TECHNICAL REPORT

Geochemical and physical characterisation of mine spoil

Kogan Creek Coal Mine

Prepared for: **CS Energy Limited**

LEADERS IN MINING GEOCHEMISTRY

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1 Introduction

1.1 Project Overview

RGS Environmental Pty Ltd (RGS) was commissioned by CS Energy Limited (CS Energy) to complete a geochemical and physical assessment of overburden and interburden mine waste (spoil) from Kogan Creek Coal Mine (KCCM) located near Chinchilla in the western Darling Downs of Queensland (**Figure A1, Attachment A**). Mining activity at the operation commenced in 2006 and is expected to continue until at least 2022. The mine operates as an open cut, using a truck and shovel method. KCCM delivers approximately 2.8 Mtpa of Run-of-Mine (ROM) raw coal to the nearby Kogan Creek power station.

Overburden is removed to access the coal seams and is then transferred to the spoil dumps, which progressively refill the void after the coal has been mined, allowing for the rehabilitation of the land. The mine has a shallow overburden thickness and coal starts from approximately 15 to 30 metres below the surface. The three main seams of coal (M, N and O) have a total thickness of 12 metres and dip gently to the south west. The coal sits in relatively flat 0.1 metre to 3 metre thick seams with parting layers of rock and clay between each coal seam. The coal is selectively mined from the parting and transported to the Run of Mine (ROM) pad, where it is loaded into the crusher and conveyed directly to the power station.

Once mined, coal is delivered to a local power station via overland conveyor. The coal does not require washing, and therefore no coal reject or tailing are produced at the operation. Overburden and interburden is placed in spoil dumps, which are used to refill the open pit void as part of a progressive rehabilitation process. Ash waste from the power plant is placed in cells within the spoil dump, then capped and revegetated as part of the rehabilitation process.

The proposed mining area under consideration is located to the south and east of the current mining area previously studied by RGS in 2015 and 2017. The objective is to confirm that the spoil materials generated from removal of overburden and interburden materials at the Eastern Area are geochemically similar and also to determine if certain material types have physical characteristics that make them suitable for use in rehabilitation.

1.2 Previous Studies

RGS has completed two previous studies at KCCM (RGS, 2015 and 2017). The 2015 study involved a geochemical assessment of the spoil and ash materials generated at KCCM, as part of a study into co-disposal of ash within spoil. The spoil was classified as Non-Acid Forming (NAF) and had a high factor of safety with respect to potential for Acid and Metalliferous Drainage (AMD), Neutral Mine Drainage (NMD) and/or saline drainage. The spoil material also contained low concentrations total and leachable metals/metalloids. However, the acquired data indicated that the spoil is sodic and could require amendment with gypsum to improve soil structure as part of rehabilitation activities and reduce the potential for dispersion and erosion. The ash tested was classified as NAF and likely to be acid consuming, although the potential for oxyanions to be mobilised under alkaline conditions required management consideration, such as encapsulation of ash within spoil.

The second study (RGS, 2017) involved a geochemical assessment of the expected spoil materials likely to be generated for the proposed Eastern Mining Area at KCCM. This study confirmed the findings of the previous 2015 study and found that the geology and geochemistry of the spoil has been consistent over the mine life. Due to the nature of the deposit and the depositional environment under which the spoil and coal was laid down, it was expected that results from the two RGS studies could be extrapolated throughout the future mine area to be mined at the deposit.

1.3 Scope of work

The scope of work involved completing a geochemical and physical assessment of spoil likely to be generated from disturbance of overburden and interburden materials from an area to the south and east of the current mining area that was previously studied by RGS. The objective was to determine if any of the spoil material showed geochemical and physical characteristics that would make it suitable for use in rehabilitation activities.

The work program was completed in accordance with relevant industry guidelines (DME, 1995, DEHP, 2013; COA, 2016a,b; and INAP, 2009). The scope of work was developed by RGS based upon information provided to RGS by CS Energy and previous site experience and included:

- Data and document review of geochemical, geological and resource assessment information;
- Design and implementation of a sampling protocol to align with available drill core from the drilling program;
- Provision of written instructions for CS Energy personnel regarding samples selection and collection;
- Provision of a detailed "stand-alone" technical report (this report); and
- Provision of brief monthly update reports, to include confirmation of progress against the work schedule and performance against budget.

The geochemical and physical test program was designed to assess the degree of risk from acid and metalliferous drainage (AMD), oxidation of pyrite, leachability of metals, and characterisation of standard soil parameters including salinity, cation exchange capacity, potential nutrients and major metal/metalloid compositions.

1.4 Climate

The climate is humid sub-tropical according to the Köppen climate classification (Cfa), and has two distinct seasons characterised with a hot, wet summer period generally from December to February and a relatively cool dry winter period from June to August. January is the hottest month with a mean maximum temperature of 32.4 °C and mean minimum of 18.7 °C, while July is the coolest with a mean maximum temperature of 19.6 °C and mean minimum temperature of 4.0°C. Rainfall is variable with a mean monthly rainfall varying between 20.2 mm and 96.4 mm, with the majority of rainfall generally over the summer months. Daily evaporation is in the order of 10 mm in summer and approximately 3 mm in winter months.

1.5 Geology

1.5.1 Regional geology

KCCM is located on the north-eastern margin of the Early Jurassic to Early Cretaceous Surat Basin. The Surat Basin extends from the Moreton Basin East of the Kumbarilla Ridge to Roma in the West and as far North as Taroom, covering a total area of 270,000 km^2 (Xenith, 2014). The Surat Basin occurs stratigraphically above the north-south trending Permian to Triassic Sydney-Gunnedah-Bowen Basin system; with the Gunnedah Basin underlying in the east and the Bowen Basin in the northeast.

Structure

The Surat Basins' extents are limited by the New England Fold Belt towards the easternmost part of the Basin. The Nebine Ridge delineates the boundary between the Surat Basin and the Eromanga Basin to the west. In Queensland the Kumbarilla Ridge divides the Surat Basin from the Clarence-Moreton Basin to the east. The northern and southern extents of the Surat Basin are limited by the outcropping of its stratigraphic succession (NSW Trade & Investment, 2013). Similar to the Bowen Basin, the deposits within the Surat Basin are typically flat-lying, with dips increasing in areas proximal to interpreted faulting. The deposits are laterally restricted, resulting in sub-basins, approximately 10 km in length.

Stratigraphy

Sediments within the Surat Basin consist of Jurassic to Cretaceous fluvial, lacustrine and marginal marine sediments, and coal-bearing successions. The deposits are laterally restricted (NSW Trade & Investment, 2013). The economically mineable coal seams within KCCM are restricted to the upper portion of the Juandah Coal Measures of the Walloon Subgroup, and are the equivalents of the Macalister and Nangram seams (**Figure A2, Attachment A**). The Juandah Coal Measures are unconformably overlain by the Springbok Sandstone and overlie the Tangalooma Sandstone, which in turn overlie the Taroom Coal Measures. The Walloon Subgroup is mostly composed of siltstones and silty sandstones, and only relatively small intervals of coal (approximately 10 %) which have been deposited by swamps or lakes.

1.5.2 Local geology

Stratigraphy

The stratigraphic units in KCCM are the upper portion of the Late Jurassic Springbok Sandstone and the Middle Jurassic Juandah Coal Measures. Historically, six distinct coal intervals have been defined in the Juandah Coal Measures; including, from the top of the sequence: Kogan, Macalister, Nangram, Wambo, Iona and Argyle. These seams occur as numerous thin coal plies within a fine grained sediment unit, separated by relatively massive alluvial channel and point bar sandstone units. Limited information suggests that the Kogan Seam has often been eroded by the unconformably overlying Springbok Sandstone, and in some cases the minor coal seams in the Springbok Sandstone may have been misinterpreted as the Kogan Seam in the Juandah Coal Measures. Generally, the Springbok Sandstone consists of an upper sandstone unit, a middle fine-grained unit often containing thin, relatively dirty coal seams, and a lower sandstone unit.

Coal Seams

The coal seams in the KCCM area have been informally named into major seams, in descending order K, M, N, O, R, S, T and U (**Figure A3, Attachment A**). The M, N and O seams are correlative to the Macalister and Nangram seams; whereas the R, S and T seams are correlative to the Wambo Seam.

The seams have then been further subdivided into plies which represent the mining method, which is used in the open cut mine, with the seam correlations made based on geophysical log signatures. A minimum thickness of 0.10 m was used to define a coal seam, with any coaly sections less than 0.10 m incorporated into a parting band and given a stone band name. Any stone bands less than 0.10 m thick were incorporated into the coal seam that existed above or below it.

Odd-numbered plies are the coal bands, while even-numbered plies represent the interburden or parting stone bands. The current resource estimate model has incorporated a “parent-child” relationship and these relationships are present in the lower plies of the M Seam (M9-17), the upper and lower plies of the N Seam (N1-3 and N7-11), all plies of the O Seam (O1-3 and O5-7), and the middle plies of the T Seam (T3-5). The seams are subdivided as follows, as shown in **Figure A3 (Attachment A**):

- M Seam consists of plies M1 – M18
- N Seam consists of N1 – N12
- Seam consists of O1 – O8
- R Seam consists of plies R – RS
- S Seam consists of plies S1 – S6, and
- T Seam Consists of plies T1 – T7.

The geochemical assessment included units from surface through to the base of the R seam. The coal seams within KCCM show some variation on a ply basis in terms of seam thickness and quality characteristics. Seam splitting and coalescence is common, as is deterioration into stony-coal material over relatively short distances.

Soft tuffaceous mudstone bands do exist within the coal seams or can sometimes be greater than 0.10 m thickness, in which case they are named separately. These soft bands are interpreted to be reworked ash fall tuffs.

1.5.3 Structural framework

Faults

The general structure of KCCM shows a gentle dip to the South with the seams sub-cropping along the northern and eastern margin of the deposit. Seam dips range from 1 degree up to a maximum of 5 degrees in the vicinity of the interpreted fault lines.

Within the deposit, three major faults have been interpreted with the general North-South trend. These faults are regarded as being a moderate size with throws ranging from 2 m up to 20 m along the western-most fault.

These faults have been interpreted but have not been modelled, as further definition drilling will be required to assist interpretation as to how they may be related to sedimentary washouts.

Base of Weathering

The base of weathering has been logged in the majority of the holes within KCCM drilling database. This horizon represents the upper cut-off for the coal seams. Depth of weathering ranges from a minimum of 8 m to a maximum of 42 m in the southeast of the topographical high area.

Depth of Cover

Due to the shallow dip of the seams to the South, the general depth of cover to the M Seam increases from the sub-crop zone in the North of the deposit (approximately 15 m) to approximately 60 m at the southern lease boundary. The overburden thickness is related to the topographic high areas across the deposit.

1.6 Report Structure

The detailed methodology used for the geochemical and physical sampling and testing program is described in **Section 2.0**.

Representative samples of overburden and interburden (spoil) materials associated with KCCM study area were collected and transferred to ALS Brisbane laboratory (ALS) for static geochemical testing. Selected samples were then subjected to additional static geochemical tests also at ALS. Based on the results of the initial testing, samples were selected for kinetic leach testing (KLC) testing at RGS in-house laboratory.

The spoil characterisation work program was completed in accordance with mine closure guidelines where applicable (COA, 2016b).

The geochemical and physical results obtained from the test program on these sample materials are presented at **Section 3.0.**

The main conclusions and recommendations for spoil materials generated from the project are presented at **Section 4.0**. A complete list of references relied upon to complete this report are presented at **Section 5.0**.

2 Methodology

RGS personnel (Dr Alan Robertson) worked closely with CS Energy (geological and environmental personnel) and CS Energy geology sub-contractors (Xenith) to facilitate the development of an appropriate sampling and geochemical testing plan for obtaining representative samples of overburden and interburden materials associated with proposed KCCM mining area.

2.1 Sampling and Characterisation Program

2.1.1 Sampling Program

The sampling methodology used to obtain representative samples of overburden and interburden spoil from the proposed KCCM mining 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, 2016a) 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.

CS Energy provided a suitable qualified person (Xenith Consulting geologist) to collect representative samples of the required range of overburden and interburden materials. RGS worked closely with the supervising geologist and provided a written sampling protocol to utilise samples of drill core and drill chip material from the Xenith drilling program, which commenced in January, 2016.

A total of 117 samples were collected from 31 drill holes with a drill hole spacing of approximately 125 m in an area of the open cut pit proposed to be mined over the life of mine. The samples were subjected to a range of static geochemical and physical tests at ALS and Trilab laboratories in Brisbane. The location of the drill holes used for sampling and characterisation is provided in **Figure A4 (Attachment A)** and the distribution of the samples and drill holes by location is provided in **Table 2.1**.

Table 2.1: Sample materials collected for geochemical testing

Lithology	Number of samples
Soil	6
Mudstone	43
Sandstone	45
Siltstone	23
Total	**117**

Note: A single sample logged as conglomerate was assigned to the soil category for presentation of results

Samples were sent to ALS Brisbane via ALS Chinchilla in Queensland. Once received, samples were prepared by crushing 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 tests

Acid Base Accounting (ABA) was used to assess the acid-neutralising and acid generating characteristics of each sample. All 117 samples were screened using ABA for the following parameters:

- pH;
- Electrical conductivity;
- Total sulfur;
- Net acid production potential; and
- Acid neutralising capacity.

Selected samples (13 samples) with total sulfur results above 0.1 %S were also tested for sulfide as chromium reducible sulfur (Scr). From the total sulfur (or Scr where available) and ANC results, maximum potential acidity (MPA) values were calculated. The use of Scr data 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. The results of the ABA screening assessment are discussed in **Section 3.1**.

After the results of the ABA screening tests were received and interpreted, ten composite samples were prepared and sent to ALS Stafford for multi-element analysis. The samples for each composite were selected based on stratigraphy, lithology, and geochemical characteristics. **Table 2.2** outlines the lithology represented by each composite, while **Table B1** (**Attachment B**) outlines the samples used to make each composite. The composited samples were tested for:

- Total cations (Ca, Mg, Na and K);
- Major cations (Ca, Mg, Na and K);
- Major anions (Cl, F and SO_4);
- Total metals/metalloids (Al, As, B, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, V and Zn);
- Soluble metals/metalloids (Al, As, B, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, V and Zn);
- Effective cation exchange capacity (eCEC);
- Exchangeable sodium percentage (ESP); and
- Plant available phosphorous and nitrogen.

Table 2.2: Composite sample lithology

Sample name	Represented lithology
Composite 1	Mudstone
Composite 2	Mudstone
Composite 3	Sandstone
Composite 4	Siltstone
Composite 5	Mudstone
Composite 6	Sandstone
Composite 7	Siltstone
Composite 8	Mudstone
Composite 9	Sandstone
Composite 10	Siltstone

Each composited sample was also sent for physical testing at Trilab Laboratory in Geebung. The composited samples were tested for percentage dispersion (including particle size analysis) and Emerson Class number.

Summary results tables are provided in **Attachment B** and discussed in **Section 3.0.** The raw ALS and Trilab test results for the geochemical and physical test program are provided in **Attachment C**.

3 Results and Discussion

3.1 Acid Base Account results

Acid Base Account results for the spoil samples from the project are presented in **Table B1** (**Attachment B**) and summarised below. Results are shown by lithology (rock 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 117 samples ranges from 4.4 to 10.1 (**Figure 3.1**) and has a median pH value of 8.8. The soil, mudstone and sandstone materials all covered a wide range in pH, while the siltstone material exhibited a smaller range in pH (from 7.8 to 9.6). The pH results indicate that the soil is typically pH neutral to slightly acidic; the mudstone and sandstone cover a range of pH values but are mainly alkaline; and the siltstone is alkaline. Other than lithology, there is no other correlation between pH and the sample location, depth or type.

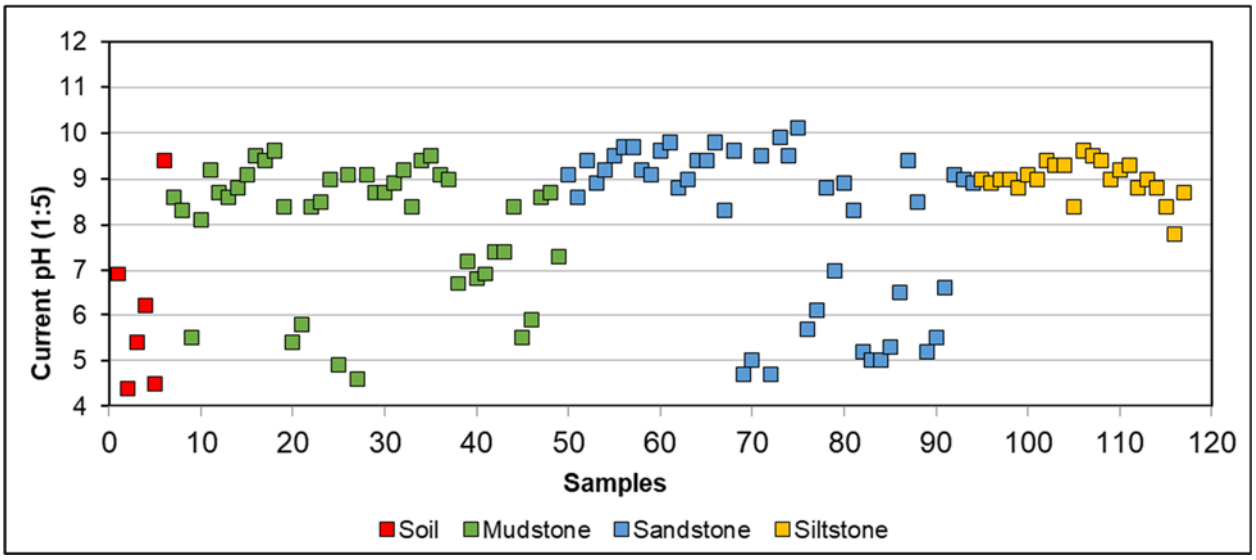

Figure 3.1: pH results for Kogan Creek spoil

The current $EC_{(1:5)}$ of the samples ranges from 62 to 1,650 µS/cm, with a relatively low median value of 285 µS/cm (**Figure 3.2**). A total of 108 of the 117 samples tested (92.3 %) tested have an EC value less than 600 µS/cm. A single outlier mudstone sample returned an EC value of 1,650 µS/cm. There appears to be no correlation between EC and the sample lithology, location, depth or type.

