Appendix F - Material Characterisation

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Appendix D – Materials Characterisation Study

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Section 1 Introduction – Rustlers Roost and Quest 29 Preliminary Geochemical Assessment

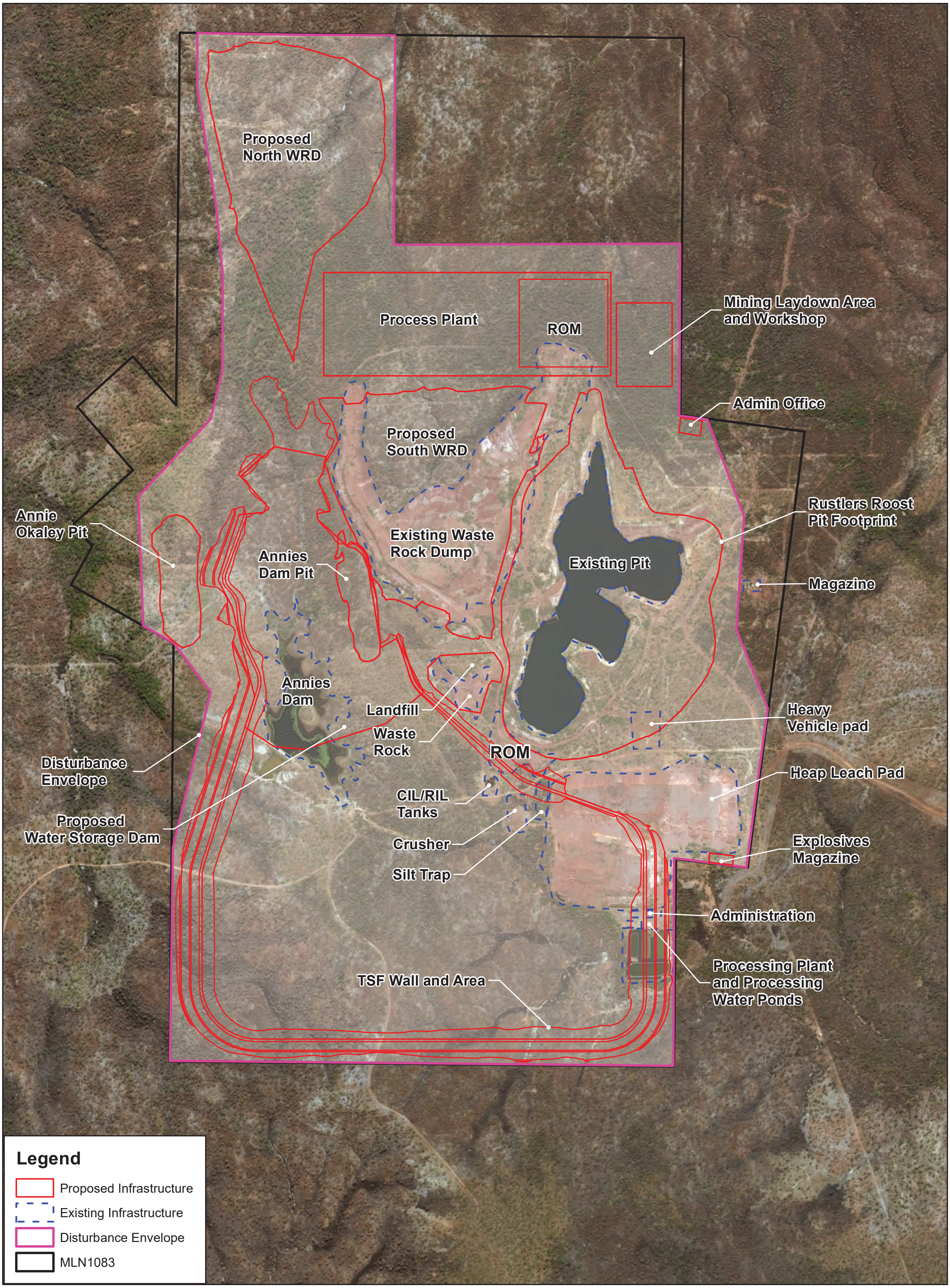
The Rustlers Roost and Quest 29 Open-cut Mine Redevelopment (herein referred to as the Project) will involve open-cut mining with the expansion of all existing open-cut pits and the development to two new smaller pits at Rustlers Roost. Primary Gold Limited (PGO) is the proponent of the mine redevelopment. The mine sites are located approximately 11 km apart and are connected by an existing unsealed access track, which will be upgraded to accommodate haulage of ore from the Quest 29 satellite pits to Rustlers Roost processing facility. Ore mined at both sites will be processed at a new purpose-built processing facility located at the Rustlers Roost site to produce gold bullion. The rate of production will be up to 5 Mtpa over an approximately ten-year life-of-mine (LOM).

Waste rock will be deposited in surface waste rock dumps (WRDs) and will be used to backfill a number of pits where mine scheduling permits. At Quest 29, a new surface WRD is proposed for mining of the first pit (Zamu), with the waste material from the four consecutive pits to be backfilled into Zamu pit and a portion of oxide material used for rehabilitation of the decommissioned heap leach facility. At Rustlers Roost, the majority of the waste rock material will be deposited within two surface WRDs (located partially over the historic WRD to the north-west of the main pit) and a portion backfilled into the two new minor pits (Annie's Dam pit and Annie's Oakley pit) (refer to Figure 1 and Figure 2).

Mined ore will be processed using a Carbon in Leach (CIL) processing method, which extracts gold from the ore by mixing with a cyanide solution. Tailings produced from the processing facility will be deposited in a Tailings Storage Facility (TSF) to be constructed as part of the Project.

The mining methodology will be consistent over Rustlers Roost and Quest 29, with the open-cut mining operation being conducted with conventional truck and shovel methods. Mining of Rustlers Roost and Quest 29 will be undertaken concurrently with each site having their own mining fleet.

Mined ore from each of the Quest 29 pits will be placed on the surface crest of the pit where it will be loaded into a haul truck and transported to the Rustlers Roost ROM for processing (refer to Figure 1).



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Notes:

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0 95 190 380
Meters
1 cm = 125 meters
GCS GDA 1994 MGA Zone 52

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DATA SOURCE
QLD Government Open Source Data

DESIGNER

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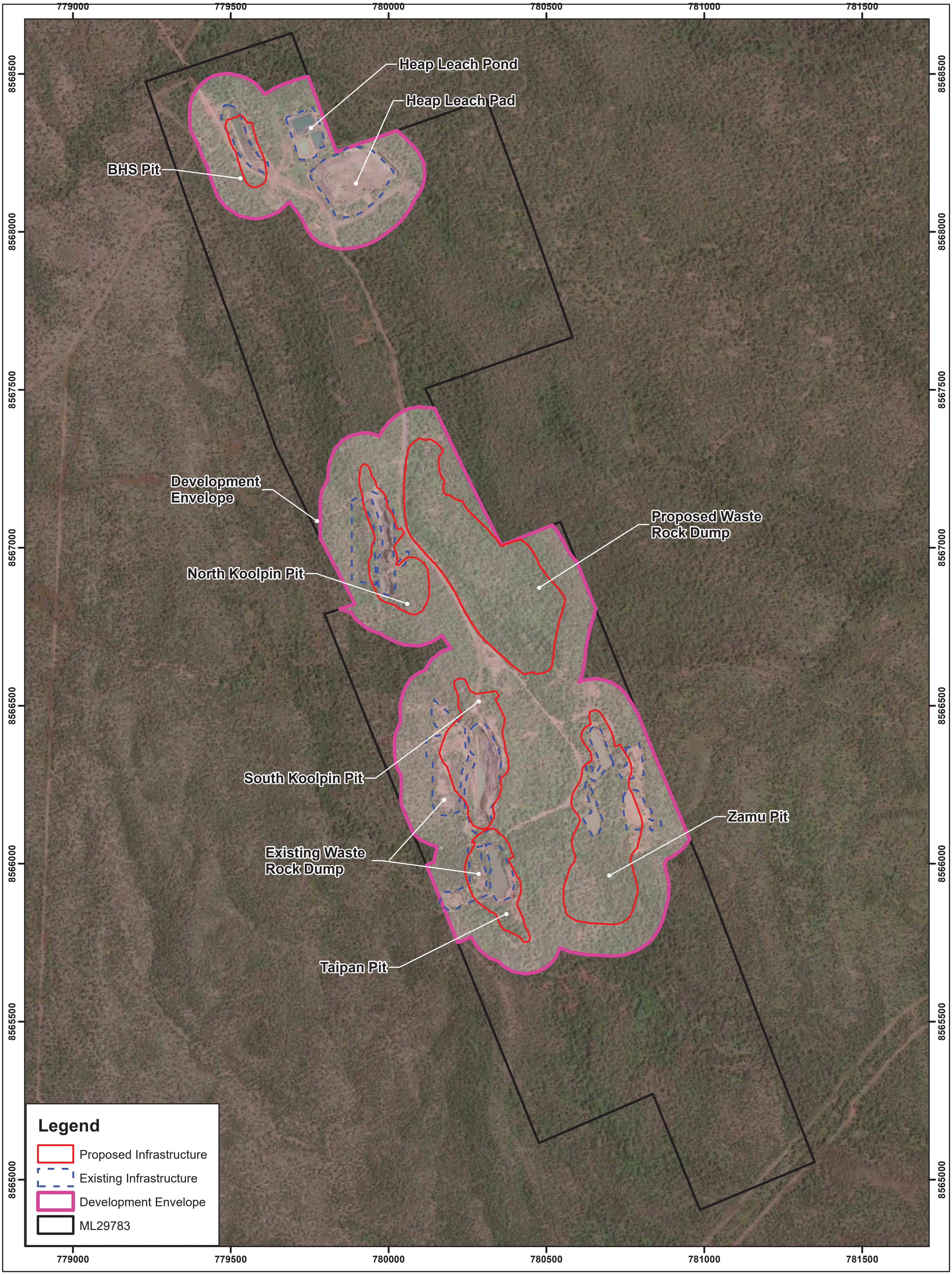
FIGURE 1

Rustlers Roost Existing and Proposed Infrastructure

DRG Ref: 1001087-EIS-04-4.1

C:\Users\Shilpass\Desktop\Hanking Gold Mine EIS\1001087 - Rustlers Roost EIS\1001087 - Rustlers Roost EIS\02 MXD\SEIS\Figure 2-3 RR Existing Proposed Infrastructure.mxd



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1 cm = 106 meters
GCS GDA 1994 MGA Zone 52

DATA SOURCE
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FIGURE 2

Quest 29 Existing and Proposed Disturbance Footprint

DRG Ref: 1001087-EIS-04-4.2

\\bga1svr1\Projects\US DOT\AustRoads\Hanking Gold Mine EIS\1001087 - Rustlers Roost EIS\1001087 - Rustlers Roost EIS\02 MXD\Chapter 4\Figure 4-2.mxd

Section 2 Objective and Scope of Works

The objective of this assessment is to consider the risk of acid and/or metalliferous drainage (AMD) generation from mining associated with the Project within the Pine Creek Inlier (Rustlers Roost and Quest 29).

In order to inform the risks and management measures necessary for the Project Environmental Impact Statement (EIS) to following scope has been completed:

- Task 1 - Desktop study: Review the available geological, hydrogeological and exploration information (drill hole assay data base, block model (descriptors of lithologies combined for each geozone) and cross-sectional outputs based on sulfur) for Quest 29 and any additional information of Rustlers Roost as an initial assessment for potential acid rock drainage issues for the two areas of interest;

- Task 2 - Complete a Static Geochemical Assessment: The static program was costed for a total of 150 samples collected from available drill core from Rustlers Roost and Quest 29. Rustlers Roost sampling was completed on historical drill core pulps, while Quest 29 sampling was completed on cores raised during the 2020 drilling program; and

- Task 3 - Complete a Kinetic Geochemical Assessment: A kinetic column program has been completed for 12 months. Ten columns containing waste, low grade ore, ore and tailings have progressed through the 12-month schedule. This Material Characterisation Study contains the original month 5 data results and is informed by analysis of the 12 month data from the kinetic column leach (refer to Appendix C). Based on review of the 12 monthly data, there have been changes in the results from the 5 and 10 month sample analysis. The results have been considered in the management and monitoring approaches included in the separate Acid and Metalliferous Drainage Management Plan (AMDMP). Primary Gold have also committed to continuing the kinetic test program as per the recommendations presented in Appendix C.

Section 3 Geology and Mineralisation

A detailed summary of the geology, soils, stream sediments, climate and hydrogeology has been provided previously by CDM Smith (CDM Smith 2019[1]). The following is a short summary of the geology and mineralisation of the region to support interpretation of the geochemical results.

3.1.1 Geology - Regional Setting (Pine Creek Inlier)

The Pine Creek inlier can be divided into five sub-regions: Lichfield Province, Rum Jungle Region, Central Region, South Alligator Valley and Alligator River (Ahmed 1998[1]).

Pine Creek is a metamorphosed and deformed Palaeoproterozoic sequence of pellites and psammites (silty and sandy sediments), with minor carbonate sediments and volcanics. Dolerite sills intruded into the region (Zamu Dolerite and equivalents) before the metamorphism and deformation (Ahmed 1998[1]).

During the regional deformation and metamorphism, the lithologies were tightly folded and faulted, metamorphic grades range from sub-greenschist facies (Lichfield Province) to upper Amphibolite facies (western Lichfield Province to eastern Alligator River). A series of younger granites cut through the Proterozoic metamorphic sequence (refer to Figure 3 below, Ahmed 1998[2]).

The mineral deposits are predominantly found within the central region where the granitoids dominate the geology.

The Pine Creek Inlier gold deposits have been into three groups; gold-quartz vein, stratiform gold lenses in iron rich sediments and stratabound zinc-lead-copper-gold-silver lenses (Ahmed *et al*., 1993[3]).

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[1] CDM Smith, 2019. Desktop Geochemical Assessment of the Rustlers Roost deposit. Report prepared for Primary Gold. April 2019.

[2] Ahmed M., 1998, Geology and Mineral Deposits of the Pine Creek Inlier and McArthur Basin, Northern Territory. AGSO Journal of Australian Geology and Geophysics, 17(3), 1-17.

[3] Ahmed, M., Wygralak, A.S., Ferenczi, P.A. and Bajwah, Z.U. 1993, 1:250 000 Metallogenic Map Series, Pine Creek, Northern Territory Geological Survey, Explanatory Notes, SD52-8.

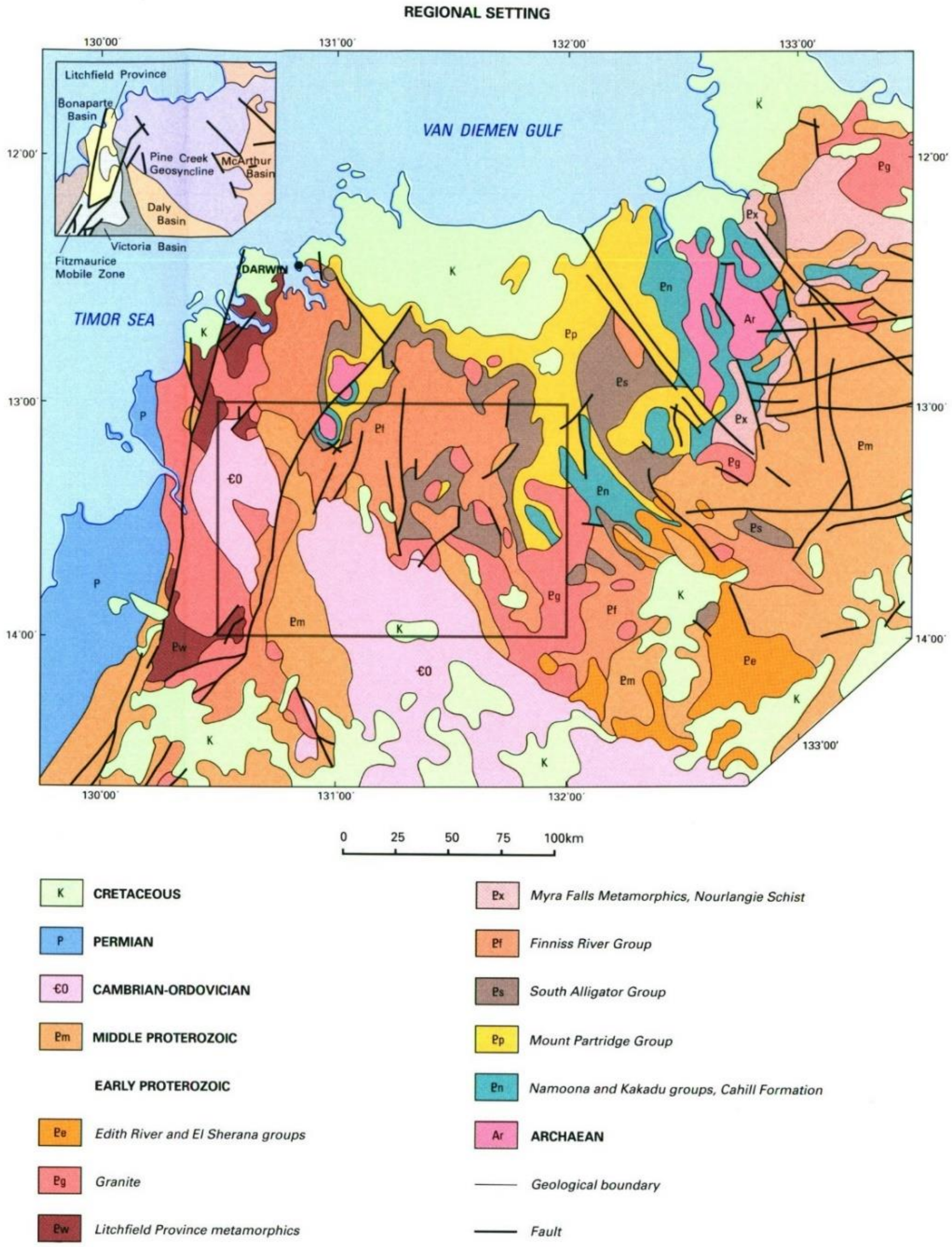

Figure 3 Geological Map of Pine Creek Inlier (GA Online Resource, Geological Map sd5208 Pine Creek

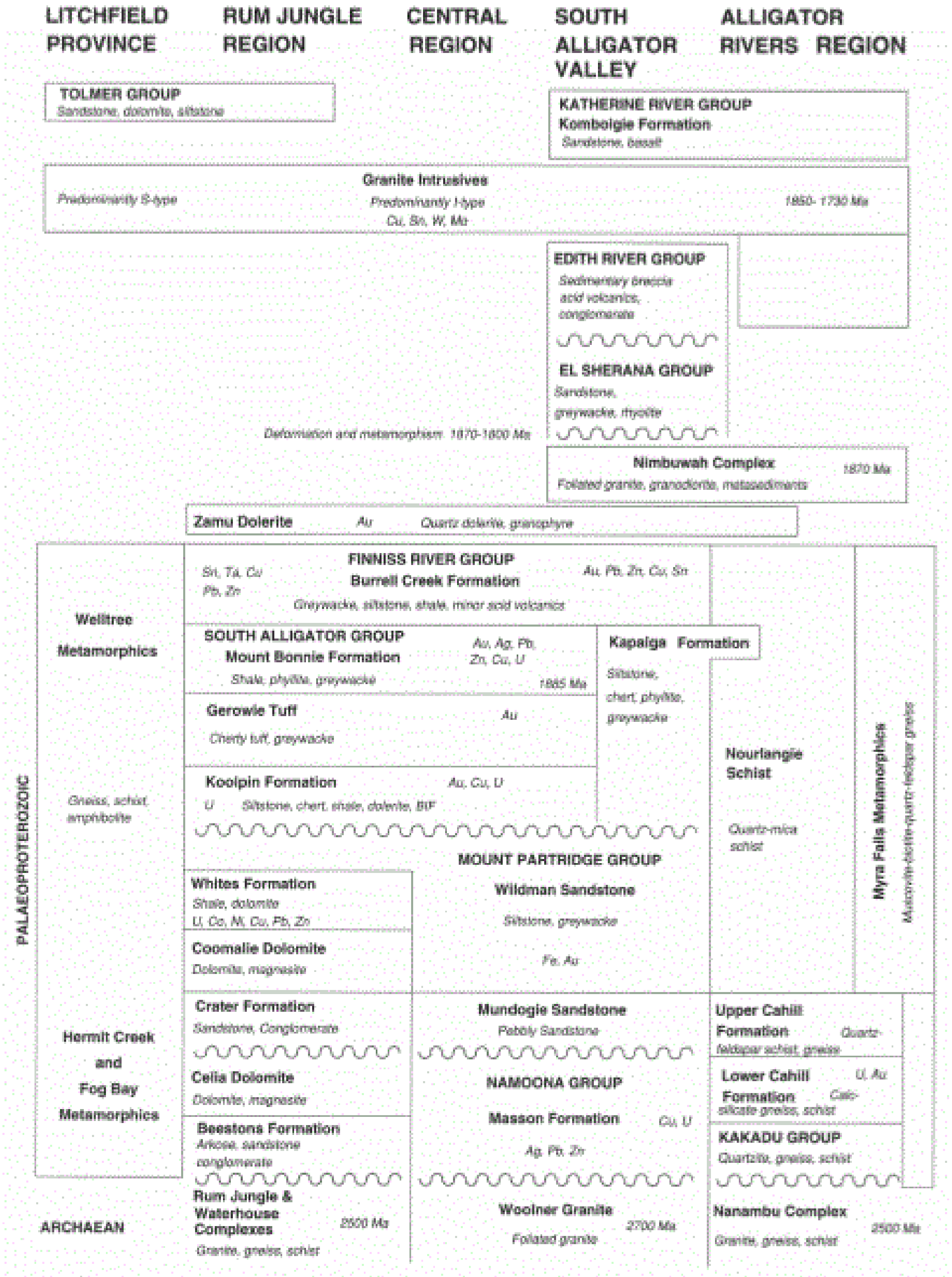

Figure 4 Regional Stratigraphy from Ahmed 1998

3.2 Local Geological Setting

Locally, the geology is described as highly weathered, thus the mining operations in the region have predominantly developed oxide ore. However, a substantial amount of transitional and sulfide mineralisation occurs beneath the oxide ore.

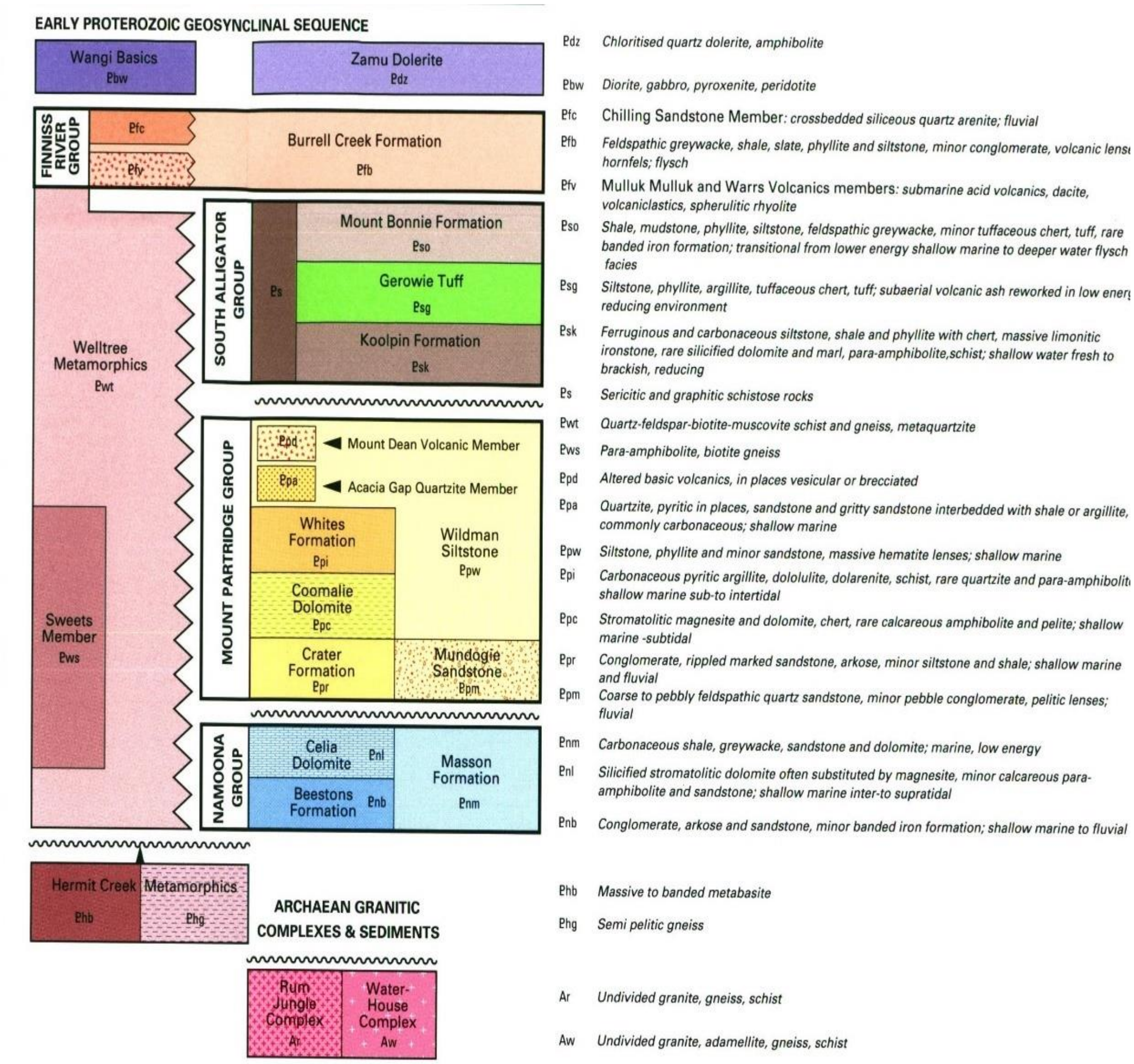

Figure 5 Archaean to Early Proterozic Stratigraphy and Lithological Descriptions (Geological Map Northern Territory Geological Survey 1993)

3.2.1 Rustlers Roost

The deposit type is described as “post Archean lode Au (Cu-Pb-Zn)”(Geoscience Australia, 2012[4]) and sits within sediments of the Wildman Siltstone (sandstone) and locally within Burrell Creek Formation (refer to Figure 4 and Figure 5 which are a series of Proterozoic turbidite marine sediments.

Rustlers Roost deposit also hosts mineralisation of the gold-quartz vein type. This fluid injection provided an overprint to the sedimentary geochemical signature. The quartz veins can be up to 2 m thick and contain gold as free metal. The gold in the host sediments is present as sub-micron particles in arsenopyrite and pyrite, but also can occur as free gold (Ahmed, 1998).

The mudstones in the oxidised unit are characterised by hematisation forming a distinctive red colour (with some green banding). The carbonate and pyrite can be seen to have been replaced either by a void (the carbonate) or by limonite (the pyrite), this is documented as evidence of groundwater movement (Higham, 1989[5]) through this zone.

In the fresh zone the mudstones contain chlorite, dolomitic carbonate, carbonaceous material (possibly graphite), clastic quartz and accessory leucoxene. Chert nodules surrounded by pyrite are common in the chlorite rich layers, pyrite rich zones can often be seen 1 mm to 1 cm in thickness (Higham, 1989). The pyrite within these zones is disseminated throughout the layer, in both euhedral (up to 1 mm in size) and framboidal (cluster) forms (Higham, 1989).

The chert is possibly formed from carbonate, these cherty units also contain pyrite, which can form up to 30% of the unit which can range in thickness from 5 cm to 1 m (Higham, 1989).

In general, for the region, it is documented that the gold-quartz veins formed at pressure-temperatures of approximately 1 kbar and 300°C in low to moderate salinity CO_2-CH_4-H_2O-Na-Ca-Mg-Cl brines of a mixed metamorphic and magmatic source. It is likely that this mixing of the magmatic and metamorphic fluids caused the precipitation of the gold Ahmed 1998).

There is a lack of correlation between gold mineralisation and any particular mineral assemblage. This is likely as a result of these multiple phases of fluid rock interaction.

3.2.2 Quest 29

Gold (Au) mineralisation is associated with structural features in sulfidic carbonaceous siltstones of the Koolpin formation and highly sulfidic contact zones of the Zamu dolerite and host sediments.

Host sediment mineralogy consists of hydrothermal alteration minerals such as amphibole, chlorite, sericite, tremolite, zeolite and clays. Ore mineralogy consists of the sulfide minerals arsenopyrite, bornite, chalcopyrite, galena, pyrite and pyrrhotite (GHD 2015).

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[4] Geoscience Australia Online Resource Geological Map sd5208 Pine Creek.

5 Higham, I.H., 1989. Annual Exploration Report for year four EL4773 and 4578, a report for Pegasus Gold Australia Limited by Eupene Exploration Enterprises Ltd, September 1989.

Section 4 Geochemical Characterisation – Previous Studies

Little is known in terms of the regions acid mine drainage (AMD) potential. GHD reported that Environmental Geochemistry International (EGi) had completed a site visit to the Mt Bundy Project assets; Toms Gully, Quest 29 and Rustlers Roost which was reported in 2011. EGi (2011[6]) noted that selective mine waste placement had not been implemented during operation of these sites. It was also noted that arsenic bearing acid generating wastes were likely at the sites particularly from the transitional and fresh zone of the geological profile. However, it was also mentioned that acid neutralising capacity is sufficient in some areas to neutralise the acid and thus not all mined material from the transition and fresh zones is potentially acid forming.

Given the lack of segregation of materials in the historic WRDs, EGi recommended that all WRDs be considered as acid and metalliferous drainage (AMD) sources.

In addition to the site visit, EGi also referenced a wider more regional study completed of the Pine Creek Inlier in recent times. A total of 243 samples were collected from across multiple deposits, the sulfur content (acid generation potential) and acid neutralising capacity was found to be highly variable, and the geochemistry was described as without lithological control. EGi proposed a sulfur cut off of 0.2 %S for acid generation based on their earlier regional study for the Pine Creek Area. Noting the limitations of the sample size that this estimate was based on, they (EGi) considered the cut off applicable to most materials within the region to manage AMD, as a conservative estimate.

EGi concluded that further geochemical assessment should focus on the in-situ materials and not the materials stored in the WRDs. EGi recommended that detailed characterisation of the lithologies present be carried out to assess the acid generation potential and the distribution of metals such as lead, zinc, cadmium, antimony, nickel and cobalt and metalloids such as arsenic and molybdenum.

