- | ---- |
| **EG020F: Dissolved Metals by ICP-MS - Continued** | | | | | | | | | |
| **Boron** | 7440-42-8 | 0.05 | mg/L | | **0.07** | **0.12** | ---- | ---- | ---- |
| **Iron** | 7439-89-6 | 0.05 | mg/L | | <0.05 | **0.34** | ---- | ---- | ---- |
| **EK040P: Fluoride by PC Titrator** | | | | | | | | | |
| **Fluoride** | 16984-48-8 | 0.1 | mg/L | | **0.2** | **0.2** | ---- | ---- | ---- |
| **EN055: Ionic Balance** | | | | | | | | | |
| ø **Total Anions** | ---- | 0.01 | meq/L | | **19.3** | **29.9** | ---- | ---- | ---- |
| ø **Total Cations** | ---- | 0.01 | meq/L | | **22.4** | **32.7** | ---- | ---- | ---- |
| ø **Ionic Balance** | ---- | 0.01 | % | | **7.41** | **4.50** | ---- | ---- | ---- |


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