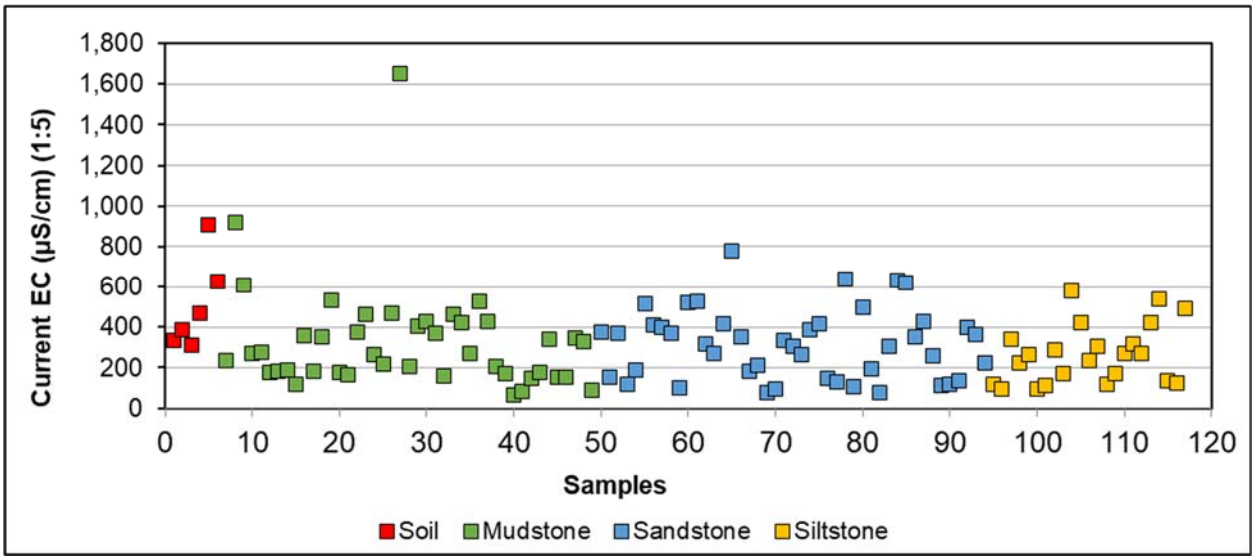

Figure 3.2: Electrical conductivity results for Kogan Creek spoil

To provide additional context, the $EC_{(1:5)}$ and $pH_{(1:5)}$ results are classified against pH and salinity criteria for mine 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: pH and salinity criteria for assessment of mining waste samples

	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 – 8.8)	**> 9.0**
$EC_{1:5}$ (µS/cm)	**< 150**	**150 – 450** (Median – 285)	**450 – 900**	**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 spoil samples.

Based on the median pH and EC values, the majority of samples tested are regarded as having 'high' soil pH and 'low' salinity values. The main exception to this finding is the soil material, which would be classified as having a low to medium soil pH.

The pH and EC tests were generally completed on 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 'worst case' scenario. It is also expected that the salinity of leachate from low sulfur spoil 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 weathering/erosion of the materials.

3.1.2 Total sulfur

The total sulfur content of the samples ranges from below the laboratory limit of detection (less than 0.01 %S) to 0.57 %S and is considered to be low. The median sample value is 0.03 %S, compared to the median crustal abundance value of 0.07 %S in unmineralised soils (Bowen, 1979; INAP, 2009). Materials containing less than 0.1 %S are generally considered to be barren of sulfur, as they represent the background concentration in soils, and have a negligible capacity to generate acidity.

Figure 3.3 illustrates the sulfur content of the sample materials (note the logarithmic scale used in the lower graph for clarity) and shows that most samples have very low sulfur content. Only 13 samples of the 117 samples have a total sulfur content greater than 0.1 %S, and mostly represent carbonaceous material.

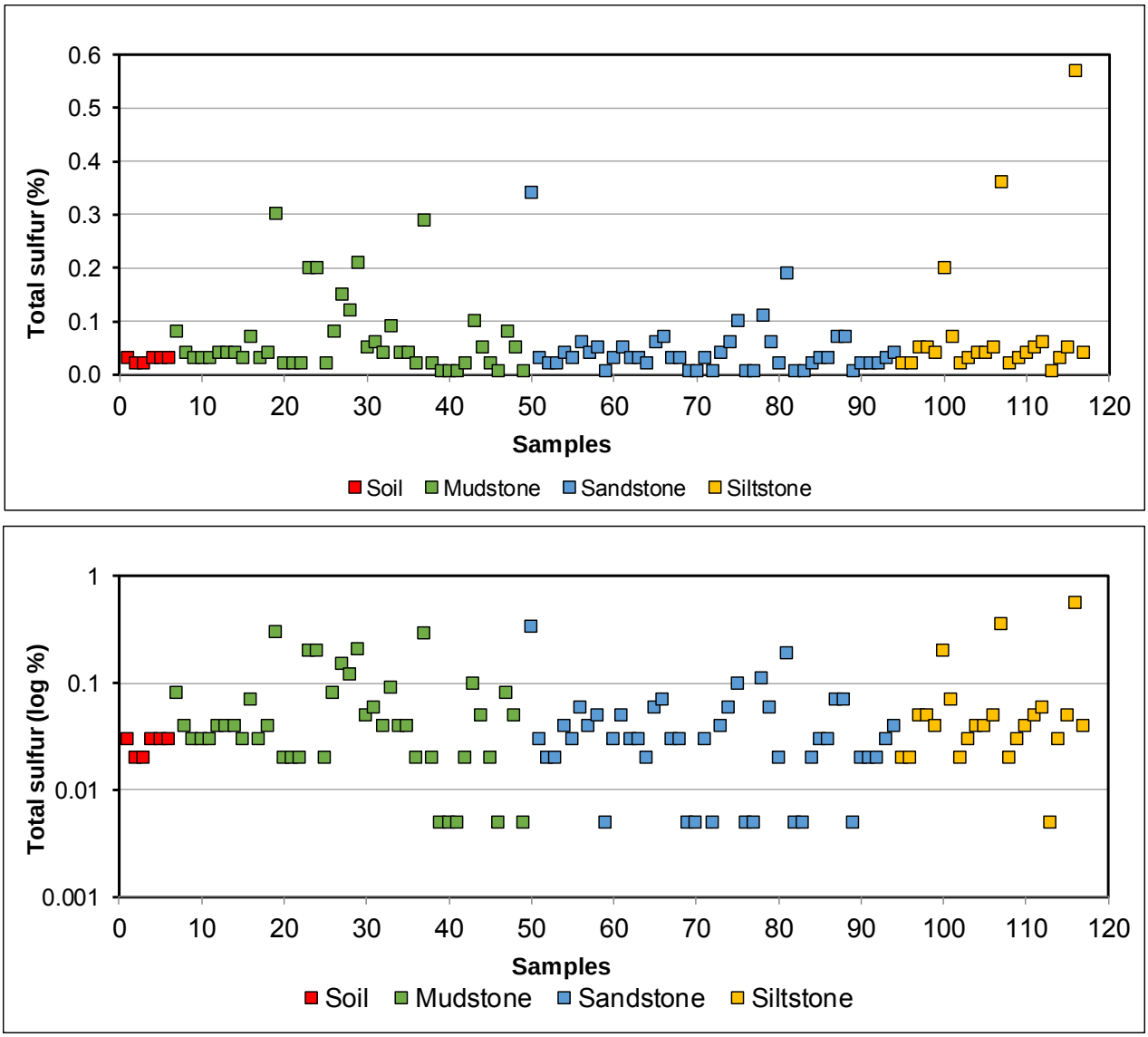

Figure 3.3: Total sulfur results for Kogan Creek spoil

3.1.3 Sulfide sulfur

The sulfide sulfur content of the 13 samples with a total sulfur content greater than 0.1 %S was tested using the Scr method. The test results show a sulfide content ranging from 0.01 to 0.21 %S. **Figure 3.4** shows a plot of the total sulfur versus sulfide sulfur for samples with a total sulfur over 0.1 %S. The results indicate that, on average, less than half of the sulfur content is present as sulfide sulfur (eg. pyrite) and therefore materials represented by these samples have a low potential to generate acidity.

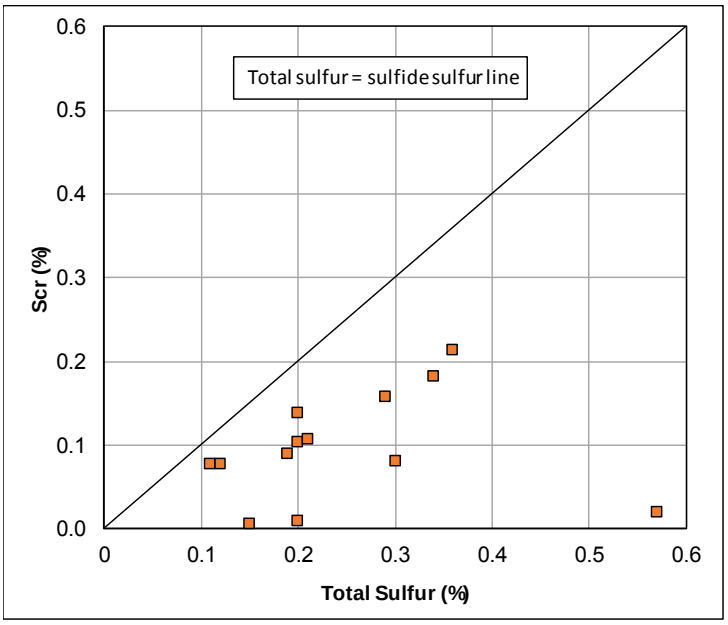

Figure 3.4: Sulfur speciation results for Kogan Creek spoil

3.1.4 Maximum potential acidity (MPA)

The Maximum Potential Acidity (MPA) for the samples ranges from 0.2 to 6.5 kg H_2SO_4/t, and is typically low with a median value of 0.9 kg H_2SO_4/t.

3.1.5 Acid neutralising capacity (ANC)

The Acid Neutralising Capacity (ANC) for the samples ranges from 0.25 to 150.0 kg H_2SO_4/t and has a median value of 10.5 kg H_2SO_4/t (ie. an order of magnitude greater than the median MPA).

3.1.6 Net acid producing potential (NAPP)

The Net Acid Producing Potential (NAPP) is the capacity of a sample to generate acidity (MPA) minus its capacity to neutralise acidity (ANC). NAPP values range from -149.1 to +0.4 kg H_2SO_4/t, with a negative median value of -8.7 kg H_2SO_4/t . The NAPP data is presented in **Figure 3.5**. Given the low sulfide content of the materials tested and the negative NAPP values, the risk of generating acidity from these materials is considered to be low.

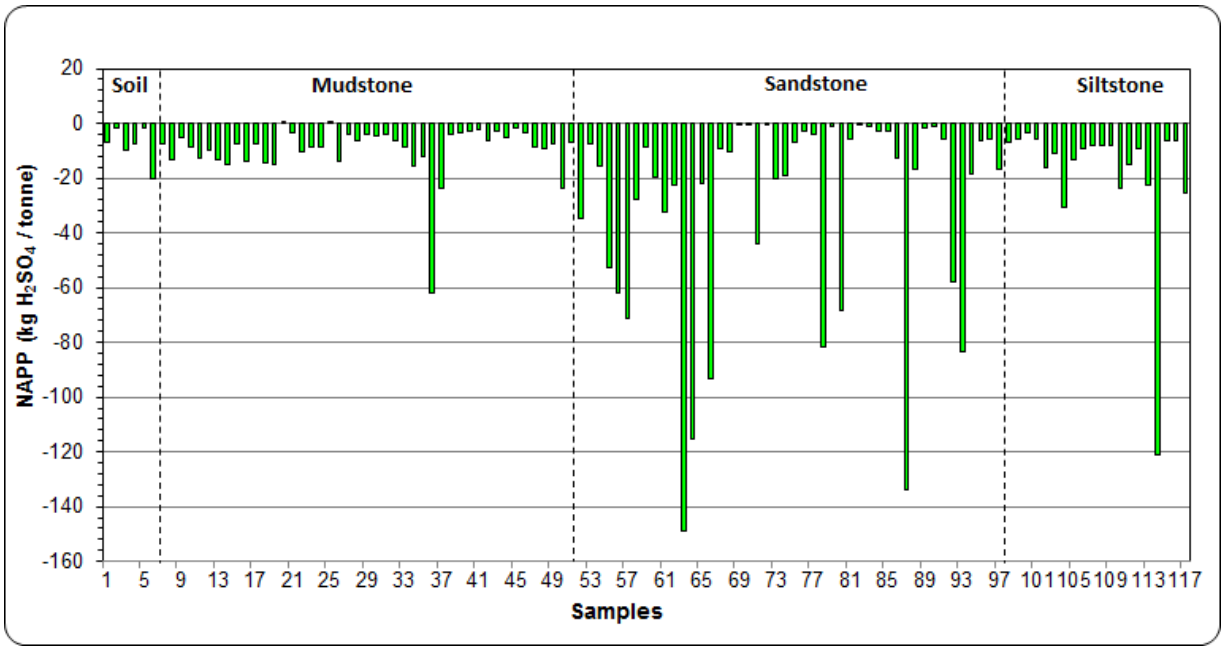

Figure 3.5: NAPP results for Kogan Creek spoil

3.1.7 ANC:MPA ratio

The ANC:MPA ratio of the samples ranges from 0.4 to 189.4, with a median value of 11.2. **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 AMD. Generally, those samples with an ANC:MPA ratio of greater than 2 and a sulfide content of ≤0.1% S 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). All of the spoil samples fall in the 'negligible to low risk' domains in the graph and therefore have a high factor of safety and very low risk of acid generation.

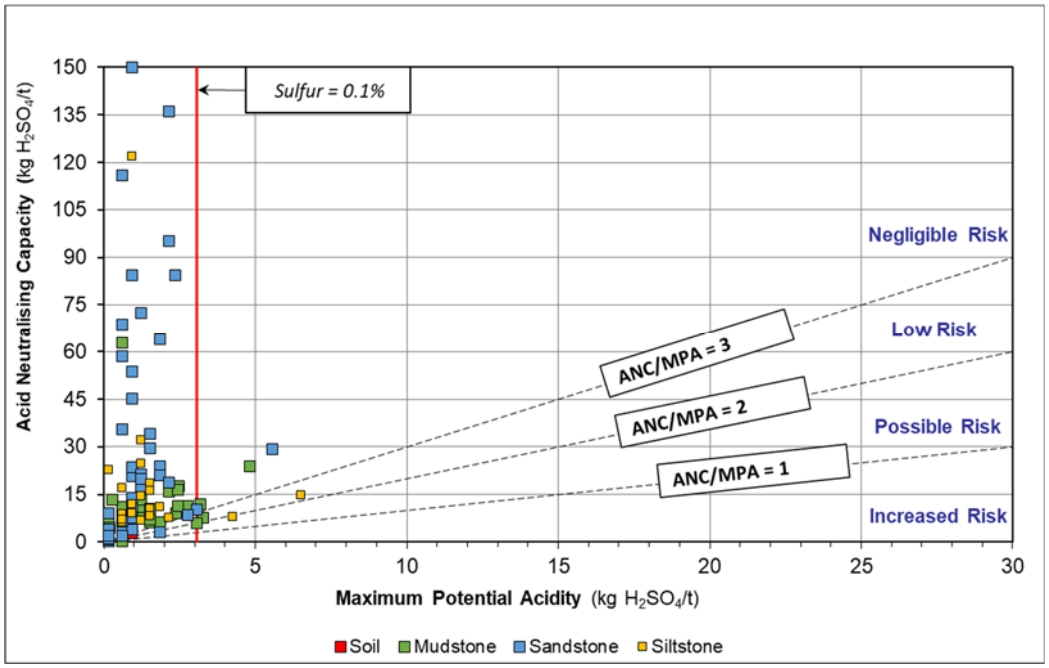

Figure 3.6: ANC vs MPA for Kogan Creek spoil

3.1.8 Geochemical classification

The results of the ABA testing have been used to classify the acid forming nature of the spoil samples. The classification criteria reflect Australian (COA, 2016a,b,c) 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

Geochemical Classification	Total Sulfur[1] (%)	NAPP (kg H_2SO_4/t)	ANC:MPA Ratio	No. Samples (n = 117)
Non-Acid Forming (Barren)[2]	≤ 0.1	-	-	112
Non-Acid Forming	≤ 0.1	≤ -5	≥ 2	4
Uncertain	≤ 0.1	> -5 and ≤ +5	≥ 2	1
Potentially Acid Forming	> 0.1	> +5	< 2	0

Notes:
1. If total sulfur is less than or equal to 0.1 %S, the NAPP and ANC:MPA ratio are not required for material classification as the sample is essentially barren of oxidisable sulfur.
2. A sample classified as NAF can be further described as 'barren' if the total sulfur and/or sulfide sulfur content is less than or equal to 0.1 %S, as the sample essentially has negligible acid generating capacity.

The data presented in **Table 3.2** illustrate that 116 of the 117 spoil samples (over 99 %) are classified as NAF and one sample is classified as Uncertain. No samples are classified as Potentially Acid Forming (PAF).

3.2 Multi-element concentration in solids

Multi-element assays were carried out on ten composite spoil samples 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 B2** (**Attachment B**). 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 As, Cr, Cd, Cu, Pb, Se and Zn, more so than with major rock-forming elements, such as Al, Ca, Fe, Mg and Na.

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 average 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 particular 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 solubility of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

Table B.3 (**Attachment B**) provides total metal/metalloid concentrations for the ten composite samples described in **Section 2.2**, and is compared to median crustal abundance in unmineralised soils. The GAI results indicate that of the metals/metalloids measured, none of the major elements are significantly enriched compared to median crustal abundance.

The potential solubility of any metals/metalloids in the materials was investigated further through water extract tests and the results are presented in **Section 3.6**.

3.4 Soil characteristics

3.4.1 Exchangeable cations

The total cation exchange capacity (CEC) and individual exchangeable cation values for the ten composite samples are presented in **Table B.2** (**Attachment B**).

CEC measures the capacity of a soil to hold and exchange cations, which provides a buffering effect to changes in pH and available nutrient levels (Hazelton and Murphy, 2007). The results show that the CEC of the samples ranges from 9.9 to 28.1 meq/100g, with an average CEC of 19.9 meq/100g. This is considered to be a moderate CEC rating, based on the classification outlined in **Table 3.4**.

Table 3.4: Ratings for cation exchange capacity

CEC Rating	CEC (meq/100g)
Very low	<6
Low	6 – 12
Moderate	12 – 25
High	25 – 40
Very high	>40

The exchangeable cation values in the spoil samples are summarised in **Table 3.5**. The sodium and magnesium values are considered very high and high, respectively. The Ca/Mg ratio ranges from 0.9 to 3.5, and the samples are considered to have a relatively low calcium concentration (Hazelton and Murphy, 2007).

Table 3.5: Summary of exchangeable cation levels

Cation	Minimum (meq/100g)	Maximum (meq/100g)	Average (meq/100g)	Rating[1]
Na^+	2.9	9.6	6.2	Very high
K^+	0.2	0.6	0.5	Moderate
Ca^{2+}	3.9	10.9	7.5	Moderate
Mg^{2+}	1.1	9.4	5.8	High

[1] Ratings based on Hazelton and Murphy (2007)

3.4.2 Soil nutrient and organic carbon content

The soil nutrient and organic carbon results for the 10 composite samples are shown in **Table B.2** (**Attachment B**).