GHD (2015) also reported that a preliminary waste characterisation study was completed in 1998 by Woodward Clyde for the pits proposed at Quest 29 at the time. A total of 20 samples were selected for geochemical characterisation from 18 drill holes across the suite of geological materials present within the project likely to be waste, oxide and fresh rock. Sample depths ranged from 3 to 65 m.

The Woodward Clyde review of ore and waste rocks described the composition of the geology as relatively homogeneous, consequently compositing of samples of 2-5m intervals was completed to gain sufficient samples for the test suite. The samples were described as representative or ore and waste, however no lithological descriptions were provided other than for the dolerite samples.

Nineteen (19) out of 20 samples were found to be potentially acid forming (PAF) or uncertain (UC) with one sample of dolerite classified as non-acid forming (NAF). Woodward Clyde noted that the lithological description of the materials was not well documented and mineralogical analysis was not available at the time. Thus, they concluded that further assessment of the project should include more sampling with greater descriptions of the rock type, weathering and mineralogy.

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[6] EGI 2011 report as referenced in GHD. 2015. Toms Gully Draft EIS - AMD Management Plan GHD 2015. Prepared by GHD for Primary Gold Ltd, March 2015.

4.1 Mine Waste

4.1.1 Rustlers Roost

A total of 56.4 Mt of waste material will be produced from Rustlers Roost pits (Table 1). A large portion of this waste material will be oxide zone materials (37%) and fresh zone materials (47%) (Table 1). Most of the waste will be placed within the two proposed surface WRDs, with the southern WRD being partially located over the historic WRD. A total of 5.36 Mt will be back filled into the mined pits.

Table 1 Rustlers Roost Pit Waste Volumes by Weathering Zone

Waste Zone	M Tonnes
Oxide	20.7
Transitional	9.0
Fresh	26.7
Total waste	**56.4**

The final WRD designs will be developed following geochemical characterisation of waste material. Graeme Campbell and Associates undertook a material characterisation program as part of the 1997 Public Environmental Review (PER) for stage 2 development. All fresh material was determined to be PAF and transitional material was a mixture of NAF and PAF. This current geochemical assessment of the materials available from the recent drilling program has been undertaken to further characterise the geochemistry of each of the main lithologies, with a particular focus on those in the transitional zone.

4.1.2 Quest 29

Total waste produced from Quest 29 is 12.1 Mt. Approximately 38% of waste material from Quest 29 will be oxide, 23% transitional and 39% fresh (Table 2).

Table 2 Quest 29 Pit Waste Volumes by Weathering Zone

Waste Zone	M Tonnes
Oxide	4.6
Transitional	2.8
Fresh	4.7
Total waste	**12.1**

A total of 4.39 Mt of waste from Zamu pit will be placed on the surface (just north of the Zamu pit) to create a new WRD. The WRD construction will commence with the placement of NAF material for the base and outer annulus. PAF material encountered will be placed onto of the NAF base, encapsulated within the centre of the WRD. No PAF material will be placed on outer perimeter, slopes, toe, surface or base of the dump.

The balance of waste material from mining will either be backfilled within Zamu pit or NAF material used to rehabilitate the decommissioned heap leach facility.

4.2 Sulfur Block Model

Integrated ore and waste/sulfur block models have been prepared for the project based on the geochemical data received from laboratory analysis to date (refer to Appendix A for Rustlers Roost and Appendix B for Quest 29).

For Rustlers Roost the modelling indicates the higher sulfur content material is near the 480 mRL to 460 mRL, about 100 m below surface (-20 to -40m AHD). Below the 530 mRL or 30 m AHD level there is a considerable amount of PAF material in the pit. The figure below provides an extract of the block model showing material with a S% content above 0.2% which is the cut-off concentration for PAF.

The Sulphur model has >0.2% total sulphur results below the geological oxide zone, confirming the oxide material is NAF.

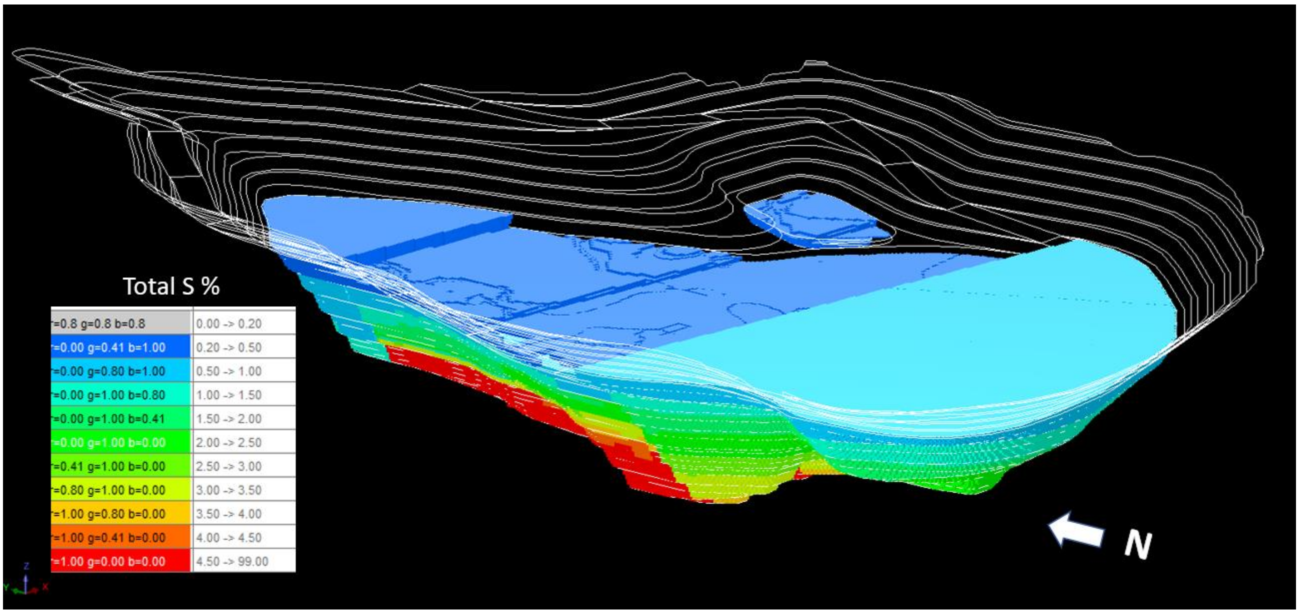


Figure 6 Isometric of the Designed Pit with Sulfide Waste Above 0.2% Total Sulfur

Evaluation of the Sulphur model usingx0.2% total sulphur as a cutoff the following tonnages of NAF and PAF are estimated from the sulphur model.

Table 3 Classification of PAF and NAF Wastes

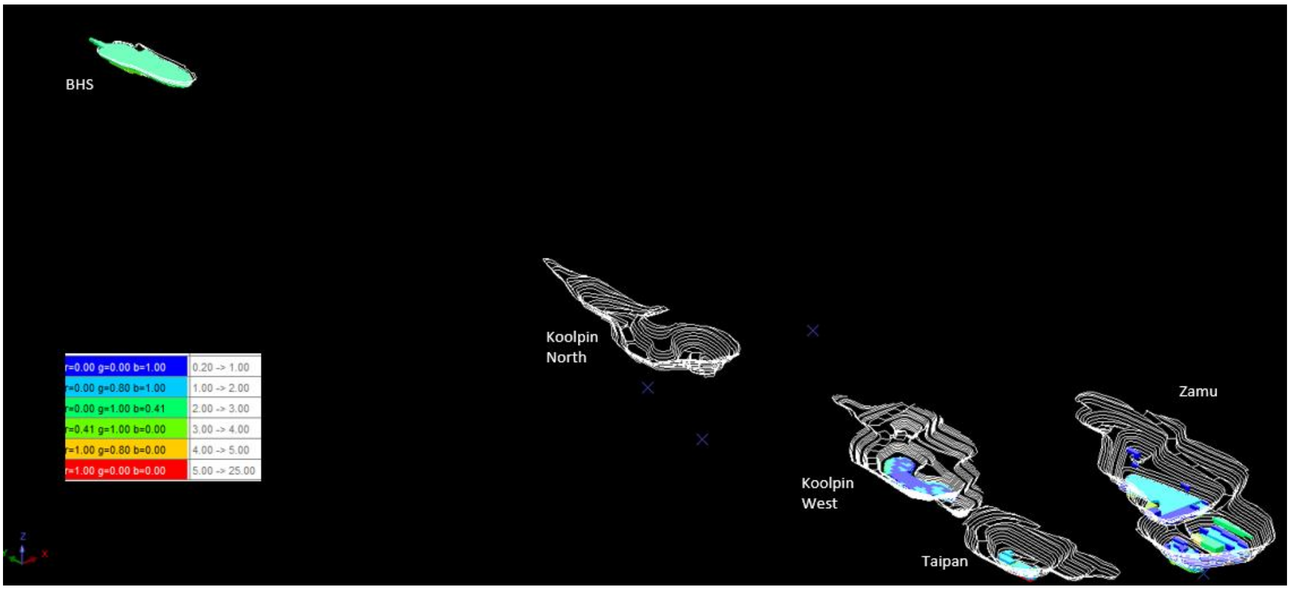
Classification	Tonnes	Total Sulfur %	Percentage of Pit Waste
PAF waste >0.2%% S	19.34	1.46	38%
NAF waste <0.2% S	31.56	0.00	62%

In the designed pit the PAF waste tonnes with a S% above 0.2% amounts to 19.34 Mt at an average percentage of 1.46% sulfur. There is approximately 0.29 Mt of sulfur in the PAF pit waste. In the Sulphur model 62% of the waste is classed as NAF and 38% is PAF.

With a total waste volume of 56.4 Mt (inclusive of all three pits at Rustlers Roost), this provides 37.06 Mt of waste material below the 0.2% sulfur content cutoff (NAF) (with 31.56 Mt coming from the main Rustlers Roost pit).

For Quest 29 the modelling indicates there is high sulfur content (PAF) material occurring in the base of the pits. The exceptions being BHS pit is high total sulfur (3% to 4%) from near surface and Koolpin North pit has no high S% sulfur (PAF material).

In the mine planning, oxide material will be used to encapsulate the transitional and fresh material. Most of the +0.2% sulfur material is below the base of oxide. The figure below provides an extract of the block model showing material with a S% content above 0.2.



In the designed pits the PAF waste tonnes with a S% above 0.2% amounts to 0.8 Mt at an average percentage of 2.30% sulfur. This equates to approximately 18.8 kt of sulfur in the PAF pits waste. The Quest 29 pits are relatively shallow, consequently this results in a relatively low tonnage of PAF material. With a total waste volume of 12.1 Mt, this provides 11.3 Mt of waste material below the 0.2% sulfur content cutoff (NAF).

4.3 Drill Programs

The most recent drill program at Rustlers Roost was completed in 2018. For Quest 29, PGO completed their drill program in late 2020. Rock samples (pulps, chips and core) were available for the preliminary geochemical assessment.

Cross-sections depicting the location of each drillhole were provided which were annotated by PGO. For Rustlers Roost, waste and ore zones were depicted with the proposed pit design.

For Quest 29, the cross-sections provided an indication of the location of the drill hole and the proposed pit shell outline. One drill hole per pit was available for sampling, with the exception of the two new small pits at Rustlers Roost.

Assay data was also provided for both deposits for these recent drill programs. Most samples were analysed for their gold (Au) content only.

As presented above, at each deposit three weathering zones exist. Sample selection was designed to select samples from each geological unit present in the data set, across each weathering zone while providing as best a spatial distribution as the sample set allowed.

4.4 Sample Limitations

For both deposits, the samples available for geochemical assessment are derived from drill programs designed to provide information for the areas designated for the proposed pit expansions.

Section 5 Geochemical Assessment Approach

Our iterative geochemical assessment approach drew upon the results of each phase of assessment to build a body of evidence of the geochemical nature of each material type (lithology).

This staged approach was one where the geological description drove the initial sample selection, with 30-50% of the samples selected for each subsequent phase of testing with a goal of selecting units for kinetic testing.

The static program was designed to support the material characterisation for full acid base accounting (ABA) analysis suite and elemental concentrations enabling classification for the potential for acid drainage (AD), saline drainage (SD) and neutral metalliferous drainage (NMD).

5.1 Sample Selection

5.1.1 Approach

Sampling has been undertaken from the pulps remaining from exploration assays. For Rustlers Roost these samples are those in storage from the 2018 drill program, material from nine drill holes were available for testing. At Quest 29, samples were selected from six drill holes undertaken during the 2020 drill program which targeted the waste units within the proposed expanded pits.

The sampling program was designed to sample all major lithologies described in the available data, with coverage of all weathering zones while providing as great a spatial distribution as possible.

The samples were selected from the assay database. This data set contained the hold identification (i.d.), sample i.d., gold concentration and also provided some indication of the sulfide mineralogy present.

5.1.2 Rustlers Roost

A total of 2,154 samples were listed in the assay database. Of these samples, 180 samples had insufficient mass remaining for further testing. A number of lithologies were poorly represented in the data set. The majority of the samples available were from the fresh zone (Table 4).

Table 4 Number of Samples Available for Analysis at Rustlers Roost

Total No. Pulp Samples Listed	Weathering Zone	No. Pulps
2154	Fresh	1465
	Transition	144
	Oxide	445

The major lithologies (those present as greater than 2% of drill hole length in the data set) were identified, reducing the number of samples to select from to a total of 2001 pulp samples.

The number of samples selected for each major lithology in each weathering zone is presented in Table 5.

Table 5 Major Lithologies Present in Rustlers Roost Dataset

Weathering Zone	Pct	Psh	Psl	Pst	Rsl	Scs	Ss	Total
Lithology	**Possible Chert**	**Shale**	**Siltstone**	**Sandstone**	**Lower Saprolite**	**Cherty Shale**	**Shale**	
Oxide		150	40	31	46		159	426
Transition	1	13	44	2		1	83	144
Fresh		229	313	65		3	821	1431
Total No. Samples Selected	**1**	**23**	**32**	**5**	**2**	**1**	**67**	**131**

Where Sulfur data was not available, the visible presence of pyrite logged was used as an indicator for sample selection.

A total of 80 samples were recommended for analysis from the transition zone, eight from the oxide zone and 43 from the fresh zone. Samples were selected from each lithology and each core where that lithology was recorded to provide as best a spatial representation as possible.

It is noted that the pulps remaining for Rustlers Roost under-represents the transitional zone as the samples for the transitional zone were only available for a limited area of the proposed pit.

Some samples of shale could not be found and thus were replaced by samples directly above or below the selected interval. This led to cherty shale (Scs) being introduced to the list of lithologies tested.

5.1.3 Quest 29

A total of 773 pulp samples were available for the study from nine drill holes. Assay for gold (Au) had been completed on the pulps at 1 m intervals for all nine drill holes. A total of 664 samples from the sample set had a gold concentration of less than or equal to 0.3% Au and thus would be considered waste. The majority of the gold is hosted within the units Pdz (dolerite), Psh (shale), Pst (sandstone), Sbs (black shale) and Vq (vein quartz).

Sulfur (S) data was not available, thus, as for Rustlers Roost, the visible presence of sulfide in the log was used as an indicator for sample selection. Sulfide was reported in 403 samples logged as pyrite, py (389), pyrrhotite, po (3) and arsenopyrite, ap (11).

There are seven main lithologies within the Quest 29 sample set (lithologies which have less than 12 samples in total in the sample set have been omitted) (Table 6). Noting the ore unit Vq is not included, given its minor presence in the logged core. All other ore lithologies are included.

Table 6 Number of Samples Available from each Major Lithology and Number Selected for Analysis at Quest 29

Weathering Zone	Psh	Rc	Rsr	Pst	Pdz	Psl	Sbs	Total
Lithology	**Shale**	**Clay**	**Saprock**	**Sandstone**	**Dolerite**	**Siltstone**	**Black Shale**	
Oxide	1	40	16	21				78
Transition	11		32	11	18	1	3	76
Fresh	17			34	191	44	198	480
Samples Selected	**5**	**4**	**8**	**7**	**16**	**4**	**16**	**60**

A minimum of three samples per lithology were selected, with one from each weathering zone where possible. Where possible, samples were selected from the top and bottom of the unit thickness to assist with delineation of any PAF, UC and NAF zones.

The gave a total of 60 samples to be selected for geochemical analysis comprising oxide (13), transition zone (10) and fresh (37). As far as possible the selected samples were located within the pit shell outline provided.

5.2 Phased Analytical Approach

A phased approach has been adopted for implementation of the geochemical assessment as presented in Table 7. The initial batch of 191 samples were selected for phase 1 of the analytical program, the number of samples moving through to each subsequent phase is indicative only, the final numbers selected were based on the interpretation of results from the preceding phase. Thus, the final number moving through to each phase are presented and discussed in each relevant results section.

Table 7 Phased Geochemical Assessment Approach – Initial Sample Numbers

Phase of Testing	Analytical Suite	No. of Samples
1	Paste pH, paste EC and total sulfur and total carbon	191
2	Acid base accounting - • Net acid generation – NAG, single addition • Acid neutralising capacity – ANC • Calculation of net acid production potential, NAPP and maximum potential acidity, MPA from total S • Multi elemental determination via four acid digest	50
3	Kinetic NAG and Acid buffering characterisation curves (ABCC)	50
4	Mineralogy – quantitative x-ray diffraction	20
5	Batch leach test program in de-ionised (DI) water Sequential 18 hr bottle roll at low liquid solid ratio (2:1) (5 steps) Assessment of leachates for a broad suite of components Note that that if no readily soluble materials are present this DI program can be replaced by a sequential NAG and liquor characterisation program to assess the drainage composition from the oxidation of fresh materials.	20 samples 100 leachates

5.3 Relevant Guidelines

The scope of works has been developed with consideration to the following guidelines:

- AMIRA (2002). ARD Test Handbook. Project P387A Prediction and kinetic control of acid mine drainage;
- Department of Foreign Affairs and Trade (DFAT) and Department of Industry Innovation and Science (2016). Leading Practice Sustainable Development Program for the Mining Industry: Preventing Acid and Metalliferous Drainage. Canberra;
- The International Network for Acid Prevention (INAP) (2009). Global Acid Rock Drainage Guide. Online resource;
- NT Environment Protection Authority (2013). Environmental Assessment Guidelines: Acid and Metalliferous Drainage. Version 2.0; and
- ANZECC/ARMCANZ 2018 Water quality guidelines.

Section 6 Results - Rustlers Roost

6.1 Phase 1 Static Testing

The analyses used to screen the samples for their potential to generate acid are paste pH, paste electrical conductivity and total sulfur (S %) results. Table 8 provides a summary of the data received for the Rustlers Roost deposit.

Table 8 Summary of Saturated Paste and Total Sulfur – Rustlers Roost

	Paste pH	Paste EC µS/cm	S %
Max	9.6	1180	2.55
Min	4.5	38	0.01 (LOR)
Average	7.2	183	0.336

Of the 131 samples analysed, 61 samples had measured S% below the limit of reporting (LOR) (0.01% S).

The following depicts these data in more detail. Box and whisker plots have been created which display the maximum and minimum values recorded (these are joined to form the vertical whisker), 25th and 75th percentiles are calculated which are represented by the top and bottom extent of the box which represents the interquartile range (IQR). The mean is represented by the line within the IQR, the median value of the data is represented by a cross (x).

Using the box and whisker presentation of these data, one can clearly determine whether there is a significant difference between the lithologies. If the IQR overlap, one can say that there is not a significant difference between the results.

6.1.1 Paste pH

Samples display a varied paste pH ranging from 4.5 to 9.6 (Figure 7, Figure 8 and Figure 9). The shale (Psh) in the transition zone had the lowest pH (with a pH value of 4.5).

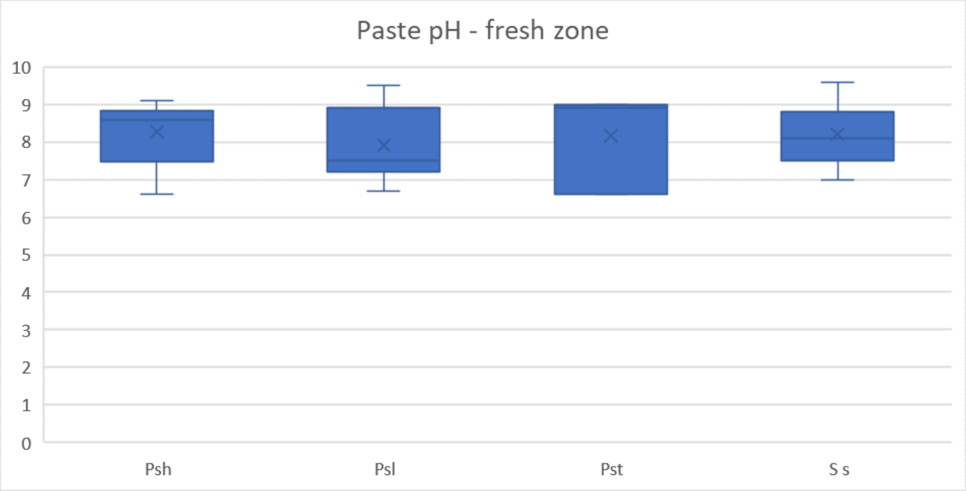


Figure 7 Paste pH - Fresh Zone – Rustlers Roost

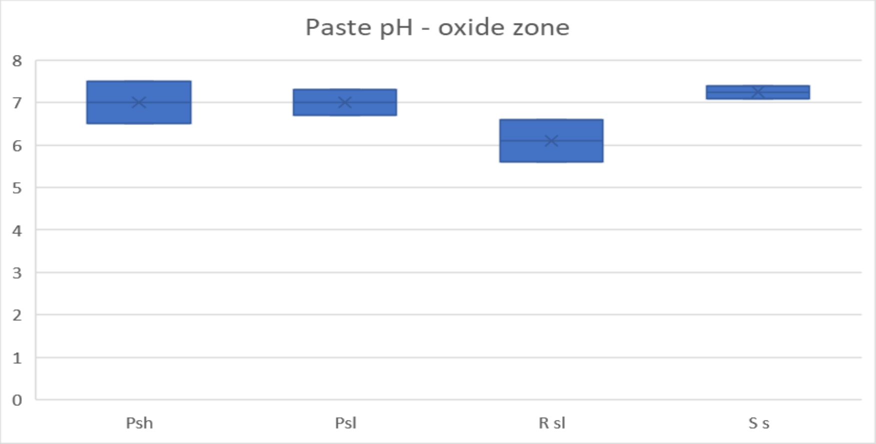


Figure 8 Paste pH Oxide Zone – Rustlers Roost

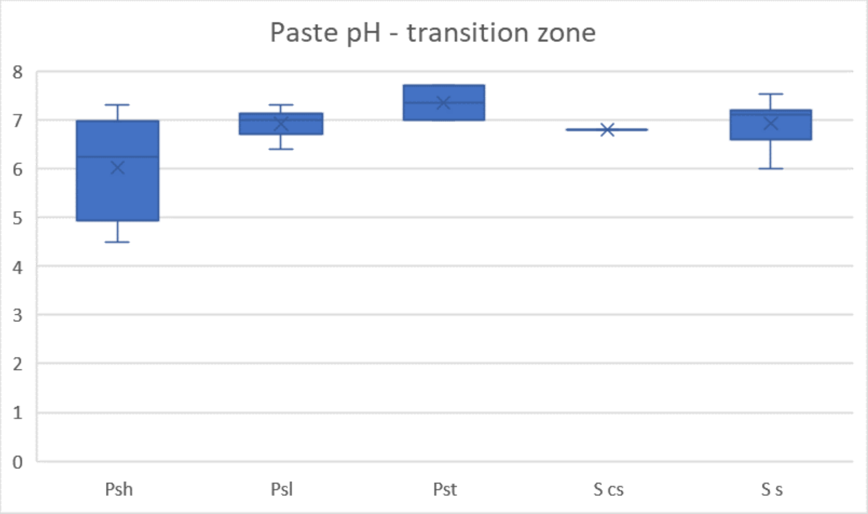


Figure 9 Paste pH Transition Zone – Rustlers Roost

6.1.2 Paste Electrical Conductivity

The samples displayed a varied range of EC values from fresh (38-500 µS/cm) to brackish (500 µS/cm -1180 µS/cm) (Figure 10, Figure 11 and Figure 12).

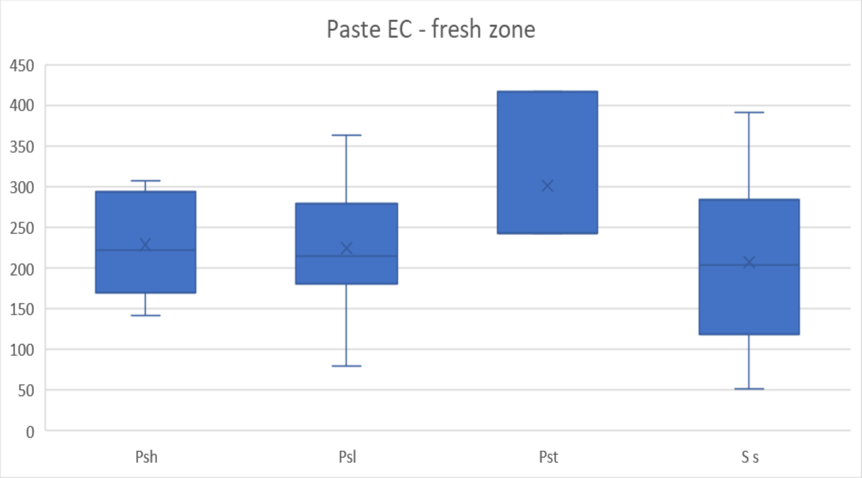


Figure 10 Paste Electrical Conductivity, Fresh Zone – Rustlers Roost

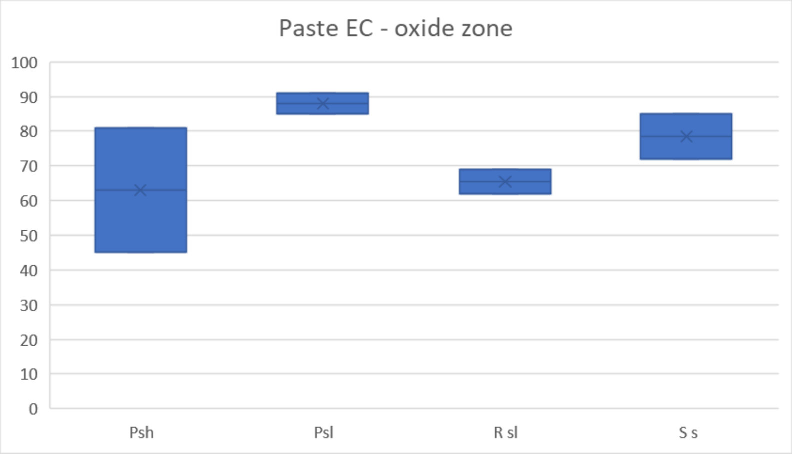


Figure 11 **Paste Electrical Conductivity, Oxide Zone – Rustlers Roost**

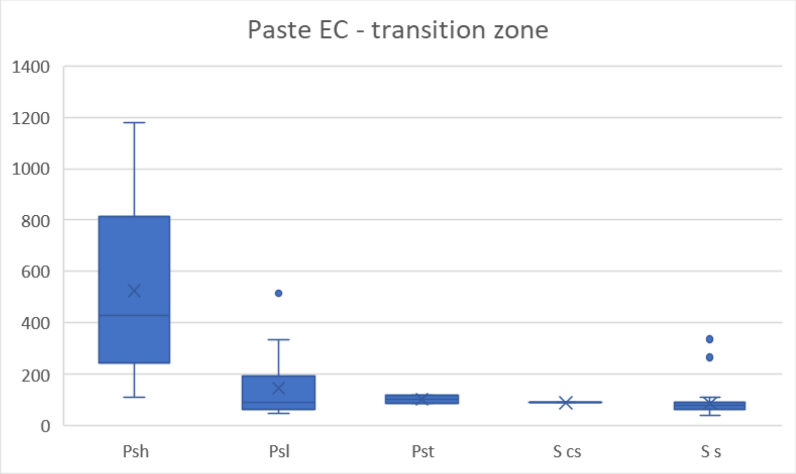


Figure 12 **Paste Electrical Conductivity, Transition Zone – Rustlers Roost**

It is clear that the transition zone lithologies (Figure 12) produce the highest paste EC values and also the greatest range of EC values of the sample set.

6.1.3 Total Sulfur Content

Total sulfur content of all selected samples was measured via the LECO combustion method. Figure 13 depicts the range of sulfur concentrations (as %S) measured in all samples, samples reporting sulfur below the LOR have been included with the value at the LOR (0.01 %S).