Nitrogen occurs in several forms in soils. Total nitrogen is a measure of all the nitrogen present in a sample, however, generally most of this nitrogen is tied up in organic matter and is not available to plants. The sample results returned for total nitrogen (as N) and total Kjeldahl nitrogen (as N) were the same. The total nitrogen (as N) results range from 100 to 1,000 mg/kg, indicating that the samples are low in nitrogen (Hazelton and Murphy, 2007).

Nitrogen that has been mineralised to form nitrate or ammonium is accessible for plant growth. The soluble nitrate plus nitrite (as N) results for the samples range from <0.1 mg/kg (below the laboratory limit of reporting (LoR)) to 1.2 mg/kg, with an average value of 0.4 mg/kg. The samples are therefore considered to be low in plant-available nitrogen.

Phosphorous in soils occurs in both organic and inorganic forms, with organic forms of phosphorous often accounting for a large percentage of the amount of total phosphorous. Generally, organic forms of phosphorous are not directly available for update by vegetation but can provide a source of plant-available phosphorous upon mineralisation. The Bray phosphorous test is commonly used to test for plant available (or inorganic) phosphorous forms.

The Bray phosphorus (as fluoride extractable P) results show values ranging from <1 mg/kg (below LoR) to 6.2 mg/kg, with an average value of 2.0 mg/kg. The samples are therefore considered to be low in plant-available phosphorous.

Elevated levels of fluoride are associated with increases in pH. Additionally, high levels of fluoride are associated with decreased microbial activity, resulting in a decrease in the breakdown of organic matter and increased concentrations of Total Organic Carbon (TOC). The soluble fluoride results for the composite samples range from <1 mg/kg (below LoR) to 4 mg/kg, (average 1.6 mg/kg), which is considered elevated.

Organic matter is a general term used to describe the organic components in a soil. These organic compounds originate from plants and animals and are largely responsible for much of the physical and chemical fertility of a soil (Hazelton and Murphy, 2007). The total organic carbon levels in the samples range from 0.7 to 4.6%, with an average value of 1.8%. Hazelton and Murphy (2007) classify this as ranging from low to very high, with an average classification of moderate.

3.5 Dispersion and erosion

To further investigate the potential suitability of using spoil materials for rehabilitation activities, a series of physical tests were completed on the ten composite samples. The tests included exchangeable sodium percentage, Emerson aggregate testing, particle size distribution and percentage dispersion. The results of these tests are shown in **Tables B.2** and **B.5** (**Attachment B**) and are summarised below.

3.5.1 Sodicity

Sodicity occurs when exchangeable sodium on the cation-exchange complex leads to clay dispersion in the soil (Hazelton and Murphy, 2007). Sodicity is of interest as it can result in surface crusting and low infiltration and hydraulic conductivity within affected soils. The exchangeable sodium percentage of the samples ranges from 22.1 to 45.6 %. Under the rating for Australian soils established by Northcote and Skene (1972), the samples are considered to be strongly sodic.

Table 3.6: Ratings for exchangeable sodium percentage (ESP)

ESP Rating[1]	Percentage
Non-sodic	< 6
Moderate	6 – 14
Strong	> 14%

ESP ratings are based on Isbell (2002) and Northcote and Skene (1972).

3.5.2 Dispersion

The dispersion percentage estimates the percentage of clay that is dispersed in the sample. The percentage dispersion for the samples ranges from 7% to 50% (with a median of 33%). This indicates that all of the composite samples are characterised as 'moderate dispersibility' with some degree of tunnelling susceptibility (Hazelton and Murphy, 2007).

3.5.3 Emmerson Aggregate testing

The Emmerson aggregate test is a measure of the dispersibility or structural stability of a material. All of the composite samples tested returned Class 2 Emerson aggregate results. Class 2 materials are considered to have moderate dispersibility after rainfall, irrigation or tillage. Class 2 materials are also susceptible to some degree of tunnelling, and readily form surficial crusts.

3.5.4 Particle size distribution

Particle size distribution (PSD) describes the relative amounts of gravel, sand, silt and clay within a sample (Hazelton and Murphy, 2007). Samples with higher proportions of finer material (such as clay and silt) have higher surface areas and can have higher levels of chemical and physical activity. Coarser particles (such as sand) have smaller surface areas and are generally less chemically and physically active (Hazelton and Murphy, 2007).

PSD tests were completed on crushed material from the ten composite samples. Whilst the sample materials have therefore altered from their in-situ state (crushed), their inherent cohesive characteristics are recorded and can be used to infer the material performance in a 'real-life' setting.

The composite samples range from silty clay to gravel based on the PSD results. The PSD results are shown below in **Figure 3.7**.

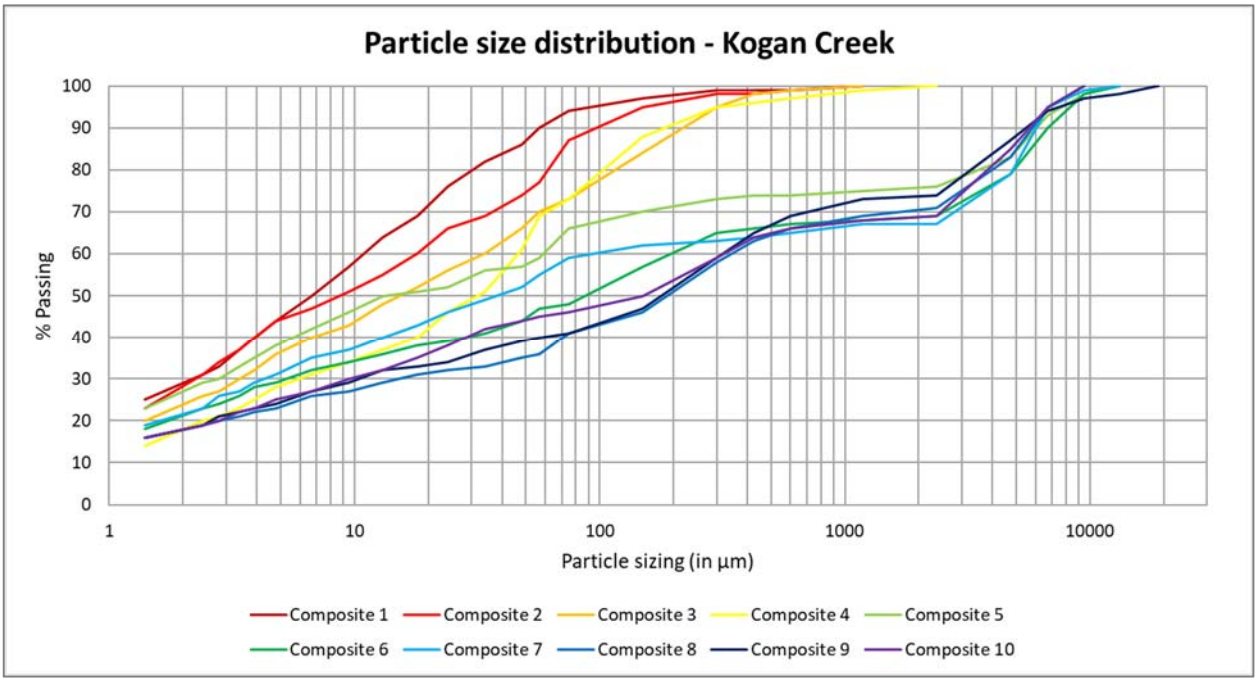

Figure 3.7: Particle size distribution of composite samples

The PSD results illustrate the finer nature of the silty clay samples (Composites 1-4), and the relatively coarser nature of the gravelly sand samples (composites 8-10). Composites 5-7 were classified as clayey gravel and can be seen as plotting between the other two classifications. The PSD results also illustrate that each composite sample contained a proportion of clay, regardless of the lithology the composite sample represented. For example, Composite 9 represents a sandstone lithology, but 16 % of the sample was less than 1.4µm in particle size.

3.6 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 waste extracts from the samples provided (as described in **Sections 4.2** to **4.4**) with Australian guideline values for livestock drinking water and aquatic freshwater ecosystems (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 of 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 10 composite Kogan Creek spoil samples are presented in **Table B.4** (**Attachment B**). The pH of the water extracts ranges from pH 6.7 to 9.8 (median 9.1) and is considered to be neutral to alkaline. The alkalinity value in the water extract samples is dominated by bicarbonate and exceeds any acidity value, such that the net alkalinity value is strongly positive.

The EC in the water extracts is typically low, ranging from 136 to 692 µS/cm (median 365 µS/cm). This confirms that these materials exhibit low salinity and are likely to have relatively low concentrations of dissolved solids when in contact with water. The concentrations for calcium, magnesium and potassium were generally below the laboratory LoR, however the concentrations of sodium, chloride and sulfate were higher, at a median value of 82 mg/L, 33 mg/L and 33 mg/L, respectively. The highest major ion concentrations were well below the water quality guidelines for livestock drinking water, where these exist.

The concentration of dissolved trace metals/metalloids tested in the water extracts is mostly at or below the laboratory LoR for most samples. The exceptions are aluminium (6 samples), arsenic (3 samples), copper (2 samples) and nickel (1 samples) which are greater than guideline levels for freshwater aquatic ecosystems, but well within guideline trigger levels for livestock drinking water (ANZECC and ARMCANZ, 2000).

It is possible that a colloidal effect may have contributed to the elevated dissolved concentrations (eg. aluminium) in the water extracts. If the material contains fine colloidal material, it has the potential to pass through the 0.45 µm laboratory filtration stage prior to sample acidification and metals/metalloids analysis, and report as part of the filterable (ie dissolved) fraction. The particle size distribution test results described in **Section 3.5.4** suggest that all of the samples contain at least a small amount of very fine material (clay fraction or below), which may have transported some metal/metalloid bearing materials through the sample filtration stage.

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

4 Discussion

4.1 Geochemical classification

Overall, the spoil materials represented by the samples tested are classified as NAF and have a high factor of safety with respect to potential for AMD, Neutral Mine Drainage (NMD) and/or saline drainage. The spoil material also contained low concentrations total and leachable metals/metalloids.

The geology and geochemical characteristics of the spoil has been, and is likely to remain, consistent over the current and predicted mine life due to the nature of the deposit and the depositional environment under which the spoil and coal was laid down. It is clear that the results of previous geochemical studies (RGS, 2015; 2017) can be extrapolated throughout the future mine area to be mined at the deposit.

Notwithstanding, the spoil is likely to be sodic and could require amendment with gypsum and organic matter to improve soil structure as part of rehabilitation activities and reduce the potential for dispersion and erosion.

The spoil material is likely to be alkaline and in terms of lithology, siltstone appears to be consistently alkaline and this attribute may be detrimental to nutrient availability, plant germination and sustainable growth. In contrast, sandstone and mudstone materials contain a proportion of materials that are less alkaline and as a bulk material could be more appropriate for use in rehabilitation activities. Naturally occurring soil at the mine appears to be pH neutral to slightly acidic and therefore some mixing of sandstone or mudstone spoil with soil could results in a better overall material for rehabilitation activities. However, this expected outcome would need to be confirmed as part of rehabilitation field trials.

The low levels of plant-available nitrogen and phosphorous found in the spoil (as discussed in **Section 3.4.2**) suggest that additional fertiliser may be required as part of any rehabilitation activities to establish and sustain plant growth in the materials represented by the spoil samples.

4.2 Physical characteristics

The physical testing classified the sampled material as strongly sodic, which is a common feature of materials with higher clay content. The strongly sodic nature of the samples indicates that rehabilitation completed with this material may have problems with surface crusting; low infiltration and hydraulic conductivity values; and high levels of susceptibility to gully and tunnel erosion. Additionally, structural collapse of the material from dispersion could lead to closing off of soil pores, restricting the movement of air and water through the material.

Deep ripping of the material and the application of gypsum may be an effective management strategy, however, due to the large area likely to be involved it may be cost-prohibitive. Due to the alkaline pH values displayed by the spoil materials, the application of lime is likely to be ineffective. An increase in the amount of organic matter present in the spoil material may also help manage the sodicity.

5 Conclusions

5.1 Conclusions

Overall, Kogan Creek spoil material is considered to be NAF and have a high factor of safety with respect to potential for AMD, Neutral Mine Drainage (NMD) and/or saline drainage. The spoil material also contains low concentrations total and leachable metals/metalloids.

Most spoil materials are likely to be sodic and alkaline, although sandstone and mudstone may be less alkaline than siltstone.

Spoil is likely to require amendment with gypsum to improve soil structure as part of rehabilitation activities and reduce the potential for dispersion and erosion. An increase in the amount of organic matter present in the spoil material may also help manage the sodicity.

The low levels of plant-available nitrogen and phosphorous found in the spoil suggest that additional fertiliser may be required as part of any rehabilitation activities to establish and sustain plant growth.

5.2 Recommendations

The use of siltstone spoil in rehabilitation activities should be avoided due to the alkaline nature of this material.

KCCM should consider the merits of the following as part of rehabilitation field trials:

- Rehabilitation of spoil storage areas using sandstone and/or mudstone in the surface cover.
- Addition of sandstone and/or mudstone to salvaged soil material for use in rehabilitation activities.
- Amendment of spoil used in rehabilitation activities through addition of gypsum, fertiliser and organic matter.