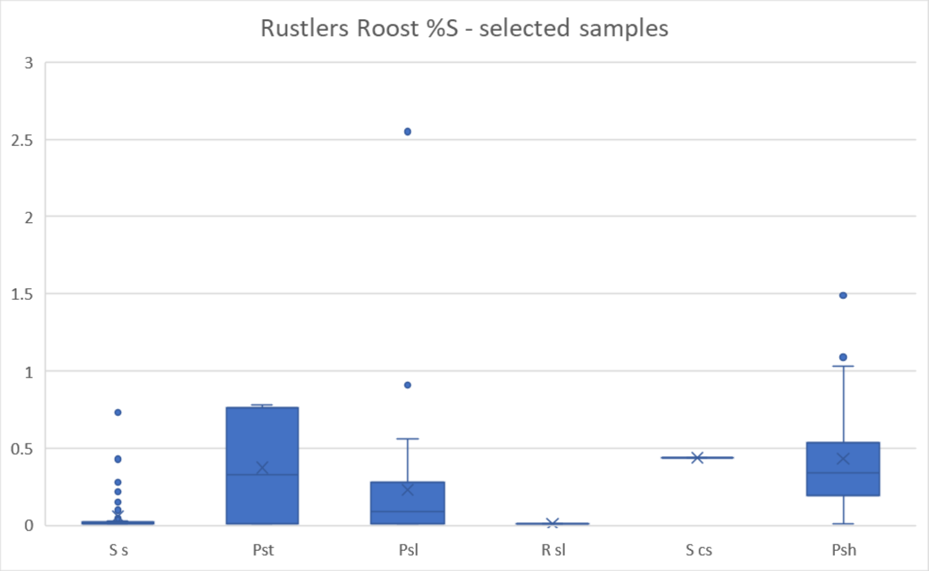


Figure 13 Total Sulfur Content (S%) of all Samples – Rustlers Roost

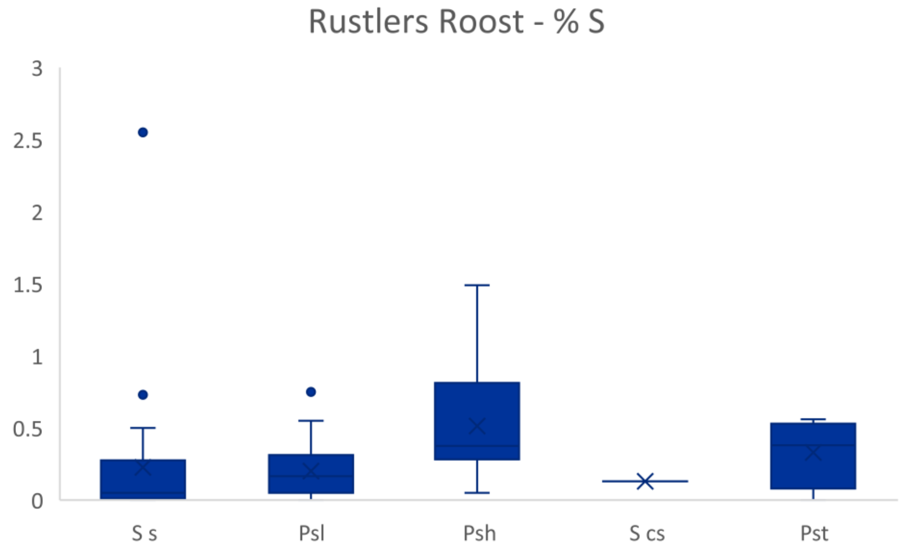


Figure 14 Total Sulfur Content (%S) for all Lithologies with %S above LOR – Rustlers Roost

When one compares Figure 13 with Figure 14, it is noted that the unit Rsl has no sample with a measured total sulfur concentration above LOR. Thus, although the two samples of this lithology had relatively low paste pH (below pH 6), this is not due to the presence of sulfur.

Based on these results, the unit Rsl was removed from further assessment.

A comparison of the measured sulfur contents of each lithology within each weathering zone has been undertaken to determine whether there is evidence of a relative sulfur depletion/enrichment for each zone. Figure 15, Figure 16 and Figure 17 present the results of this comparison.

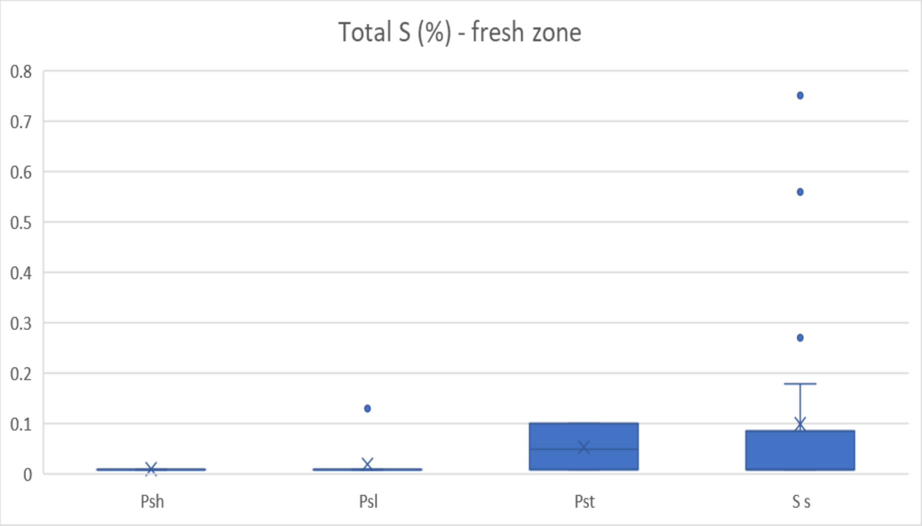


Figure 15 Total Sulfur (%S) Fresh Zone – Rustlers Roost

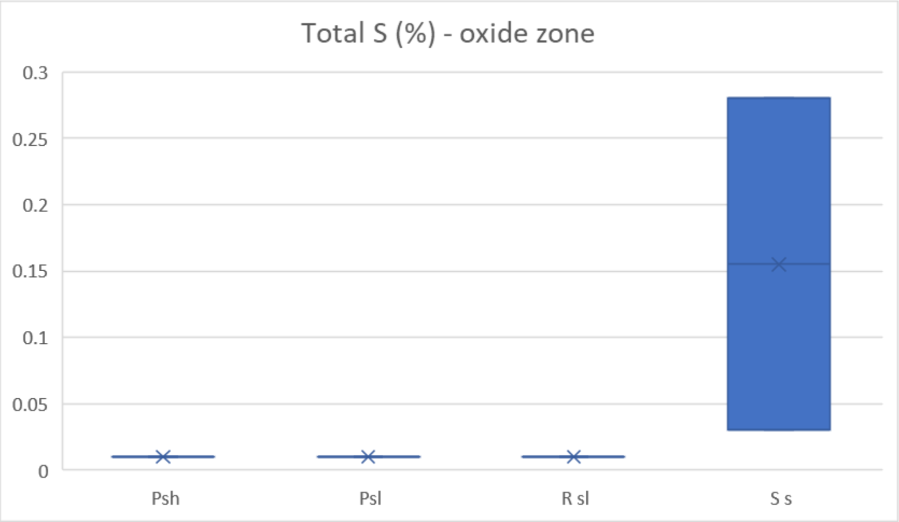


Figure 16 Total Sulfur (%S) Oxide Zone – Rustlers Roost

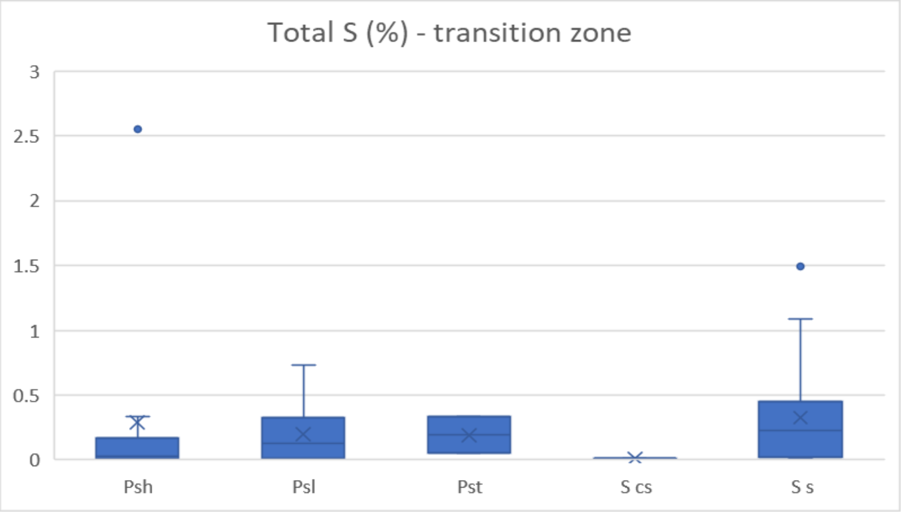


Figure 17 Total Sulfur (%S) Transition Zone – Rustlers Roost

The highest sulfur values in the sample set are located in shales (Psh and Ss) within the transition zone. The fresh zone has a relatively low sulfur content for all lithologies and the oxide lithologies are also generally low in sulfur.

The sulfur in the shales may have two forms; disseminated fine sulfides with sulfur contents of less than 1%S, and larger sulfide crystals, the larger crystals may represent the outliers in the data set. For example, in shale, Ss, in the oxide zone one sample was measured as containing 0.28%S, an order of magnitude higher than the remaining samples in the data set.

6.1.4 Carbon

Total carbon content of all samples was measured as %C, via the LECO combustion method, LOR was 0.1%C.

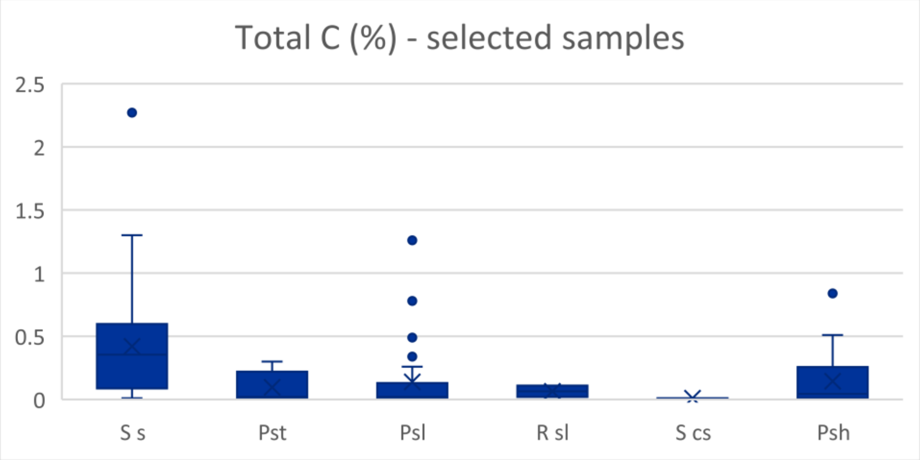


Figure 18 Total Carbon (%C) for Rustlers Roost Samples

Total carbon content of the samples was had values below the LOR (0.1% C) to a maximum of 2.27%. Figure 18 depicts the total carbon content of all samples assessed, where values were reported below LOR, these are graphed as LOR.

As completed for sulfur, a comparison of the carbon content of each major lithology within each weathering zone was completed. The results demonstrate that the transition zone samples host the highest carbon content of the sample set (Figure 21), the higher carbon values appear to generally be outliers given the majority of results are below 0.5%C in all weathering zones for all lithologies (Figure 19, Figure 20 and Figure 21).

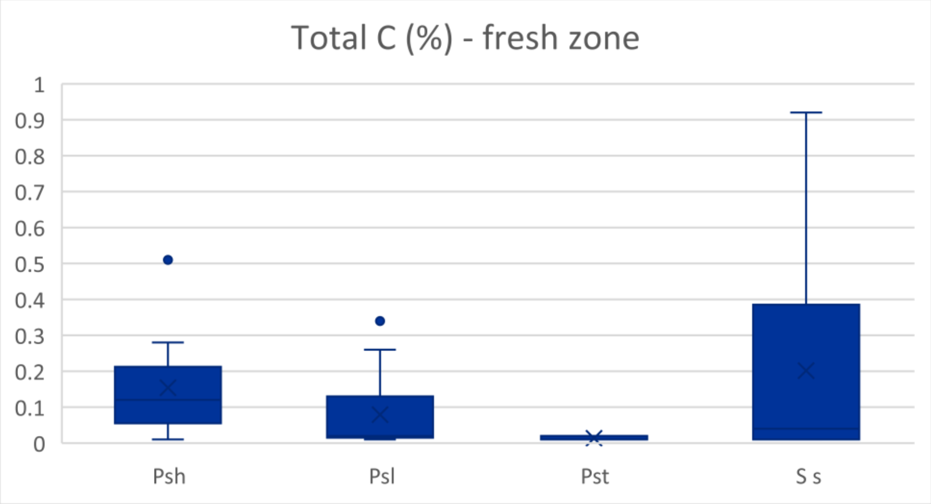


Figure 19 Total Carbon Content (%C) in Fresh Zone – Rustlers Roost

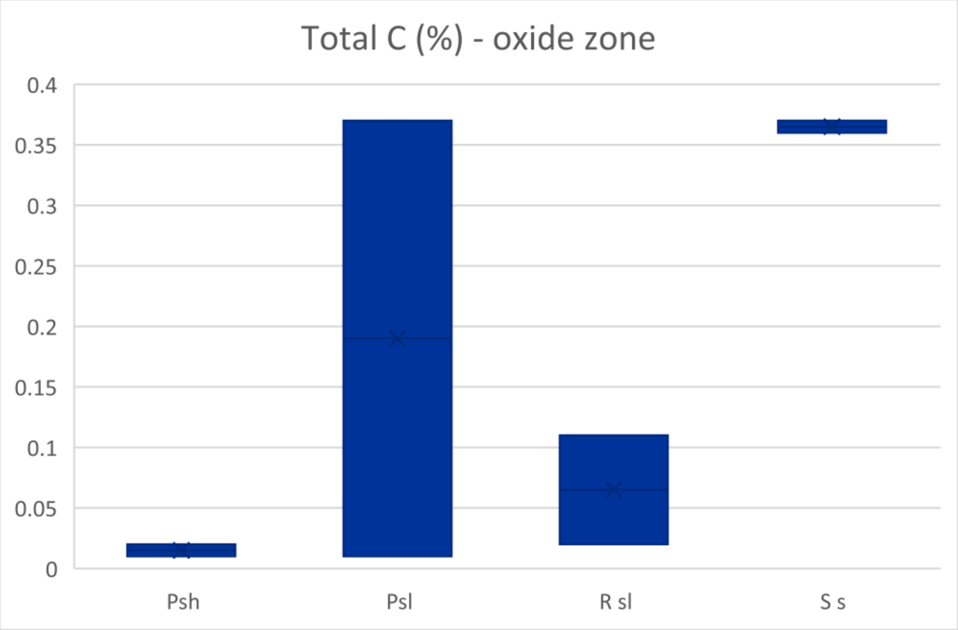


Figure 20 **Total Carbon Content (%C) in Oxide Zone – Rustlers Roost**

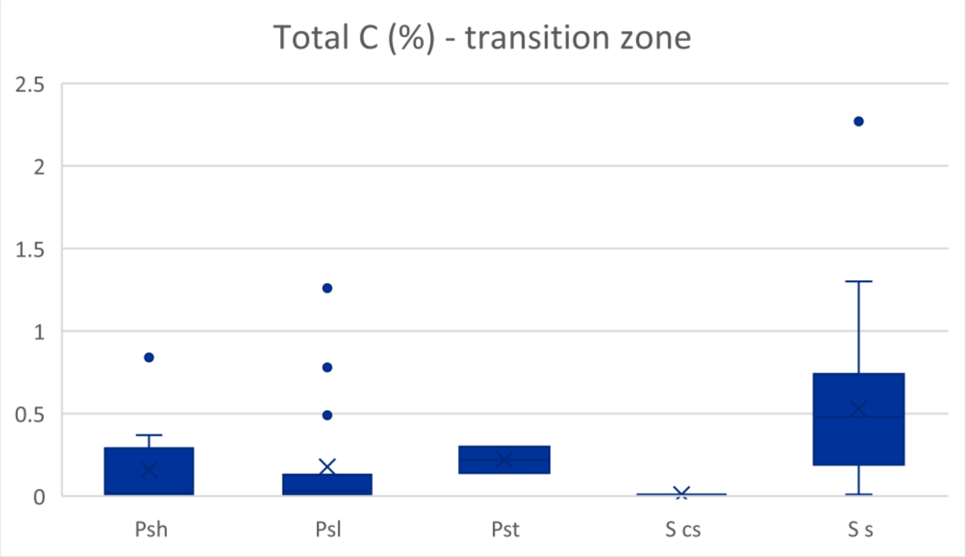


Figure 21 **Total Carbon Content (%C) in Transition Zone – Rustlers Roost**

6.2 Phase 2 – Static Testing (Rustlers Roost)

In phase 2 of the assessment, sulfur speciation and net acid generation (NAG) was determined on 30 samples from the sample set. These samples were those containing sulfur above the LOR with the lowest paste pH and the highest paste EC in each lithology.

6.2.1 Sulfur Speciation

To determine whether the sulfur within the samples was oxidised sulfur (sulfate) or reduced sulfur (sulfide), the acid soluble sulfur (S_{HCl}) and chromium reducible sulfur, CRS, expressed as Scr, were determined on thirty samples. All sulfur speciation results are presented as %S.

Acid soluble sulfate, SHCl, recovers soluble and exchangeable sulfate, sulfate from gypsum and a large proportion of the relatively insoluble iron and aluminium hydroxy sulfate compounds (for example jarosite, natrojarosite, schwertmannite). It also will allow the measured measurement of the concentration of some sulfur from organic matter, but not pyrite sulfur.

Chromium reducible sulfur determines the sulfide sulfur (Scr) content, without interference from organic sulfur.

Twenty five of the thirty samples assessed had Scr above the LOR (0.01%S), and all samples assessed had low concentration of SHCl indicating that most of the sulfur measured in the samples is sulfide rather than sulfate or exchangeable sulfur, all results are presented in Table 9.

Table 9 Sulfur Speciation Results; Acid Soluble Sulfur and Chromium Reducible Sulfur for Rustlers Roost

Sample	Lithology	Weathering Zone	S_{HCl} %S	S_{cr} %S
Fresh Zone				
HKR02354	Psl	fr	<0.01	<0.01
HKR00399	S s	fr	<0.01	0.01
HKR02253	Psl	fr	<0.01	0.12
HKR00394	S s	fr	<0.01	0.02
HKR02034	S s	fr	<0.01	0.02
HKR02126	Psl	fr	<0.01	0.13
HKR02161	S s	fr	<0.01	0.15
HKR00556	S s	fr	<0.01	0.02
HKR00935	Pst	fr	<0.01	0.26
HKR00953	Psl	fr	<0.01	0.21
HKR00598	S s	fr	<0.01	0.35
HKR00664	S s	fr	<0.01	<0.01
HKR01629	Psh	fr	<0.01	0.31
HKR01666	Psl	fr	<0.01	0.07
HKR01321	Psh	fr	<0.01	0.15
Transition and Oxide				
HKR02233	Ss	tr	<0.01	0.24
HKR02238	Psl	tr	0.02	0.58

Sample	Lithology	Weathering Zone	S_{HCl} %S	S_{cr} %S
HKR00007	S s	tr	<0.01	0.01
HKR00009	S s	tr	<0.01	<0.01
HKR00879	Psl	tr	<0.01	<0.01
HKR00681	Psh	tr	0.04	0.73
HKR00684	Psh	tr	0.09	1.3
HKR00687	Psh	tr	0.06	0.83
HKR00695	Psh	tr	0.02	0.32
HKR00696	Psh	tr	0.04	0.86
HKR00697	Psh	tr	0.04	0.74
HKR01141	Psl	ox	<0.01	<0.01
HKR01147	Psh	tr	0.02	0.30
HKR01148	Psh	tr	0.02	0.32
HKR01154	Psl	tr	<0.01	0.06

6.2.2 Carbon Speciation

To determine the proportion of carbon present as organic carbon, the total organic carbon (TOC) content was determined through acid digest of the sample followed by analysis of the residue by LECO combustion method. The inorganic carbon content is the Total Carbon (TC) value minus the TOC content.

Acid neutralising capacity (ANC) was also determined via the modified Sobek[7] method (as referenced in AMIRA 2002[8]). The Sobek method uses a known volume of hot hydrochloric acid to digest an accurately weighed sample of soil or rock. Sufficient time is allowed for the sample to react, then the resultant liquor is back titrated with sodium hydroxide to determine the amount of unreacted hydrochloric acid. The amount of acid consumed is then calculated and expressed as equivalents of sulfuric acid per unit mass of sample (kg H2SO4/t). If the sample has little acid neutralising capacity it will not react with the hot acid, or only has acid generating capacity, there will be an excess of acid in the final liquor. Both these situations will produce a low to below detection ANC result. If the sample has a mineral which reacts with the hydrochloric acid, this is measured as ANC.

The results are presented per lithology in each weathering zone in Table 10.

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[7] Sobek AA Schuller WA, Freeman JR and Smith RM, 1978. Field and Laboratory Methods Applicable to Overburdens and Mine Soils, EPA-600/2-78-054, pp 47-50.

[8] AMIRA (2002). ARD Test Handbook. Project P387A Prediction and kinetic control of acid mine drainage.

Table 10 Carbon Speciation – Rustlers Roost

Sample	Lithology	Weathering Zone	TOC %C	ANC kg H_2SO_4/t
Fresh Zone				
HKR02354	Psl	fr	0.09	4.6
HKR00399	S s	fr	0.11	12
HKR02253	Psl	fr	0.31	5.0
HKR00394	S s	fr	0.15	5.5
HKR02034	S s	fr	0.08	2.3
HKR02126	Psl	fr	0.09	11
HKR02161	S s	fr	0.73	44
HKR00556	S s	fr	0.11	18
HKR00935	Pst	fr	0.10	20
HKR00953	Psl	fr	0.12	5.6
HKR00598	S s	fr	0.89	38
HKR00664	S s	fr	<0.05	1.2
HKR01629	Psh	fr	0.21	11
HKR01666	Psl	fr	0.25	5.8
HKR01321	Psh	fr	0.15	18
Transition and Oxide				
HKR02233	Ss	tr	0.08	2.4
HKR02238	Psl	tr	0.21	2.0
HKR00007	S s	tr	0.23	2.5
HKR00009	S s	tr	0.12	3.7
HKR00879	Psl	tr	<0.05	1.9
HKR00681	Psh	tr	0.35	<0.5
HKR00684	Psh	tr	0.52	0.6

Sample	Lithology	Weathering Zone	TOC %C	ANC kg H_2SO_4/t
HKR00687	Psh	tr	0.51	1.5
HKR00695	Psh	tr	0.43	2.6
HKR00696	Psh	tr	0.14	2.9
HKR00697	Psh	tr	0.31	<0.5
HKR01141	Psl	ox	<0.05	1.4
HKR01147	Psh	tr	0.31	2.0
HKR01148	Psh	tr	0.39	0.9

6.3 Net Acid Generation and Net Acid Production Potential (RR)

The pH of the sample following digestion in a solution of hot hydrogen peroxide at a 1:100 solid to liquid ratio was conducted on the same 30 samples from Rustlers Roost as those tested for the previous analytes in phase 2 of the analytical program.

The fresh zone lithologies generally reported slightly higher NAG pH (from pH 2.9 to pH 8.8, with an average pH 5.05) than the lithologies present in the oxide and transition zone (pH 2.4 to pH 7.7, average pH 4.87).

The shale Psh produced the lowest NAG pH in both the fresh and transition weathering zones.

Net acid production potential (NAPP) is calculated from sulfide sulfur (S_{cr}) to calculate the maximum potential acidity (MPA) in kg of sulfuric acid per tonne of rock, and the measured ANC, also expressed as kg sulfuric acid per tonne of rock.

Sulfide sulfur, Scr (%S) x 30.6 gives MPA in kg H_2SO_4/t

MPA – ANC = NAPP

If the MPA is less than the measured ANC, the NAPP is negative which indicates the sample may have sufficient ANC to neutralise the acid it could generate (MPA). If the MPA exceeds the ANC, the NAPP will be positive indicating the sample could be acid generating.

The results of the NAG pH testing and NAPP calculations are presented in Table 11.

Table 11 **Net Acid Generation pH – Rustlers Roost**

Sample	Lithology	Weathering Zone	NAG pH pH Units	NAPP kg H_2SO_4/t
Fresh Zone				
HKR02354	Psl	fr	6.2	-4.60
HKR00399	S s	fr	7.6	-11.69
HKR02253	Psl	fr	4.0	-1.32
HKR00394	S s	fr	7.0	-4.88
HKR02034	S s	fr	5.6	-1.68
HKR02126	Psl	fr	7.1	-7.02
HKR02161	S s	fr	8.8	-39.41
HKR00556	S s	fr	7.9	-17.38
HKR00935	Pst	fr	6.6	-12.04
HKR00953	Psl	fr	3.2	0.82
HKR00598	S s	fr	8.3	-27.29
HKR00664	S s	fr	5.8	-1.20
HKR01629	Psh	fr	2.9	-1.51
HKR01666	Psl	fr	4.6	-3.65
HKR01321	Psh	fr	6.3	-13.41
Transition and Oxide				
HKR02233	Ss	tr	3.3	4.94
HKR02238	Psl	tr	2.7	15.74
HKR00007	S s	tr	6.1	-2.19
HKR00009	S s	tr	6.3	-3.7
HKR00879	Psl	tr	7.7	-1.9
HKR00681	Psh	tr	2.6	22.33
HKR00684	Psh	tr	2.4	39.18

Sample	Lithology	Weathering Zone	NAG pH pH Units	NAPP kg H_2SO_4/t
HKR00687	Psh	tr	2.6	23.89
HKR00695	Psh	tr	3.3	7.19
HKR00696	Psh	tr	2.6	23.41
HKR00697	Psh	tr	2.6	22.64
HKR01141	Psl	ox	6.9	-1.40
HKR01147	Psh	tr	3.2	7.18
HKR01148	Psh	tr	3.0	8.89

The NAPP of the fresh zone ranges from -39.41 to 0.82 kg H_2SO_4/t, with the highest NAPP reported in Psl, which is a siltstone, the lowest NAPP is reported in shale (Ss).

For the transition and oxide zones NAPP ranges from -3.7 to 39.18 kg H_2SO_4/t with the highest NAPP reported in shale Psh, the lowest NAPP is also reported in shale (Ss).

6.4 Geochemical Classification (Rustlers Roost)

Static test results (total S, total C and paste results), NAG pH and net acid production potential (NAPP) (calculated from sulfide sulfur (Scr) and ANC) are used to provide a classification of materials with respect to their acid generating potential. The following categories are used in the AMIRA classification system (Table 12):

- Non-acid forming (NAF);
- Potentially acid forming (PAF); and
- Uncertain (UC).

Table 12 Acid Generation Classification System

Sample Potential	Criteria	Comments
PAF	NAPP > 0 NAG pH < 4.5	A sample classified as PAF always has a significant sulfur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material.
NAF	NAPP < 0 NAG pH ≥ 4.5	A sample classified as NAF may, or may not, have a significant sulfur content but the availability of ANC within the sample is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulfide minerals.
UC	NAPP > 0 NAG pH ≥ 4.5	An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results. Uncertain samples are generally given a tentative classification that is shown in brackets e.g. UC (NAF).
	NAPP < 0 NAG pH < 4.5	

Source: AMIRA (2002). ARD Test Handbook. Project P387A Prediction and kinetic control of acid mine drainage.

The results of the classification are presented for the transition and oxide and fresh zones separately.

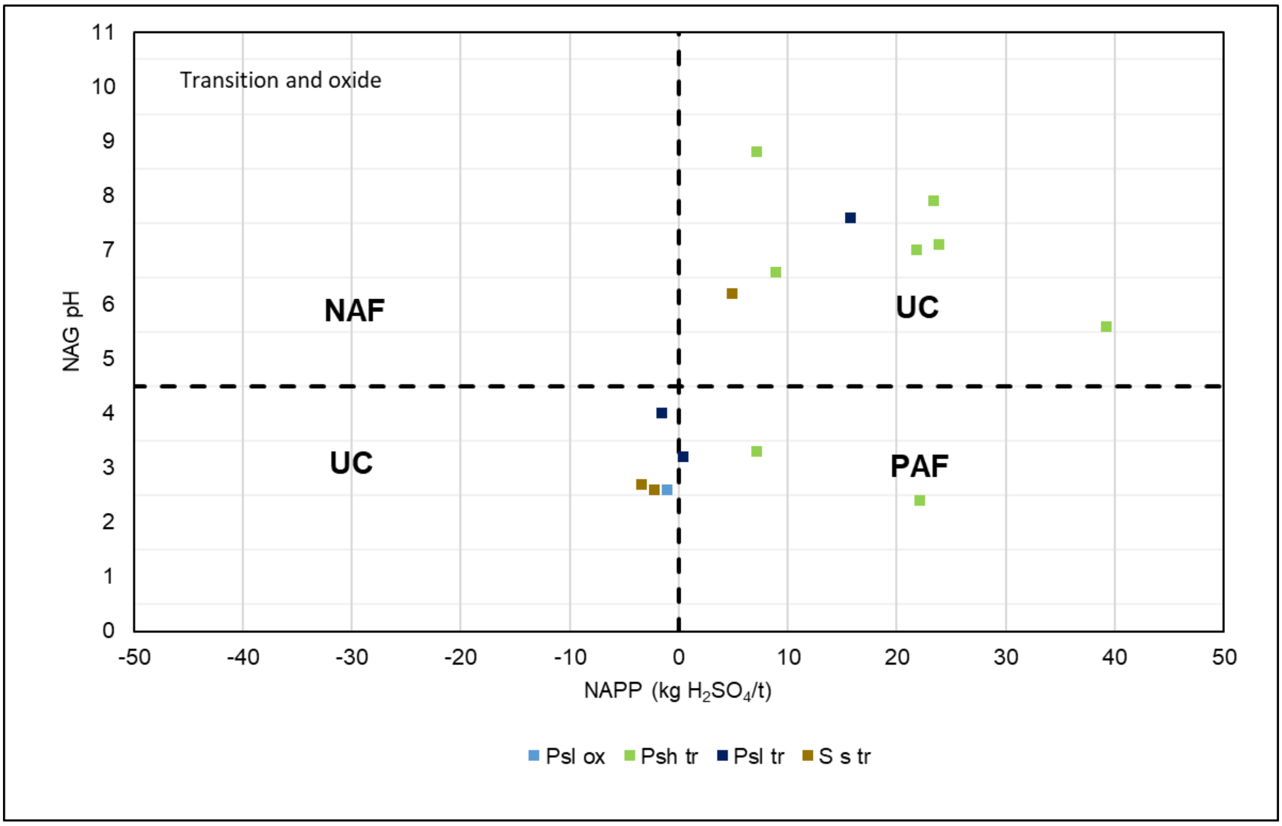

Figure 22 Geochemical Classification of Transition and Oxide Lithologies in Rustlers Roost

Of the 14 samples analysed from the transition zone, three have been characterised as potentially acid forming (PAF), the majority of the lithologies plot as uncertain (UC) they have a positive NAPP, but produce neutral to alkaline NAG pH.

This may be due to the NAG test not fully digesting the sulfide present given that only three out of the 14 samples did not report sulfide present as S_{cr} (%S).