6 References

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Attachment A Figures

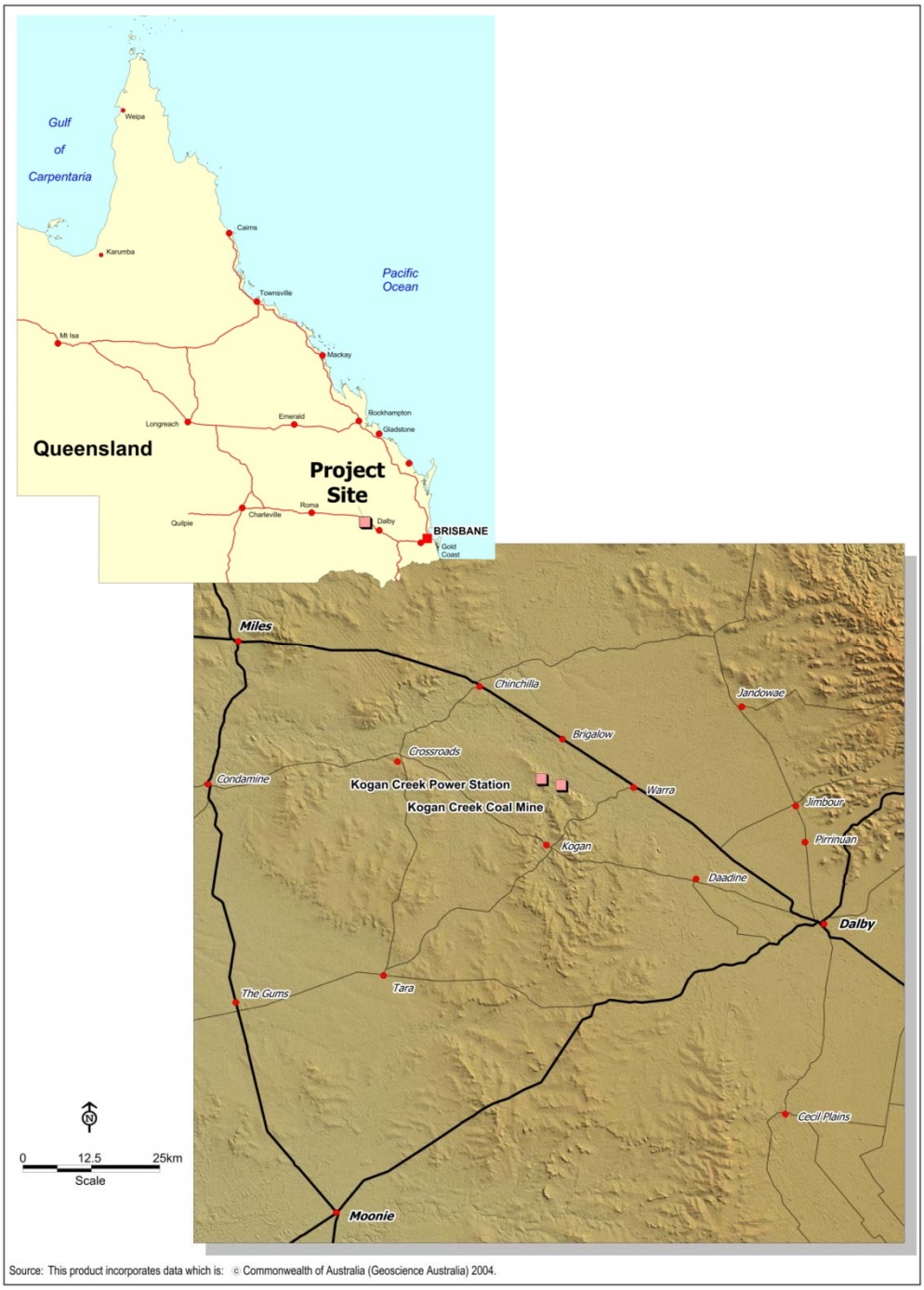

Figure A1: Project location

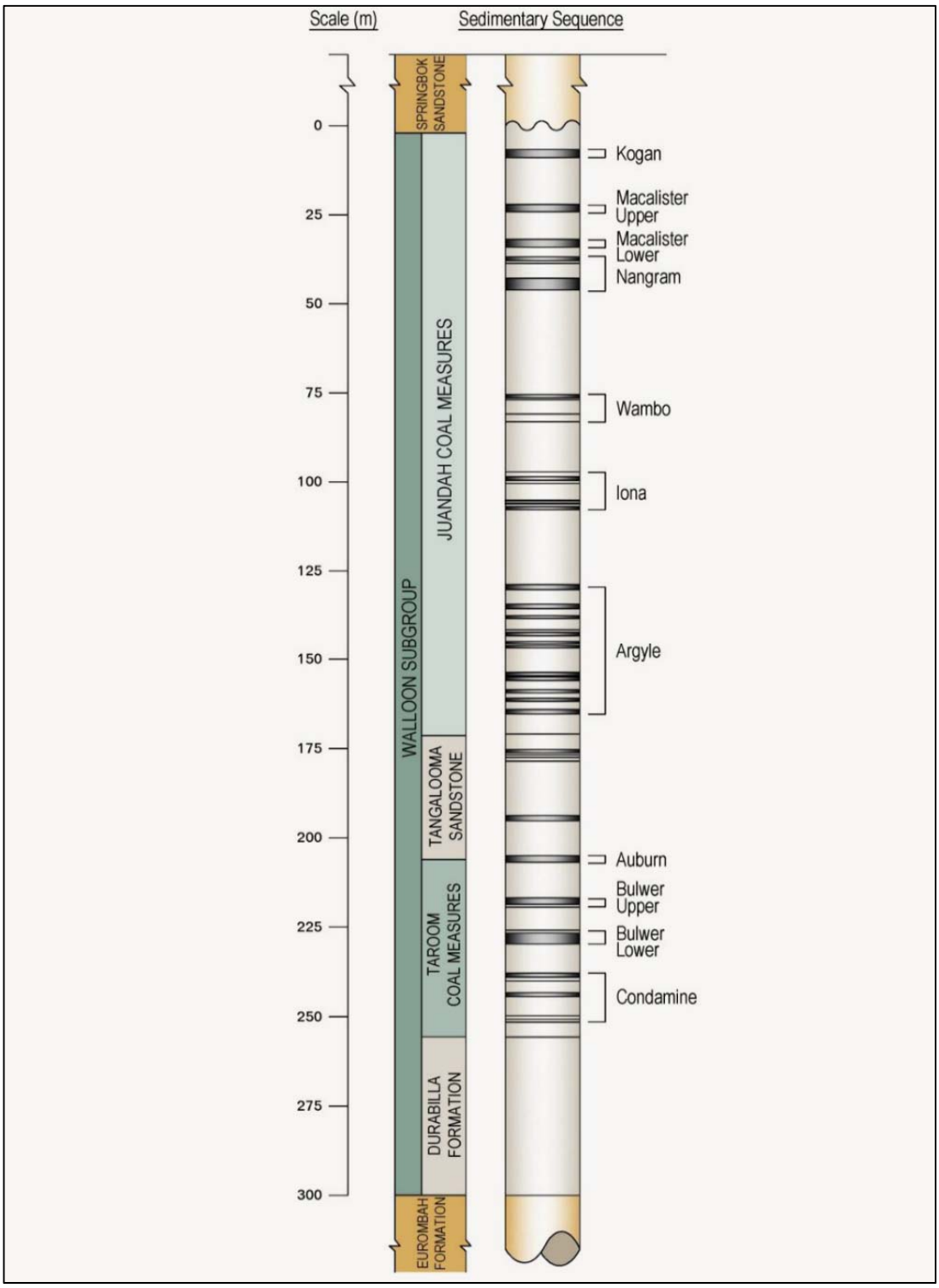

Figure A2: Regional stratigraphy of the Surat Basin

Source: Xenith Consulting

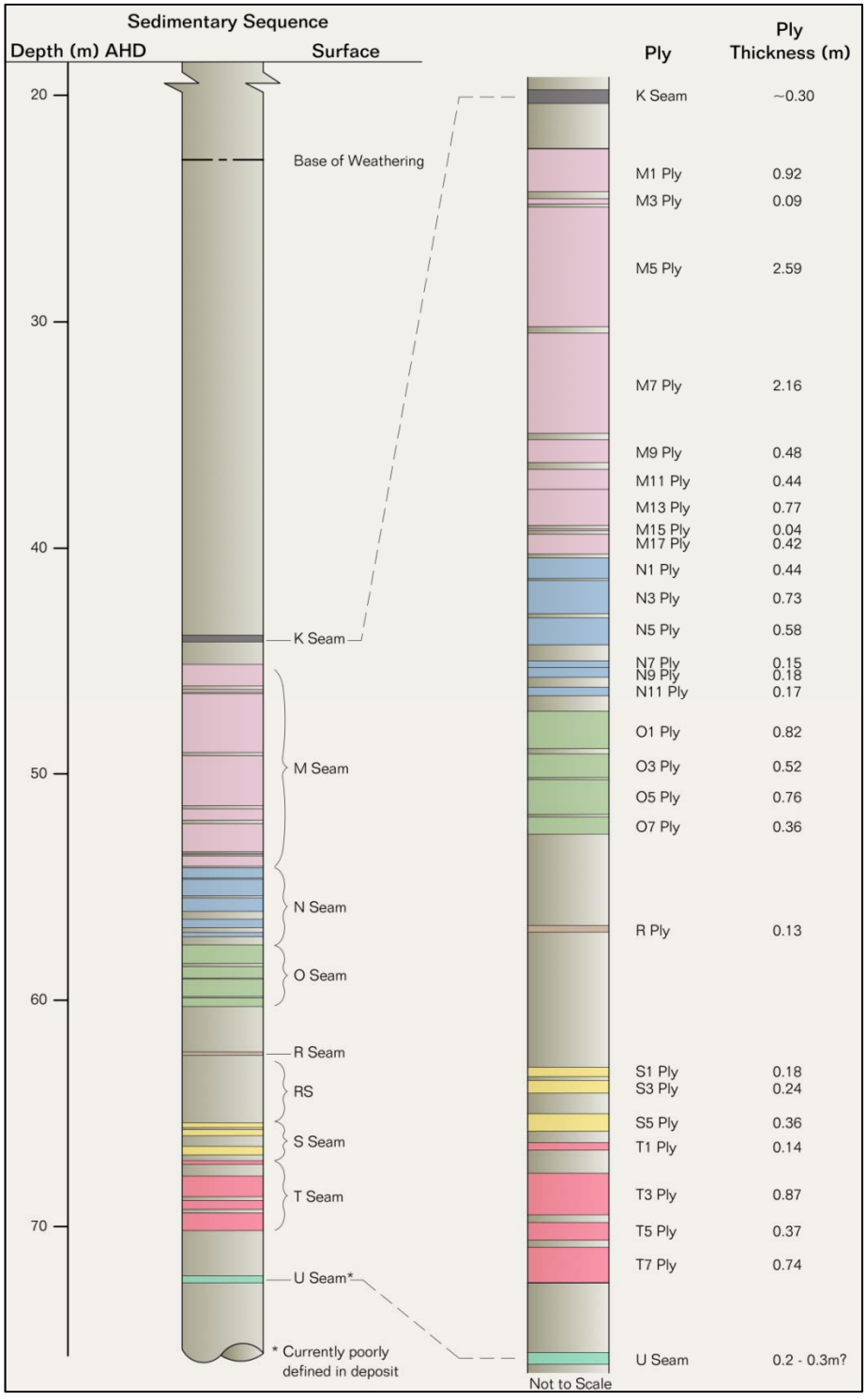

Figure A3: Local stratigraphy of the Kogan Creek Coal Mine

Source: Xenith Consulting

Figure A4: Geochemistry sampling locations

Attachment B Static geochemical results

Table B1: Acid Base Account Results for Kogan Creek Spoil

RGS Sample No.	ALS ID	Drill Hole ID	Sample ID	Sample Lithology	From	To	Depth Interval	pH[1]	EC[1]	Total S	Scr	MPA[2]	ANC[2]	NAPP[2]	ANC: MPA Ratio	Sample Classification[3]
					(m)				(µS/cm)	(%)		(kg H_2SO_4/t)				
1	EB1902543003	KC19_025	BH KC19_025 0-3m	Soil	0.00	3.00	3.00	6.9	332	0.03		0.9	7.8	-6.9	8.5	Non-Acid Forming (Barren)
2	EB1902543002	KC19_027	BH KC19_027 0-1m	Soil	0.00	1.00	1.00	4.4	386	0.02		0.6	2.3	-1.7	3.8	Non-Acid Forming (Barren)
3	EB1903984024	KC19_039	KC19_039 1.0-6.0m geochem18	Soil	1.00	6.00	5.00	5.4	309	0.02		0.6	10.3	-9.7	16.8	Non-Acid Forming (Barren)
4	EB1902543004	KC19_025	BH KC19_025 3-6m	Soil	3.00	6.00	3.00	6.2	471	0.03		0.9	8.4	-7.5	9.1	Non-Acid Forming (Barren)
5	EB1902543005	KC19_027	BH KC19_027 1-6m	Soil	1.00	6.00	5.00	4.5	906	0.03		0.9	2.8	-1.9	3.0	Non-Acid Forming (Barren)
6	EB1903984006	KC19_033	KC19_033 15.37-15.67m	Conglomerate	15.37	15.67	0.30	9.4	626	0.03		0.9	21.0	-20.1	22.9	Non-Acid Forming (Barren)
7	EB1831519029	KC19_001	KC19_001 25.00-25.28m	Mudstone	25.00	25.28	0.28	8.6	233	0.08		2.5	10.0	-7.6	4.1	Non-Acid Forming (Barren)
8	EB1831519013	KC19_002	KC19_002 9.80-10.22m	Mudstone	9.80	10.22	0.42	8.3	922	0.04		1.2	14.6	-13.4	11.9	Non-Acid Forming (Barren)
9	EB1831519028	KC19_001	KC19_001 10.00-10.37m	Mudstone	10.00	10.37	0.37	5.5	609	0.03		0.9	6.4	-5.5	7.0	Non-Acid Forming (Barren)
10	EB1831519027	KC19_002	KC19_002 14.08-14.24m	Mudstone	14.08	14.24	0.16	8.1	272	0.03		0.9	9.6	-8.7	10.4	Non-Acid Forming (Barren)
11	EB1831519011	KC19_007	(SITE KC18_060) KC19_007 58.65-58.85m	Mudstone	58.65	58.85	0.20	9.2	278	0.03		0.9	13.7	-12.8	14.9	Non-Acid Forming (Barren)
12	EB1831519008	KC19_009	(SITE KC18_027) KC19_009 33.87-34.04m	Mudstone	33.87	34.04	0.17	8.7	176	0.04		1.2	11.1	-9.9	9.1	Non-Acid Forming (Barren)
13	EB1831519026	KC19_013	KC19_013 18.77-19.03m	Mudstone	18.77	19.03	0.26	8.6	182	0.04		1.2	14.6	-13.4	11.9	Non-Acid Forming (Barren)
14	EB1831519023	KC19_014	KC19_014 14.02-14.36m	Mudstone	14.02	14.36	0.34	8.8	190	0.04		1.2	16.5	-15.3	13.5	Non-Acid Forming (Barren)
15	EB1831519021	KC19_016	KC19_016 37.32-37.64m	Mudstone	37.32	37.64	0.32	9.1	119	0.03		0.9	8.2	-7.3	8.9	Non-Acid Forming (Barren)
16	EB1831519014	KC19_022	KC19_022 41.10-41.60m	Mudstone	41.10	41.60	0.50	9.5	356	0.07		2.1	15.9	-13.8	7.4	Non-Acid Forming (Barren)
17	EB1831519015	KC19_023	KC19_023 36.84-37.16m	Mudstone	36.84	37.16	0.32	9.4	184	0.03		0.9	8.7	-7.8	9.5	Non-Acid Forming (Barren)
18	EB1831519016	KC19_023	KC19_023 40.95-41.34m	Mudstone	40.95	41.34	0.39	9.6	353	0.04		1.2	15.8	-14.6	12.9	Non-Acid Forming (Barren)
19	EB1903984013	KC19_034	KC19_034 geochem 8	Mudstone	45.01	46.04	1.03	8.4	531	0.30	0.081	2.5	17.6	-15.1	7.1	Non-Acid Forming (Barren)
20	EB1831519002	KC19_012	KC18_040 (PREVIOUSLY KC18_045) *CHIPPPING* 0-3.00m	Mudstone	0.00	3.00	3.00	5.4	174	0.02		0.6	0.25	0.4	0.4	Non-Acid Forming (Barren)
21	EB1831519003	KC19_012	KC18_040 (PREVIOUSLY KC18_045) *CHIPPPING* 3.00-6.00m	Mudstone	3.00	6.00	3.00	5.8	165	0.02		0.6	3.9	-3.3	6.4	Non-Acid Forming (Barren)
22	EB1902543006	KC19_029	BH KC19_029 7-8m (site KC18_18)	Mudstone	7.00	8.00	1.00	8.4	372	0.02		0.6	11.2	-10.6	18.3	Non-Acid Forming (Barren)
23	EB1903984001	KC19_031	KC19_031 24.73-25.35m	Mudstone	24.73	25.35	0.62	8.5	460	0.20	0.104	3.2	11.8	-8.6	3.7	Non-Acid Forming (Barren)
24	EB1903984011	KC19_036	KC19_036 46.91-47.16m	Mudstone	46.91	47.16	0.25	9.0	265	0.20	0.157	4.8	13.4	-8.6	2.8	Non-Acid Forming
25	EB1903984015	KC19_042	KC19_042 3.0-4.0m geochem27	Mudstone	3.00	4.00	1.00	4.9	217	0.02		0.6	0.25	0.4	0.4	Non-Acid Forming (Barren)
26	EB1831519017	KC19_015	KC19_015 26.75-26.88m	Mudstone	26.75	26.88	0.13	9.1	471	0.08		2.5	16.6	-14.2	6.8	Non-Acid Forming (Barren)
27	EB1902543012	KC19_025	KC19_025 9.97-10.47m	Mudstone	9.97	10.47	0.50	4.6	1650	0.15	0.006	0.2	4.4	-4.2	23.9	Non-Acid Forming (Barren)
28	EB1902543001	KC19_025	BH KC19_025 25-25.31m	Mudstone	25.00	25.31	0.31	9.1	204	0.12	0.078	2.4	9	-6.6	3.8	Non-Acid Forming (Barren)
29	EB1902543013	KC19_027	KC19_027 42.26-42.66m	Mudstone	42.26	42.66	0.40	8.7	403	0.21	0.107	3.3	7.6	-4.3	2.3	Non-Acid Forming
30	EB1902543010	KC19_029	KC19_029 18.73-19.10m	Mudstone	18.73	19.10	0.37	8.7	430	0.05		1.5	6.3	-4.8	4.1	Non-Acid Forming (Barren)
31	EB1902543009	KC19_029	KC19_029 21.04-21.35m	Mudstone	21.04	21.35	0.31	8.9	370	0.06		1.8	6.1	-4.3	3.3	Non-Acid Forming (Barren)
32	EB1902543015	KC19_029	KC19_029 26.94-27.40m	Mudstone	26.94	27.40	0.46	9.2	161	0.04		1.2	7.6	-6.4	6.2	Non-Acid Forming (Barren)
33	EB1903984021	KC19_039	KC19_039 13.79-14.14m geochem19	Mudstone	13.79	14.14	0.35	8.4	465	0.09		2.8	11.4	-8.6	4.1	Non-Acid Forming (Barren)
34	EB1903984026	KC19_039	KC19_039 18.12-18.35m geochem20	Mudstone	18.12	18.35	0.23	9.4	422	0.04		1.2	16.9	-15.7	13.8	Non-Acid Forming (Barren)
35	EB1903984020	KC19_042	KC19_042 60.19-61.41m geochem31	Mudstone	60.19	61.41	1.22	9.5	272	0.04		1.2	13.3	-12.1	10.9	Non-Acid Forming (Barren)
36	EB1903984022	KC19_038	KC19_038 19.22-19.42m geochem15	Mudstone	19.22	19.42	0.20	9.1	528	0.02		0.6	62.7	-62.1	102.4	Non-Acid Forming (Barren)
37	EB1903984010	KC19_036	KC19_036 49.70-50.04m	Mudstone	49.70	50.04	0.34	9.0	430	0.29	0.009	0.3	23.9	-23.6	86.7	Non-Acid Forming (Barren)
38	EB1907170004	KC19_045	KC19_045 Geochem18 20-21m	Mudstone	20.00	21.00	1.00	6.7	204	0.02		0.6	4.6	-4.0	7.5	Non-Acid Forming (Barren)
39	EB1907170018	KC19_051	KC19_051 Geochem22 2-3m	Mudstone	2.00	3.00	1.00	7.2	172	0.005		0.2	3.5	-3.3	22.9	Non-Acid Forming (Barren)
40	EB1907170012	KC19_051	KC19_051 Geochem23 3-5m	Mudstone	3.00	5.00	2.00	6.8	62	0.005		0.2	3.2	-3.0	20.9	Non-Acid Forming (Barren)
41	EB1907170014	KC19_051	KC19_051 Geochem24 5-6m	Mudstone	5.00	6.00	1.00	6.9	84	0.005		0.2	2.5	-2.3	16.3	Non-Acid Forming (Barren)
42	EB1907170017	KC19_051	KC19_051 Geochem26 15-16m	Mudstone	15.00	16.00	1.00	7.4	144	0.02		0.6	6.7	-6.1	10.9	Non-Acid Forming (Barren)
43	EB1907170011	KC19_051	KC19_051 Geochem27 19-20m	Mudstone	19.00	20.00	1.00	7.4	175	0.10		3.1	5.9	-2.8	1.9	Non-Acid Forming (Barren)
44	EB1907170022	KC19_055	KC19_055 Geochem40 55.43-55.83m	Mudstone	55.43	55.83	0.40	8.4	337	0.05		1.5	7	-5.5	4.6	Non-Acid Forming (Barren)
45	EB1907170039	KC19_056	KC19_056 Geochem43 4-5m	Mudstone	4.00	5.00	1.00	5.5	151	0.02		0.6	2.4	-1.8	3.9	Non-Acid Forming (Barren)
46	EB1907170020	KC19_056	KC19_056 Geochem45	Mudstone	9.00	11.00	2.00	5.9	150	0.005		0.2	3.4	-3.2	22.2	Non-Acid Forming (Barren)
47	EB1907170033	KC19_056	KC19_056 Geochem49 63.76-64.20m	Mudstone	63.76	64.20	0.44	8.6	345	0.08		2.5	11.4	-9.0	4.7	Non-Acid Forming (Barren)
48	EB1907170036	KC19_056	KC19_056 Geochem50 65.38-64.79m	Mudstone	65.18	65.59	0.41	8.7	329	0.05		1.5	10.6	-9.1	6.9	Non-Acid Forming (Barren)
49	EB1907170007	KC19_045	KC19_045 Geochem19 28-29m	Mudstone	28.00	29.00	1.00	7.3	90	0.005		0.2	7.8	-7.6	50.9	Non-Acid Forming (Barren)

Table B1: Acid Base Account Results for Kogan Creek Spoil

RGS Sample No.	ALS ID	Drill Hole ID	Sample ID	Sample Lithology	From	To	Depth Interval	pH[1]	EC[1]	Total S	Scr	MPA[2]	ANC[2]	NAPP[2]	ANC: MPA Ratio	Sample Classification[3]
					(m)				(µS/cm)	(%)		(kg H_2SO_4/t)				
50	EB1831519005	KC19_011	(SITE KC18_030) KC19_011 49.18-49.50m	Sandstone	49.18	49.50	0.32	9.1	375	0.34	0.182	5.6	29.3	-23.7	5.3	Non-Acid Forming
51	EB1831519012	KC19_007	(SITE KC18_060) KC19_007 67.73-67.90m	Sandstone	67.73	67.90	0.17	8.6	155	0.03		0.9	7.6	-6.7	8.3	Non-Acid Forming (Barren)
52	EB1831519009	KC19_008	(SITE KC18_070) KC19_008 52.35-52.67m	Sandstone	52.35	52.67	0.32	9.4	367	0.02		0.6	35.5	-34.9	58.0	Non-Acid Forming (Barren)
53	EB1831519010	KC19_008	(SITE KC18_070) KC19_008 71.82-72.02m	Sandstone	71.82	72.02	0.20	8.9	119	0.02		0.6	7.9	-7.3	12.9	Non-Acid Forming (Barren)
54	EB1831519007	KC19_009	(SITE KC18_027) KC19_009 23.00-23.41m	Sandstone	23.00	23.41	0.41	9.2	186	0.04		1.2	17	-15.8	13.9	Non-Acid Forming (Barren)
55	EB1831519025	KC19_013	(SITE KC18_013) KC19_013 7.00-12.00m	Sandstone	7.00	12.00	5.00	9.5	517	0.03		0.9	53.7	-52.8	58.4	Non-Acid Forming (Barren)
56	EB1831519019	KC19_016	KC19_016 14.09-14.67m	Sandstone	14.09	14.67	0.58	9.7	407	0.06		1.8	64	-62.2	34.8	Non-Acid Forming (Barren)
57	EB1831519020	KC19_016	KC19_016 17.50-18.09m	Sandstone	17.50	18.09	0.59	9.7	401	0.04		1.2	72.4	-71.2	59.1	Non-Acid Forming (Barren)
58	EB1831519004	KC19_012	KC18_040 (PREVIOUSLY KC18_045) *CHIPPPING* 18.00-22.00m	Sandstone	18.00	22.00	4.00	9.2	366	0.05		1.5	29.6	-28.1	19.3	Non-Acid Forming (Barren)
59	EB1831519018	KC19_015	KC19_015 30.85-31.29m	Sandstone	30.85	31.29	0.44	9.1	99	0.005		0.2	9	-8.8	58.8	Non-Acid Forming (Barren)
60	EB1902543016	KC19_027	KC19_027 25.38-25.78m	Sandstone	25.38	25.78	0.40	9.6	522	0.03		0.9	20.6	-19.7	22.4	Non-Acid Forming (Barren)
61	EB1902543014	KC19_027	KC19_027 29.86-30.06m	Sandstone	29.86	30.06	0.20	9.8	527	0.05		1.5	34.2	-32.7	22.3	Non-Acid Forming (Barren)
62	EB1903984003	KC19_032	KC19_032 14.91-15.35m	Sandstone	14.91	15.35	0.44	8.8	319	0.03		0.9	23.6	-22.7	25.7	Non-Acid Forming (Barren)
63	EB1903984005	KC19_033	KC19_033 34.61-35.04m	Sandstone	34.61	35.04	0.43	9.0	272	0.03		0.9	150	-149.1	163.3	Non-Acid Forming (Barren)
64	EB1903984007	KC19_034	KC19_034 20.05-20.46m	Sandstone	20.05	20.46	0.41	9.4	415	0.02		0.6	116	-115.4	189.4	Non-Acid Forming (Barren)
65	EB1903984008	KC19_035	KC19_035 32.97-33.21m	Sandstone	32.97	33.21	0.24	9.4	776	0.06		1.8	23.8	-22.0	13.0	Non-Acid Forming (Barren)
66	EB1903984009	KC19_035	KC19_035 53.71-54.99m	Sandstone	53.71	54.99	1.28	9.8	350	0.07		2.1	95.3	-93.2	44.5	Non-Acid Forming (Barren)
67	EB1903984012	KC19_036	KC19_036 27.20-27.51m	Sandstone	27.20	27.51	0.31	8.3	182	0.03		0.9	10.3	-9.4	11.2	Non-Acid Forming (Barren)
68	EB1903984029	KC19_039	KC19_039 28.19-28.45m geochem21	Sandstone	28.19	28.45	0.26	9.6	213	0.03		0.9	11.2	-10.3	12.2	Non-Acid Forming (Barren)
69	EB1903984031	KC19_041	KC19_041 3.0-6.0m geochem22	Sandstone	3.00	6.00	3.00	4.7	77	0.005		0.2	0.6	-0.4	3.9	Non-Acid Forming (Barren)
70	EB1903984030	KC19_041	KC19_041 9.0-10.0m geochem23	Sandstone	9.00	10.00	1.00	5	92	0.005		0.2	0.25	-0.1	1.6	Non-Acid Forming (Barren)
71	EB1903984025	KC19_041	KC19_041 47.11-47.36m geochem24	Sandstone	47.11	47.36	0.25	9.5	331	0.03		0.9	45.1	-44.2	49.1	Non-Acid Forming (Barren)
72	EB1903984018	KC19_042	KC19_042 13-14m geochem28	Sandstone	13.00	14.00	1.00	4.7	303	0.005		0.2	0.25	-0.1	1.6	Non-Acid Forming (Barren)
73	EB1903984016	KC19_042	KC19_042 43-44m geochem29	Sandstone	43.00	44.00	1.00	9.9	266	0.04		1.2	21.2	-20.0	17.3	Non-Acid Forming (Barren)
74	EB1903984014	KC19_042	KC19_042 47-47.91m geochem 30	Sandstone	47.00	47.91	0.91	9.5	387	0.06		1.8	21.1	-19.3	11.5	Non-Acid Forming (Barren)
75	EB1902543011	KC19_027	KC19_027 32.07-32.46m	Sandstone	32.07	32.46	0.39	10.1	415	0.10		3.1	10.2	-7.1	3.3	Non-Acid Forming (Barren)
76	EB1907170008	KC19_045	KC19_045 Geochem16 9-10m	Sandstone	9.00	10.00	1.00	5.7	144	0.005		0.2	3.3	-3.1	21.6	Non-Acid Forming (Barren)
77	EB1907170006	KC19_045	KC19_045 Geochem17 14-15m	Sandstone	14.00	15.00	1.00	6.1	127	0.005		0.2	3.9	-3.7	25.5	Non-Acid Forming (Barren)
78	EB1907170009	KC19_045	KC19_045 Geochem20 54.69-54.94m	Sandstone	54.69	54.94	0.25	8.8	637	0.11	0.077	2.4	84.3	-81.9	35.7	Non-Acid Forming (Barren)
79	EB1907170019	KC19_051	KC19_051 Geochem25 9-10m	Sandstone	9.00	10.00	1.00	7.0	105	0.06		1.8	3.2	-1.4	1.7	Non-Acid Forming (Barren)
80	EB1907170016	KC19_051	KC19_051 Geochem28 26-27m	Sandstone	26.00	27.00	1.00	8.9	495	0.02		0.6	68.7	-68.1	112.2	Non-Acid Forming (Barren)
81	EB1907170035	KC19_051	KC19_051 Goechem32 52.01-52.39m	Sandstone	52.01	52.39	0.38	8.3	195	0.19	0.090	2.8	8.5	-5.7	3.1	Non-Acid Forming (Barren)
82	EB1907170026	KC19_055	KC19_055 Geochem33 2-3m	Sandstone	2.00	3.00	1.00	5.2	74	0.005		0.2	0.9	-0.7	5.9	Non-Acid Forming (Barren)
83	EB1907170027	KC19_055	KC19_055 Geochem34 3-6m	Sandstone	3.00	6.00	3.00	5.0	304	0.005		0.2	1.1	-0.9	7.2	Non-Acid Forming (Barren)
84	EB1907170025	KC19_055	KC19_055 Geochem35 12-14m	Sandstone	12.00	14.00	2.00	5.0	631	0.02		0.6	3.5	-2.9	5.7	Non-Acid Forming (Barren)
85	EB1907170041	KC19_055	KC19_055 Geochem36 16-18m	Sandstone	16.00	18.00	2.00	5.3	622	0.03		0.9	3.9	-3.0	4.2	Non-Acid Forming (Barren)
86	EB1907170028	KC19_055	KC19_055 Geochem37 21-22m	Sandstone	21.00	22.00	1.00	6.5	354	0.03		0.9	13.9	-13.0	15.1	Non-Acid Forming (Barren)
87	EB1907170034	KC19_055	KC19_055 Geochem38 39.11-39.62m	Sandstone	39.11	39.62	0.51	9.4	425	0.07		2.1	136	-133.9	63.4	Non-Acid Forming (Barren)
88	EB1907170024	KC19_055	KC19_055 Geochem39 43.66-44.70	Sandstone	43.66	44.70	1.04	8.5	256	0.07		2.1	18.7	-16.6	8.7	Non-Acid Forming (Barren)
89	EB1907170002	KC19_056	KC19_056 Geochem42 3-4m	Sandstone	3.00	4.00	1.00	5.2	109	0.005		0.2	2.1	-1.9	13.7	Non-Acid Forming (Barren)
90	EB1907170001	KC19_056	KC19_056 Geochem44 5-7m	Sandstone	5.00	7.00	2.00	5.5	118	0.02		0.6	2	-1.4	3.3	Non-Acid Forming (Barren)
91	EB1907170037	KC19_056	KC19_056 Geochem46 15-18m	Sandstone	15.00	18.00	3.00	6.6	137	0.02		0.6	6.4	-5.8	10.4	Non-Acid Forming (Barren)
92	EB1907170040	KC19_056	KC19_056 Geochem47	Sandstone	22.00	24.00	2.00	9.1	397	0.02		0.6	58.4	-57.8	95.3	Non-Acid Forming (Barren)
93	EB1907170021	KC19_056	KC19_056 Geochem48 50.69-50.99m	Sandstone	50.69	50.99	0.30	9.0	363	0.03		0.9	84.3	-83.4	91.8	Non-Acid Forming (Barren)
94	EB1907170038	KC19_056	KC19_056 Geochem51 69.60-70.11m	Sandstone	69.60	70.11	0.51	8.9	223	0.04		1.2	19.9	-18.7	16.2	Non-Acid Forming (Barren)

Table B1: Acid Base Account Results for Kogan Creek Spoil

RGS Sample No.	ALS ID	Drill Hole ID	Sample ID	Sample Lithology	From	To	Depth Interval	pH[1]	EC[1]	Total S	Scr	MPA[2]	ANC[2]	NAPP[2]	ANC: MPA Ratio	Sample Classification[3]
					(m)				(µS/cm)	(%)		(kg H_2SO_4/t)				
95	EB1831519006	KC19_012	(SITE KC18_040) KC19_012 49.33-49.60m	Siltstone	49.33	49.60	0.27	9.0	116	0.02		0.6	7.2	-6.6	11.8	Non-Acid Forming (Barren)
96	EB1831519001	KC19_013	KC19_013 33.56-33.82m	Siltstone	33.56	33.82	0.26	8.9	94	0.02		0.6	6.3	-5.7	10.3	Non-Acid Forming (Barren)
97	EB1831519022	KC19_014	(SITE KC18_029) KC19_014 0-6.00m	Siltstone	0.00	6.00	6.00	9.0	338	0.05		1.5	18.4	-16.9	12.0	Non-Acid Forming (Barren)
98	EB1831519024	KC19_014	KC19_014 31.74-32.08m	Siltstone	31.74	32.08	0.34	9.0	222	0.05		1.5	8.7	-7.2	5.7	Non-Acid Forming (Barren)
99	EB1902543008	KC19_025	BH KC19_025 23-23.88m (site KC18_079)	Siltstone	23.00	23.88	0.88	8.8	265	0.04		1.2	6.9	-5.7	5.6	Non-Acid Forming (Barren)
100	EB1902543007	KC19_025	BH KC19_025 28.67-28.8m	Siltstone	28.67	28.80	0.13	9.1	94	0.20	0.139	4.3	7.8	-3.5	1.8	Uncertain
101	EB1902543017	KC19_027	KC19_027 47.66-48.02m	Siltstone	47.66	48.02	0.36	9.0	112	0.07		2.1	7.7	-5.6	3.6	Non-Acid Forming (Barren)
102	EB1903984002	KC19_031	KC19_031 31.3-31.6m	Siltstone	31.30	31.60	0.30	9.4	285	0.02		0.6	17	-16.4	27.8	Non-Acid Forming (Barren)
103	EB1903984004	KC19_032	KC19_032 34.55-34.84m	Siltstone	34.55	34.84	0.29	9.3	172	0.03		0.9	11.9	-11.0	13.0	Non-Acid Forming (Barren)
104	EB1903984023	KC19_038	KC19_038 14.38-14.59m geochem14	Siltstone	14.38	14.59	0.21	9.3	582	0.04		1.2	32	-30.8	26.1	Non-Acid Forming (Barren)
105	EB1903984017	KC19_038	KC19_038 31.44-31.8m geochem16	Siltstone	31.44	31.80	0.36	8.4	422	0.04		1.2	14.4	-13.2	11.8	Non-Acid Forming (Barren)
106	EB1903984027	KC19_038	KC19_038 40.28-40.54m geochem17	Siltstone	40.28	40.54	0.26	9.6	232	0.05		1.5	10.5	-9.0	6.9	Non-Acid Forming (Barren)
107	EB1903984019	KC19_041	KC19_041 64.79-65.13m geochem25	Siltstone	64.79	65.13	0.34	9.5	307	0.36	0.213	6.5	14.8	-8.3	2.3	Non-Acid Forming
108	EB1903984028	KC19_041	KC19_041 70.2-70.5m geochem26	Siltstone	70.20	70.50	0.30	9.4	119	0.02		0.6	8.7	-8.1	14.2	Non-Acid Forming (Barren)
109	EB1907170032	KC19_042	KC18-076 KC19_042 Geochem 33 67.72-68.27m	Siltstone	67.72	68.27	0.55	9.0	170	0.03		0.9	9.2	-8.3	10.0	Non-Acid Forming (Barren)
110	EB1907170029	KC19_044	KC19_044 Geochem 14 53.31-53.84m	Siltstone	53.31	53.84	0.53	9.2	271	0.04		1.2	24.8	-23.6	20.2	Non-Acid Forming (Barren)
111	EB1907170030	KC19_044	KC19_044 Geochem 15 69.67-69.94m	Siltstone	69.67	69.94	0.27	9.3	314	0.05		1.5	16.3	-14.8	10.6	Non-Acid Forming (Barren)
112	EB1907170005	KC19_045	KC19_045 Geochem21 68.36-68.80m	Siltstone	68.36	68.80	0.44	8.8	270	0.06		1.8	11.1	-9.3	6.0	Non-Acid Forming (Barren)
113	EB1907170013	KC19_051	KC19_051 Geochem29 28-29m	Siltstone	28.00	29.00	1.00	9.0	424	0.005		0.2	22.6	-22.4	147.6	Non-Acid Forming (Barren)
114	EB1907170015	KC19_051	KC19_051 Geochem30 39-40m	Siltstone	39.00	40.00	1.00	8.8	536	0.03		0.9	122	-121.1	132.8	Non-Acid Forming (Barren)
115	EB1907170003	KC19_055	KC19_055 Geochem41 60.82-61.18	Siltstone	60.82	61.18	0.36	8.4	136	0.05		1.5	8.1	-6.6	5.3	Non-Acid Forming (Barren)
116	EB1907170031	KC19_042	Coal Sample 64m depth	Siltstone	63.95	64.23	0.28	7.8	121	0.57	0.020	0.6	7.2	-6.6	11.8	Non-Acid Forming (Barren)
117	EB1907170010	KC19_051	KC19_051 Geochem31 49-50m	Siltstone	49.00	50.00	1.00	8.7	491	0.04		1.2	26.5	-25.3	21.6	Non-Acid Forming (Barren)

Notes

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.

* Where total sulfur or ANC results are less than the laboratory LoR a value of half of the LoR is used .

Table B2: Multi-Element Test Results for Kogan Creek Spoil

		RGS Sample Number →	Mudstone	Mudstone	Sandstone	Siltstone	Mudstone	Sandstone	Siltstone	Claystone	Sandstone	Siltstone
		ALS Laboratory ID →	EB1903521001	EB1903521002	EB1903521003	EB1903521004	EB1910431001	EB1910431002	EB1910431003	EB1910431004	EB1910431005	EB1910431006
		Sample ID →										
Parameters	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C	Composite 1	Composite 2	Composite 3	Composite 4	Composite 5	Composite 6	Composite 7	Composite 8	Composite 9	Composite 10
Major Cations			All units mg/kg									
Calcium (Ca)	50	-	3,360	3,660	18,100	1,200	3,880	8,910	7,780	1,510	4,790	11,800
Magnesium (Mg)	50	-	3,220	2,200	3,010	570	2,370	3,110	2,840	1,120	1,590	2,790
Potassium (K)	50	-	830	920	690	640	580	460	710	320	260	680
Sodium (Na)	50	-	1,520	1,970	2,540	1,370	2,000	1,910	1,620	1,000	1,050	1,940
Major, Minor and Trace Elements			All units mg/kg									
Aluminium (Al)	50	-	4,890	5,060	5,010	2,040	3,730	3,480	4,100	2,150	2,700	4,960
Antimony (Sb)	0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	0.1	300	5.8	3.0	3.3	0.8	3.4	2.8	1.3	1.6	2.5	1.9
Boron (B)	50	20,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	0.1	90	0.3	0.2	0.2	0.2	0.1	0.2	0.2	<0.1	<0.1	0.3
Chromium (Cr) - hexavalent	0.1	300 **	5.8	5.5	3.8	1.2	2.8	3.0	3.3	3.6	4.4	3.6
Cobalt (Co)	0.1	300	61.7	12.7	14.5	1.0	6.7	10.4	4.0	6.9	3.8	20.8
Copper (Cu)	0.1	17,000	34.6	32.8	24.0	35.9	21.9	22.8	27.8	6.2	7.3	16.7
Iron (Fe)	50	-	29,400	14,200	13,200	2,850	13,400	38,000	25,600	5,510	13,800	29,200
Lead (Pb)	0.1	600	12.4	15.1	10.8	12.0	13.9	10.6	16.2	5.8	4.6	14.1
Manganese (Mn)	0.1	19,000	2,210	250	542	97	279	1,210	694	180	300	1,890
Molybdenum	0.1	80	0.9	0.5	0.8	0.1	0.4	0.4	0.3	0.5	0.2	0.5
Nickel (Ni)	0.1	1,200	33.4	13.0	12.4	1.6	6.9	6.1	4.2	5.9	4.0	9.5
Selenium (Se)	1	700	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium (V)	1	-	32	32	20	5	23	24	17	18	24	23
Zinc (Zn)	0.5	30,000	218.0	84.6	87.8	71.5	64.4	92.9	57	17.4	23.2	53.2
Soil Nutrients/Organic Carbon			All units mg/kg (except Total Organic Carbon as a percentage of sample weight (%))									
Nitrate plus Nitrite as N	0.1		0.9	1.2	0.2	0.1	0.6	0.2	0.2	<0.1	0.3	0.3
Total Kjeldahl Nitrogen as N	20		960	940	370	280	740	370	1,000	100	190	400
Total Nitrogen as N	20		960	940	370	280	740	370	1,000	100	190	400
Fluoride Extractable Phosphorous	1		1.2	2.2	<1.0	<1.0	4.3	1.2	1	<1.0	6.2	2.2
Total Organic Carbon	0.02		1.13	1.42	0.7	1.01	3.47	0.7	3	0.71	0.96	4.61
Soluble Fluoride	1		4	1	1	2	<1	2	1	2	<1	2
Exchangable Cations			All units meq/100g (except Exchangable Sodium & Aluminium Percentage (%))									
Exch. Calcium	0.1		7.8	5.2	9.7	3.9	8.9	10.9	7.7	4	7	10.2
Exch. Magnesium	0.1		8.8	3.1	5.6	1.1	7.9	7	3.5	5.1	6.4	9.4
Exch. Potassium	0.1		0.4	0.4	0.6	0.4	0.5	0.6	0.6	0.2	0.2	0.6
Exch. Sodium	0.1		4.8	6.6	9.6	4.5	7	8.4	5.6	2.9	4.3	7.9
Cation Exchange Capacity	0.1		21.8	15.3	25.5	9.9	24.4	26.9	17.3	12.2	17.8	28.1
Calcium:Magnesium Ratio	-		0.9	1.7	1.7	3.5	1.1	1.6	2.2	0.8	1.1	1.1
Magnesium:Potassium Ratio	-		20.7	6.9	9.2	3	16.4	10.7	6	22	32.8	14.8
Exchangable Sodium Percentage	0.1%		22.1	42.9	37.5	45.6	28.8	31.1	32.3	23.7	24.2	28
Moisture Content (Dried @ 105-110°C)	1.0%		3.0	2.6	5.0	1.7	6.3	4.2	2.8	8.9	8.3	8.7