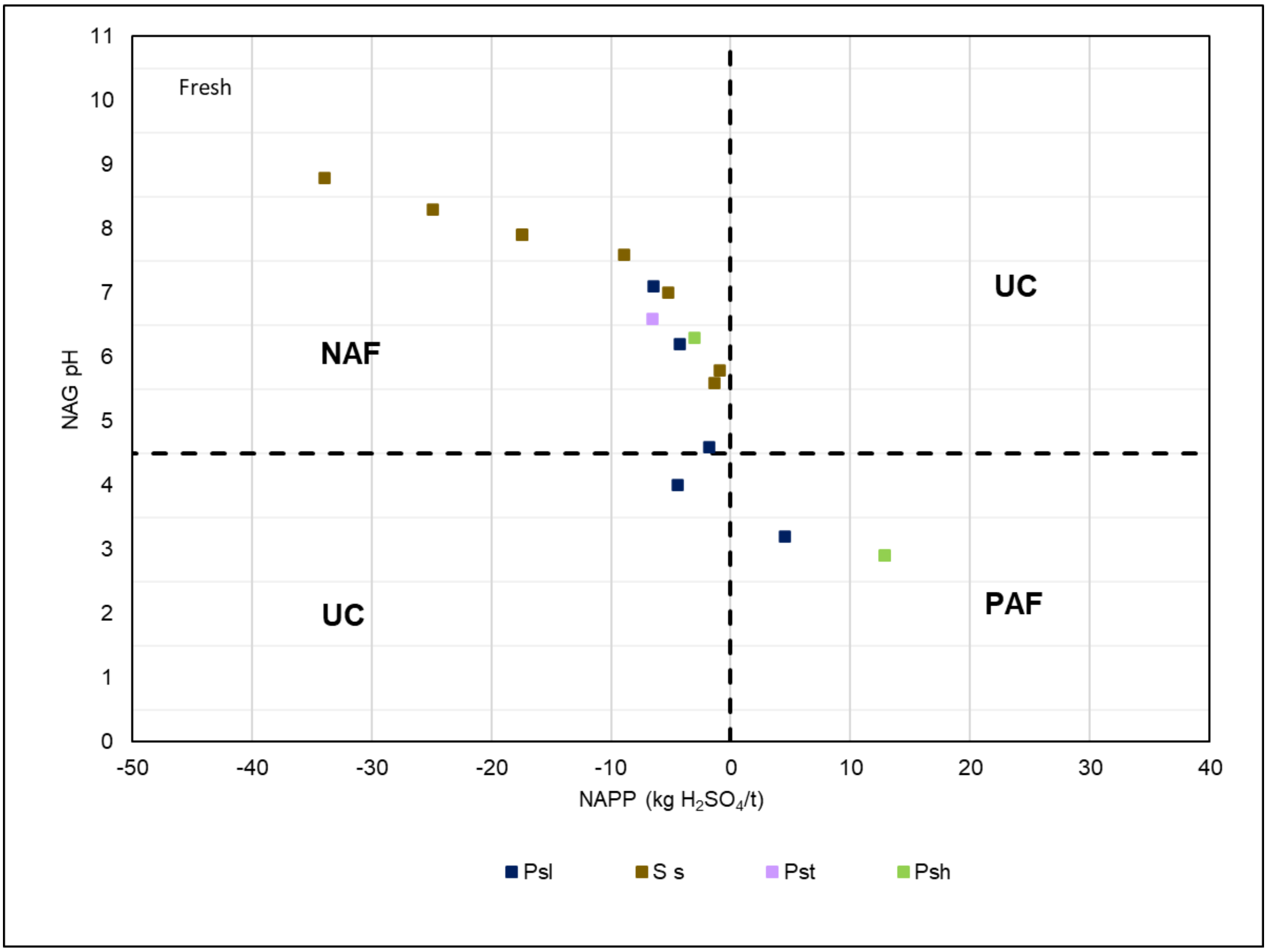

Figure 23 **Geochemical Classification of Fresh Zone Lithologies of Rustlers Roost**

6.5 Multi Element Content (Rustlers Roost)

All samples selected for phase 2 of the geochemical program were digested with four acids and their elemental composition determined. Figures of all trace elements assessed for each weathering zone is presented in Figure 24.

In general, there is little to distinguish the lithologies or which weathering zone they are from. The major components of all lithologies are Fe, C, and S which are present at levels measured in % (not shown). The remaining elements (trace elements) were reported as parts per million (or mg/kg), Figure 24.Of these trace elements, those dominating the signature of all lithologies are Al, K, Mg, P and Ti. One differentiating feature of the fresh zone lithologies is their Ca and Na concentrations, these are significantly higher than those of the oxide and transition zones.

The trace elemental signatures are also presented with the dominant trace elements removed to allow for differences within these elements of lower concentration to be observed (Figure 25). At the lower concentrations, Arsenic (As) is noted as having a relatively strong signature in the fresh zone Pst and oxide zone Rsl (Figure 25). This is likely due to the presence of arsenopyrite which has been documented in the logging of the core at the site and is a known sulfide mineral in the region.

Aluminium (Al) likely indicates the presence of alumino-silicates. The variable Na in each weathering zone with K one of the major elements present may be evidence of alkali feldspars (e.g. Albite (Na end member, high temperature) or Microcline (low temperature)). Sodium (Na) may also be evidence of sodic end members of the amphibole mineral group, which are common in hydrothermally altered sediments.

Calcium (Ca) and Mg may reflect influences from magnesian calcite or dolomite (Ca, Mg, carbonate) but can equally be due to Ca and Mg silicates such as olivine and diopside, pyroxenes or amphiboles such as hornblende which are common in gneiss and schists. Hydrothermal alteration minerals containing Ca and Mg such as chlorites are also likely to be present.

Manganese (Mn) and Ti possibly reflect marine mud influences of the original sediments prior to alteration and metamorphism.

Given Ce and La are present any phosphates may include Monazite. Fluorapatite is also a common phosphate in metamorphosed rocks, noting that fluorapatite has been reported with inclusions/solid solution with Monazite, this co-existence is possibly due to mobilisation of light rare earth elements with hydrothermal brines during the metamorphic event.

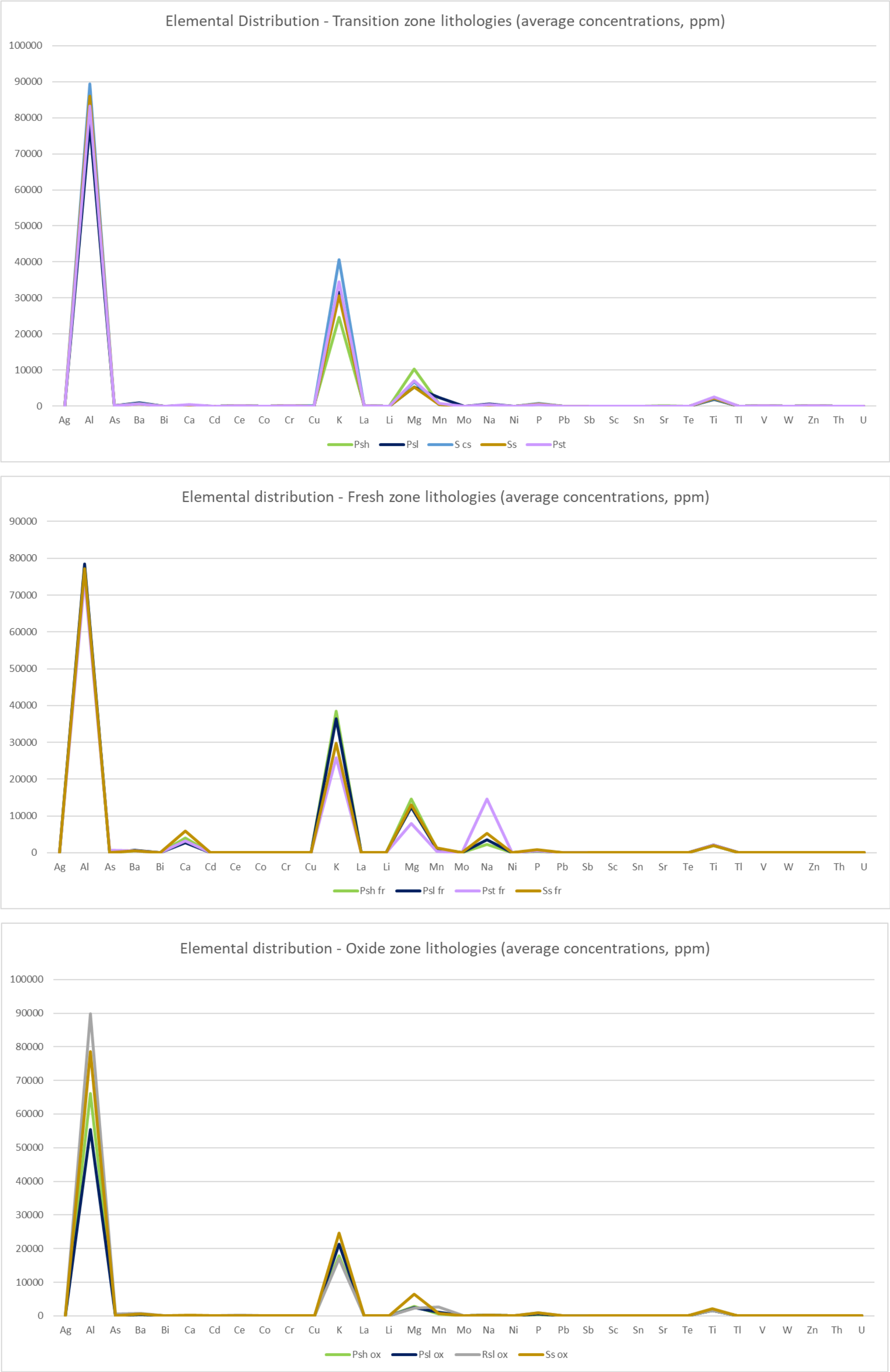

Figure 24 **Trace Elemental Distribution in all Zones at Rustlers Roost**

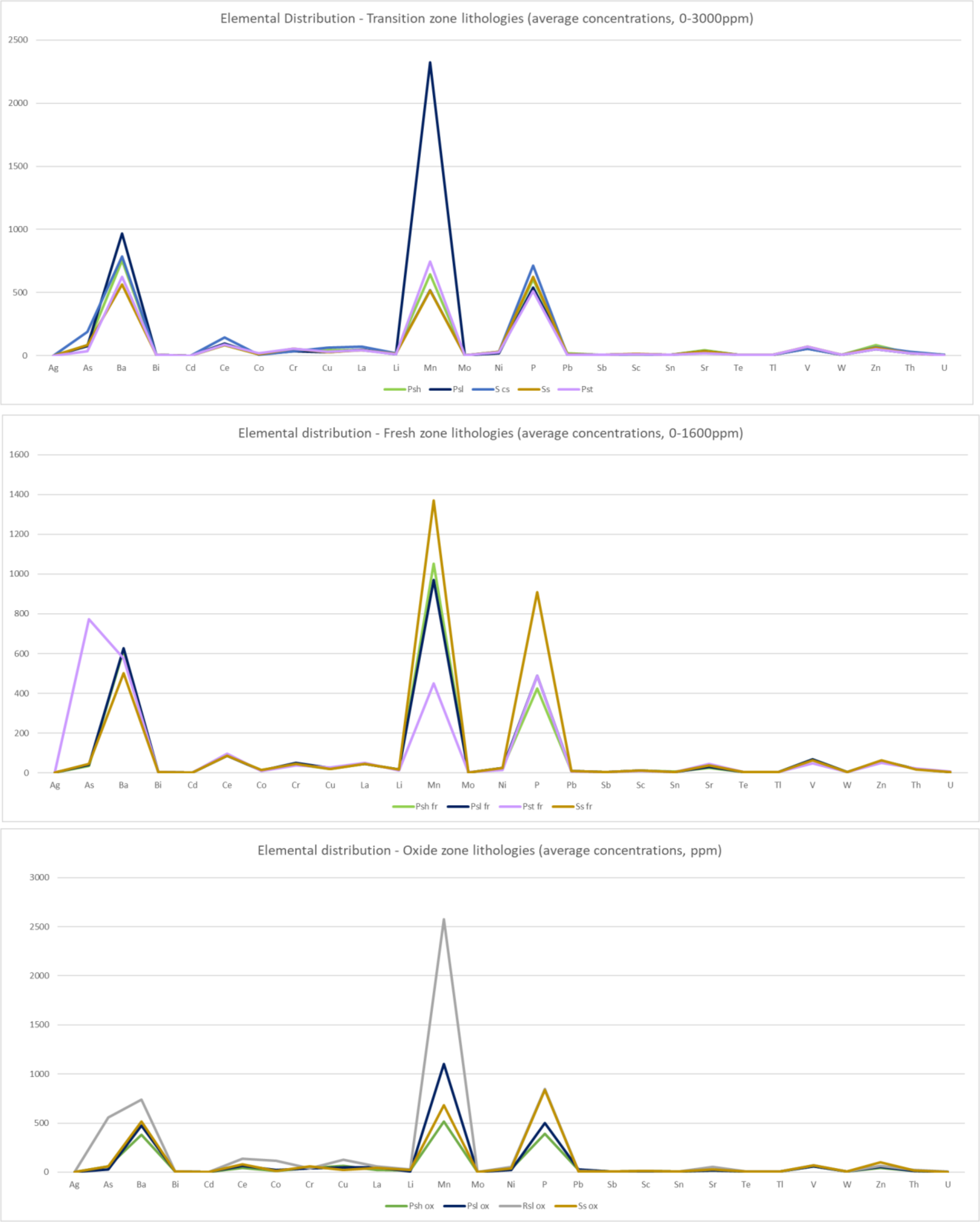

Figure 25 Distribution of Selected Trace Elements in Lithologies at Rustlers Roost

6.6 Phase 3 Static Testing - Additional Characterisation (Rustlers Roost)

Further characterisation was completed on materials where the classification was unclear, that is where the sample results plotted on or close to a boundary in the classification plot (Figure 22 and Figure 23).

Further characterisation consists of better defining the acid generation and buffering capacity of the materials, the two methods adopted were acid buffering characterisation curves (ABCC) and a kinetic NAG test. These methods treat the sample with the reactant for a longer period of time than the screening tests; ANC and NAG, and measure the pH change over this time, thus allowing for a more robust calculation of NAPP.

Six samples from the Rustlers Roost deposit were selected for additional characterisation (Table 13).

Table 13 Samples Selected for Further Acid Base Accounting

CoC#	Sample ID	Hole ID	From (m)	To (m)	Lithology
RR 039	HKR00394	RRDH02	115	116	Shale (Ss)
RR 084	HKR00953	RRDH06	141	142	Sandstone (Pst)
RR 097	HKR00664	RRDH08	79	80	Siltstone (Psl)
RR 112	HKR01629	RRDH08	249	250	Shale (Psh)
RR 113	HKR01666	RRDH08	282	282.35	Siltstone (Psl)
RR 125	HKR01154	RRDH09	105	106	Siltstone (Psl)

6.7 Acid Buffering Characterisation Curves

Acid base characterisation curves (ABCC) depict the change in pH of the solution as incremental volumes of hydrochloric acid are added (two concentrations are used, 0.1M and 0.5M). As described for the Sobek method for ANC determination the concentration of HCl added is converted to sulfuric acid equivalents which is then plotted against the measured pH.

Six samples classified as UC based on their NAG pH and NAPP, had their ANC further assessed via the ABCC method. The results of testing are summarised in Table 14 alongside the original ANC values measured for the sample in the initial ANC determination (Sobek initial).

Table 14 Results of Acid Buffering Characterisation

Sample ID	Hole ID	Lithology	ANC(Sobek initial) kg H2SO4/t	ANC(Sobek repeat) kg H2SO4/t	ANC(ABCC) kg H2SO4/t
HKR00394	RRDH02	Shale (Ss)	5.0	5.5	17.3
HKR00953	RRDH06	Sandstone (Pst)	5.6	5.6	15.4
HKR00664	RRDH08	Siltstone (Psl)	1.2	1.2	13.5
HKR01629	RRDH08	Shale (Psh)	11	11	18.3
HKR01666	RRDH08	Siltstone (Psl)	5.8	5.8	17.3
HKR01154	RRDH09	Siltstone (Psl)	1.4	1.4	17.3

The difference between the two results is possibly due to the Sobek method only measuring the readily available carbonate buffering capacity whereas the ABCC method has released additional buffering capacity from silicates or less soluble carbonates such as dolomite. Characterisation of the mineralogical content of these samples is used to assess what has caused this difference in ANC for the materials.

6.8 Kinetic NAG (Rustlers Roost)

The same six samples also underwent kinetic NAG testing to assess the acid forming potential over a great time period than allowed for in the static NAG test (Table 15).

Table 15 Results of Kinetic NAG Testing

CoC#	Sample ID	Hole ID	Lithology	Start pH	Final pH (24 hours)
RR 039	HKR00394	RRDH02	Shale (Ss)	5.40	5.56
RR 084	HKR00953	RRDH06	Sandstone (Pst)	5.16	3.76
RR 097	HKR00664	RRDH08	Siltstone (Psl)	5.04	5.20
RR 112	HKR01629	RRDH08	Shale (Psh)	5.00	3.74
RR 113	HKR01666	RRDH08	Siltstone (Psl)	5.20	5.13
RR 125	HKR01154	RRDH09	Siltstone (Psl)	4.91	4.64

From these data, two out of the six samples had a lower final pH than the single addition NAG, thus HKR00953 (Pst fr) and HKR01629 (Psh fr) are now classified as PAF. The remaining samples are still classified as UC given the pH did not drop significantly upon continued oxidation.

Noting the increased ANC release with continued acid titration of all samples assessed in phase 3 ABCC, the acid generation for samples HKR00953 (Pst fresh) and HKR01629 (Psh fr) must have been significant to decrease the pH with the increase in the available ANC over the 24 hours period.

6.9 Phase 4 Static Testing – Characterisation of NAG Liquors (Rustlers Roost)

6.9.1 NAG Liquor Analysis and Sample Selection

The majority of the samples had relatively low paste EC results, for Rustlers Roost and thus leaching with de-ionised water was not completed as it would unlikely provide any useful information.

The oxide samples were generally contained little to no sulfur, thus, these materials are unlikely to generate acidity and metalliferous drainage from oxidation and thus were omitted from this phase of analysis.

The materials where the risk of AMD is present from oxidation are those within the transition and fresh zones of the deposit. Oxidation of these materials may not generate acid however, the elements contained within the rock matrix may be released even without acid generation.

To assess the possible composition of drainage that could be generated from sulfide bearing lithologies, the liquors generated in the NAG test were characterised for a range of components. These included electrical conductivity, major ion composition (Ca, Mg, SO_4, Cl, alkalinity and acidity), nutrients (nitrogen and phosphorus species), metals and metalloids.

Thus, with the omission of the five samples with sulfur below detection, 25 samples were submitted for their NAG liquors to be analysed for a broad range of components.

6.9.2 NAG Liquor pH and Electrical Conductivity

Electrical conductivity (EC) ranged from 12-161 mS/m (which is equivalent to µS/cm). The average EC for each lithology assessed with its corresponding pH is presented in Figure 26.

The highest EC was recorded in liquors generated from the shale Psh in the transition zone (tr) of the Rustlers Roost deposit. This relatively elevated EC (max = 161 mS/m, average 88 mS/m) corresponds with the lowest measured pH of 2.6 (Psh tr average pH of 3.0).

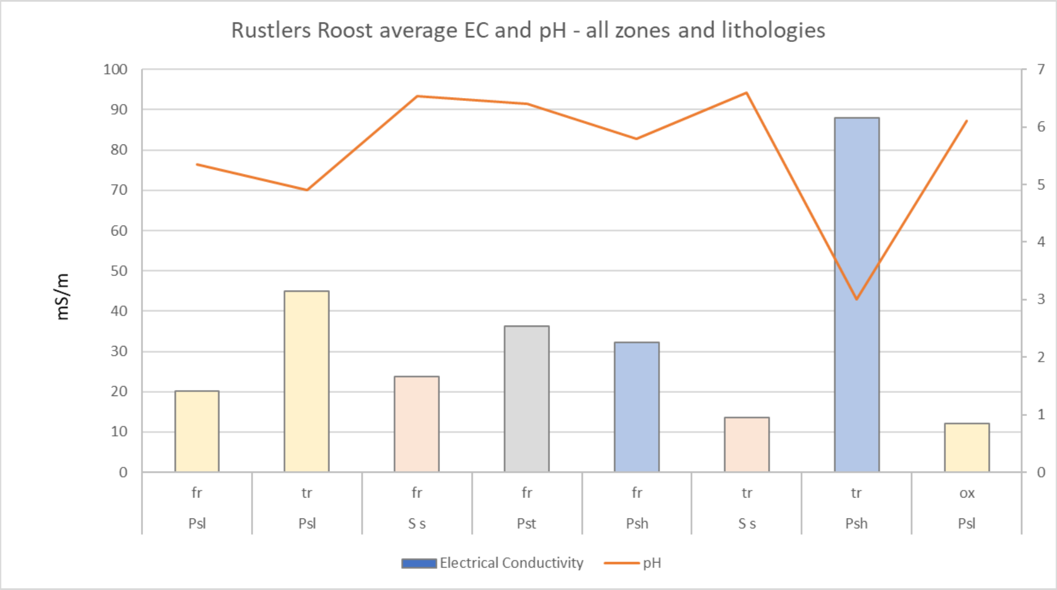

Figure 26 pH and Electrical Conductivity of NAG Liquors

6.9.3 NAG Liquor Elemental Composition

The elemental composition of the liquors varies with oxidation zone, and lithology. The fresh zone lithologies produce liquors dominated by Al, Ca, K, Mg, S and Si, with Na released from the shale Ss and sandstone Pst.

The significant difference in the transition zone liquors is the low levels of Ca released and higher concentrations of S and Al.

The oxide samples signatures are what would be expected from a weathered leached profile with the elemental signature dominated by Si.

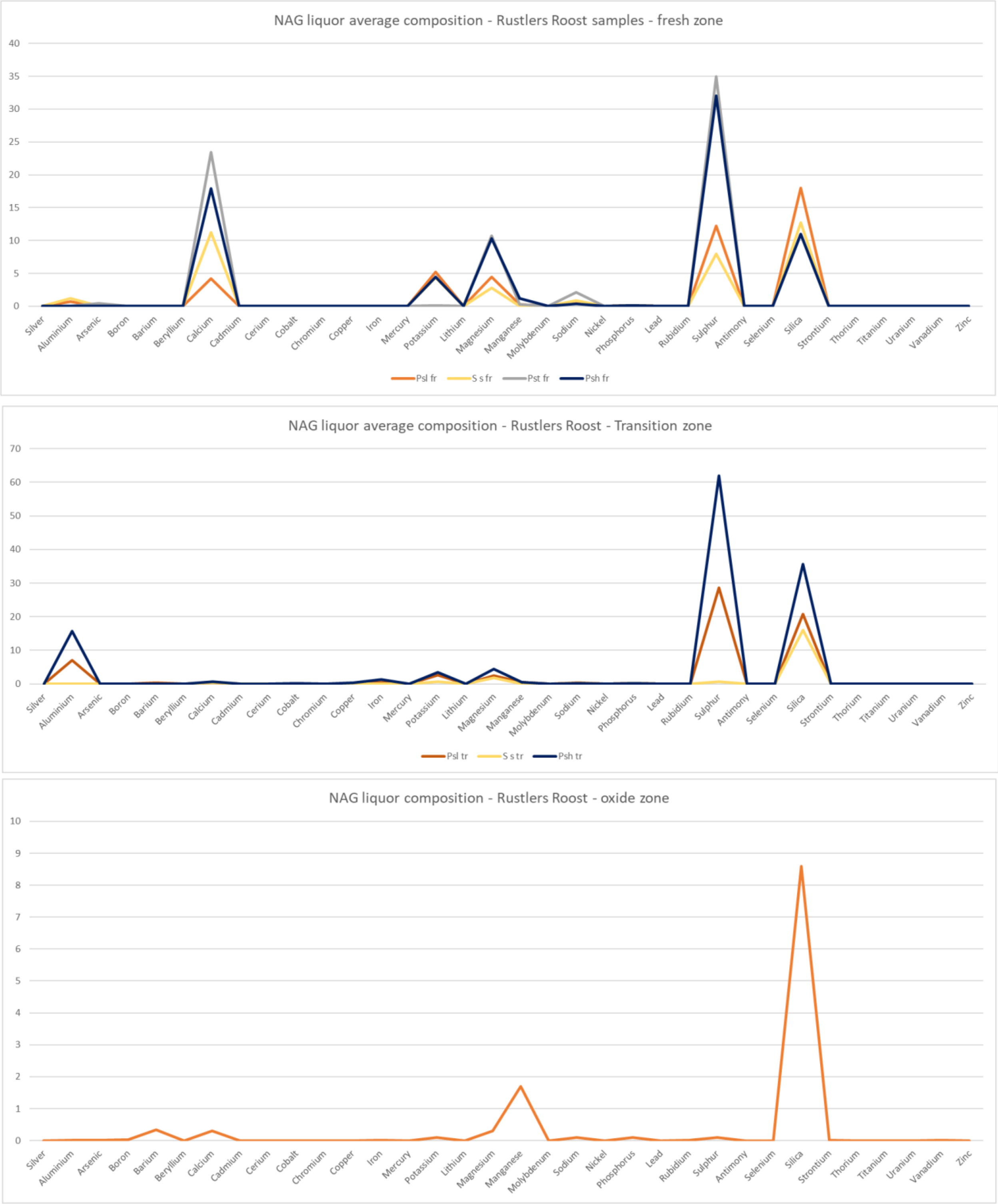

Figure 27 **Elemental Composition of NAG Liquors (all concentrations are mg/L)**

6.10 Water Quality Prediction – Rustlers Roost

To assess the possible risk to water quality from drainage that could be produced during long-term storage of mine wastes generated from the Rustlers Roost deposit, the NAG liquor composition was used as a proxy for the possible drainage quality and to provide a preliminary risk assessment. This assessment was completed by comparing the data to national water quality guidelines.

The most relevant guideline to assess risk to water quality at the site, in the absence of site-specific criteria are the freshwater guidelines documented by the Australian and New Zealand Governments; ANZECC and ARMCANZ freshwater criteria published in 2018. We have applied the default 95% species protection values and where relevant we have also applied low reliability criteria as recently recommended by ANZECC. For nitrogen species, pH and EC, tropical northern Australian values have been adopted. These guidelines are designed to provide a preliminary assessment of possible risk to surface water species living in waters with low EC values (EC less than 500 µS/cm). They are not relevant to the protection of groundwater quality. If groundwater has the potential to flow into surface water environments, the quality of the groundwater may be screened against the freshwater guidelines to assess the potential risk of impact to the receiving environment (the surface water body) but not to assess impacts to a freshwater groundwater resource. To assess risk to groundwater, the NAG liquors results should be compared to local groundwater quality when such data becomes available.

6.11 Data Handling

It is noted that the LORs for Silver (Ag), Mercury (Hg), Titanium (Ti) and nitrate (NO_3) are above the guideline value documented. For these chemicals, although all values are technical exceedances due to the LOR, to highlight those samples with measured values, we have only included values reported above the LOR as exceedances. Where a value equals the criterion this is deemed an exceedance.

A criterion is not available for all chemicals, and thus a preliminary assessment of risk cannot be completed for all chemicals. Consideration of a site-specific assessment for chemicals without a criterion should be considered. This assessment can be completed through comparison with surface and groundwater quality data from across the site.

6.12 Preliminary Risk Assessment (RR)

A summary of the exceedances is presented in Table 16, and at the back of this memo. The following components of the liquors were found to exceed the nominated water quality criterion: Ag, As, Al, Cd, Co, Cr, Cu, Fe, Mo, Ni, P, Pb, Se, Ti, U, V and Zn, and nitrate.

When these elements are compared to the pH of the liquor generated, key chemicals of concern in neutral liquors were As, Cr, Cu, Ti, V and nitrate.

Whereas, for the acid liquors there was a broader suite of chemicals of potential concern identified which include Ag, Cd, Co, Cr, Cu, Fe, Mo, Ni, P, Pb, Se, Ti, U, V and Zn, and nitrate.