Notes:

< indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** 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 B3: Geochemical Abundance Index Results for Kogan Creek Spoil

	RGS Sample Number →		Mudstone	Mudstone	Sandstone	Siltstone	Mudstone	Sandstone	Siltstone	Claystone	Sandstone	Siltstone
	ALS Laboratory ID →		EB1903521001	EB1903521002	EB1903521003	EB1903521004	EB1910431001	EB1910431002	EB1910431003	EB1910431004	EB1910431005	EB1910431006
	Sample ID →		Composite 1	Composite 2	Composite 3	Composite 4	Composite 5	Composite 6	Composite 7	Composite 8	Composite 9	Composite 10
Parameters	Limit of Reporting	Average Crustal Abundance[1]										
Major Elements	all units in mg/kg											
Calcium (Ca)	50	15,000	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	50	5,000	0	0	0	0	0	0	0	0	0	0
Potassium (K)	50	14,000	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000	0	0	0	0	0	0	0	0	0	0
Major, Minor and Trace Elements	all units in mg/kg											
Aluminium (Al)	50	71,000	0	0	0	0	0	0	0	0	0	0
Antimony (Sb)	0.1	5	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.1	6	0	0	0	0	0	0	0	0	0	0
Boron (B)	50	100	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.1	0.35	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	0.1	70	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	2	0	0	0	0	0	0	0	0	1
Copper (Cu)	0.1	30	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.1	35	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	0.1	1,000	1	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.1	2.00	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	0.1	50	0	0	0	0	0	0	0	0	0	0
Selenium (Se)	1	0.4	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	0.5	90	1	0	0	0	0	0	0	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

Table B4: Multi-Element Test Results for Water Extracts from Kogan Creek Spoil

		RGS Sample Number →		Mudstone	Mudstone	Sandstone	Siltstone	Mudstone	Sandstone	Siltstone	Mudstone	Sandstone	Siltstone
		ALS Laboratory ID →		EB1903521001	EB1903521002	EB1903521003	EB1903521004	EB1910431001	EB1910431002	EB1910431003	EB1910431004	EB1910431005	EB1910431006
		Water Quality Guidelines:											
Parameters	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Composite 1	Composite 2	Composite 3	Composite 4	Composite 5	Composite 6	Composite 7	Composite 8	Composite 9	Composite 10
pH	0.01 pH unit	6 to 9	-	8.8	8.5	9.8	9.5	7.6	9.6	9.4	8.3	6.7	9.5
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	692	360	443	136	658	434	280	230	297	369
Carbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	21	<1	77	35	<1	97	89	<1	<1	330
Bicarbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	224	192	800	88	167	58	63	97	108	163
Total Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	244	192	876	122	167	155	152	97	108	494
Acidity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	36	<1	<1	<1	40	<1
Net Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	244	192	876	122	130	155	152	97	67	494
Major Ions	All units mg/L												
Calcium (Ca)	2	-	1,000	4	<2	<2	<2	4	<2	<2	<2	<2	<2
Magnesium (Mg)	2	-	-	4	<2	<2	<2	2	<2	<2	<2	<2	<2
Potassium (K)	2	-	-	4	<2	<2	<2	4	<2	2	<2	<2	2
Sodium (Na)	2	-	-	144	72	88	22	124	88	66	56	84	80
Chloride (Cl)	2	-	-	90	42	22	12	60	44	22	24	50	18
Sulfate (SO_4)	2	-	1,000	140	34	36	10	134	40	26	22	22	14
Trace Metals/Metalloids	All units mg/L												
Aluminium (Al)	0.02	0.055	5	<0.02	0.14	0.10	0.54	<0.02	0.04	0.10	0.16	0.04	0.14
Antimony (Sb)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic (As) - trivalent	0.002	0.024 **	0.5	<0.002	0.012	0.048	0.022	<0.002	0.058	0.028	0.006	<0.002	0.004
Boron (B)	0.2	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (Cd)	0.002	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr) - total	0.002	0.001 (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.002	-	1	<0.002	0.006	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.002	0.0014	1	<0.002	0.034	<0.002	<0.002	0.008	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.2	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Lead (Pb)	0.002			<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese (Mn)	0.002	1.90	-	0.008	0.004	<0.002	<0.002	0.008	<0.002	<0.002	<0.002	0.008	<0.002
Molybdenum (Mo)	0.002	-	0.15	0.026	0.032	0.056	0.010	0.024	0.036	0.026	0.022	0.004	0.006
Nickel (Ni)	0.002	0.011	1	<0.002	0.018	<0.002	<0.002	0.010	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium (Se)	0.02	0.011	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Vanadium (V)	0.02	-	-	<0.02	<0.02	0.04	0.04	<0.02	0.02	0.02	<0.02	<0.02	<0.02
Zinc (Zn)	0.01	0.008	20	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<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 freshwater aquatic ecosystems (95% species protection level)

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

1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

* 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.

Table B5: Particle Size Distribution, Emerson Class and Soil Classification Results for Kogan Creek Spoil

RGS Sample Number →			Composite 1	Composite 2	Composite 3	Composite 4	Composite 5	Composite 6	Composite 7	Composite 8	Composite 9	Composite 10
Trilab Laboratory ID →			19020779	19020780	19020781	19020782	19040665	19040666	19040667	19040668	19040669	19040670
Composite Sample ID →			Mudstone	Mudstone	Sandstone	Siltstone	Mudstone	Sandstone	Siltstone	Mudstone	Sandstone	Siltstone
Emerson Aggregate	Units	LOR										
Color (Munsell)	-	-	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Pale brown/orange	Pale brown/orange	Pale brown/orange
Texture	-	-	Silty clay (mudstone)	Silty clay (mudstone)	Silty clay (mudstone)	Silty clay (mudstone)	Clayey gravel (mudstone)	Clayey gravel (mudstone)	Clayey gravel (mudstone)	Gravelly sand	Gravelly sand	Gravelly sand
Emerson Class Number	-	-	2	2	2	2	2	2	2	2	2	2
Particle Sizing	Units	LOR										
+1.4 µm	%	1	25	23	20	14	23	18	19	16	16	16
+2.4 µm	%	1	31	31	26	20	29	23	23	19	19	19
+2.8 µm	%	1	33	34	27	21	30	24	26	20	21	20
+3.4 µm	%	1	37	37	30	23	33	26	27	21	22	22
+3.9 µm	%	1	40	40	32	25	35	28	29	22	23	23
+4.8 µm	%	1	44	44	36	28	38	29	31	23	24	25
+6.7 µm	%	1	50	47	40	31	42	32	35	26	27	27
+9.5 µm	%	1	57	51	43	34	46	34	37	27	29	30
+13 µm	%	1	64	55	48	37	50	36	40	29	32	32
+18 µm	%	1	69	60	52	40	51	38	43	31	33	35
+24 µm	%	1	76	66	56	46	52	39	46	32	34	38
+34 µm	%	1	82	69	60	51	56	41	49	33	37	42
+48 µm	%	1	86	74	66	61	57	44	52	35	39	44
+57 µm	%	1	90	77	70	69	59	47	55	36	40	45
+75 µm	%	1	94	87	73	73	66	48	59	41	41	46
+150 µm	%	1	97	95	84	88	70	57	62	46	47	50
+300 µm	%	1	99	98	95	95	73	65	63	58	59	59
+425 µm	%	1	99	98	98	96	74	66	64	63	65	64
+600 µm	%	1	99	99	99	97	74	67	65	66	69	66
+1180 µm	%	1	100	100	100	99	75	68	67	69	73	68
+2.36 mm	%	1				100	76	69	67	71	74	69
+4.75 mm	%	1					83	79	79	83	87	85
+6.7 mm	%	1					93	90	95	95	94	95
+9.5 mm	%	1					98	98	99	100	97	100
+13.2 mm	%	1					100	100	100		98	
+19 mm	%	1									100	
+26.5 mm	%	1										
+37.5 mm	%	1										
+53 mm	%	1										
Soil Classification	Units	LOR										
Dispersion (%)	%	1	50	25	18	42	12	7	12	42	40	45
Moisture content	%	0.1	2.8	2.4	4.8	1.9	6.8	3.7	3.0	10.0	8.4	10.0
Soil Particle Density	g/cm^3	0.01	2.56	2.54	2.56	2.56	2.48	2.60	2.55	2.59	2.59	2.62

Notes: LOR - Laboratory Limit of Reporting
Hydrometer used to measure down to percentage passing 2µm (ALS code EA150-H). Hydrometer type ASTM E100. Test Method AS1289.3.6.3.

Attachment C ALS and Trilab laboratory results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1831519**	Page	: 1 of 8
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018064 Kogan Creek	Date Samples Received	: 20-Dec-2018 17:20
Order number	:	Date Analysis Commenced	: 08-Jan-2019
C-O-C number	: ----	Issue Date	: 11-Jan-2019 13:18
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 29		
No. of samples analysed	: 29		

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*
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.

- 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**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_013 33.56-33.82m	KC18_040 (PREVIOUSLY KC18_045) *CHIPPPING* 0-3.00m	KC18_040 (PREVIOUSLY KC18_045) *CHIPPPING* 3.00-6.00m	KC18_040 (PREVIOUSLY KC18_045) *CHIPPPING* 18.00-22.00m	(SITE KC18_030) KC19_011 49.18-49.50m
				Client sampling date / time	27-Nov-2018 00:00	26-Nov-2018 00:00	26-Nov-2018 00:00	26-Nov-2018 00:00	26-Nov-2018 00:00
					EB1831519-001	EB1831519-002	EB1831519-003	EB1831519-004	EB1831519-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**8.9**	**5.4**	**5.8**	**9.2**	**9.1**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-5.7**	**0.6**	**-3.3**	**-28.1**	**-18.9**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**94**	**174**	**165**	**366**	**375**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**6.3**	<0.5	**3.9**	**29.6**	**29.3**
ANC as CaCO3	----	0.1	% CaCO3		**0.6**	<0.1	**0.4**	**3.0**	**3.0**
Fizz Rating	----	0	Fizz Unit		**1**	**0**	**0**	**1**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.02**	**0.02**	**0.05**	**0.34**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	(SITE KC18_040) KC19_012 49.33-49.60m	(SITE KC18_027) KC19_009 23.00-23.41m	(SITE KC18_027) KC19_009 33.87-34.04m	(SITE KC18_070) KC19_008 52.35-52.67m	(SITE KC18_070) KC19_008 71.82-72.02m
				Client sampling date / time	26-Nov-2018 00:00	24-Nov-2018 00:00	24-Nov-2018 00:00	23-Nov-2018 00:00	23-Nov-2018 00:00
					EB1831519-006	EB1831519-007	EB1831519-008	EB1831519-009	EB1831519-010
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.0**	**9.2**	**8.7**	**9.4**	**8.9**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-6.6**	**-15.8**	**-9.9**	**-34.9**	**-7.3**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**116**	**186**	**176**	**367**	**119**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**7.2**	**17.0**	**11.1**	**35.5**	**7.9**
ANC as CaCO3	----	0.1	% CaCO3		**0.7**	**1.7**	**1.1**	**3.6**	**0.8**
Fizz Rating	----	0	Fizz Unit		**1**	**1**	**1**	**2**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.04**	**0.04**	**0.02**	**0.02**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	(SITE KC18_060) KC19_007 58.65-58.85m	(SITE KC18_060) KC19_007 67.73-67.90m	KC19_002 9.80-10.22m	KC19_022 41.10-41.60m	KC19_023 36.84-37.16m
			Client sampling date / time	22-Nov-2018 00:00	22-Nov-2018 00:00	15-Nov-2018 00:00	11-Dec-2018 00:00	11-Dec-2018 00:00
Compound	CAS Number	LOR	Unit	EB1831519-011	EB1831519-012	EB1831519-013	EB1831519-014	EB1831519-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.2	8.6	8.3	9.5	9.4
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-12.8	-6.7	-13.4	-13.8	-7.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	278	155	922	356	184
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	13.7	7.6	14.6	15.9	8.7
ANC as CaCO3	----	0.1	% CaCO3	1.4	0.8	1.5	1.6	0.9
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.03	0.04	0.07	0.03

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	KC19_023 40.95-41.34m	KC19_015 26.75-26.88m	KC19_015 30.85-31.29m	KC19_016 14.09-14.67m	KC19_016 17.50-18.09m
			Client sampling date / time	11-Dec-2018 00:00	07-Dec-2018 00:00	07-Dec-2018 00:00	07-Dec-2018 00:00	07-Dec-2018 00:00
Compound	CAS Number	LOR	Unit	EB1831519-016	EB1831519-017	EB1831519-018	EB1831519-019	EB1831519-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.6	9.1	9.1	9.7	9.7
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-14.6	-14.2	-9.0	-62.2	-71.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	353	471	99	407	401
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	15.8	16.6	9.0	64.0	72.4
ANC as CaCO3	----	0.1	% CaCO3	1.6	1.7	0.9	6.5	7.4
Fizz Rating	----	0	Fizz Unit	1	1	1	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.08	<0.01	0.06	0.04

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

				Client sample ID	KC19_016 37.32-37.64m	(SITE KC18_029) KC19_014 0-6.00m	KC19_014 14.02-14.36m	KC19_014 31.74-32.08m	(SITE KC18_013) KC19_013 7.00-12.00m
				Client sampling date / time	07-Nov-2018 00:00	06-Dec-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	27-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EB1831519-021	EB1831519-022	EB1831519-023	EB1831519-024	EB1831519-025
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.1**	**9.0**	**8.8**	**9.0**	**9.5**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-7.3**	**-16.9**	**-15.3**	**-7.2**	**-52.8**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**119**	**338**	**190**	**222**	**517**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**8.2**	**18.4**	**16.5**	**8.7**	**53.7**
ANC as CaCO3	----	0.1	% CaCO3		**0.8**	**1.9**	**1.7**	**0.9**	**5.5**
Fizz Rating	----	0	Fizz Unit		**1**	**1**	**1**	**0**	**2**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.03**	**0.05**	**0.04**	**0.05**	**0.03**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	KC19_013 18.77-19.03m	KC19_002 14.08-14.24m	KC19_001 10.00-10.37m	KC19_001 25.00-25.28m	----
			Client sampling date / time	27-Nov-2018 00:00	15-Nov-2018 00:00	15-Nov-2018 00:00	15-Nov-2018 00:00	----
Compound	CAS Number	LOR	Unit	EB1831519-026	EB1831519-027	EB1831519-028	EB1831519-029	--------
				Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	8.1	5.5	8.6	----
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-13.4	-8.7	-5.5	-7.6	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	182	272	609	233	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	14.6	9.6	6.4	10.0	----
ANC as CaCO3	----	0.1	% CaCO3	1.5	1.0	0.6	1.0	----
Fizz Rating	----	0	Fizz Unit	1	0	0	0	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.03	0.03	0.08	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1902543**	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 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018064 Kogan Creek	Date Samples Received	: 01-Feb-2019 17:05
Order number	:	Date Analysis Commenced	: 13-Feb-2019
C-O-C number	: ----	Issue Date	: 15-Feb-2019 15:21
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 17		
No. of samples analysed	: 17		

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.

- 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	BH KC19_025-25.31m	BH KC19_027 0-1m	BH KC19_025 0-3m	BH KC19_025 3-6m	BH KC19_027 1-6m
			Client sampling date / time	26-Jan-2019 00:00	27-Jan-2019 00:00	25-Jan-2019 00:00	25-Jan-2019 00:00	27-Jan-2019 00:00
Compound	CAS Number	LOR	Unit	EB1902543-001	EB1902543-002	EB1902543-003	EB1902543-004	EB1902543-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.1	4.4	6.9	6.2	4.5
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-5.3	-1.7	-6.9	-7.5	-1.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	204	386	332	471	906
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	9.0	2.3	7.8	8.4	2.8
ANC as CaCO3	----	0.1	% CaCO3	0.9	0.2	0.8	0.8	0.3
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.12	0.02	0.03	0.03	0.03

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	BH KC19_029 7-8m (site KC18_18)	BH KC19_025 28.67-28.8m	BH KC19_025 23-23.88m (site KC18_079)	KC19_029 21.04-21.35m	KC19_029 18.73-19.10m
				Client sampling date / time	29-Jan-2019 00:00	26-Jan-2019 00:00	26-Jan-2019 00:00	29-Jan-2019 00:00	29-Jan-2019 00:00
				EB1902543-006	EB1902543-007	EB1902543-008	EB1902543-009	EB1902543-010	
				Result	Result	Result	Result	Result	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	**8.4**	**9.1**	**8.8**	**8.9**	**8.7**	
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-10.6**	**-1.7**	**-5.7**	**-4.3**	**-4.8**	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	**372**	**94**	**265**	**370**	**430**	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**11.2**	**7.8**	**6.9**	**6.1**	**6.3**	
ANC as CaCO3	----	0.1	% CaCO3	**1.1**	**0.8**	**0.7**	**0.6**	**0.6**	
Fizz Rating	----	0	Fizz Unit	**1**	**0**	**0**	**0**	**0**	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.20**	**0.04**	**0.06**	**0.05**	

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	KC19_027 32.07-32.46m	KC19_025 9.97-10.47m	KC19_027 42.26-42.66m	KC19_027 29.86-30.06m	KC19_029 26.94-27.40m
			Client sampling date / time	27-Jan-2019 00:00	25-Jan-2019 00:00	27-Jan-2019 00:00	27-Jan-2019 00:00	29-Jan-2019 00:00
Compound	CAS Number	LOR	Unit	EB1902543-011	EB1902543-012	EB1902543-013	EB1902543-014	EB1902543-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	10.1	4.6	8.7	9.8	9.2
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-7.1	<0.5	-1.2	-32.7	-6.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	415	1650	403	527	161
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	10.2	4.4	7.6	34.2	7.6
ANC as CaCO3	----	0.1	% CaCO3	1.0	0.4	0.8	3.5	0.8
Fizz Rating	----	0	Fizz Unit	1	0	0	1	0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.10	0.15	0.21	0.05	0.04

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	KC19_027 25.38-25.78m	KC19_027 47.66-48.02m	----	----	----
			Client sampling date / time	27-Jan-2019 00:00	27-Jan-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB1902543-016	EB1902543-017	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.6**	**9.0**	----	----	----
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-19.7**	**-5.6**	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**522**	**112**	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**20.6**	**7.7**	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	**2.1**	**0.8**	----	----	----
Fizz Rating	----	0	Fizz Unit	**1**	**0**	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.07**	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1903984**	Page	: 1 of 9
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018064 Kogan Creek	Date Samples Received	: 22-Feb-2019 14:40
Order number	:	Date Analysis Commenced	: 01-Mar-2019
C-O-C number	: ----	Issue Date	: 06-Mar-2019 15:45
Sampler	: ----		
Site	: Kogan Creek		
Quote number	: EN/222		
No. of samples received	: 31		
No. of samples analysed	: 31		

Accreditation No. 825
Accredited for compliance with
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- 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*
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.