Table 16 NAG Liqour Composition Screened Against ANZECC 2000 Freshwater Criteria

Analyte	UNITS	LOR	ANZECC 2018 Freshwater default guideline values (mg/L)	RR 020	RR 024	RR 035	RR 036	RR 038	RR 055	RR 057	RR 058
			Sample ID	RRDH01_HKR02354	RRDH02_HKR00399	RRDH02_HKR02233	RRDH02_HKR02238	RRDH02_HKR02253	RRDH03_HKR02034	RRDH03_HKR02126	RRDH03_HKR02161
			Lithology	Psl	S s	S s	Psl	Psl	S s	Psl	S s
			Weathering	fr	fr	fr	tr	fr	fr	fr	fr
Metals											
Silver	mg/L	0.0001	**0.00005**	<0.0001	<0.0001	**0.0002**	**0.0011**	<0.0001	<0.0001	<0.0001	<0.0001
Aluminium	mg/L	0.005	**0.055**	<0.005	<0.005	**6.7**	**14**	**2**	0.017	<0.005	0.044
Arsenic	mg/L	0.001	**0.013****	0.001	**0.078**	<0.001	0.002	<0.001	0.006	0.006	0.005
Boron	mg/L	0.005	**0.37**	<0.005	0.036	0.044	0.04	0.042	0.017	0.018	0.011
Barium	mg/L	0.0001		0.0044	0.0057	0.13	0.09	0.083	0.0092	0.016	0.014
Beryllium	mg/L	0.0001		<0.0001	<0.0001	0.0011	0.0018	0.0007	<0.0001	<0.0001	<0.0001
Calcium	mg/L	0.1		0.2	7.7	0.5	0.7	2.5	0.2	12.5	22.8
Cadmium	mg/L	0.0001	**0.0002**	<0.0001	<0.0001	0.0001	0.0014	<0.0001	**0.0002**	<0.0001	<0.0001
Cerium	mg/L	0.0005		<0.0005	<0.0005	0.0071	0.014	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	0.0001	**0.0014**	0.0001	<0.0001	**0.06**	**0.072**	**0.064**	0.0012	<0.0001	<0.0001
Chromium	mg/L	0.0005	**0.001*****	**0.0072**	**0.0048**	**0.0071**	**0.0046**	**0.0039**	**0.007**	**0.001**	**0.0049**
Copper	mg/L	0.0001	**0.0014**	<0.0001	<0.0001	**0.038**	**0.19**	<0.0001	<0.0001	<0.0001	<0.0001
Iron	mg/L	0.005		<0.005	<0.005	0.068	1	0.011	<0.005	<0.005	<0.005
Mercury	mg/L	0.0001	**0.00006**	<0.0001	<0.0001	<0.0001	**0.0042**	<0.0001	<0.0001	<0.0001	<0.0001
Potassium	mg/L	0.1		6.8	5.4	11.8	5.3	4.2	2.8	4.6	4.6
Lithium	mg/L	0.0001		0.001	0.0012	0.0098	0.011	0.0048	0.0006	0.0019	0.0021
Magnesium	mg/L	0.1		2.3	3.4	3.5	4.6	5.8	1.3	5.7	2.7
Manganese	mg/L	0.0001	**1.9**	0.07	0.036	0.12	0.23	0.43	0.048	0.29	0.017
Molybdenum	mg/L	0.001	**0.034**	<0.001	0.001	<0.001	<0.001	0.001	0.003	<0.001	0.018
Sodium	mg/L	0.1		0.3	0.6	0.8	0.3	0.3	0.2	0.5	0.3
Nickel	mg/L	0.001	**0.011**	**0.012**	0.001	**0.069**	**0.076**	**0.063**	<0.001	<0.001	<0.001
Phosphorus	mg/L	0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	mg/L	0.0001	**0.0034**	<0.0001	<0.0001	0.0025	**0.068**	0.0004	<0.0001	<0.0001	<0.0001
Rubidium	mg/L	0.0001		0.021	0.029	0.046	0.034	0.033	0.028	0.036	0.028
Sulphur	mg/L	0.1		0.9	1.2	27	57	18	2.8	18	7.9
Antimony	mg/L	0.0001		0.0002	0.0008	<0.0001	<0.0001	<0.0001	0.0007	0.0006	0.0007
Selenium	mg/L	0.001	**0.005**	0.001	<0.001	0.002	0.002	<0.001	<0.001	0.001	0.001
Silica	mg/L	0.1		16	11	24	34	24	13	11	9.6
Strontium	mg/L	0.0001		0.0022	0.0075	0.0037	0.0044	0.0094	0.0017	0.016	0.044
Thorium	mg/L	0.0001		<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	mg/L	0.0001	**0.00003**	<0.0001	<0.0001	**0.0002**	**0.0001**	**0.0001**	<0.0001	<0.0001	<0.0001
Uranium	mg/L	0.0001	**0.0005**	0.0001	0.0002	**0.0008**	**0.0027**	0.0002	0.0002	<0.0001	<0.0001
Vanadium	mg/L	0.005	**0.006**	**0.011**	0.005	**0.009**	**0.016**	**0.006**	**0.008**	<0.005	**0.006**
Zinc	mg/L	0.001	**0.008**	<0.001	<0.001	**0.075**	**0.096**	**0.019**	<0.001	<0.001	<0.001
Nutrients											
Nitrate (as N)	mg/L	0.05	**0.005^**	**40**	**40**	**42**	**35**	**31**	**35**	**40**	**39**
Sulphate as (SO4)	mg/L	1		3	5	76	170	50	12	55	26
Alkalinity											
Acidity (as CaCO3)	mg/L	2		100	14	76	170	60	110	7	<5
Total Alkalinity (as CaCO3)	mg/L	1		<3	38	<3	<3	<3	<3	3	58
General											
Chloride	mg/L	1		7	4	6	4	4	6	4	4
Electrical Conductivity	mS/m	0.2		12.3	18.7	31.7	78.4	22.6	14	26.3	28.2
pH		0.1	**6.0 - 8.0^**	6.2	7.6	**3.6**	**2.9**	**4.3**	**5.5**	6	7.3

Analyte	RR 061	RR 067	RR 068	RR 079	RR 083	RR 095	RR 102	RR 103
Sample ID	RRDH03_HKR00556	RRDH05_HKR00007	RRDH05_HKR00009	RRDH06_HKR00879	RRDH06_HKR00935	RRDH07_HKR00598	RRDH08_HKR00681	RRDH08_HKR00684
Lithology	S s	S s	S s	Psl	Pst	S s	Psh	Psh
Weathering	fr	tr	tr	tr	fr	fr	tr	tr
Metals								
Silver	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.0016**	**0.0012**
Aluminium	0.053	<0.005	<0.005	<0.005	<0.005	0.49	**18**	**26**
Arsenic	**0.023**	0.002	0.005	**0.013**	**0.44**	0.012	0.009	0.002
Boron	0.027	<0.005	0.035	0.016	0.027	0.028	0.04	0.05
Barium	0.022	0.0078	0.0036	0.5	0.051	0.0067	0.086	0.079
Beryllium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0028	0.0022
Calcium	16.9	0.5	0.1	0.1	23.4	19.3	1	0.9
Cadmium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.0009**	**0.0002**
Cerium	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.012	0.011
Cobalt	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.052**	**0.097**
Chromium	**0.0015**	**0.009**	**0.0056**	<0.0005	**0.0016**	**0.0065**	**0.0053**	**0.0071**
Copper	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.47**	**0.64**
Iron	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	1.5	4.1
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Potassium	<0.1	1.1	<0.1	<0.1	<0.1	1.4	3.3	2.5
Lithium	0.0009	0.0004	<0.0001	0.0004	0.0008	0.0007	0.02	0.018
Magnesium	4.9	1.8	1.7	0.4	10.7	0.8	1.3	7.3
Manganese	0.07	0.12	0.051	0.94	0.28	0.0033	0.13	0.86
Molybdenum	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001
Sodium	2.8	<0.1	<0.1	0.3	2.1	0.7	0.2	0.2
Nickel	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.06**	**0.09**
Phosphorus	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0007	0.0016
Rubidium	0.0061	0.024	0.024	0.021	0.015	0.025	0.027	0.034
Sulphur	1.1	1.3	<0.1	<0.1	35	7.8	74	110
Antimony	0.0008	<0.0001	0.0003	0.0001	0.0012	0.0008	<0.0001	<0.0001
Selenium	<0.001	0.002	<0.001	<0.001	0.004	0.001	**0.01**	**0.011**
Silica	12	17	15	7.6	11	6.6	34	48
Strontium	0.0085	0.0016	0.0012	0.01	0.011	0.039	0.016	0.014
Thorium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0012	0.0034
Titanium	<0.0001	<0.0001	<0.0001	**0.0017**	<0.0001	<0.0001	**0.0001**	**0.0002**
Uranium	0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.0045**	**0.006**
Vanadium	<0.005	**0.02**	**0.009**	<0.005	<0.005	0.005	**0.021**	**0.01**
Zinc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.047**	**0.1**
Nutrients								
Nitrate (as N)	**38**	**36**	**36**	**36**	**37**	**34**	**35**	**32**
Sulphate as (SO4)	4	5	<1	<1	110	24	220	340
Alkalinity								
Acidity (as CaCO3)	<5	72	43	<5	6	<5	240	360
Total Alkalinity (as CaCO3)	71	<3	3	<3	<3	39	<3	<3
General								
Chloride	4	5	5	4	4	4	4	4
Electrical Conductivity	25.3	14.4	12.6	11.4	36.3	24.9	113	161
pH	8	6.5	6.7	6.9	6.4	7.2	**3**	**3**

Analyte	RR 105	RR 106	RR 107	RR 108	RR 113	RR 115	RR 119	RR 120	RR 129
Sample ID	RRDH08_HKR00687	RRDH08_HKR00695	RRDH08_HKR00696	RRDH08_HKR00697	RRDH08_HKR01666	RRDH09_HKR01141	RRDH09_HKR01147	RRDH09_HKR01148	RRDH09_HKR01321
Lithology	Psh	Psh	Psh	Psh	Psl	Psl	Psh	Psh	Psh
Weathering	tr	tr	tr	tr	fr	ox	tr	tr	fr
Metals									
Silver	**0.0012**	**0.0003**	**0.0006**	**0.0017**	<0.0001	<0.0001	**0.0005**	**0.0005**	<0.0001
Aluminium	**19**	**10**	**20**	**18**	**0.87**	<0.005	**7.2**	**7.8**	<0.005
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.001	<0.001
Boron	0.042	0.017	0.019	0.06*	0.051	0.02	0.06*	0.07*	0.07*
Barium	0.065	0.12	0.09	0.079	0.15	0.33	0.13	0.094	0.055
Beryllium	0.0013	0.0013	0.0011	0.0015	0.0004	<0.0001	0.0013	0.002	<0.0001
Calcium	0.6	0.6	0.5	0.5	1.7	0.3	0.8	0.9	17.9
Cadmium	0.0001	0.0001	**0.0007**	**0.0005**	<0.0001	<0.0001	0.0001	0.0001	<0.0001
Cerium	0.0084	0.0073	0.013	0.011	<0.0005	<0.0005	0.0058	0.0083	<0.0005
Cobalt	**0.16**	**0.088**	**0.1**	**0.18**	**0.014**	<0.0001	**0.056**	**0.052**	**0.0026**
Chromium	**0.0049**	**0.0025**	**0.0073**	**0.0064**	**0.0064**	0.0006	**0.0013**	**0.0012**	**0.0033**
Copper	**0.55**	**0.2**	**0.38**	**0.26**	<0.0001	<0.0001	**0.19**	**0.33**	<0.0001
Iron	1.6	0.14	1.6	1.4	<0.005	<0.005	0.22	0.37	<0.005
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Potassium	0.8	5.2	2.5	4.7	5.1	<0.1	4.1	4.8	4.5
Lithium	0.013	0.011	0.016	0.013	0.0024	<0.0001	0.0069	0.0066	0.0004
Magnesium	6.9	4.3	6.4	4.1	4	0.3	2.7	3	10.3
Manganese	1	0.43	0.84	0.42	0.25	1.7	0.21	0.17	1.2
Molybdenum	<0.001	<0.001	<0.001	<0.001	0.009	<0.001	**0.037**	0.017	<0.001
Sodium	<0.1	0.1	<0.1	0.2	0.7	0.1	0.1	0.1	0.4
Nickel	**0.14**	**0.066**	**0.13**	**0.15**	**0.036**	<0.001	**0.07**	**0.062**	<0.001
Phosphorus	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	**0.01**	0.002	**0.0078**	**0.017**	0.0004	<0.0001	0.0004	0.0021	<0.0001
Rubidium	0.025	0.042	0.032	0.043	0.039	0.0097	0.035	0.03	0.018
Sulphur	74	33	73	68	12	0.1	29	35	32
Antimony	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002
Selenium	**0.007**	0.001	0.002	0.002	**0.005**	<0.001	**0.005**	**0.006**	0.004
Silica	39	33	44	41	21	8.6	23	23	11
Strontium	0.0051	0.0044	0.0078	0.0054	0.01	0.003	0.007	0.0067	0.011
Thorium	0.0006	<0.0001	0.0005	0.0009	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	**0.0002**	**0.0002**	**0.0002**	**0.0003**	**0.0002**	**0.0006**	**0.0002**	**0.0001**	<0.0001
Uranium	**0.0031**	**0.0011**	**0.0019**	**0.0056**	<0.0001	<0.0001	**0.0013**	**0.0017**	<0.0001
Vanadium	**0.018**	**0.014**	**0.014**	**0.016**	**0.015**	<0.005	**0.011**	**0.01**	<0.005
Zinc	**0.1**	**0.064**	**0.11**	**0.1**	<0.001	<0.001	**0.042**	**0.062**	<0.001
Nutrients									
Nitrate (as N)	**32**	**35**	**32**	**34**	**35**	**35**	**34**	**36**	**38**
Sulphate as (SO4)	220	100	220	200	38	<1	90	100	91
Alkalinity									
Acidity (as CaCO3)	220	89	220	210	39	10	81	100	11
Total Alkalinity (as CaCO3)	<3	<3	<3	<3	<3	<3	<3	<3	<3
General									
Chloride	3	4	4	4	5	4	4	4	4
Electrical Conductivity	101	37.9	97.8	96.2	19.5	12	42	55.1	32.2
pH	**3**	**4**	**3**	**3**	**5**	6.1	**3**	**3**	**6**

* Denotes ICP analysis and higher LOR

**Value for AsV adopted

*** Value for CrVI adopted

^ Default trigger values for tropical Australia freshwater

6.13 Phase 5 Static Testing - Mineralogy Results (Rustlers Roost)

Semi-quantitative x-ray diffraction (XRD) was completed on four composite samples from the Rustlers Roost deposit and a tailings sample provided by PGO. These samples were analysed by Microanalysis Australia.

The composite samples were the samples selected for the kinetic program currently underway. The kinetic program includes waste, low grade ore, ore and tailings across both Rustlers Roost and Quest 29 deposits. Each composite is lithologically distinct, and representative of the transition and fresh weathering zones. The sample set from Rustlers Roost allow comparison of two of the major lithologies (Siltstone and Shale) in two of the weathering zones, transition and fresh.

The oxide zone was not included in the mineralogical assessment, the composites assessed were those materials displaying characteristics of acid generation and or the potential to generate deleterious drainage quality. The materials in the oxide zone are predominantly NAF with low levels of dissolved solutes released in aqueous environment and upon oxidation, thus, as oxide samples present a low risk with respect to AMD, neutral drainage (ND) or saline drainage generation, oxide lithologies were not included in this phase of testing.

PGO provided a LOM tailings sample for inclusion in the mineralogical and kinetic program. The tailings data is presented below alongside the waste rock samples.

Only crystalline material present in the sample give peaks in the XRD scan. Amorphous (non-crystalline) material will add to the background. The search match software used was Eva 4.3.

An up-to-date international crystallographic library was used. The X-ray source was cobalt radiation. The LOR for XRD is 0.1 wt%.

Results of the mineralogical assessment are presented in Table 17.

Table 17 Results of Mineralogical Assessment

Sample Mineral	Siltstone (Psl) Fresh Zone	Siltstone (Psl) Transition Zone	Shale (Psh) Transition Zone	Shale (Psh) Fresh Zone	Tailings
Quartz	4	43	9	24	17
Muscovite	4	27	5	14	12
Clinochlore	44	17	54	46	42
Microcline	17	5	13	3	8
Pyrite	1	3	4	3	2
Calcite (Mg bearing)	1	2	1	1	1
Maghemite		2		1	1
Albite	13	1	4	1	4
Magnesio – ferro hornblende	14		11		12
Vermiculite	2				
Grossular				2	1
Fluorapatite (Th bearing)				6	1

The mineralogy of the samples is generally dominated by sheet silicates such as Clinochlore, an iron bearing chlorite mineral (the dominant mineral phase in four out of the five samples assessed) and Muscovite, both indicators of low temperature alteration. Quartz and the feldspars Albite and Microcline are also abundant. The assemblage also includes

Calcite, Hornblende and Garnet (Grossular) with a thorium bearing Fluorapatite, and Vermiculite, a clay mineral. These are common minerals associated with the metamorphism of limestones.

The presence of maghemite may suggest that siderite (iron carbonate) was also present in the original sediment. During metamorphism siderite would be transformed through loss of carbon dioxide to the iron oxide, maghemite.

Pyrite was reported in all samples assessed, but no arsenopyrite was reported.

6.14 Life of Mine Tailings

The tailings sample considered representative of the LOM (pers comm PGO) was provided for geochemical characterisation.

The sample underwent phases 1, 2 and 5 of the static suite of tests. Additionally, the sample was assessed for its cyanide content.

6.14.1 Tailings Sulfur Content

The sulfur within the samples was assessed as both reduced (S_{cr}) and oxidised forms (sulfate sulfur, S_SO_4). The results received are presented in Table 18. The majority of the sulfur present is sulfide. Total oxidisable sulfur (TOS) is greater than the sulfide sulfur, S_{cr} component, thus in addition to sulfide there is potentially elemental sulfur present.

Table 18 Results of Sulfur Speciation in Tailings

Analyte		TS	S_SO4	TOS	Scr
Sample	Units	%S	%S	%S	%S
Tailings		1.76	0.02	1.74	1.5

Where S= sulfur, SO4 = sulfate, TOS = total oxidisable sulfur, S_{cr} = chromium reducible sulfur (sulfide)

6.14.2 Tailings Carbon Content

Carbon within the samples was assessed as total carbon C, and total organic carbon (TOC) each expressed as %C. The results of the analysis are presented in Table 19.

Table 19 Results of Carbon Speciation in Tailings

Analyte		C	TOC
Sample	Units	%C	%C
Tailings		0.92	0.52

Approximately half the carbon present is organic carbon thus total C is not a good proxy for acid neutralising capacity (carbonate required for neutralisation is inorganic carbon).

6.14.3 Tailings Acid Base Accounting

Saturated paste results for the tailings sample indicate that the tailings are neutral to alkaline when in contact with water and release a low level of dissolved solutes resulting in a low paste EC value (Table 20).

Table 20 Results of Paste, ANC and NAG Testing in Tailings

Analyte		pH (1:2)	EC (1:2)	ANC	NAGpH	NAG
Sample	**Units**	**pH units**	**mS/m (µS/cm)**	**kg H2SO4/t**	**pH Units**	**kg H2SO4/t**
Tailings		8.6	30	27	2.4	30

The tailings sample has a positive net acid generation (NAG) and a low NAG pH indicating that the ANC present is insufficient to buffer the acid generated and upon oxidation the tailings are acid forming (Table 20).

The low EC in the paste test is likely due to the neutral to alkaline pH that the tailings have at present. Once acidified it is expected that the EC of any drainage from the tailings will increase.

6.14.4 Tailings Cyanide Species

The tailings sample was leached in de-ionised water to release the stored cyanide compounds. The leachate produced was assessed via colorimetric methods. The results of these tests are presented in Table 21.

Table 21 Results of Cyanide Species Testing in Tailings

Analyte		CN_total	CN_WAD	SCN_L
Sample	**Units**	**mg/kg**	**mg/kg**	**mg/kg**
Tailings		<0.5	<0.5	27

Where CN_total is total cyanide (CN), CN_WAD is weak acid dissociable cyanide, which includes free and moderately stable complexes such as those with Cu, Cd and Zn. SCN_L is thiocyanate, the sulfur cyanide complex. From these results it is clear the cyanide in the tailings sample is present as thiocyanate, the sulfur form. Toxicity and stability of this complex is dependent on the cation associated with this anion.

The tailings are acid forming and thus the thiocyanate may decompose to free cyanide during tailing storage. This in turn could be a source of HCN either as a gas or dissolved solute in water. Both the gas and solute are toxic to organisms.

Consequently, management measures will need to be adopted which minimise the contact of tailings leachate with surface or groundwater.

In summary, the LOM tailings for Rustlers Roost will need to be managed to minimise their contact with water as they are acid forming and will likely generate acidic, possibly saline drainage when oxidised, also appropriate measures need to be put in place to manage the residual cyanide content. Once the tailings acidify, the thiocyanate will become unstable and there is the potential that HCN gas will be released.

6.15 Rustlers Roost Discussion

The Rustlers Roost deposit consists of leached saprolite over lying hydrothermally altered marine and lacustrine sediments. Quartz veins cross-cut these sediments, the veining likely represents one or more of the fluid flows which penetrated the sediments during the metamorphic events.

The host sediments were likely pyritic; however, the hydrothermal alteration brought additional sulfur into the system which formed additional sulfide phases within the deposit. Thus, sulfide is distributed throughout the deposit.

Gold was introduced to the deposit through this hydrothermal activity and thus the presence of gold, is also not lithologically controlled. Permeability controlled the pathway of the ore bearing fluids, with fractures and discontinuities providing a migration path. Thus, gold is found in areas of greatest fracturing rather than in any particular lithology.

The fluids were likely both silica rich, leading to the formation of quartz veins, and carbonate rich, leading to the presence of carbonate phases throughout the deposit. Thus, as with the mineralisation, the presence of acid neutralising phases is not lithologically controlled.

The results of geochemical assessment demonstrate this pervasive sulfide and carbonate distribution. All of the major lithologies present within the deposit are acid forming. Noting that each lithology is not always acid forming, however the density of sampling is not sufficient to delineate areas where a higher risk of acid generation is present.

It has been demonstrated by others (e.g Graham Campbell 1997[9]) that the weathered waste rock units in the oxide zone are generally non-acid forming, with increasing uncertainty of the acid forming nature of the materials with increasing depth from natural ground surface into the fresh zone. The results presented here corroborate these findings. However, the fresh zone contains significant ANC concentrations leading to many of the fresh zone lithologies classifying as UC or NAF.

Additional characterisation through kinetic NAG and ABCC demonstrates that the uncertain materials may be long lag time PAF materials. Acid neutralising capacity may increase with ongoing acid generation thus the final net acid generation potential of these uncertain materials remains, uncertain.

The dominant sulfide identified in this assessment was pyrite. Although arsenic was identified in the multi-elemental analysis, arsenopyrite was not identified in the mineralogical characterisation.

None of the mineral phases identified are particularly soluble as they are predominantly silicates. However, the characterisation of the oxidised liquors demonstrates that the acid generation is sufficient to cause release of elements in sufficient quantities to pose a potential risk to surface water quality. Characterisation of the oxidised liquors also demonstrated silica is released into solution indicating that silicate buffering is likely a key mechanism maintaining/buffering the pH of the NAG liquor above pH 2.5, particularly when carbonates are not present.

The preliminary water quality risk assessment completed listed the following chemicals of potential concern (COPC): Ag, As, Al, Cd, Co, Cr, Cu, Fe, Mo, Ni, P, Pb, Se, Ti, U, V and Zn, and nitrate.

The pH of the leachate has an influence on the release of these COPC. The multi-elemental analysis demonstrated that there was little data to distinguish the lithologies from each other in terms of the distribution and concentration of elements present. However, in the liquor analysis, where neutral leachates were generated, the composition of the leachate was far simpler than the acidic leachates, with the COPC reduced to As, Cr, Cu, Ti, V and nitrate.

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[9] Acid Forming Potential and Multi-Element Composition of Waste Rock and Ore Samples – Implications for Waste Rock Management. Report prepared by Graham Campbell and Associates Pty Ltd for Rustlers Roost Mining Pty Ltd in January 1997.

Further, a thorium (Th) bearing Fluorapatite was identified in the fresh zone shales (Psh) through XRD analysis. Fluorapatite, a phosphate, has a low solubility in water, but its solubility increases in saline conditions, thus even without acidification, fluorapatite may dissolve over time as salinities increase. This will potentially release phosphate and Th into aquatic environments at concentrations of concern given that this mineral was present at concentration up to 6 wt%.

Thus, both pH and salinity are important controls on the release of COPC from the materials at Rustlers Roost.

The preliminary risk assessment only provides an indication of risk for those chemicals with available default water quality guideline values. To understand better the range of COPC at the Project, the results of the NAG liquor characterisation should be compared against site-specific water quality data. This water quality should be characterised for the same suite of chemicals to allow for direct comparison of the concentrations.

Tailings are characterised as acid forming, the water leachable cyanide species remaining in the tailings is thiocyanate, the sulfur cyanide complex. The toxicity and stability of this sulfur complex is dependent on the cation associated with this anion. Further characterisation of this leachate is possible during the kinetic column program, and thus there is an opportunity to improve the understanding of the risk the leachates present to the environment. Given the tailings represent a composite of all lithologies at Rustlers Roost, and are acid forming, from our preliminary risk assessment, the additional COPCs likely to be released from tailings are Ag, As, Al, Cd, Co, Cr, Cu, Fe, Mo, Ni, P, Pb, Se, Ti, U, V and Zn, and nitrate.

In terms of management of the waste, ore and tailings at Rustlers Roost, any materials mined from within the transition zone and fresh zone of the deposit should be managed as PAF. The oxide zone is generally NAF, however, shales (Ss) within this zone may contain sufficient sulfide to present an acid generation risk.

Section 7 Results – Quest 29

7.1 Phase 1 Static testing (Quest 29)

7.1.1 Paste pH and Electrical Conductivity

These tests were completed as described in the Rustlers Roost equivalent section. A summary of results is provided in Table 22.

Table 22 Summary of Saturated Paste and Total Sulfur – Quest 29

	Paste pH	Paste EC mS/m	S %
Max	8.7	5.68	21.56
Min	2.6	0.06	0.01
Average	6.33	1.34	3.23

Of the 59 samples analysed, none of the samples had measured S % below the LOR (limit of reporting, 0.01%S). The maximum paste pH was reported in Pdz (dolerite) in the fresh zone (fr), the minimum pH was reported in Sbs fr (shale). Sbs fr also reported the highest paste EC and highest sulfur content at 21.56%.

As completed for Rustlers Roost box and whisker plots have been created for each analyte and lithology.

Figure 28, Figure 29, Figure 30 and Figure 31 depict the paste results. The paste pH within the transition and oxide zones is generally around neutral to alkaline, whereas for the fresh zone the pH is highly variable ranging from acidic to alkaline. The trend is similar in the EC results with the transition and oxide zone materials registering consistently low readings and the fresh zone registering highly variable data, with the greatest variability seen in the Sbs data.