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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.

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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.

- 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	KC19_031 24.73-25.35	KC19_031 31.3-31.6	KC19_032 14.91-15.36	KC_19_032 34.55-34.84	KC19_033 34.61-35.04
			Client sampling date / time	31-Jan-2019 00:00	31-Jan-2019 00:00	31-Jan-2019 00:00	02-Feb-2019 00:00	02-Feb-2019 00:00
Compound	CAS Number	LOR	Unit	EB1903984-001	EB1903984-002	EB1903984-003	EB1903984-004	EB1903984-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.5**	**9.4**	**8.8**	**9.3**	**9.0**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-5.7**	**-16.4**	**-22.7**	**-11.0**	**-149**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**460**	**285**	**319**	**172**	**272**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**11.8**	**17.0**	**23.6**	**11.9**	**150**
ANC as CaCO3	----	0.1	% CaCO3	**1.2**	**1.7**	**2.4**	**1.2**	**15.3**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**1**	**3**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.20**	**0.02**	**0.03**	**0.03**	**0.03**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	KC_033 15.37-15.67	KC19_034 20.05-20.46	KC19_035 32.97-33.21	KC19_035 53.71-54.99	KC19_036 49.70-50.04
			Client sampling date / time	02-Feb-2019 00:00	03-Feb-2019 00:00	04-Feb-2019 00:00	04-Feb-2019 00:00	05-Feb-2019 00:00
Compound	CAS Number	LOR	Unit	EB1903984-006	EB1903984-007	EB1903984-008	EB1903984-009	EB1903984-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.4**	**9.4**	**9.4**	**9.8**	**9.0**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-20.1**	**-115**	**-22.0**	**-93.2**	**-15.0**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**626**	**415**	**776**	**350**	**430**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**21.0**	**116**	**23.8**	**95.3**	**23.9**
ANC as CaCO3	----	0.1	% CaCO3	**2.1**	**11.8**	**2.4**	**9.7**	**2.4**
Fizz Rating	----	0	Fizz Unit	**1**	**3**	**1**	**2**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.02**	**0.06**	**0.07**	**0.29**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_036 46.91-47.16	KC19_036 27.20-27.51	KC19_034 geochem 8	KC19_042 47-47.91m geochem30	KC19_038 31.44-31.80m geochem16
				Client sampling date / time	05-Feb-2019 00:00	05-Feb-2019 00:00	03-Feb-2019 00:00	11-Feb-2019 00:00	07-Feb-2019 00:00
					EB1903984-011	EB1903984-012	EB1903984-013	EB1903984-014	EB1903984-017
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.0**	**8.3**	**8.4**	**9.5**	**8.4**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-7.3**	**-9.4**	**-8.4**	**-19.3**	**-13.2**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**265**	**182**	**531**	**387**	**422**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**13.4**	**10.3**	**17.6**	**21.1**	**14.4**
ANC as CaCO3	----	0.1	% CaCO3		**1.4**	**1.0**	**1.8**	**2.2**	**1.5**
Fizz Rating	----	0	Fizz Unit		**1**	**1**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.20**	**0.03**	**0.30**	**0.06**	**0.04**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_041 64.79-65.13m geochem25	KC19_042 60.91-61.41m geochem31	KC19_039 13.79-14.14m geochem19	KC19_038 19.22-19.42m geochem15	KC19_038 14.38-14.59m geochem14
				Client sampling date / time	11-Feb-2019 00:00	18-Feb-2019 00:00	08-Feb-2019 00:00	07-Feb-2019 00:00	07-Feb-2019 00:00
				EB1903984-019	EB1903984-020	EB1903984-021	EB1903984-022	EB1903984-023	
				Result	Result	Result	Result	Result	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	**9.5**	**9.5**	**8.4**	**9.1**	**9.3**	
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-3.8**	**-12.1**	**-8.6**	**-62.1**	**-30.8**	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	**307**	**272**	**465**	**528**	**582**	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**14.8**	**13.3**	**11.4**	**62.7**	**32.0**	
ANC as CaCO3	----	0.1	% CaCO3	**1.5**	**1.4**	**1.2**	**6.4**	**3.3**	
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**2**	**1**	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	**0.36**	**0.04**	**0.09**	**0.02**	**0.04**	

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_041 47.11-47.36m geochem24	KC19_0.39 18.12-18.35m geochem20	KC19_038 40.28-40.54m geochem17	KC19_041 70.2-70.5m geochem26	KC19_039 28.19-28.45m geochem21
				Client sampling date / time	18-Feb-2019 00:00	08-Feb-2019 00:00	07-Feb-2019 00:00	11-Feb-2019 00:00	08-Feb-2019 00:00
					EB1903984-025	EB1903984-026	EB1903984-027	EB1903984-028	EB1903984-029
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.5**	**9.4**	**9.6**	**9.4**	**9.6**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-44.2**	**-15.7**	**-9.0**	**-8.1**	**-10.3**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**331**	**422**	**232**	**119**	**213**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**45.1**	**16.9**	**10.5**	**8.7**	**11.2**
ANC as CaCO3	----	0.1	% CaCO3		**4.6**	**1.7**	**1.1**	**0.9**	**1.1**
Fizz Rating	----	0	Fizz Unit		**2**	**1**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.03**	**0.04**	**0.05**	**0.02**	**0.03**

Analytical Results

Sub-Matrix: SOLID (Matrix: SOIL)			Client sample ID	KC19_042 3.0-4.0m geochem27	KC19_042 43-44m geochem29	KC19_042 13-14m geochem28	KC19_039 1.0-6.0m geochem18	KC19_041 9.0-10.0m geochem23
			Client sampling date / time	18-Feb-2019 00:00	18-Feb-2019 00:00	18-Feb-2019 00:00	08-Feb-2019 00:00	18-Feb-2019 00:00
Compound	CAS Number	LOR	Unit	EB1903984-015	EB1903984-016	EB1903984-018	EB1903984-024	EB1903984-030
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**4.9**	**9.9**	**4.7**	**5.4**	**5.0**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**0.6**	**-20.0**	<0.5	**-9.7**	<0.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**217**	**266**	**303**	**309**	**92**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	**21.2**	<0.5	**10.3**	<0.5
ANC as CaCO3	----	0.1	% CaCO3	<0.1	**2.2**	<0.1	**1.0**	<0.1
Fizz Rating	----	0	Fizz Unit	**0**	**1**	**0**	**1**	**0**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.04**	<0.01	**0.02**	<0.01

Analytical Results

Sub-Matrix: SOLID (Matrix: SOIL)				Client sample ID	KC19_041 3.0-6.0m geochem22	----	----	----	----
				Client sampling date / time	18-Feb-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1903984-031	--------	--------	--------	--------
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**4.7**	----	----	----	----
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-0.6**	----	----	----	----
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**77**	----	----	----	----
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**0.6**	----	----	----	----
ANC as CaCO3	----	0.1	% CaCO3		<0.1	----	----	----	----
Fizz Rating	----	0	Fizz Unit		**0**	----	----	----	----
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1907170**	Page	: 1 of 10
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018064 Kogan Creek	Date Samples Received	: 22-Mar-2019 09:00
Order number	:	Date Analysis Commenced	: 12-Apr-2019
C-O-C number	: ----	Issue Date	: 12-Apr-2019 17:58
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 40		
No. of samples analysed	: 40		

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
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

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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.

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_056 Geochem44 5-7m	KC19_056 Geochem42 3-4m	KC19_055 Geochem41 60.82-61.18m	KC19_045 Geochem18 20-21m	KC19_045 Geochem21 68.36-68.80m
				Client sampling date / time	25-Feb-2019 00:00	25-Feb-2019 00:00	25-Feb-2019 00:00	15-Feb-2019 00:00	15-Feb-2019 00:00
					EB1907170-001	EB1907170-002	EB1907170-003	EB1907170-004	EB1907170-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**5.5**	**5.2**	**8.4**	**6.7**	**8.8**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-1.4**	**-2.1**	**-6.6**	**-4.0**	**-9.3**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**118**	**109**	**136**	**204**	**270**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**2.0**	**2.1**	**8.1**	**4.6**	**11.1**
ANC as CaCO3	----	0.1	% CaCO3		**0.2**	**0.2**	**0.8**	**0.5**	**1.1**
Fizz Rating	----	0	Fizz Unit		**0**	**0**	**0**	**0**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	<0.01	**0.05**	**0.02**	**0.06**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_045 Geochem17 14-15m	KC19_045 Geochem19 28-29m	KC19_045 Geochem16 9-10m	KC19_045 Geochem20 54.69-54.94m	KC19_051 Geochem31 49-50m
				Client sampling date / time	15-Feb-2019 00:00	15-Feb-2019 00:00	15-Feb-2019 00:00	15-Feb-2019 00:00	19-Feb-2019 00:00
				EB1907170-006	EB1907170-007	EB1907170-008	EB1907170-009	EB1907170-010	
				Result	Result	Result	Result	Result	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	**6.1**	**7.3**	**5.7**	**8.8**	**8.7**	
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-3.9**	**-7.8**	**-3.3**	**-80.9**	**-25.3**	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	**127**	**90**	**144**	**637**	**491**	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**3.9**	**7.8**	**3.3**	**84.3**	**26.5**	
ANC as CaCO3	----	0.1	% CaCO3	**0.4**	**0.8**	**0.3**	**8.6**	**2.7**	
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**0**	**2**	**1**	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	**0.11**	**0.04**	

Analytical Results

Sub-Matrix: **SOLID** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_051 Geochem27 19-20m	KC19_05 Geochem23 3-5m	KC19_051 Geochem29 28-29m	KC19_051 Geochem26 5-6m	KC19_051 Geochem30 39-40m
				Client sampling date / time	19-Feb-2019 00:00	19-Feb-2019 00:00	19-Feb-2019 00:00	19-Feb-2019 00:00	19-Feb-2019 00:00
					EB1907170-011	EB1907170-012	EB1907170-013	EB1907170-014	EB1907170-015
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**7.4**	**6.8**	**9.0**	**6.9**	**8.8**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-2.8**	**-3.2**	**-22.6**	**-2.5**	**-121**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**175**	**62**	**424**	**84**	**536**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**5.9**	**3.2**	**22.6**	**2.5**	**122**
ANC as CaCO3	----	0.1	% CaCO3		**0.6**	**0.3**	**2.3**	**0.2**	**12.4**
Fizz Rating	----	0	Fizz Unit		**0**	**0**	**1**	**0**	**2**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.10**	<0.01	<0.01	<0.01	**0.03**

Analytical Results

Sub-Matrix: SOLID (Matrix: SOIL)			Client sample ID	KC19_051 Geochem28 26-27m	KC19_051 Geochem26 15-16m	KC19_051 Geochem22 2-3m	KC19_051 Geochem25 9-10m	KC19_056 Geochem45
			Client sampling date / time	19-Feb-2019 00:00	19-Feb-2019 00:00	19-Feb-2019 00:00	19-Feb-2019 00:00	25-Feb-2019 00:00
Compound	CAS Number	LOR	Unit	EB1907170-016	EB1907170-017	EB1907170-018	EB1907170-019	EB1907170-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.9**	**7.4**	**7.2**	**7.0**	**5.9**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-68.1**	**-6.1**	**-3.5**	**-1.4**	**-3.4**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**495**	**144**	**172**	**105**	**150**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**68.7**	**6.7**	**3.5**	**3.2**	**3.4**
ANC as CaCO3	----	0.1	% CaCO3	**7.0**	**0.7**	**0.4**	**0.3**	**0.3**
Fizz Rating	----	0	Fizz Unit	**2**	**0**	**0**	**0**	**0**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.02**	<0.01	**0.06**	<0.01

Analytical Results

Sub-Matrix: SOLID (Matrix: SOIL)			Client sample ID	KC19_056 Geochem48 50.69-50.99m	KC19_055 Geochem40 55.43-55.86m	KC19_055 Geochem39 43.66-44.70	KC19_055 Geochem35 12-14m	KC19_055 Geochem33 2-3m
			Client sampling date / time	25-Feb-2019 00:00	24-Feb-2019 00:00	24-Feb-2019 00:00	24-Feb-2019 00:00	24-Feb-2019 00:00
Compound	CAS Number	LOR	Unit	EB1907170-021	EB1907170-022	EB1907170-024	EB1907170-025	EB1907170-026
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.0	8.4	8.5	5.0	5.2
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-83.4	-5.5	-16.6	-2.9	-0.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	363	337	256	631	74
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	84.3	7.0	18.7	3.5	0.9
ANC as CaCO3	----	0.1	% CaCO3	8.6	0.7	1.9	0.4	<0.1
Fizz Rating	----	0	Fizz Unit	2	0	1	0	0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.05	0.07	0.02	<0.01

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_055 Geochem34 3-6m	KC19_055 Geochem37 21-22m	KC19_044 Geochem14 53.31-53.84m	KC19_044 Geochem15 69.67-69.94m	Coal Sample 64m depth
				Client sampling date / time	24-Feb-2019 00:00	24-Feb-2019 00:00	24-Feb-2019 00:00	24-Feb-2019 00:00	12-Feb-2019 00:00
					EB1907170-027	EB1907170-028	EB1907170-029	EB1907170-030	EB1907170-031
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**5.0**	**6.5**	**9.2**	**9.3**	**7.8**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-1.1**	**-13.0**	**-23.6**	**-14.8**	**10.2**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**304**	**354**	**271**	**314**	**121**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**1.1**	**13.9**	**24.8**	**16.3**	**7.2**
ANC as CaCO3	----	0.1	% CaCO3		**0.1**	**1.4**	**2.5**	**1.7**	**0.7**
Fizz Rating	----	0	Fizz Unit		**0**	**1**	**1**	**1**	**0**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	**0.03**	**0.04**	**0.05**	**0.57**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC18-076 KC19_042 Geochem33 67.72-68.27m	KC19_056 Geochem49 63.76-64.20m	KC19_055 Geochem38 39.11-39.62m	KC19_051 Geochem32 57.01-57.39m	KC19_056 Geochem50 65.38-64.79m
				Client sampling date / time	12-Feb-2019 00:00	25-Feb-2019 00:00	24-Feb-2019 00:00	20-Feb-2019 00:00	25-Feb-2019 00:00
				EB1907170-032	EB1907170-033	EB1907170-034	EB1907170-035	EB1907170-036	
				Result	Result	Result	Result	Result	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	**9.0**	**8.6**	**9.4**	**8.3**	**8.7**	
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-8.3**	**-9.0**	**-134**	**-2.7**	**-9.1**	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	**170**	**345**	**425**	**195**	**329**	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**9.2**	**11.4**	**136**	**8.5**	**10.6**	
ANC as CaCO3	----	0.1	% CaCO3	**0.9**	**1.2**	**13.8**	**0.9**	**1.1**	
Fizz Rating	----	0	Fizz Unit	**0**	**1**	**3**	**0**	**1**	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.08**	**0.07**	**0.19**	**0.05**	

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_056 Geochem46 15-18m	KC19_056 Geochem51 69.60-70.11m	KC19_056 Geochem43 4-5m	KC19_056 Geochem47	KC19_055 Geochem36 16-18m
				Client sampling date / time	25-Feb-2019 00:00	25-Feb-2019 00:00	25-Feb-2019 00:00	25-Feb-2019 00:00	25-Feb-2019 00:00
					EB1907170-037	EB1907170-038	EB1907170-039	EB1907170-040	EB1907170-041
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**6.6**	**8.9**	**5.5**	**9.1**	**5.3**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-5.8**	**-18.7**	**-1.8**	**-57.8**	**-3.0**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**137**	**223**	**151**	**397**	**622**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**6.4**	**19.9**	**2.4**	**58.4**	**3.9**
ANC as CaCO3	----	0.1	% CaCO3		**0.6**	**2.0**	**0.2**	**6.0**	**0.4**
Fizz Rating	----	0	Fizz Unit		**0**	**1**	**0**	**2**	**0**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.04**	**0.02**	**0.02**	**0.03**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1910029**	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 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018064 Kogan Creek	Date Samples Received	: 16-Apr-2019 14:19
Order number	:	Date Analysis Commenced	: 24-Apr-2019
C-O-C number	: ----	Issue Date	: 24-Apr-2019 15:57
Sampler	: AMANDA CLEMENTS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 13		
No. of samples analysed	: 13		

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

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

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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.

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	BH KC19_025 25-25.31m	BH KC19_025 28.67-28.8m	KC19_025 9.97-10.47m	KC19_027 42.26-42.66m	KC19_031 24.73-25.35m
			Client sampling date / time	26-Jan-2019 00:00	26-Jan-2019 00:00	25-Jan-2019 00:00	27-Jan-2019 00:00	31-Jan-2019 00:00
Compound	CAS Number	LOR	Unit	EB1910029-001	EB1910029-002	EB1910029-003	EB1910029-004	EB1910029-005
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.078**	**0.139**	**0.006**	**0.107**	**0.104**

Analytical Results

Sub-Matrix: **PULP**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	KC19_036 49.70-50.04m	KC19_036 46.91-47.16m	KC19_034 geochem 8	KC19_041 64.79-65.13m geochem25	KC19_045 Geochem20 54.69-54.94m
				Client sampling date / time	05-Feb-2019 00:00	05-Feb-2019 00:00	03-Feb-2019 00:00	11-Feb-2019 00:00	15-Feb-2019 00:00
				EB1910029-006	**EB1910029-007**	**EB1910029-008**	**EB1910029-009**	**EB1910029-010**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%	**0.009**	**0.157**	**0.081**	**0.213**	**0.077**

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	Coal Sample 64m depth	KC19_051 Goechem32 52.01-52.39m	(SITE KC18_030) KC19_011 49.18-49.50m	----	----
			Client sampling date / time	12-Feb-2019 00:00	12-Feb-2019 00:00	26-Jan-2019 00:00	----	----
Compound	CAS Number	LOR	Unit	EB1910029-011	EB1910029-012	EB1910029-013	--------	--------
				Result	Result	Result	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.020**	**0.090**	**0.182**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1903521**	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 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018064 CS Energy Kogan Ck	Date Samples Received	: 12-Feb-2019 17:45
Order number	:	Date Analysis Commenced	: 13-Feb-2019
C-O-C number	: ----	Issue Date	: 20-Feb-2019 10:52
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
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

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

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.

- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-S (Soluable Metals by ICP-MS). However, the difference is within experimental variation of the methods.
- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Composite 1	Composite 2	Composite 3	Composite 4	----
			Client sampling date / time	12-Feb-2019 00:00	12-Feb-2019 00:00	12-Feb-2019 00:00	12-Feb-2019 00:00	----
Compound	CAS Number	LOR	Unit	EB1903521-001	EB1903521-002	EB1903521-003	EB1903521-004	--------
				Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.8	8.5	9.8	9.5	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	692	360	443	136	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	3.0	2.6	5.0	1.7	----
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	7.8	5.2	9.7	3.9	----
ø Exchangeable Magnesium	----	0.2	meq/100g	8.8	3.1	5.6	1.1	----
ø Exchangeable Potassium	----	0.2	meq/100g	0.4	0.4	0.6	0.4	----
ø Exchangeable Sodium	----	0.2	meq/100g	4.8	6.6	9.6	4.5	----
ø Cation Exchange Capacity	----	0.2	meq/100g	21.8	15.3	25.5	9.9	----
ø Exchangeable Sodium Percent	----	0.2	%	22.1	42.9	37.5	45.6	----
ø Calcium/Magnesium Ratio	----	0.2	-	0.9	1.7	1.7	3.5	----
ø Magnesium/Potassium Ratio	----	0.2	-	20.7	6.9	9.2	3.0	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	700	170	180	50	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	450	210	110	60	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	20	<10	<10	<10	----
Magnesium	7439-95-4	10	mg/kg	20	<10	<10	<10	----
Sodium	7440-23-5	10	mg/kg	720	360	440	110	----
Potassium	7440-09-7	10	mg/kg	20	<10	<10	<10	----
ED093T: Total Major Cations								
Sodium	7440-23-5	50	mg/kg	1520	1970	2540	1370	----
Potassium	7440-09-7	50	mg/kg	830	920	690	640	----
Calcium	7440-70-2	50	mg/kg	3360	3660	18100	1200	----
Magnesium	7439-95-4	50	mg/kg	3220	2200	3010	570	----
EG005S : Soluble Metals by ICPAES								
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	4890	5060	5010	2040	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	----
Iron	7439-89-6	50	mg/kg	29400	14200	13200	2850	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Composite 1	Composite 2	Composite 3	Composite 4	----
				Client sampling date / time	12-Feb-2019 00:00	12-Feb-2019 00:00	12-Feb-2019 00:00	12-Feb-2019 00:00	----
Compound	CAS Number	LOR	Unit		EB1903521-001	EB1903521-002	EB1903521-003	EB1903521-004	--------
					Result	Result	Result	Result	----
EG020S: Soluble Metals by ICPMS									
Arsenic	7440-38-2	0.01	mg/kg		<0.01	**0.06**	**0.24**	**0.11**	----
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	----
Cadmium	7440-43-9	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
Cobalt	7440-48-4	0.01	mg/kg		<0.01	**0.03**	<0.01	<0.01	----
Chromium	7440-47-3	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
Copper	7440-50-8	0.01	mg/kg		<0.01	**0.17**	<0.01	<0.01	----
Manganese	7439-96-5	0.01	mg/kg		**0.04**	**0.02**	<0.01	<0.01	----
Molybdenum	7439-98-7	0.01	mg/kg		**0.13**	**0.16**	**0.28**	**0.05**	----
Nickel	7440-02-0	0.01	mg/kg		<0.01	**0.09**	<0.01	<0.01	----
Lead	7439-92-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
Antimony	7440-36-0	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	----
Vanadium	7440-62-2	0.1	mg/kg		<0.1	<0.1	**0.2**	**0.2**	----
Aluminium	7429-90-5	0.1	mg/kg		<0.1	**0.7**	**0.5**	**2.7**	----
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		**5.8**	**3.0**	**3.3**	**0.8**	----
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	----
Cadmium	7440-43-9	0.1	mg/kg		**0.3**	**0.2**	**0.2**	**0.2**	----
Cobalt	7440-48-4	0.1	mg/kg		**61.7**	**12.7**	**14.5**	**1.0**	----
Chromium	7440-47-3	0.1	mg/kg		**5.8**	**5.5**	**3.8**	**1.2**	----
Copper	7440-50-8	0.1	mg/kg		**34.6**	**32.8**	**24.0**	**35.9**	----
Manganese	7439-96-5	0.1	mg/kg		**2210**	**250**	**542**	**97.3**	----
Molybdenum	7439-98-7	0.1	mg/kg		**0.9**	**0.5**	**0.8**	**0.1**	----
Nickel	7440-02-0	0.1	mg/kg		**33.4**	**13.0**	**12.4**	**1.6**	----
Lead	7439-92-1	0.1	mg/kg		**12.4**	**15.1**	**10.8**	**12.0**	----
Antimony	7440-36-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	----
Zinc	7440-66-6	0.5	mg/kg		**218**	**84.6**	**87.8**	**71.5**	----
Vanadium	7440-62-2	1	mg/kg		**32**	**32**	**20**	**5**	----
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		**4**	**1**	**1**	**2**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**0.9**	**1.2**	**0.2**	**0.1**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**960**	**940**	**370**	**280**	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Composite 1	Composite 2	Composite 3	Composite 4	----
				Client sampling date / time	12-Feb-2019 00:00	12-Feb-2019 00:00	12-Feb-2019 00:00	12-Feb-2019 00:00	----
Compound	CAS Number	LOR	Unit		EB1903521-001	EB1903521-002	EB1903521-003	EB1903521-004	--------
					Result	Result	Result	Result	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ **Total Nitrogen as N**	----	20	mg/kg		**960**	**940**	**370**	**280**	**----**
EK074: Fluoride Extractable Phosphorus (Bray)									
Fluoride Extractable P (Bray)	----	1.0	mg/kg		**1.2**	**2.2**	<1.0	<1.0	**----**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**1.13**	**1.42**	**0.70**	**1.01**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1910431**	Page	: 1 of 8
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018064 Kogan Creek	Date Samples Received	: 23-Apr-2019 15:15
Order number	: 2018064	Date Analysis Commenced	: 24-Apr-2019
C-O-C number	: ----	Issue Date	: 03-May-2019 14:40
Sampler	: AMANDA CLEMENTS		
Site	: Kogan Creek		
Quote number	: EN/222		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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.

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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.

- EG020-T (Total Metals by ICP-MS): Sample EB1910431-001(Composite 5) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- EG020-T (Total Metals by ICP-MS): Sample EB1910431-002(Composite 6) shows poor matrix spike recovery due to sample heterogeneity. Confirmed by visual inspection.
- EG005T (Total Metals): Sample EB1910431-001 (Composite 5) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- ED037 (Alkalinity): NATA accreditation does not cover the performance of this service.
- ED038 (Acidity): NATA accreditation does not cover the performance of this service.
- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Composite 5	Composite 6	Composite 7	Composite 8	Composite 9
			Client sampling date / time	23-Apr-2019 00:00	23-Apr-2019 00:00	23-Apr-2019 00:00	23-Apr-2019 00:00	23-Apr-2019 00:00
Compound	CAS Number	LOR	Unit	EB1910431-001	EB1910431-002	EB1910431-003	EB1910431-004	EB1910431-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.6	9.6	9.4	8.3	6.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	658	434	280	230	297
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	6.3	4.2	2.8	8.9	8.3
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	8.9	10.9	7.7	4.0	----
ø Exchangeable Magnesium	----	0.2	meq/100g	7.9	7.0	3.5	5.1	----
ø Exchangeable Potassium	----	0.2	meq/100g	0.5	0.6	0.6	0.2	----
ø Exchangeable Sodium	----	0.2	meq/100g	7.0	8.4	5.6	2.9	----
ø Cation Exchange Capacity	----	0.2	meq/100g	24.4	26.9	17.3	12.2	----
ø Exchangeable Sodium Percent	----	0.2	%	28.8	31.1	32.3	23.7	----
ø Calcium/Magnesium Ratio	----	0.2	-	1.1	1.6	2.2	0.8	----
ø Magnesium/Potassium Ratio	----	0.2	-	16.4	10.7	6.0	22.0	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	----	----	7.0
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	6.4
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	0.2
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	4.3
Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	----	17.8
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	24.2
Calcium/Magnesium Ratio	----	0.1	-	----	----	----	----	1.1
Magnesium/Potassium Ratio	----	0.1	-	----	----	----	----	32.8
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	834	774	761	486	538
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	834	289	315	486	538
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<5	486	446	<5	<5
ED038A: Acidity								
Acidity	----	1	mg/kg	182	<5	<5	<5	202
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	670	200	130	110	110
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	300	220	110	120	250
ED093S: Soluble Major Cations								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Composite 5	Composite 6	Composite 7	Composite 8	Composite 9
				Client sampling date / time	23-Apr-2019 00:00	23-Apr-2019 00:00	23-Apr-2019 00:00	23-Apr-2019 00:00	23-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		EB1910431-001	EB1910431-002	EB1910431-003	EB1910431-004	EB1910431-005
					Result	Result	Result	Result	Result
ED093S: Soluble Major Cations - Continued									
Calcium	7440-70-2	10	mg/kg		**20**	<10	<10	<10	<10
Magnesium	7439-95-4	10	mg/kg		**10**	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg		**620**	**440**	**330**	**280**	**420**
Potassium	7440-09-7	10	mg/kg		**20**	<10	**10**	<10	<10
ED093T: Total Major Cations									
Sodium	7440-23-5	50	mg/kg		**2000**	**1910**	**1620**	**1000**	**1050**
Potassium	7440-09-7	50	mg/kg		**580**	**460**	**710**	**320**	**260**
Calcium	7440-70-2	50	mg/kg		**3880**	**8910**	**7780**	**1510**	**4790**
Magnesium	7439-95-4	50	mg/kg		**2370**	**3110**	**2840**	**1120**	**1590**
EG005(ED093)S : Soluble Metals by ICPAES									
Boron	7440-42-8	1	mg/kg		<1	<1	<1	<1	<1
Iron	7439-89-6	1	mg/kg		<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**3730**	**3480**	**4100**	**2150**	**2700**
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		**13400**	**38000**	**25600**	**5510**	**13800**
EG020S: Soluble Metals by ICPMS									
Arsenic	7440-38-2	0.01	mg/kg		<0.01	**0.29**	**0.14**	**0.03**	<0.01
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	7440-47-3	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/kg		**0.04**	<0.01	<0.01	<0.01	<0.01
Manganese	7439-96-5	0.01	mg/kg		**0.04**	<0.01	<0.01	<0.01	**0.04**
Molybdenum	7439-98-7	0.01	mg/kg		**0.12**	**0.18**	**0.13**	**0.11**	**0.02**
Nickel	7440-02-0	0.01	mg/kg		**0.05**	<0.01	<0.01	<0.01	<0.01
Lead	7439-92-1	0.01	mg/kg		**0.01**	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.1	mg/kg		<0.1	**0.1**	**0.1**	<0.1	<0.1
Aluminium	7429-90-5	0.1	mg/kg		<0.1	**0.2**	**0.5**	**0.8**	**0.2**
Zirconium	7440-67-7	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		**3.4**	**2.8**	**1.3**	**1.6**	**2.5**
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Composite 5	Composite 6	Composite 7	Composite 8	Composite 9
			Client sampling date / time	23-Apr-2019 00:00	23-Apr-2019 00:00	23-Apr-2019 00:00	23-Apr-2019 00:00	23-Apr-2019 00:00
Compound	CAS Number	LOR	Unit	EB1910431-001	EB1910431-002	EB1910431-003	EB1910431-004	EB1910431-005
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.1	mg/kg	0.1	0.2	0.2	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	6.7	10.4	4.0	6.9	3.8
Chromium	7440-47-3	0.1	mg/kg	2.8	3.0	3.3	3.6	4.4
Copper	7440-50-8	0.1	mg/kg	21.9	22.8	27.8	6.2	7.3
Manganese	7439-96-5	0.1	mg/kg	279	1210	694	180	300
Molybdenum	7439-98-7	0.1	mg/kg	0.4	0.4	0.3	0.5	0.2
Nickel	7440-02-0	0.1	mg/kg	6.9	6.1	4.2	5.9	4.0
Lead	7439-92-1	0.1	mg/kg	13.9	10.6	16.2	5.8	4.6
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.5	mg/kg	64.4	92.9	56.6	17.4	23.2
Vanadium	7440-62-2	1	mg/kg	23	24	17	18	24
EK040S: Fluoride Soluble								
Fluoride	16984-48-8	1	mg/kg	<1	2	1	2	<1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.6	0.2	0.2	<0.1	0.3
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	740	370	1000	100	190
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	740	370	1000	100	190
EK074: Fluoride Extractable Phosphorus (Bray)								
Fluoride Extractable P (Bray)	----	1.0	mg/kg	4.3	1.2	1.2	<1.0	6.2
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	3.47	0.70	2.82	0.71	0.96

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Composite 10	----	----	----	----
			Client sampling date / time	23-Apr-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1910431-006	--------	--------	--------	--------
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.5**	----	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**369**	----	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**8.7**	----	----	----	----
ED006: Exchangeable Cations on Alkaline Soils								
ø **Exchangeable Calcium**	----	0.2	meq/100g	**10.2**	----	----	----	----
ø **Exchangeable Magnesium**	----	0.2	meq/100g	**9.4**	----	----	----	----
ø **Exchangeable Potassium**	----	0.2	meq/100g	**0.6**	----	----	----	----
ø **Exchangeable Sodium**	----	0.2	meq/100g	**7.9**	----	----	----	----
ø **Cation Exchange Capacity**	----	0.2	meq/100g	**28.1**	----	----	----	----
ø **Exchangeable Sodium Percent**	----	0.2	%	**28.0**	----	----	----	----
ø **Calcium/Magnesium Ratio**	----	0.2	-	**1.1**	----	----	----	----
ø **Magnesium/Potassium Ratio**	----	0.2	-	**14.8**	----	----	----	----
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	**2470**	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	**814**	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	**1650**	----	----	----	----
ED038A: Acidity								
Acidity	----	1	mg/kg	<5	----	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**70**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**90**	----	----	----	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	----	----	----	----
Magnesium	7439-95-4	10	mg/kg	<10	----	----	----	----
Sodium	7440-23-5	10	mg/kg	**400**	----	----	----	----
Potassium	7440-09-7	10	mg/kg	**10**	----	----	----	----
ED093T: Total Major Cations								
Sodium	7440-23-5	50	mg/kg	**1940**	----	----	----	----
Potassium	7440-09-7	50	mg/kg	**680**	----	----	----	----
Calcium	7440-70-2	50	mg/kg	**11800**	----	----	----	----
Magnesium	7439-95-4	50	mg/kg	**2790**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Composite 10	----	----	----	----
				Client sampling date / time	23-Apr-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1910431-006	--------	--------	--------	--------
					Result	----	----	----	----
EG005(ED093)S : Soluble Metals by ICPAES									
Boron	7440-42-8	1	mg/kg		<1	----	----	----	----
Iron	7439-89-6	1	mg/kg		<1	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**4960**	----	----	----	----
Boron	7440-42-8	50	mg/kg		<50	----	----	----	----
Iron	7439-89-6	50	mg/kg		**29200**	----	----	----	----
EG020S: Soluble Metals by ICPMS									
Arsenic	7440-38-2	0.01	mg/kg		**0.02**	----	----	----	----
Selenium	7782-49-2	0.1	mg/kg		<0.1	----	----	----	----
Cadmium	7440-43-9	0.01	mg/kg		<0.01	----	----	----	----
Cobalt	7440-48-4	0.01	mg/kg		<0.01	----	----	----	----
Chromium	7440-47-3	0.01	mg/kg		<0.01	----	----	----	----
Copper	7440-50-8	0.01	mg/kg		<0.01	----	----	----	----
Manganese	7439-96-5	0.01	mg/kg		<0.01	----	----	----	----
Molybdenum	7439-98-7	0.01	mg/kg		**0.03**	----	----	----	----
Nickel	7440-02-0	0.01	mg/kg		<0.01	----	----	----	----
Lead	7439-92-1	0.01	mg/kg		<0.01	----	----	----	----
Antimony	7440-36-0	0.01	mg/kg		<0.01	----	----	----	----
Vanadium	7440-62-2	0.1	mg/kg		<0.1	----	----	----	----
Aluminium	7429-90-5	0.1	mg/kg		**0.7**	----	----	----	----
Zirconium	7440-67-7	0.05	mg/kg		<0.05	----	----	----	----
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		**1.9**	----	----	----	----
Selenium	7782-49-2	1	mg/kg		<1	----	----	----	----
Cadmium	7440-43-9	0.1	mg/kg		**0.3**	----	----	----	----
Cobalt	7440-48-4	0.1	mg/kg		**20.8**	----	----	----	----
Chromium	7440-47-3	0.1	mg/kg		**3.6**	----	----	----	----
Copper	7440-50-8	0.1	mg/kg		**16.7**	----	----	----	----
Manganese	7439-96-5	0.1	mg/kg		**1890**	----	----	----	----
Molybdenum	7439-98-7	0.1	mg/kg		**0.5**	----	----	----	----
Nickel	7440-02-0	0.1	mg/kg		**9.5**	----	----	----	----
Lead	7439-92-1	0.1	mg/kg		**14.1**	----	----	----	----
Antimony	7440-36-0	0.1	mg/kg		<0.1	----	----	----	----
Zinc	7440-66-6	0.5	mg/kg		**53.2**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Composite 10	----	----	----	----
				Client sampling date / time	23-Apr-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1910431-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Vanadium	7440-62-2	1	mg/kg		**23**	----	----	----	----
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		**2**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**0.3**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**400**	----	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ **Total Nitrogen as N**	----	20	mg/kg		**400**	----	----	----	----
EK074: Fluoride Extractable Phosphorus (Bray)									
Fluoride Extractable P (Bray)	----	1.0	mg/kg		**2.2**	----	----	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**4.61**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1919898**	Page	: 1 of 2
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018064 Kogan Creek	Date Samples Received	: 31-Jul-2019 17:00
Order number	: 2018064	Date Analysis Commenced	: 01-Aug-2019
C-O-C number	: ----	Issue Date	: 06-Aug-2019 11:04
Sampler	: AMANDA CLEMENTS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
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

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*
Tom Maloney	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.

- 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: SOIL (Matrix: SOIL)			Client sample ID	Composite 1	Composite 2	Composite 3	Composite 4	----
			Client sampling date / time	31-Jul-2019 00:00	31-Jul-2019 00:00	31-Jul-2019 00:00	31-Jul-2019 00:00	----
Compound	CAS Number	LOR	Unit	EB1919898-001	EB1919898-002	EB1919898-003	EB1919898-004	--------
				Result	Result	Result	Result	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**2.7**	**2.4**	**4.7**	**1.7**	**----**
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	1	mg/kg	**1220**	**962**	**4380**	**612**	**----**
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	**1120**	**962**	**4000**	**438**	**----**
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	**105**	<5	**385**	**175**	**----**
ED038A: Acidity								
Acidity	----	1	mg/kg	<5	<5	<5	<5	**----**

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