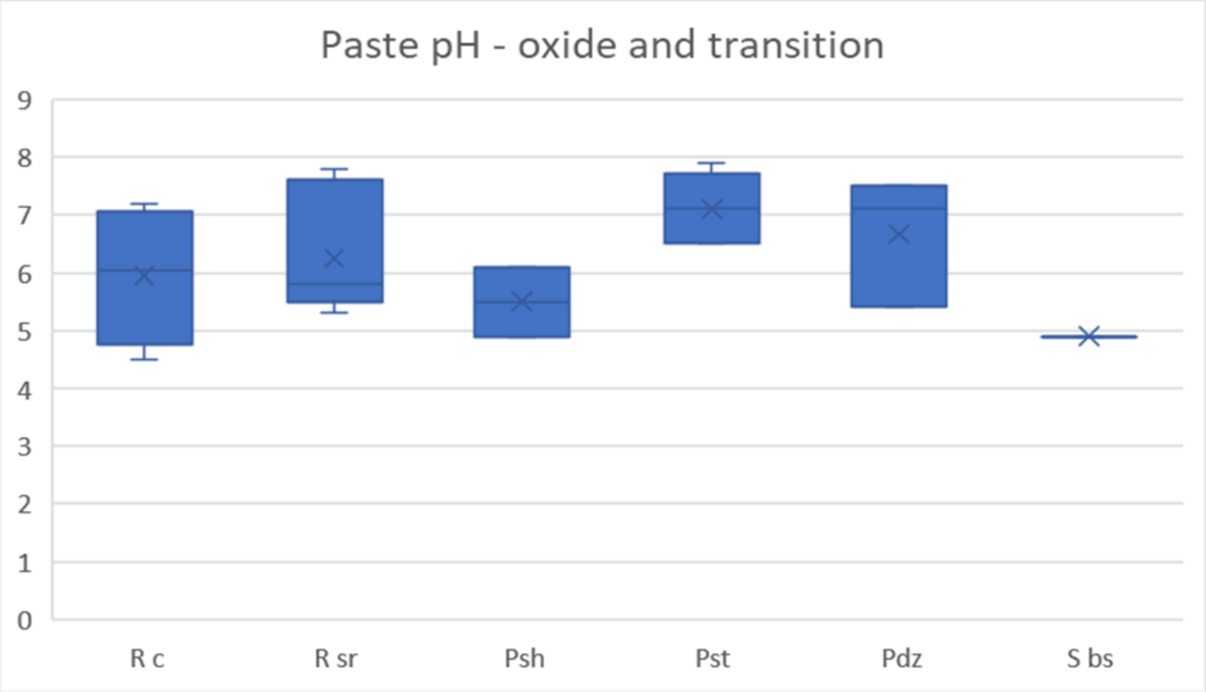

Figure 28 Paste pH Values for the Oxide and Transition Zone – Quest 29

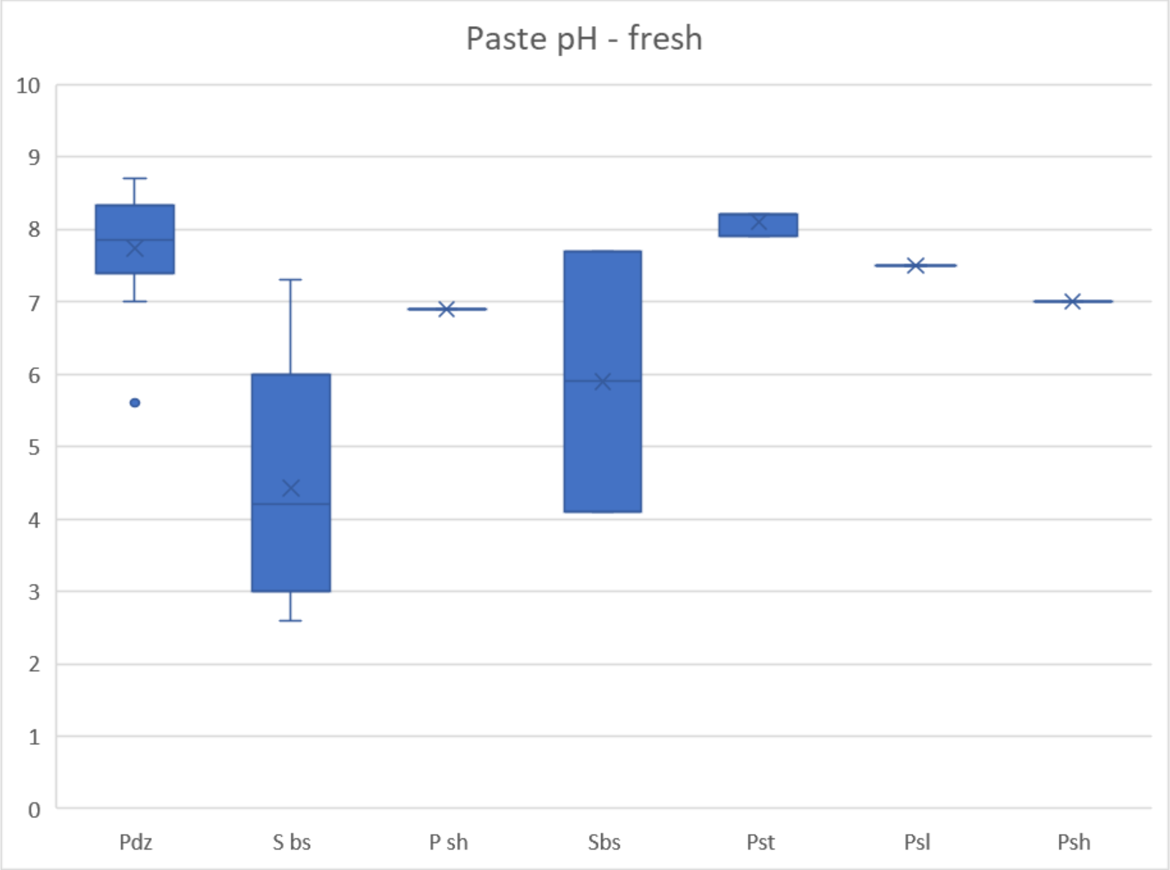

Figure 29 Paste pH Values for the Fresh Zone – Quest 29

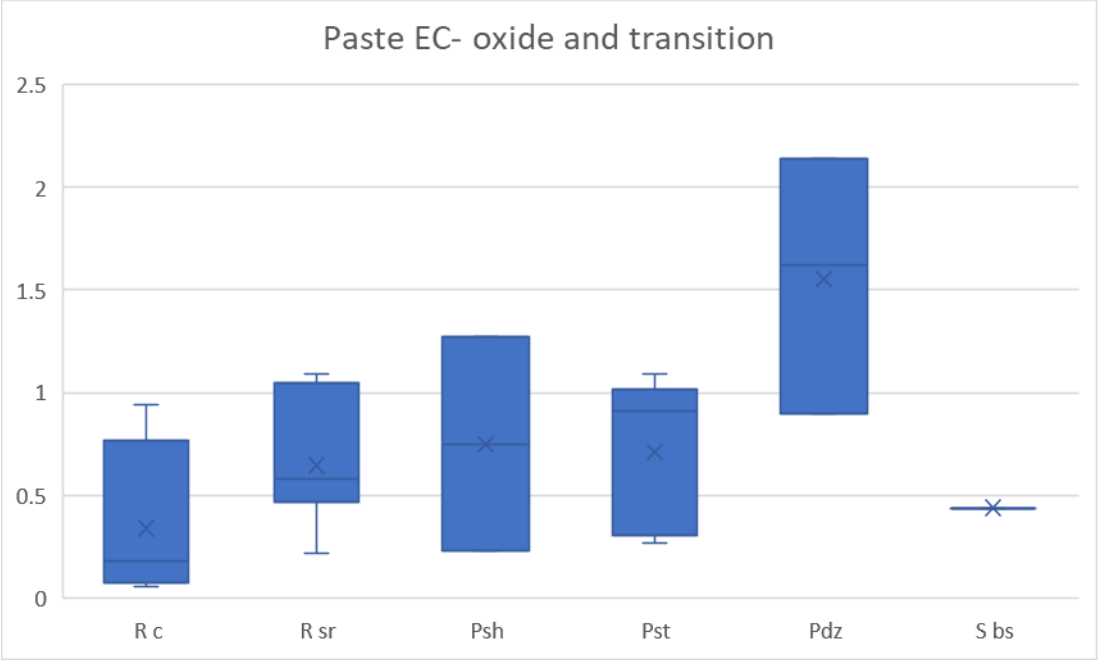

Figure 30 Paste EC (mS/m) Values for the Oxide and Transition Zone – Quest 29

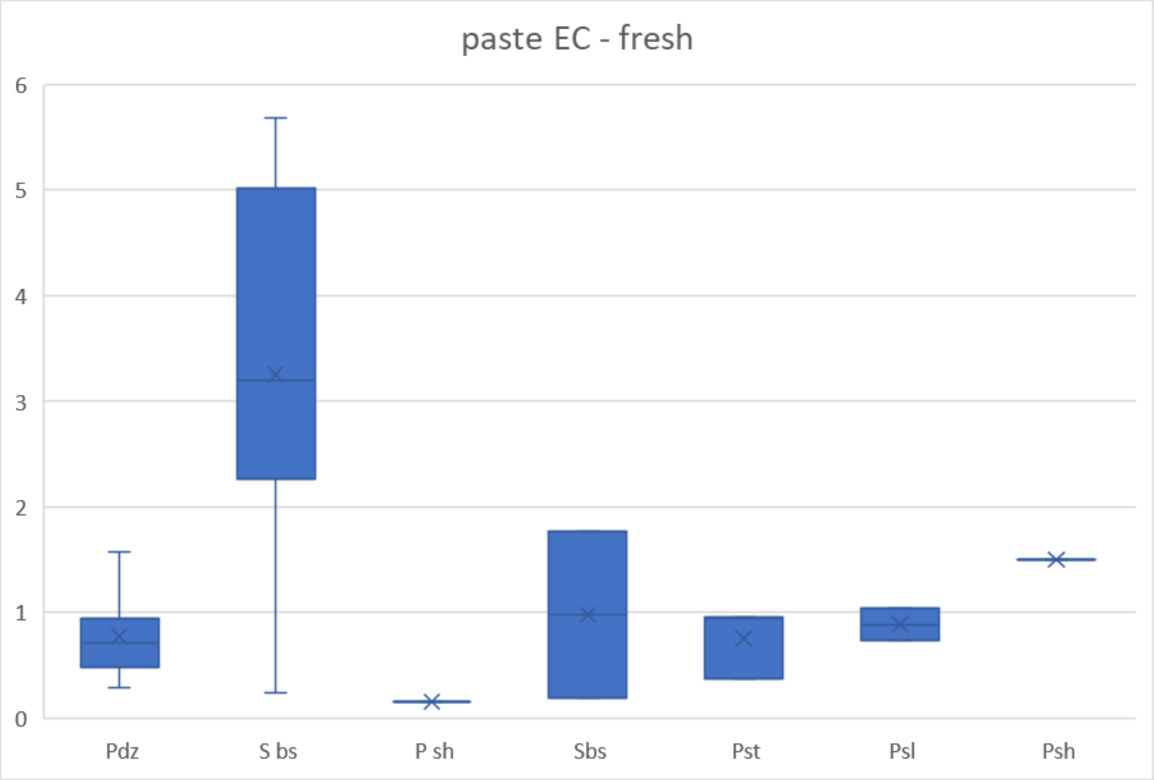

Figure 31 Paste EC Values in mS/m for the Fresh Zone – Quest 29

7.1.2 Total Sulfur Content (Quest 29)

Total sulfur content of all selected samples was measured via the LECO combustion method. The results for the oxide, transition zone and fresh zone lithologies are presented on Figure 32 and Figure 33.

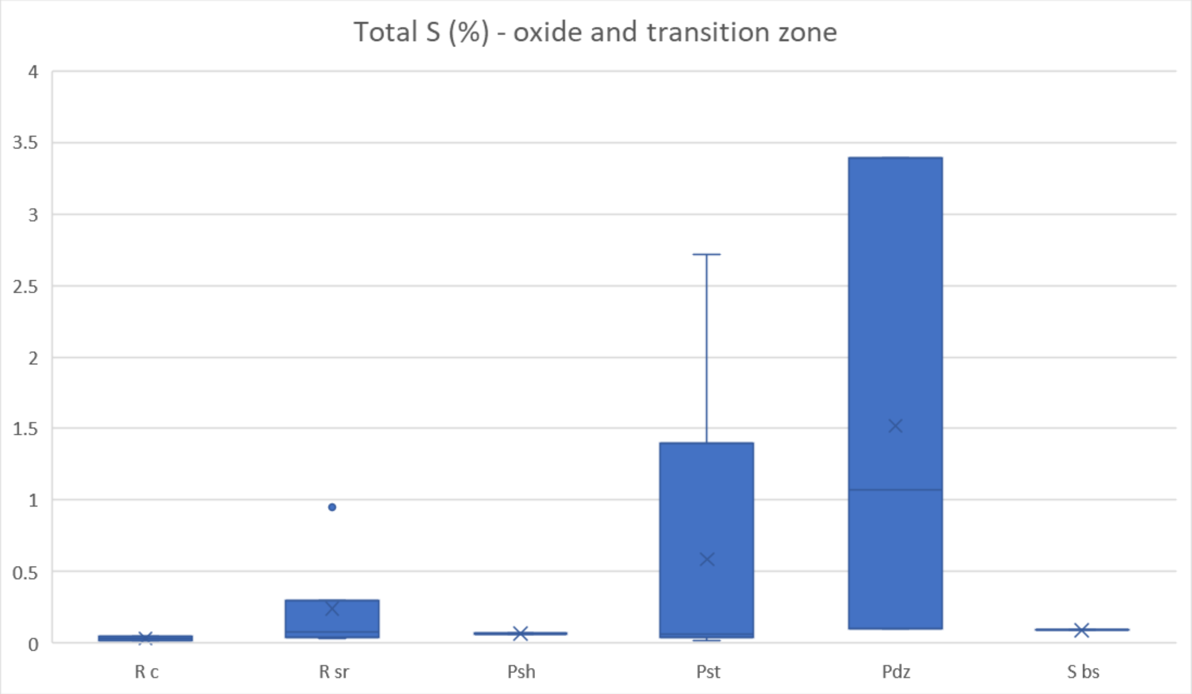

Figure 32 Total sulfur (%S) in Oxide and Transition Zone Lithologies – Quest 29

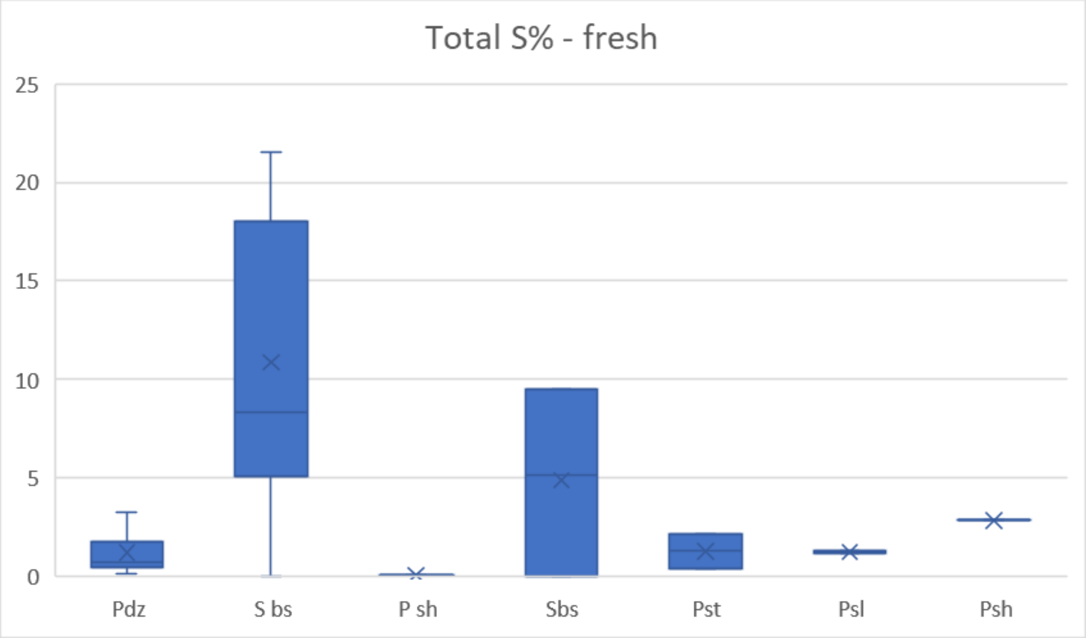

Figure 33 Total sulfur (%) in Fresh Zone Lithologies of Quest 29

Comparing the weathering zones demonstrates that the oxide and transition zones have a number of lithologies (Rc, Psh and Sbs) with little measurable sulfur (Figure 32). However, all samples reported S above the LOR.

The fresh zone is significantly more sulfur rich than the transition and oxide zone (Figure 33). There are clear differences in the lithological distribution of the sulfur in each zone. In the oxide and transition zone the sulfur lies predominantly in the regolith (Rsr), sandstones (Pst) and dolerite (Pdz), whereas in the fresh zone although the sulfur levels in the sandstone are similar, over all the sulfur content of the zone is higher due to the shales.

7.1.3 Total Carbon (Quest 29)

Total carbon content of all samples was measured as %C, via the LECO combustion method; the LOR was 0.1 %C.

Total carbon content of the samples was recorded from values below the LOR to a maximum of 8.21 %C in Sbs fr. Figure 34 and Figure 35depict the total carbon content of all samples assessed, where values were reported below the LOR, these are graphed as LOR.

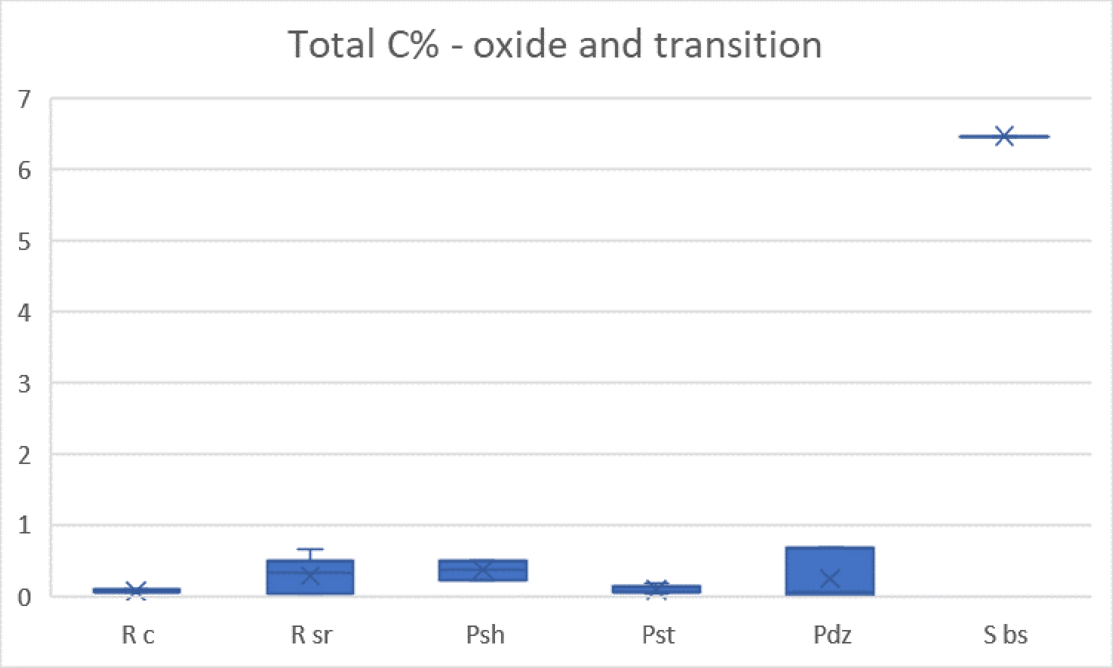

Figure 34 Total carbon (%) Content of Oxide and Transition Zone Lithologies from Quest 29

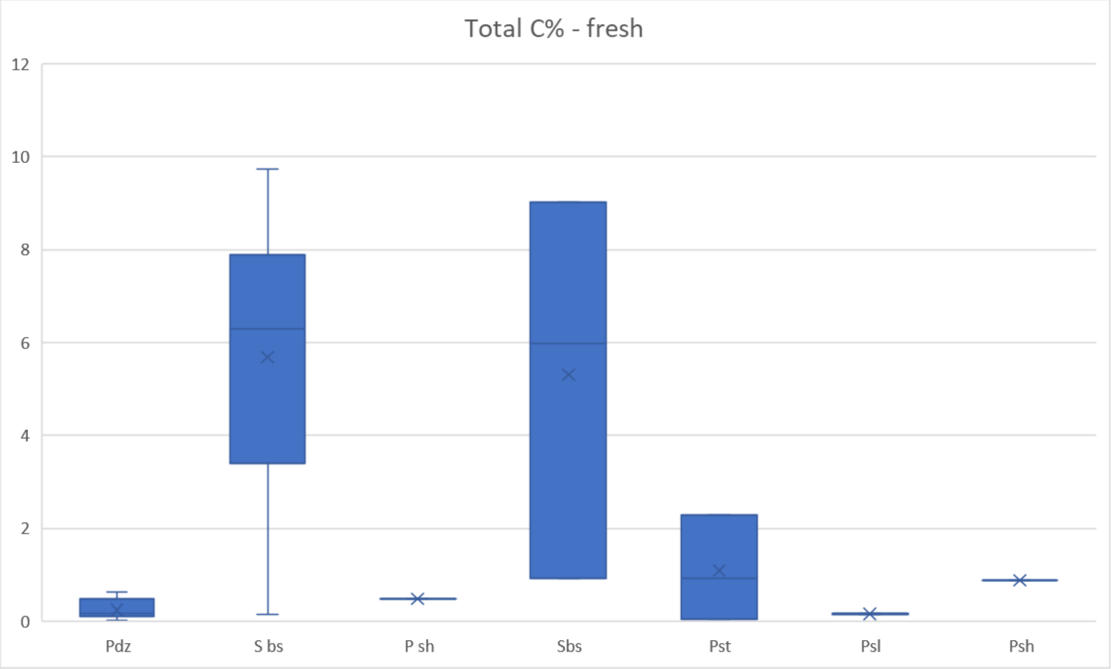

Figure 35 Total Carbon (%) in Fresh Zone Lithologies from Quest 29

7.2 Phase 2 – Static Testing (Quest 29)

In phase 2 of the assessment, sulfur speciation and net acid generation (NAG) was determined on 20 samples from the sample set.

As discussed in the Rustlers Roost results, samples with sulfur above the limit of reporting were selected. At least one sample from each of the major lithologies was selected based on their paste results (lowest pH and highest EC).

7.2.1 Sulfur Speciation

To determine whether the sulfur within the samples was oxidised sulfur (sulfate) or reduced sulfur (sulfide), the acid soluble sulfur (S_{HCl}) and chromium reducible sulfur, CRS, expressed as Scr, were determined.

Acid soluble sulfate, S_{HCl} recovers soluble and exchangeable sulfate, sulfate from gypsum and a large proportion of the relatively insoluble iron and aluminium hydroxy sulfate compounds (for example jarosite, natrojarosite, schwertmannite), as well as some sulfur from organic matter, but not pyrite sulfur.

Chromium reducible sulfur determines the sulfide sulfur (S_{cr}) content, without interference from organic sulfur.

All bar one sample (HKR34244, Pst tr) reported S_{cr} above the LOR (0.01%S), S_{HCl} was above the LOR in most samples with the exception of HKR33648 P sh_fr/fx and HKR34147 Sbs tr. The acid soluble sulfur content ranges from below LOR to 2% (average 0.3%S) in the fresh zone which is lower than in the transition and oxide zone where the soluble sulfate content ranges from 2.2 %S to 7.8%S (average 5.24 %S), Table 23.

Table 23 Sulfur Speciation Results; Acid Soluble Sulfur and Chromium Reducible Sulfur for Quest 29

Sample	Lithology	Weathering Zone	S_{HCl} %S	S_{cr} %S	Total S %S
Fresh Zone					
HKR34178	Pdz	Fresh	0.53	2.71	3.27
HKR34252	Pdz	Fresh	0.6	0.93	1.4
HKR34263	Pdz	Fresh	0.04	1.59	2.39
HKR33883	Psh	Fresh	0.05	2.26	2.84
HKR33875	Psl	Fresh	0.06	1.04	1.31
HKR33693	Pst	Fresh	0.27	1.41	2.12
HKR33768	S bs	Fresh	2	10.2	14.97
HKR33798	S bs	Fresh	0.1	16.3	21.56
HKR34089	S bs	Fresh	0.03	2.83	4.87
HKR33648	P sh_fr/fx	Fr-fx	<0.010	0.02	0.05

Sample	Lithology	Weathering Zone	S_{HCl} %S	S_{cr} %S	Total S %S
HKR33678	Pdz_fr/fx	Fr-fx	0.03	0.6	0.89
Transition and Oxide Zone					
HKR33909	Pst	Ox	0.02	0.03	0.06
HKR34267	Pst	Ox	0.07	2.11	2.72
HKR34034	R sr	Ox	0.05	0.02	0.08
HKR34049	Pdz	tr	0.07	0.77	1.07
HKR34265	Pdz	tr	0.08	2.77	3.39
HKR33855	Psh	tr	0.04	0.02	0.06
HKR34244	Pst	tr	0.08	<0.01	0.02
HKR33824	R sr	tr	0.1	0.01	0.04
HKR34147	S bs	tr	<0.010	0.01	0.09

When these results are compared to the total sulfur content of each sample, it is clear that the majority of the sulfur in all zones is sulfide sulfur.

Noting that for Sbs there is also likely to be organic sulfur present given that the sum of the sulfate and sulfide content does not equal the total sulfur value.

7.3 Carbon Speciation (Quest 29)

To determine the proportion of carbon present as organic carbon, the TOC content was determined through acid digest of the sample followed by analysis of the residue by LECO combustion method. The inorganic carbon content is the Total Carbon (TC) value minus the TOC content.

The ANC was also determined via the amended Sobek method (AMIRA 2002), as completed for the Rustlers Roost samples. The results are presented per lithology in each weathering zone in Table 24.

Table 24 Carbon Speciation – Quest 29

Sample	Lithology	Weathering Zone	TOC %C	ANC kg H_2SO_4/t	TC %C
Fresh Zone					
HKR34178	Pdz	Fresh	0.09	21	0.53
HKR34252	Pdz	Fresh	<0.05	12	0.02

Sample	Lithology	Weathering Zone	TOC %C	ANC kg H_2SO_4/t	TC %C
HKR34263	Pdz	Fresh	<0.05	15	0.12
HKR33883	Psh	Fresh	0.1	12	0.88
HKR33875	Psl	Fresh	0.14	17	0.17
HKR33693	Pst	Fresh	0.1	67	0.93
HKR33768	S bs	Fresh	2.59	<0.5	6.72
HKR33798	S bs	Fresh	1.59	<0.5	7.76
HKR34089	S bs	Fresh	1.97	<0.5	6.08
HKR33648	P sh_fr/fx	Fr-fx	0.12	2.3	0.48
HKR33678	Pdz_fr/fx	Fr-fx	<0.05	17	0.06
Transition and Oxide Zone					
HKR33909	Pst	Ox	<0.05	6.5	0.06
HKR34267	Pst	Ox	<0.05	5.9	0.05
HKR34034	R sr	Ox	<0.05	2.8	0.04
HKR34049	Pdz	tr	0.08	8.9	0.67
HKR34265	Pdz	tr	<0.05	8.1	0.02
HKR33855	Psh	tr	<0.05	19	0.23
HKR34244	Pst	tr	<0.05	24	0.04
HKR33824	R sr	tr	<0.05	2.3	0.04
HKR34147	S bs	tr	0.05	1.6	6.46

The TOC content is low with the exception of Sbs in the fresh zone where it accounts for about a third of the total carbon content of the sample.

Given this finding, and the potentially negligible ANC content, total carbon would not be a useful proxy for predicting ANC content of these lithologies.

7.4 Net Acid Generation and Net Acid Production Potential (Quest 29)

The pH of the sample following digestion in a solution of hot hydrogen peroxide at a 1:100 solid to liquid ratio was conducted on 20 samples from Quest 29. The results are presented in Table 25.

As before, NAPP and MPA were calculated from sulfide sulfur (S_{cr}) values.

Table 25 Net Acid Generation pH – Quest 29

Sample	Lithology	Weathering Zone	NAGpH pH Units	NAPP kg H_2SO_4/t
Fresh Zone				
HKR34178	Pdz	Fresh	2.3	61.92
HKR34252	Pdz	Fresh	2.5	16.45
HKR34263	Pdz	Fresh	2.4	14.82
HKR33883	Psh	Fresh	2.5	498.28
HKR33875	Psl	Fresh	0.05	86.098
HKR33693	Pst	Fresh	6.7	58.66
HKR33768	S bs	Fresh	2.1	14.662
HKR33798	S bs	Fresh	2	-18.38
HKR34089	S bs	Fresh	2.2	-23.69
HKR33648	P sh_fr/fx	Fr-fx	4.7	33.65
HKR33678	Pdz_fr/fx	Fr-fx	2.9	57.15
Transition and Oxide				
HKR33909	Pst	Ox	7.1	-23.85
HKR34267	Pst	Ox	2.3	311.62
HKR34034	R sr	Ox	5.6	-1.68
HKR34049	Pdz	tr	2.8	1.36
HKR34265	Pdz	tr	2.2	-5.58
HKR33855	Psh	tr	7.5	-2.18
HKR34244	Pst	tr	7.8	76.66

Sample	Lithology	Weathering Zone	NAGpH pH Units	NAPP kg H_2SO_4/t
HKR33824	R sr	tr	5	-1.99
HKR34147	S bs	tr	6.9	-1.29

The NAG pH ranges from 2.1 to 6.7 (with an average pH of 3) in the fresh zone which is lower than in the transition and oxide zone where NAG pH ranges from 2.2 to 7.8 (with an average pH of 5.24). The higher NAG and lower NAPP average values happen because of the excess neutralising capacity of the sandstone Pst samples in the data set causing a negative NAPP value. The presence of sandstone however cannot be used to predict the acid generation capacity as one of the highest acid generation values is reported in the sandstone HKR34267.

From these data, the lithology or degree of weathering cannot be used to assign acid generation risk as there is variable acid generation potential in each lithology and highly acid generating materials in the oxide zone as well as in the fresh zone.

7.5 Geochemical Classification (Quest 29)

Static test results (total S, total C and paste results), NAG pH and net acid production potential (NAPP) (calculated from sulfide sulfur (S_{cr}) and ANC) are used to provide a classification of materials with respect to their acid generating potential as presented in Table 12 of the Rustlers Roost section. As a reminder the three main classifications are:

- Non-acid forming (NAF);
- Potentially acid forming (PAF); and
- Uncertain (UC).

The results of the classification are presented for the transition and oxide and fresh zones separately (Figure 36 and Figure 37).

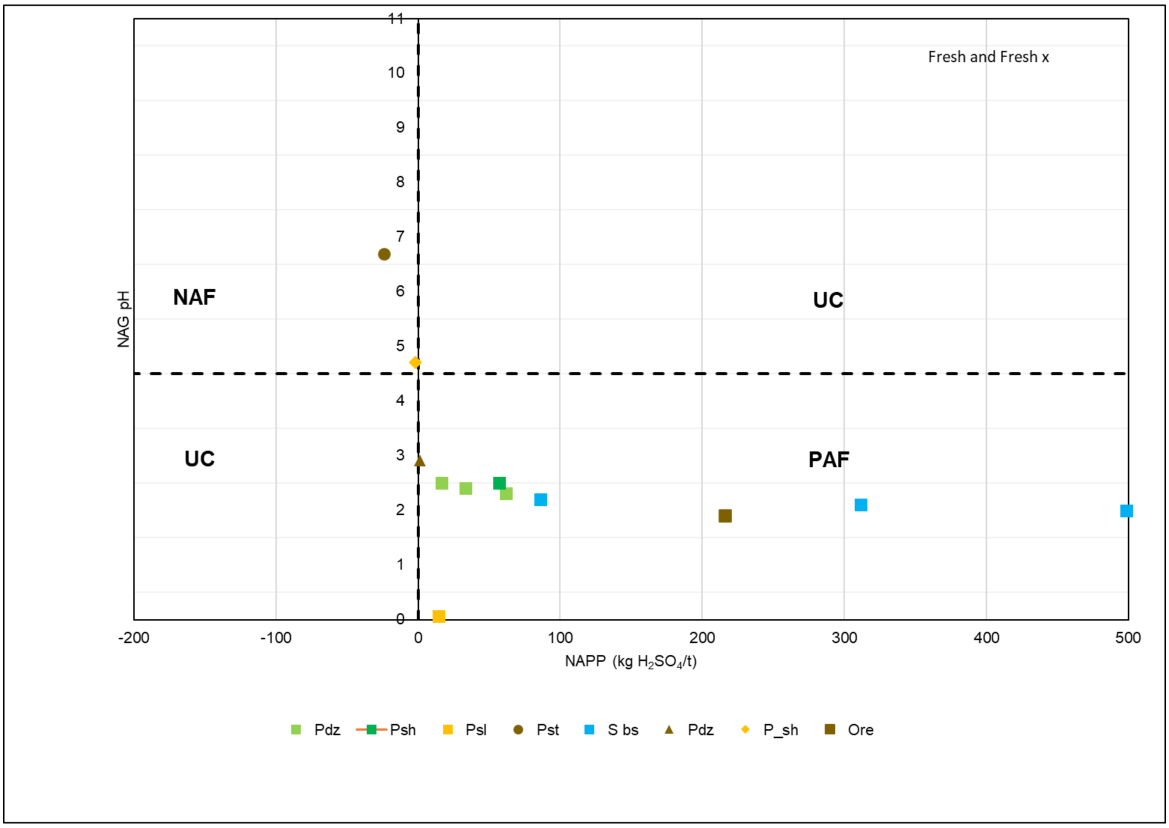

Figure 36 Geochemical Classification of Lithologies in the Fresh Zone at Quest 29

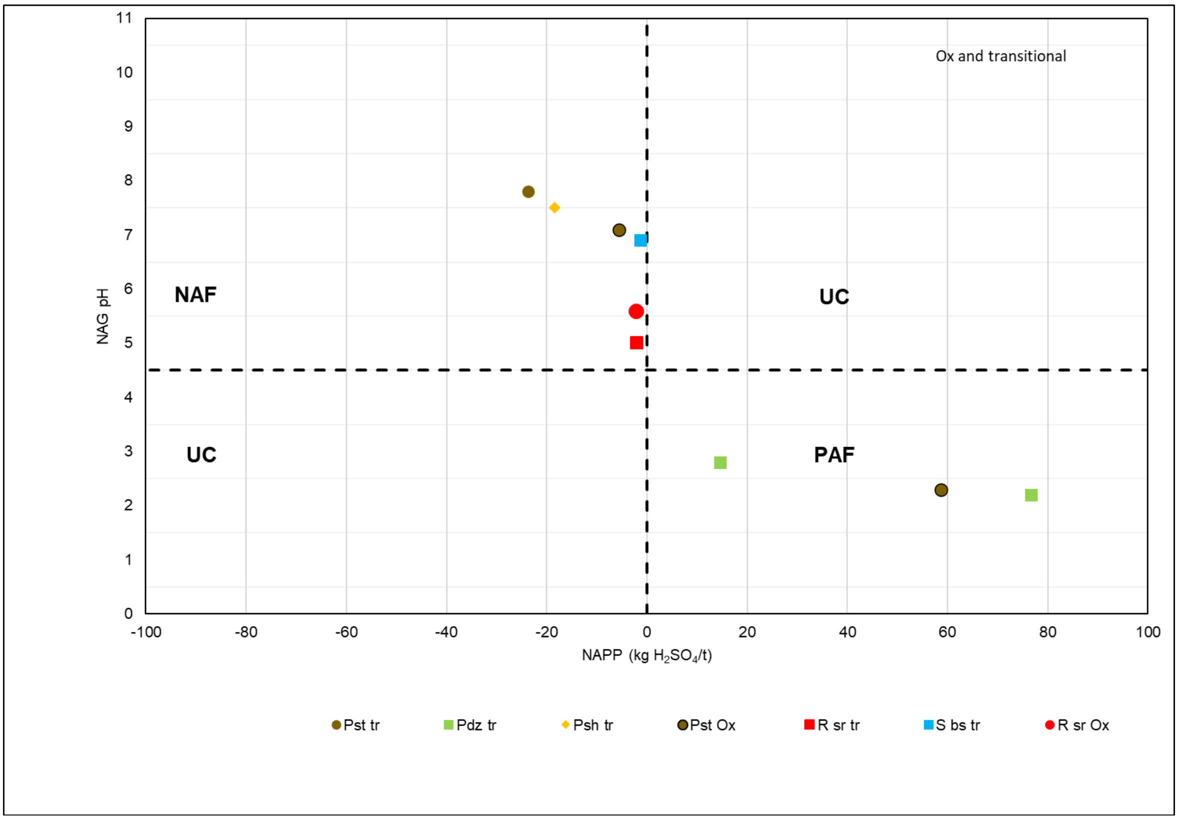

Figure 37 Geochemical Classification of Lithologies in the Oxide and Transition Zone of Quest 29

Of the samples assessed, 14 are classified as PAF and seven are classified as NAF. PAF lithologies are present in both the fresh, oxide and transition zones.

The sandstones (Pst) can be either PAF or NAF, as can the shales (Sbs). The dolerite (Pdz) and siltstones (Psl) are PAF and the residual saprock (Rsr) in both the oxide and transition zones is NAF.

Although a number of samples plotting very close to the boundary of the NAF classification, the ANC/AP is above 1.5, and therefore there is a sufficient safety factor to manage the acid production in these lithologies to not warrant further assessment of the availability of the ANC.

In summary, at least one sample of each lithology classifies as PAF. The PAF is present across all weathering zones. However, although PAF is present in the oxide and transition zone, these lithologies contain significant acid buffering capacity.

7.6 Multi Element Content (Quest 29)

All 59 samples selected for phase 2 of the geochemical program were digested with four acids and their elemental composition determined.

In general, as seen at Rustlers Roost there is little to distinguish the lithologies or their degree of weathering. The major components of all lithologies are Fe, C, and S which are present at levels measured in % (not shown). The remaining elements (trace elements) were reported as parts per million (equivalent to mg/kg) (Figure 38). Of the trace elements, the elements dominating the signature of all lithologies are Al, Ca, K, Na, Mg, P and Ti. One differentiating feature of the fresh zone lithologies is their Ca and Na concentrations, with Na displaying significantly higher concentrations in the fresh zone lithologies than in the oxide and transition zone lithologies, and Ca reported at comparatively lower concentrations in the oxide zone.

As documented in the Rustlers Roost lithologies, when the dominant elements are removed from the graphs, slight variances in the suite of elements can be observed. In the fresh zone, it is clear that the rare earth elements Ce and La are associated with the sandstones Pst and arsenic is associated with the dolerite Pdz and shales Sbs. The dolerites also host the higher concentrations of Mn and Zn. The shales can be distinguished by higher concentrations of Cu and Pb.

In the transition zone, the dolerite isn’t present in the data set. The sandstones in this zone are still distinguishable from the shales through the presence of Ce, Ba is also notably higher in concentration in the sandstones in this zone. In the oxide zone, all oxide units contain As. In the sandstones, As levels are higher than those measured in the fresh zone lithologies.

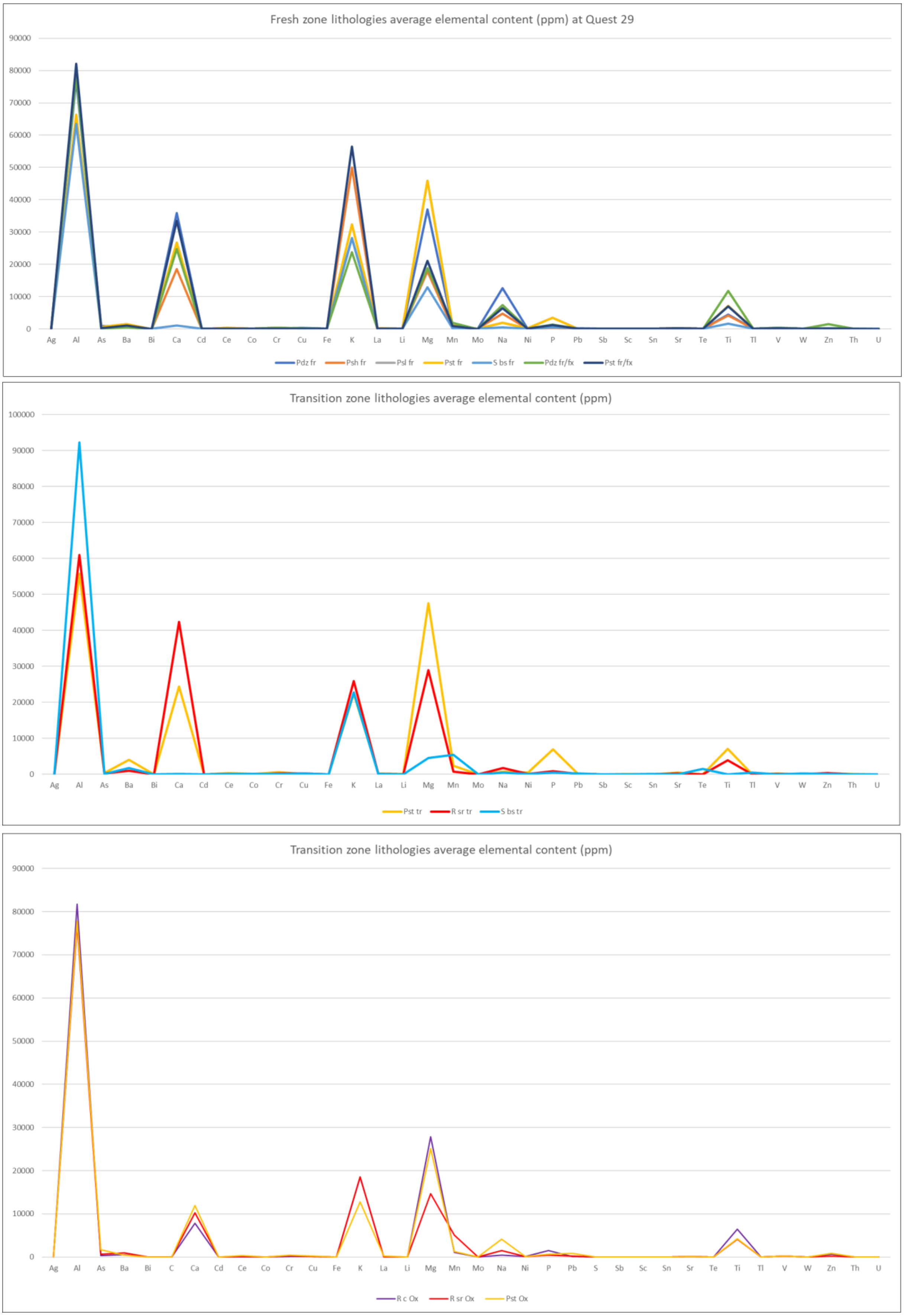

Figure 38 Average Trace Elemental Content Expressed as ppm for all Lithologies in all Weathering Zones

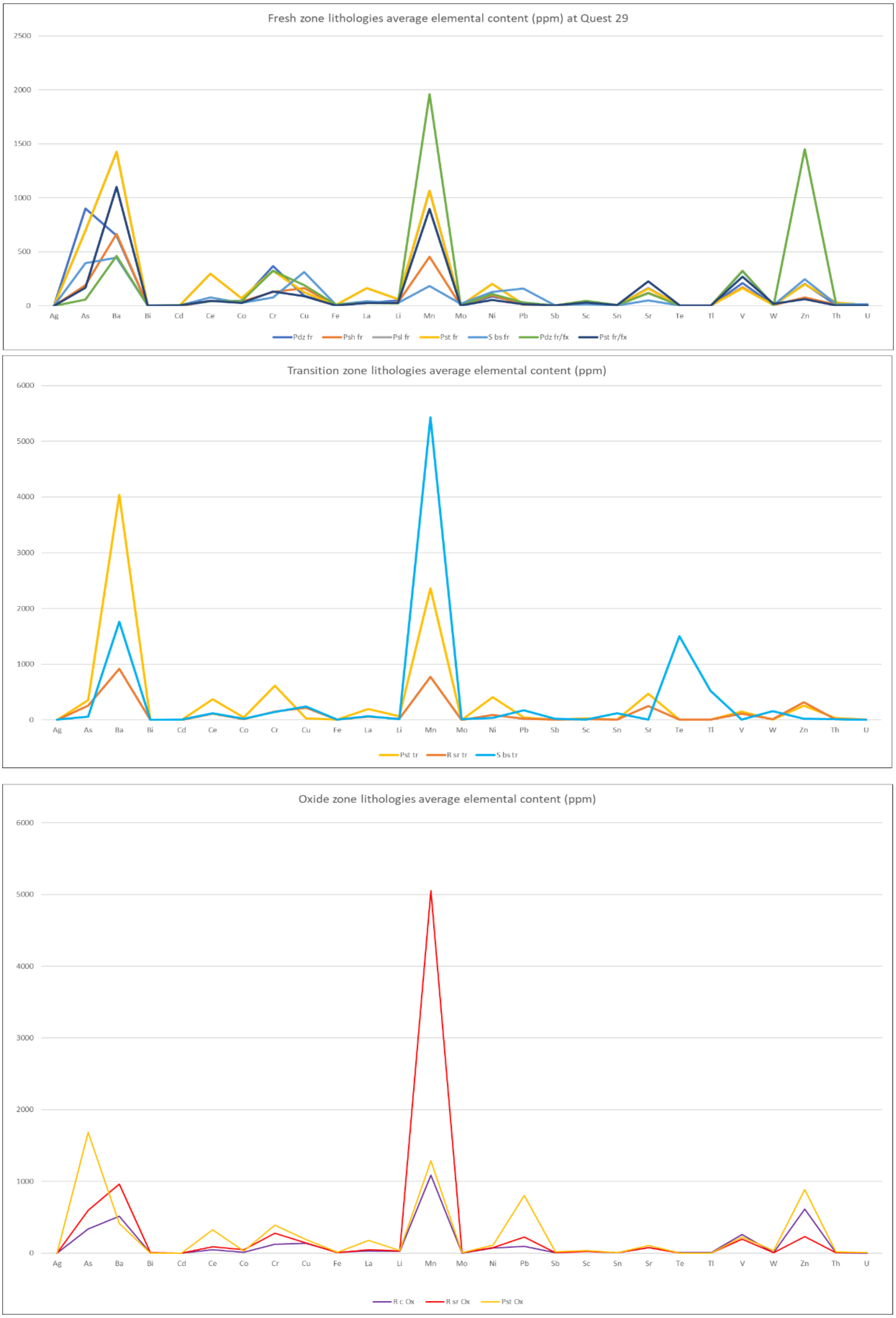

Figure 39 Average Elemental Concentrations (below 6000ppm) for all Weathering Zones

7.7 Phase 3 Static Testing (Quest 29)

Phase 3, consisting of ABCC and kinetic NAG was not completed. The ABCC and kinetic NAG tests are designed to provide additional information to assess the acid generation potential and availability of the ANC. As the samples assessed at Quest 29 were generally NAF or PAF, and the ANC/AP ratio for NAF was above 1.5, it was not deemed necessary to complete this phase of testing, as there were few lithologies providing ambiguous classification.

7.8 Phase 4 Static Testing – Characterisation of NAG Liquors (Quest 29)

All samples from phase 2 (59) were submitted for NAG liquor analysis to assess the possible composition of drainage that could be generated from the oxidation of sulfide bearing lithologies. The liquors generated in the NAG test were characterised for a range of components. These included electrical conductivity, major ion composition (Ca, Mg, SO4, Cl, alkalinity and acidity), nutrients (nitrogen and phosphorus species), metals and metalloids.

7.8.1 NAG Liquor pH and Electrical Conductivity

The pH of the NAG liquors was generally acidic (pH 2.0 in Sbs to pH 3.8 in Psh, Figure 26) with the exception of the sandstone Pst which reported a neutral pH 6.8. The lowest pH (pH 1.8) correlated to the highest EC (896 mS/m) in the shale unit (Sbs). Although the pH of the liquors was low, the EC of the liquor was only brackish (between 500 -2500 mS/m) not saline (over 2500 mS/m) (Figure 40).

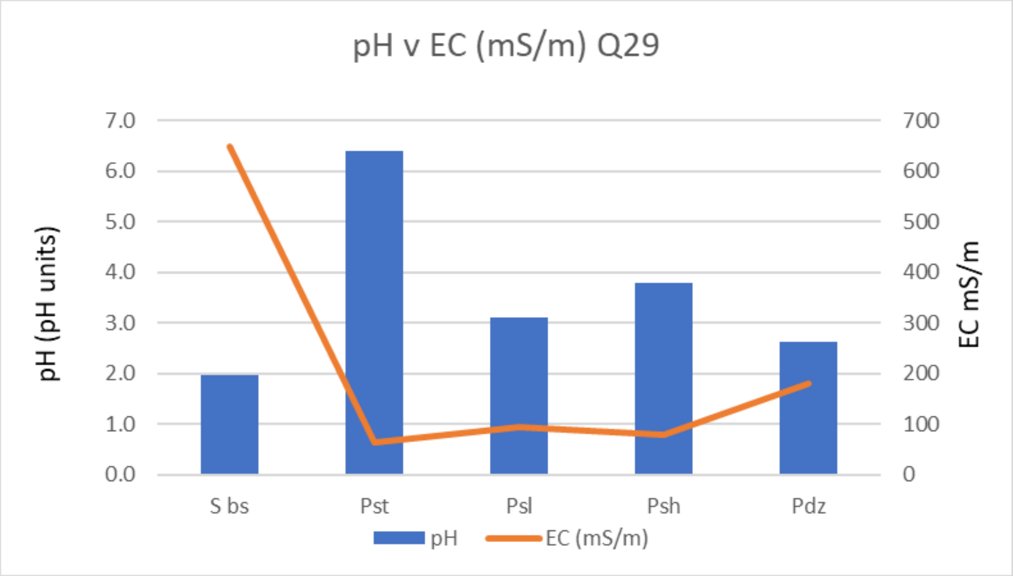

Figure 40 pH and Electrical Conductivity of NAG Liquors

7.9 NAG Liquor Composition (Quest 29)

7.9.1 Cations

The elemental composition of the liquors varies with oxidation zone, and lithology. Although all weathering zones and lithologies liquors are dominated by the major ions Al, Fe, Ca, Mg, K, and S (Figure 41) the trace elemental signature, the element present with the highest concentration is Mn (4.8 ppm in Sbs tr), there are a number of elements with concentrations around 1 ppm in all weathering zones, these are Cu, Pb and Zn, with Ni appearing at this concentration level in the fresh zone (Figure 42).

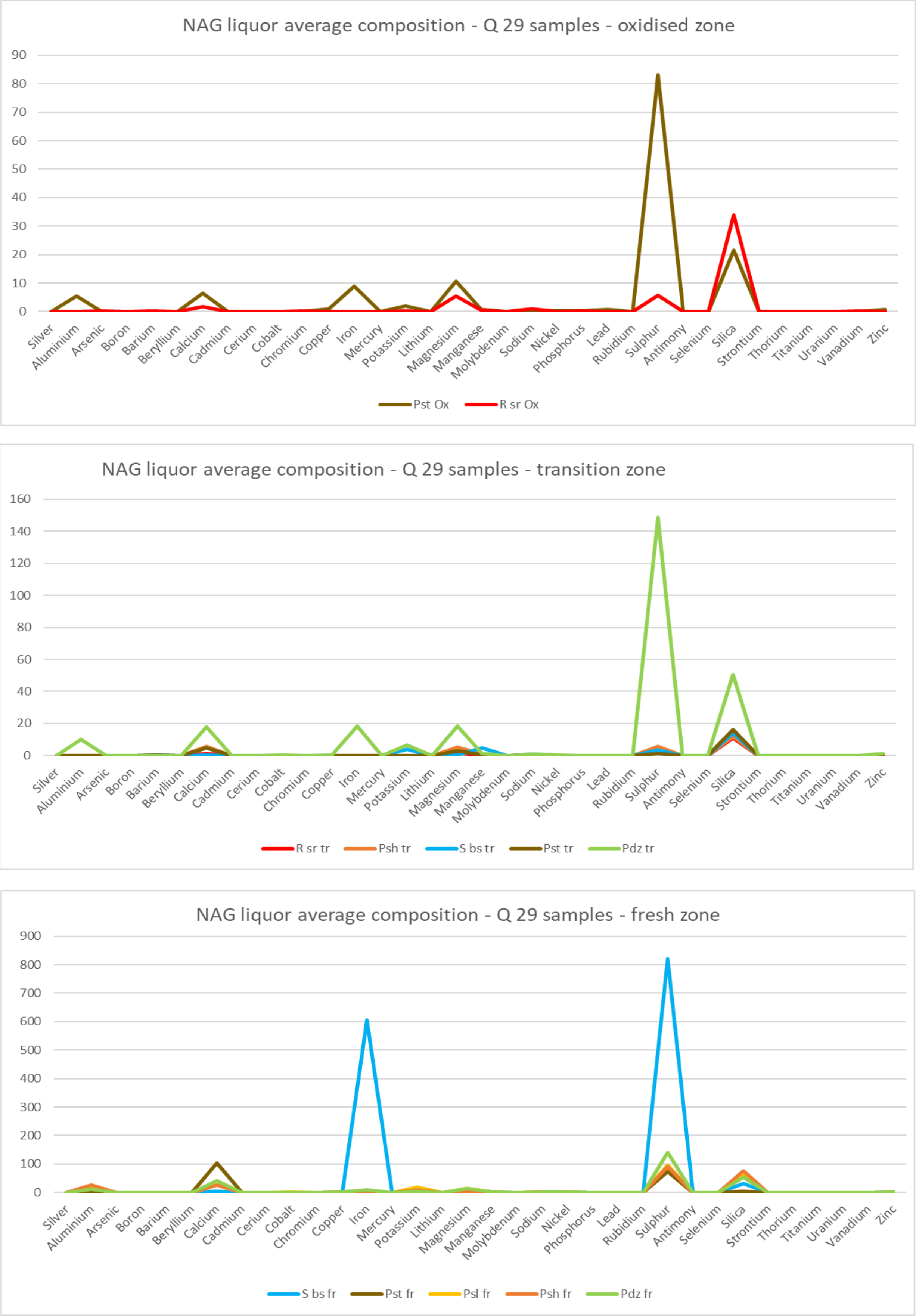

Figure 41 Elemental Signature in NAG Liquors from Quest 29 Samples

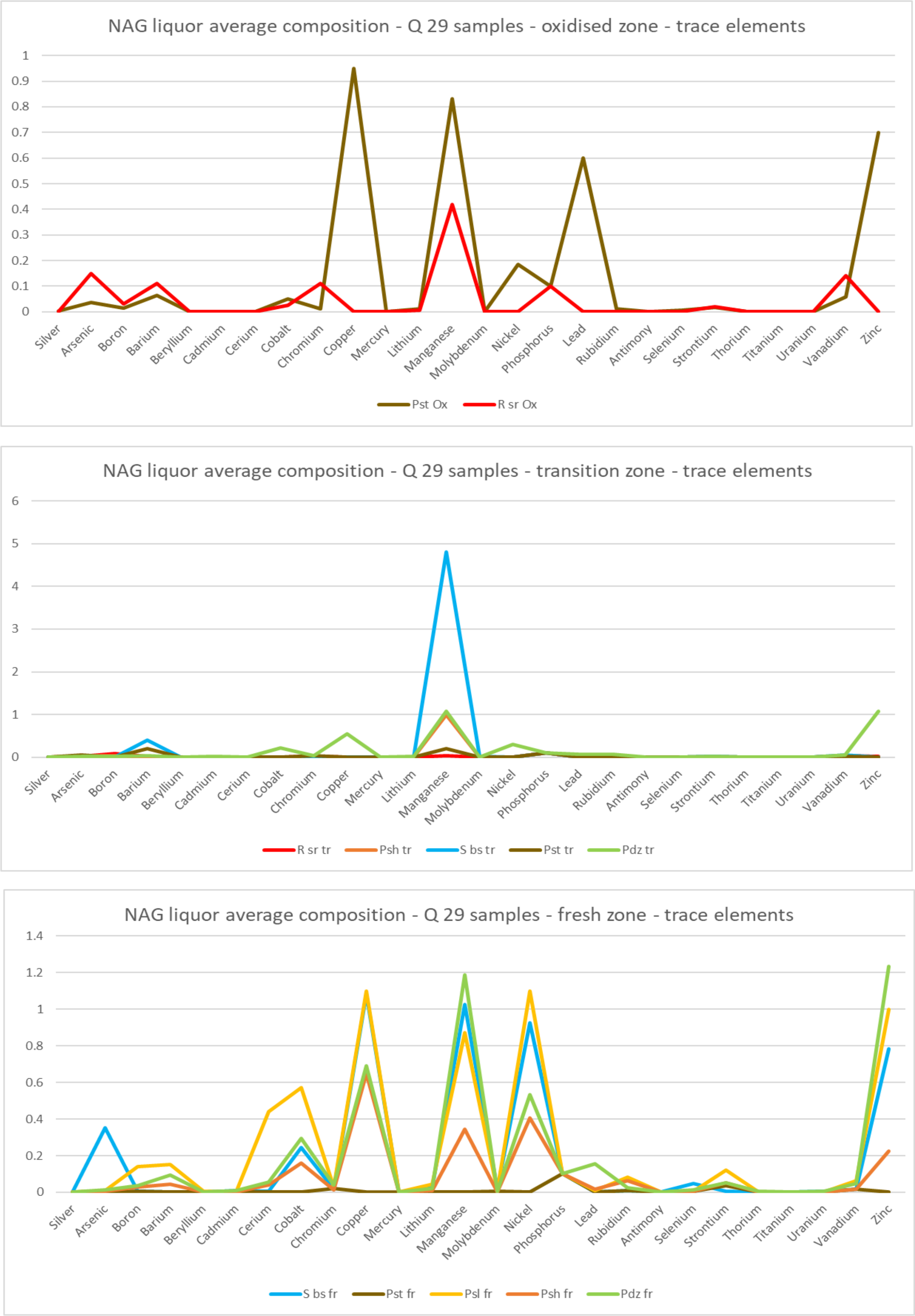

Figure 42 Trace Elemental Signature in NAG Liquors from Quest 29 Samples

7.9.2 Anions

In addition to the metal cations, the anions, nitrate, sulfate, and chloride were determined and also total alkalinity and total acidity (both expressed as mg/L $CaCO_3$).

Sulfate ranged in concentration from 4 (Pst tr) to 3600 mg/L (Sbs fr). Noting the highest sulfate concentration in the liquors correlates with the lowest NAG liquor pH of 1.8.

Nitrate concentrations ranged from 13 mg/L (Sbs fr) to 41 mg/L (Rsr tr) with an average of 34 mg/L, with Sbs reporting consistently lower nitrate concentration than all other lithologies.

Chloride concentration were consistently around 4-5 mg/L for all lithologies across all weathering zones.

Of the samples assessed only one out of 25 samples reported alkalinity levels above LOR, Pst from the fresh zone was the only lithology where alkalinity was present in the NAG liquor at a concentration of 26 mg/L as $CaCO_3$.

7.10 Water Quality Prediction (Quest 29)

To assess the possible risk to water quality from drainage that could be produced during long term storage of mine wastes generated from the Quest 29 deposit, either at Quest 29 or Rustlers Roost, the NAG liquor composition was used as a proxy for the possible drainage quality and to provide a preliminary risk assessment. To complete the assessment, the data was screened against national water quality guidelines.

The most relevant guideline to assess risk to water quality at the site, in the absence of site-specific criteria are the freshwater guidelines documented by the Australian and New Zealand Governments; ANZECC and ARMCANZ freshwater criteria published in 2018. We have applied the default 95% species protection values and where relevant we have also applied low reliability criteria as recently recommended by ANZECC.

Data was managed in the same way as described for Rustlers Roost.

7.11 Preliminary Risk Assessment

A summary of the exceedances is presented in Table 26, where green indicates an exceedance of the ANZECC criterion for that analyte.

For samples generating neutral liquors (pH 6-8) the chemicals exceeding the relevant criterion were Al, As, Co, Cr, Mn, U, V, Zn and nitrate.

For samples generating acidic NAG liquors, the exceedances were more varied; Ag, Al, As, Cd, Co, Cr, Cu, Ni, Pb, Se, Ti, U, V, Zn and nitrate.

We note that where the pH of the liquor was acidic the elements leaching from the samples included higher concentrations of those typically associated with sulfides such as Cu, Ni, Pb, Se, and Zn.

Given the similarities in the elemental signatures of the liquors from each lithology it is clear that pH is the main driver for release of the elements from the solid matrix rather than lithology.

Table 26 Quest 29 NAG Liquor Composition Screened Against ANZECC Freshwater Guidelines

			Client ID	Q29 005	Q29 008	Q29 012	Q29 016	Q29 017	Q29 018	Q29 020	Q29 023	Q29 025	Q29 028	Q29 037	Q29 039	Q29 043	Q29 046	Q29 048	Q29 052	Q29 053	Q29 054	Q29 055	Q29 056
			Sample Date	HKR33768	HKR33798	HKR33648	HKR33678	HKR33693	HKR33824	HKR33855	HKR33875	HKR33883	HKR33909	HKR34034	HKR34049	HKR34089	HKR34147	HKR34178	HKR34244	HKR34252	HKR34263	HKR34265	HKR34267
			Sample Number	S bs	S bs	P sh	Pdz	Pst	R sr	Psh	Psl	Psh	Pst	R sr	Pdz	S bs	S bs	Pdz	Pst	Pdz	Pdz	Pdz	Pst
				fr	fr	fr/fx	fr/fx	fr	tr	tr	fr	fr	Ox	Ox	tr	fr	tr	fr	tr	fr	fr	tr	Ox
Analyte	**UNITS**	**LOR**	**ANZECC 2018 Freshwater default guideline values (mg/L)**																				
Metals																							
Silver	mg/L	0.0001	0.00005	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0009	<0.0001	0.0016	0.0008	0.0006	0.0088
Aluminium	mg/L	0.005	0.055	8.4	18	0.058	6.7	0.13	<0.005	<0.005	18	52	0.01	<0.005	3.4	28	<0.005	21	<0.005	9.3	8.8	17	11
Arsenic	mg/L	0.001	0.013**	0.47	0.57	0.005	0.01	0.003	0.017	0.036	0.01	0.002	0.053	0.15	0.003	0.017	<0.001	0.007	0.053	0.008	0.02	0.036	0.022
Boron	mg/L	0.005	0.37	<0.005	<0.005	0.03*	0.09*	<0.005	0.08*	0.033	0.14	0.025	0.023	0.031	0.032	<0.005	<0.005	<0.005	<0.005	0.043	<0.005	0.007	<0.005
Barium	mg/L	0.0001		0.0017	<0.0001	0.013	0.12	0.0029	0.016	0.0031	0.15	0.078	0.069	0.11	0.071	<0.0001	0.4	0.1	0.21	0.089	0.063	0.012	0.061
Beryllium	mg/L	0.0001		0.0016	0.0029	0.0002	0.0037	<0.0001	<0.0001	<0.0001	0.0039	0.0034	<0.0001	<0.0001	0.0008	0.0027	<0.0001	0.0018	<0.0001	0.0033	0.0013	0.0019	0.0032
Calcium	mg/L	0.1		1.6	2.3	0.4	34.6	102	1.2	5.6	27.5	53.7	5	1.8	25.8	5.7	0.2	67.7	4.7	22.5	41.9	10.2	7.8
Cadmium	mg/L	0.0001	0.0002	0.021	0.0037	<0.0001	0.0017	<0.0001	0.0001	<0.0001	0.0018	0.001	<0.0001	<0.0001	0.0057	0.0007	0.001	0.021	<0.0001	0.013	0.0015	0.041	0.0033
Cerium	mg/L	0.0005		0.0023	0.0052	<0.0005	0.11	<0.0005	<0.0005	<0.0005	0.44	0.08	<0.0005	<0.0005	0.0035	0.012	<0.0005	0.097	<0.0005	0.0093	0.012	0.0086	0.0023
Cobalt	mg/L	0.0001	0.0014	0.39	0.16	0.0015	0.27	<0.0001	0.0041	0.0006	0.57	0.32	0.0026	0.027	0.16	0.18	0.0003	0.14	<0.0001	0.33	0.44	0.27	0.099
Chromium	mg/L	0.0005	0.001***	0.019	0.022	0.0076	0.024	0.022	0.026	<0.0005	0.029	0.02	0.0015	0.11	0.036	0.015	<0.0005	0.035	0.035	0.072	0.034	0.041	0.021
Copper	mg/L	0.0001	0.0014	0.73	0.52	<0.0001	0.35	<0.0001	<0.0001	<0.0001	1.1	1.3*	<0.0001	<0.0001	0.19	2*	<0.0001	0.91	<0.0001	0.89	0.61	0.9	1.9*
Iron	mg/L	0.005		660	1100	0.016	0.26	<0.005	0.023	<0.005	0.63	4.3	0.006	<0.005	0.54	54	<0.005	22	<0.005	2.5	12	36	18
Mercury	mg/L	0.0001	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Potassium	mg/L	0.1		<0.1	<0.1	2	6.4	2.5	<0.1	<0.1	18.9	17.6	<0.1	<0.1	3.3	<0.1	3.9	9.2	<0.1	2.6	2.4	9.9	3.6
Lithium	mg/L	0.0001		0.0059	0.023	0.0007	0.024	0.0014	0.0012	0.0065	0.044	0.021	0.0055	0.0054	0.028	0.042	<0.0001	0.014	0.0076	0.029	0.021	0.03	0.018
Magnesium	mg/L	0.1		4.2	14.3	1.5	13.7	0.4	1.8	5.3	15.1	5.3	6.7	5.3	18.1	15.8	0.5	11.5	3.1	18.1	16.5	18.5	14.7
Manganese	mg/L	0.0001	1.9	0.13	2.6*	0.16	1.7*	<0.0001	0.038	1	0.87	0.53	1.4*	0.42	1.7*	0.35	4.8*	0.8	0.21	0.75	1.5*	0.47	0.26
Molybdenum	mg/L	0.001	0.034	0.025	0.028	0.005	0.018	0.005	0.002	0.002	0.01	<0.001	0.002	<0.001	0.013	<0.001	0.013	<0.001	0.003	<0.001	<0.001	<0.001	<0.001
Sodium	mg/L	0.1		<0.1	<0.1	0.2	0.3	0.2	0.3	0.2	0.8	1.7	0.6	0.9	1	<0.1	0.9	1	0.4	1.1	1.2	0.3	0.1
Nickel	mg/L	0.001	0.011	0.73	1.3*	0.001	0.96	<0.001	0.009	<0.001	1.1*	0.81	<0.001	0.002	0.26	0.75	<0.001	0.45	0.003	0.32	0.4	0.35	0.37
Phosphorus	mg/L	0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	mg/L	0.0001	0.0034	0.001	0.001	<0.0001	0.0032	<0.0001	<0.0001	<0.0001	0.01	0.032	<0.0001	<0.0001	0.016	0.0022	<0.0001	0.24	<0.0001	0.15	0.23	0.13	1.2*
Rubidium	mg/L	0.0001		0.0032	0.0029	0.017	0.032	0.01	0.011	<0.0001	0.081	0.11	<0.0001	<0.0001	0.021	0.019	0.012	0.039	<0.0001	0.015	0.013	0.11	0.023
Sulphur	mg/L	0.1		920	1300	2.6	70	73	2.7	5.6	95	180	6.1	5.6	77	240	3.4	220	1.3	110	160	220	160
Antimony	mg/L	0.0001		0.0025	0.0054	0.0001	<0.0001	0.0003	<0.0001	0.0003	<0.0001	<0.0001	0.0003	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0008	<0.0001	<0.0001	<0.0001	<0.0001
Selenium	mg/L	0.001	0.005	0.054	0.068	<0.001	0.006	0.004	<0.001	<0.001	0.006	0.01	<0.001	<0.001	0.011	0.021	<0.001	0.021	<0.001	0.016	0.007	0.008	0.011
Silica	mg/L	0.1		4.6	29	10	48	3.6	11	12	67	140	12	34	57	61	14	75	16	51	43	44	31
Strontium	mg/L	0.0001		0.0038	0.0027	0.0052	0.076	0.038	0.0029	0.014	0.12	0.1	0.022	0.019	0.038	0.0069	0.013	0.041	0.0095	0.049	0.044	0.016	0.013
Thorium	mg/L	0.0001		0.0023	0.0036	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0053	<0.0001	<0.0001	<0.0001	0.0022	<0.0001	0.022	<0.0001	<0.0001	0.0005	0.0006	0.0001
Titanium	mg/L	0.0001	0.00003	0.0008	0.0011	<0.0001	0.0003	<0.0001	<0.0001	<0.0001	0.0011	0.0013	<0.0001	<0.0001	0.0003	0.0017	0.0053	0.0008	<0.0001	0.0008	0.0008	0.0037	0.0002
Uranium	mg/L	0.0001	0.0005	0.0095	0.0064	0.0004	0.0019	<0.0001	0.0001	<0.0001	0.0032	0.0039	<0.0001	<0.0001	0.002	0.0054	0.0002	0.012	<0.0001	0.0004	0.0002	0.0004	0.0009
Vanadium	mg/L	0.005	0.006	0.016	0.033	0.028	0.084	0.016	0.035	0.032	0.062	<0.005	0.11	0.14	0.093	<0.005	0.057	<0.005	0.027	0.087	0.012	0.005	<0.005
Zinc	mg/L	0.001	0.008	0.46	1.4*	0.02	0.21	<0.001	0.025	<0.001	1	0.43	<0.001	<0.001	0.77	0.49	<0.001	3.7*	<0.001	0.24	0.79	1.4*	1.4*
Nutrients																							
Nitrate (as N)	mg/L	0.05	0.005^	19	13	39	38	36	41	35	35	39	37	37	38	31	39	37	39	37	35	34	36
Sulphate as (SO4)	mg/L	1		2400	3600	11	210	230	9	18	290	550	20	18	220	660	11	700	4	320	480	690	480
Alkalinity																							
Acidity (as CaCO3)	mg/L	2		2800	4300	110	99	5	49	<5	170	450	5	7	110	720	5	550	<5	230	370	650	460
Total Alkalinity (as CaCO3)	mg/L	1		<3	<3	<3	<3	26	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
General																							
Chloride	mg/L	1		4	5	6	4	5	5	4	4	4	5	4	4	4	5	5	4	4	4	4	4
Electrical Conductivity	mS/m	0.2		752	896	13.4	75.7	63.3	12.7	15.4	94.8	146	17.1	15.5	99.1	296	15.3	266	13.4	154	228	338	250
pH	pH units	0.1	6.0 - 8.0^	2	2	5	3	6.4	6	6.4	3	3	6	6	3	2	6	2	6	3	2	2	2

* Denotes ICP analysis and higher LOR

**Value for AsV adopted

*** Value for CrVI adopted

^ Default trigger values for tropical Australia freshwater

7.12 Phase 5 Static Testing - Mineralogy Results (Quest 29)

Semi-quantitative x-ray diffraction (XRD) was completed on 5 composite samples of the principle lithologies at Quest 29 including a sample of the ore. As described in the Rustlers Roost section, the composite samples were prepared in the most part, from the static program discrete samples for the purpose of preparing kinetic columns. The composite sample representative of the contents of the kinetic column were submitted to Microanalysis Australia and analysed on the same instrument using the same software as described in the Rustlers Roost section. The results of the mineralogical analysis are presented in Table 27.

Table 27 X-ray Diffraction Results – Quest 29 Presented as Weight %

Sample Mineral	Pdz fr	Sbs fr	Pdz (LG) Ore	Sbs Ore	Pdz tr
	Dolerite	Black Shale	Dolerite	Black Shale	Dolerite
Quartz	38	44	38	30	24
Muscovite	27	31	13	19	17
Clinochlore	28	18	28	31	53
Microcline	2	1			2
Pyrite		1	2	1	2
Dolomite				12	2
Albite	2	1	trace	3	1
Kaolinite	3	5	19	2	

The mineralogy of the two lithologies assessed (the shale (Sbs fr) and the dolerite Pdz fr) are dominated by quartz, muscovite and clinochlore. The dolerite in the transition zone contains dolomite, a magnesian carbonate whereas it is below LOR for the same lithology in the fresh zone.

Kaolinite is present in the fresh (Pdz fr, Sbs fr) and ore samples (Pdz (LG ore) and Sbs ore. This clay mineral is noted as one of the ore minerals in the Mt Bundy logging codes provided by PGO.

7.13 Ore

The initial sample set available for the geochemical assessment did not include high grade ore samples as these had all been used for gold assay. Thus, an additional sample of high-grade ore black shale (sample ID MTS_248-251) was provided by PGO which was representative of ore at the Rustlers Roost and Quest 29 deposits for the kinetic program. As the sample had not undergone any static testing, a limited program of testing inclusive of paste pH and EC, NAG pH, sulfur and carbon speciation and ANC was completed. The results are summarised in Table 28.

Table 28 Static Test Results for Ore Sample

	ANC	EC(1:2)	NAG	pH(1:2)	S	S-S04	TOS
Units	kg H2SO4/t	mS/m	kg H2SO4/t		%	%	%
MTS_248-251	14	75	110	6.9	7.51	0.05	7.46

Where TOS = total oxidisable sulfur

Mineralogical analysis was also completed, please refer to sample Sbs ore presented in Table 26.

The ore is classified as PAF (Figure 36), and plots within the same area of the PAF classification as the other samples of black shale assessed in this study.

The mineralogical analysis of the ore sample indicates that the ore contains appreciable carbonate (12 wt%) however, it is clear that it is not immediately available to neutralise the acid generated even at relatively low pyrite contents (1 wt % py). The carbonate present is dolomite, this magnesian carbonate has low solubility however, may be available for long term acid management. The results of the kinetic program will be useful in determining whether this carbonate becomes available during sulfide oxidation.

7.14 Discussion and Conclusions (Quest 29)

At Quest 29, the oxide and transition zones represent a smaller proportion of the mine void than at Rustlers Roost. The majority of the ore at Quest 29 lies within the fresh zone. The majority of the gold is hosted within the units Pdz, Psh, Pst, Sbs and Vq (vein quartz).

Sulfur, S, data was not available in the assay data set thus, to assess the potential for acid formation, as for Rustlers Roost, the visible presence of sulfide in the log was used as an indicator for sample selection. Sulfide was reported in 403 samples logged as pyrite, py (389), pyrrhotite, po (3) and arsenopyrite, ap (11) within seven (7) key lithologies. All sulfide bearing lithologies with sufficient samples/proportion of the available core were selected for geochemical characterisation; Fifty nine samples consisting of shale, Psh, clay Rc, saprock Rsr, sandstone Pst, dolerite Pdz, siltstone Psl and black shale Sbs were selected based on the interpretation of their phase 1 screening results:

All 59 samples assessed for their sulfur content had concentrations above LOR.

The paste results showed a wide range of pH and EC values, with the black shales providing the highest sulfur content, lowest pH and highest EC.

The sulfur present is predominantly sulfide, with some organic sulfur present in the black shales, correlating with a higher organic carbon content. Organic carbon can account for up to a third of the carbon content in these shales.

For most of the samples assessed, the ANC content was variable. Of the twenty samples that were selected for detailed acid base accounting, eight samples had a negative NAPP. The lithologies did not have consistent classifications, with all lithologies having at least one sample with insufficient ANC to manage its acid generating potential and thus all lithologies have the potential to host PAF materials. PAF material were present in all weathering zones, including the oxide zone. The only carbonate mineral identified in the deposit is dolomite. This magnesian carbonate will neutralise acid, however not as readily as calcite.

From the historical work completed at the site it is thought the distribution of PAF is likely related to the structural setting within the area of interest. The ore fluids would have contained sulfide, their pathway was structurally not lithologically controlled (refer to Geochemical desk study 2019 and references therein). The PAF zones will likely correlate to the ore zones, although they will extend into the waste zones following the fluid pathway. From the data generated in this study there is insufficient data to delineate areas of greatest PAF risk but generalisations can be made:

The lithologies at Quest 29 are generally more sulfidic than those at Rustlers Roost, particularly in the fresh zone.

The sandstones, siltstones, shales and dolerite all contain sulfides which can be found unoxidized even in the oxide zone.

The saprock and clays in the oxide zone are NAF and are unlikely to contain PAF material, the low paste pH reported is likely due to free iron in the solution and not from the oxidation of sulfides.

The elemental content of the lithologies reflects the hydrothermal setting, with all lithologies displaying a similar elemental signature. The mineralogy is consistent with these findings, with the lithologies across the weathering zones being relatively indistinguishable from each other mineralogically. One would have expected a shale (a metamorphic sediment) to have a different mineralogy to a dolerite (a mafic igneous rock) but that was not the case at this site.

The major elemental components of all lithologies are Fe, C, and S which are present at levels measured in %. The remaining elements (trace elements) were reported as parts per million (ppm – mg/kg). Of the trace elements, the elements dominating the signature of all lithologies are Al, Ca, K, Na, Mg, P and Ti.

The trace elemental signature displayed notable concentrations of As in the elemental composition of the sandstones both in the oxide and fresh zones of the deposit.

On further data evaluation we noted Arsenic (As) has a positive correlation with the concentration of iron in the transition zone. This is not unexpected as the transition zone hosts the majority of the ore, with arsenopyrite a known ore mineral. However, the relationship with iron does not continue in the oxide and fresh zones. This is interpreted as demonstrating the numerous sources of iron in the fresh and oxide zones that are not related to the ore forming processes. For example, the chlorite mineral clinochlore which represents over 50% of the mineralogy of the dolerite, contains iron but not arsenic. Chlorites are formed during alteration of the host rock, thus although they are a direct consequence of the hydrothermal event, they did not precipitate directly from the hydrothermal fluids, unlike the gold and arsenopyrite. In the oxide zone there are likely many mineral phases containing iron which can sequester As onto their surface or into the mineral matrix such as carbonates, oxides, sulfates and phosphates. We note that As can be released from these phases upon wetting particularly in high pH waters which can eventuate during the first flush events following a prolonged dry period.

The elemental signature of the NAG liquors is also reflective of the mineralogy recorded in the major lithologies. As previously discussed, the chlorite mineral clinochlore is present as a major mineral phase, although Mg and Fe are the typical elements associated with this aluminium silicate, other divalent elements such as Ni may also substitute into the mineral matrix. The presence of these elements in the elemental and NAG liquor signature suggests that such substitutions are likely to have occurred in this system.

Arsenic is released from the fresh and oxide zones. For the oxide zones, the As was likely released by the higher pH generated in these liquors as As is known to desorb from solid phases at pH above 8.5 (Smedley and Kinniburgh, 2001). The high pH in the oxide zones may be due to evaporation, or concentration of dissolved salts due to surface water percolation through the soil/sediment profile. Other elements likely to also be released by this desorption mechanism are Mn, Se, V, and U.

In the fresh zone, particularly in the sulfidic black shales, As was likely released during the oxidation of sulfides. The low pH generated by the oxidation of sulfides caused a wide range of elements to be released from the minerals present, by both mineral dissolution and desorption mechanisms. The elements typically associated with sulfides such as As, Cu, Pb, Ni, Se and Zn are all represented in the acidic NAG liquors.

Based on the preliminary risk assessment completed in this study, there are a range of chemicals of potential concern (COPC) with respect to site water quality. The current site water quality is a freshwater system. Refer to Appendix C for further analysis of the drainage quality and preliminary ecological risks.

Section 8 Naturally Occurring Radioactive Material

The head of chain radionuclides uranium (U) and thorium (Th) content of the principles lithologies present within the two deposits, Rustlers Roost and Quest 29 were measured (Table 29).

All pulps collected for the static geochemical assessment described above were digested with four acids and their total U and total Th content determined.

The average content of each lithology is presented in Table 29 along with the content measured in the ore and tailings samples provided by PGO.

Table 29 Uranium and Thorium Content of Waste, Ore and Tailings for Rustlers Roost and Quest 29

Quest 29		**Th**	**U**
		mg/kg	**mg/kg**
Pdz	fr	6.16	1.45
Psh	fr	11.40	2.76
Psl	fr	32.09	6.65
Pst	fr	32.09	6.65
S bs	fr	16.08	13.92
Pdz	fr/fx	5.57	1.56
Pst	fr/fx	4.96	2.15
Pst	tr	40.6	6.53
R sr	tr	15.52	3.79
S bs	tr	13.93	1.99
R c	Ox	9.02	3.13
Life of Mine		**Th**	**U**
		mg/kg	**mg/kg**
Tailings		15.41	4.41
Ore		28.26	20.47
		Th	**U**
Rustlers Roost		**mg/kg**	**mg/kg**
Psh	fr	18.82	5.24
Psl	fr	19.30	4.87
Pst	fr	21.94	5.48
Ss	fr	18.05	4.46
Psh	tr	18.93	5.34
Psl	tr	19.90	5.17
Pst	tr	17.78	4.14
S cs	tr	31.68	7.7
Ss	tr	19.26	4.76
Psh	ox	14.8	3.60
Psl	ox	12.28	3.18
Rsl	ox	24.47	7.15
Ss	ox	16.45	3.48

Under the guidance from the National Directory (ARPANSA) a material is deemed radioactive if the concentration of any radionuclide in the U and Th decay chain is above the exemption values in schedule 4. The exemption value is 1 Bq/g.

As we have not measured the activities of the U and Th, only the total content. To calculate the activities we must assume that the minerals at the site are in secular equilibrium that is that their radioactivity is directly proportional to the total head of chain elemental concentration.

Published specific activities for natural uranium and thorium isotopes in a system in equilibrium are as follows:

- U-238 specific activity = 12.4 Bq/kg; and
- Th-232 specific activity = 4 Bq/kg.

Thus, the activity is measured concentration (mg/kg) x 0.0124 for U to give Bq/g. The activity is measured concentration (mg/kg) x 0.004 for Th to give Bg/g.

U-238 and Th-232 are the most common isotopes, to calculate the total activity of the sample we add the activities of the U and Th head of chain elements together (Table 30).

Table 30 Total Activities of each Lithology, Ore and Tailings for Rustlers Roost and Quest 29

Quest 29		Th	U	Th	U	Total Activity
		mg/kg	mg/kg	Activity Bq/g	Activity Bq/g	Bq/g
Pdz	fr	6.16	1.45	0.02	0.02	0.04
Psh	fr	11.40	2.76	0.05	0.03	0.08
Psl	fr	32.09	6.65	0.13	0.08	0.21
Pst	fr	32.09	6.65	0.13	0.08	0.21
S bs	fr	16.08	13.92	0.06	0.17	0.24
Pdz	fr/fx	5.57	1.56	0.02	0.02	0.04
Pst	fr/fx	4.96	2.15	0.02	0.03	0.05
Pst	tr	40.60	6.53	0.16	0.08	0.24
R sr	tr	15.52	3.79	0.06	0.05	0.11
S bs	tr	13.93	1.99	0.06	0.02	0.08
R c	Ox	9.02	3.13	0.04	0.04	0.07
Life of Mine		**Th**	**U**	**Th**	**U**	**Total Activity**
		mg/kg	**mg/kg**	**Activity Bq/g**	**Activity Bq/g**	**Bq/g**
Tailings		15.41	4.41	0.06	0.05	0.12
Ore		28.26	20.47	0.11	0.25	0.37
Rustlers Roost		**Th**	**U**	**Th**	**U**	**Total Activity**
		mg/kg	**mg/kg**	**Activity Bq/g**	**Activity Bq/g**	**Bq/g**
Psh	fr	18.82	5.24	0.08	0.06	0.14
Psl	fr	19.3	4.87	0.08	0.06	0.14
Pst	fr	21.94	5.48	0.09	0.07	0.16
Ss	fr	18.05	4.46	0.07	0.06	0.13
Psh	tr	18.93	5.34	0.08	0.07	0.14
Psl	tr	19.9	5.17	0.08	0.06	0.14
Pst	tr	17.78	4.14	0.07	0.05	0.12
S cs	tr	31.68	7.7	0.13	0.10	0.22
Ss	tr	19.26	4.76	0.08	0.06	0.14
Psh	ox	14.8	3.6	0.06	0.04	0.10
Psl	ox	12.28	3.18	0.05	0.04	0.09
Rsl	ox	24.47	7.15	0.10	0.09	0.19
Ss	ox	16.45	3.48	0.07	0.04	0.11

There are no samples exceeding the 1 Bq/g activity limit based on their average U and Th content.

8.1 NORM Discussion

The Australian Radiation Protection and Nuclear Safety Authority (ARPANSA) published the national codes and guidance in the Radiation Protection Series (RPS)[10] to provide guidance and promote protection of human health and the environment from radiation.

In 2020, ARPANSA published a guide to classification of radioactive wastes, RPS G-4, which includes guidance on the classification of mine waste. They acknowledge that the criteria for assessing NORM is different than that for manmade radioisotopes. The principal factors informing the management measures are activity and half-life of the radioisotopes present. NORM tends to have a very long half-life, which is why we can still measure it in geological strata that were deposited many years prior.

Exemption levels exist for materials mined from areas with NORM, exemption levels are presented in the National Directory for Radiation Protection Series No 6 published in February 2014 and *Schedule I of the General Safety Requirements No. GSR Part 3 Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*[4], published by the IAEA (2014)11. The exemption levels for natural U and Th is 1 Bq/g for each isotope in the U and Th decay chain. Thus, based on the data presented here (which provides an indication of the NORM content and activities of subsurface materials that could be present in the wastes, ore and tailings generated from mining of the Rustlers Roost and Quest 29 deposits) in the most part an exemption may be possible.

It is noted that some samples contain a considerable amount of fluorapatite which was found to be Th bearing (up to 6 wt% of the sample tested). Thus, there are likely areas of the Rustlers Roost mine where total activities may be higher than documented here.

For radiation protection requirements for NORM the reader is directed to RPS 9 (ARPANSA 2005) and RPS 15 (ARPANSA 2008) for more information.

Given the data presented above, further assessment of these materials is required to better understand the radionuclide content of this material given the activity of the one ore sample assessed. Therefore, it is recommended that prior to operation, further radionuclide analysis is conducted on the materials which includes and assessment of the total activity and assessment of each material's secular equilibrium.

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[10] https://www.arpansa.gov.au/regulation-and-licensing/regulatory-publications/radiation-protection-series/guides-and-recommendations

[11] https://www-pub.iaea.org/MTCD/Publications/

Section 9 Overall Conclusions

The Rustlers Roost and Quest 29 project areas contain waste materials (rock and tailings) which are acid forming, these materials will require management to minimise the impacts to the surrounding environment from the release of solutes (leachable elements and compounds).

Based on the 12 month kinetic test results, PAF from Quest 29 will continue to leach acidic drainage for a considerable period of time. It is the ore samples that has the longest sulfide depletion time (>600 years), this is reflected in the results for the tailings >500 years for sulfide depletion (refer to Appendix C).

However, the waste rock generated at Rustlers Roost may contain less PAF than previously thought given additional NAF material may be present at Rustlers Roost in the transition zone with the PAF(LC) sample (Psl tr, column 2) currently classifying as NAF (refer to Appendix C).

Oxide waste materials (all lithologies assessed) are predominantly NAF; however, caution must be adopted in assigning all materials in the oxide zone as NAF given at the boundary into the transitional zone, the oxide materials can classify as PAF.

Additional NAF waste (in the shales) is present in the fresh zone at depth at Rustlers Roost. Transitional zone waste is generally classified as UC (long lag PAF) or PAF. The ore (from Quest 29) is also PAF. Sulfur block models prepared for the Project (Appendix A and B) indicate that 38% (19.34 Mt) of waste would be classified as PAF for Rustlers Roost and 0.8 Mt (6.6%) of waste for Quest 29 would align with this threshold.

As mining is progressed, continuous total sulphur sampling will have to be conducted to regularly update the sulphur model.

For the ore transported from Quest 29 to Rustlers Roost for processing, measures to manage both acidic leachate and radioactivity should be put in place.

Typical management considerations where the avoidance of disturbance is not an option include:

- Segregation and selective placement;
- Encapsulation;
- Backfilling of hydrogeologically contained voids with minimal re-handling of materials; and
- Water management measures such as bunding.

The selection of the most appropriate management measures is based on site-specific environmental considerations including the climate, geology, hydrogeology, hydrology and geochemistry of the materials and cost and schedule implications to the Project.

Encapsulation should consider not only the acid generation potential of the waste but should also consider radioactivity requirements given the results gathered for the ore.

Appendix A – Rustlers Roost Waste Block Model

HANKING AUSTRALIA INVESTMENT

MEMORANDUM

TO:	Mark Qiu
COPY:	Fan Wu, John Zimmermann, Leon He,
FROM:	Charles Hastie
DATE:	31/05/2022
SUBJECT:	Description of Waste Model for Rustlers Roost

Introduction

Rustlers Roost has had total sulphur % added to the geological model to assist in scheduling and locating waste for encapsulating Potentially Acid Forming (PAF) material.

Total sulphur is used because it is reliable and provides a conservative estimate of the sulphide S content and hence the acid potential of a sample (ANC).

During operations waste rock geochemistry testing and Acid base accounting will continue including sulphide sulphur, Non-acid Forming (NAG) and metals content in waste for mining planning, mapping, and marking out on ground and for closure planning.

Local Geology

The Rustlers Roost deposit is hosted within a turbidite sequence within the Mt Bonnie Formation. The sequence is at least 1,500 m thick and comprises shale, siltstone, minor tuff, greywacke and bedded chert units (Goulevitch, 2004)[1]. Sedimentary units outcrop as banded carbonaceous siltstone and mudstone. The sediments have undergone regional greenschist grade metamorphism and later contact metamorphic events.

The sequence was later subjected to a major folding episode along north-northeast trending regional fold axes. The folds are open-to-tight in style and plunge consistently to the south at approximately 35°.

Gold mineralisation is hosted in planar, south dipping quartz-sulphide sheeted vein sets that are interpreted to postdate the folding event.

Following the folding, an extensive array of northeast and northwest trending dolerite dykes were intruded during extensional deformation.

The stratigraphic sequence can be subdivided into six distinct stratigraphic units on the basis of dominant rock-types, which include laminated dolomitic carbonaceous chloritic pyritic siltstone-shale and sulphidic laminated and nodular chert beds, greywacke-shale of turbiditic origin and volcaniclastics.

The rock material in the pit area is folded, sheared, and has various layers dipping in various shallow angles. The rock is fairly broken up and forms a massive low grade gold orebody. The gold ore was deposited along shears after the host sedimentary rocks were folded and sheared. Below is a figure that shows the faulting folding and structural dip variation.

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[1] Goulevitch, J., 2004. Results of core drilling program November 2003, Mount Porter Gold Prospect, NT. Annual report ERL 116

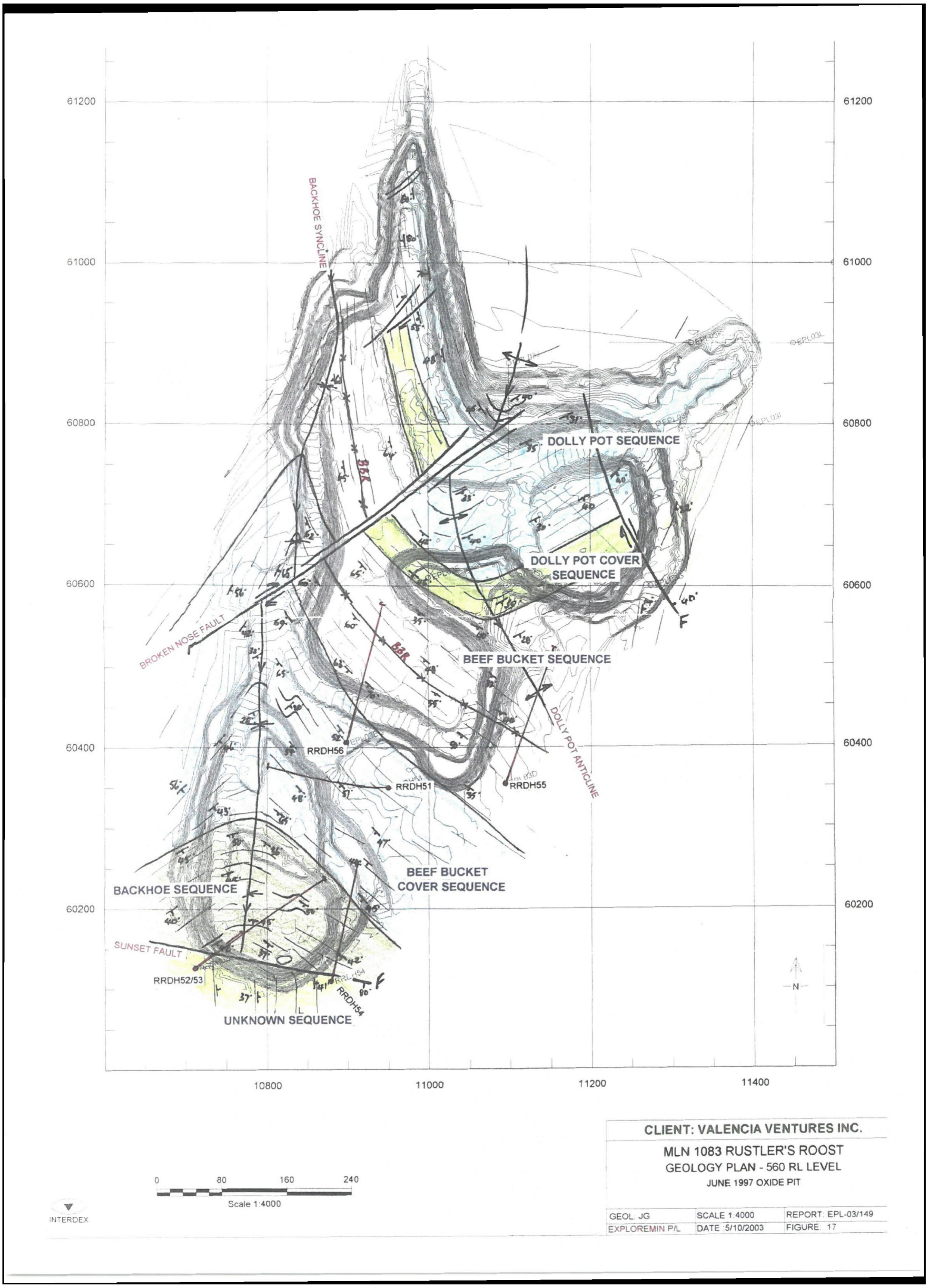


Figure 1 Diagram of folding, faulting, and structural dip variation at Rustlers Roost

Block Models

The recent block model was created by Cube Consulting Pty Ltd in 2021.

Rustlers Roost **“cube_rr_bm_20210131.mdl”** – 31/01/2021 .

This block model had an additional field added called “sul”. This represents the total sulphur % in the material.

The geological and waste model is called “**cube_rr_bm_20210131waste1.mdl**”.

There were six recently drilled holes tested for total sulphur % in 2021.

The holes were named RRDH02, RRDH05, RRDH06, RRDH07, RRDH08 AND RRDH09.

Determination of Oxide Transitional and Fresh

Rocks near earth surface have undergone weathering process which has resulted the breakdown of rocks and minerals. It is caused by chemical and physical interactions of air, water and living organisms.

Rocks are categorised in three domains based on the degree of weathering: fresh, transitional and oxide:

- **Fresh** rock has undergone no weathering. The weathering front is the boundary between fresh rock and material that has undergone weathering. The first signs of weathering are generally oxidation of sulphides and dissolution of carbonates, because these minerals are highly unstable within the weathering profile;

- **Transitional** material is only weakly weathered, and the destruction of primary sulphides and carbonates is only partially completed; and

- When the destruction is complete the material is referred to as **oxide** a zone found near the surface that forms as a result of chemical decomposition of unstable minerals under the action of surface waters and groundwater, as well as the oxygen and carbon dioxide present in the air and dissolved in these waters**.**

An increase in the degree of weathering coincides with a decrease in the density.

At Mt Bundy area, oxide zone is characterised as generally brown to red colour due to oxidation of Fe, broken core from the logging, no sulphide present and lighter weight.

	Degree of weathering		**Oxidation of primary sulphides**	**Dissolution of primary carbonates**	**Density**
Oxide	↑ Increase in the degree of weathering	Moderately to intensely weathered	Complete oxidation and destruction	Complete dissolution	↑ Decrease in density
Transitional		Weakly to moderately weathered	Partial oxidisation	Partial dissolution	
Fresh		No weathering	No oxidation	No dissolution	

Table 1 Oxidation class definition

Effects of Blasting on Total Sulphur % Estimation

The material in the pit will be blasted. When blasted, the waste, including PAF lodes, will be mixed together. When the waste is excavated, the waste material will be mined in 2.5 m to 3 m thick mining levels (benches), which will average out the total sulphur percentage in each mining bench. The sulphur model created simulates the sulphur % that will be mined out after blasting and excavation of a normal mining bench.

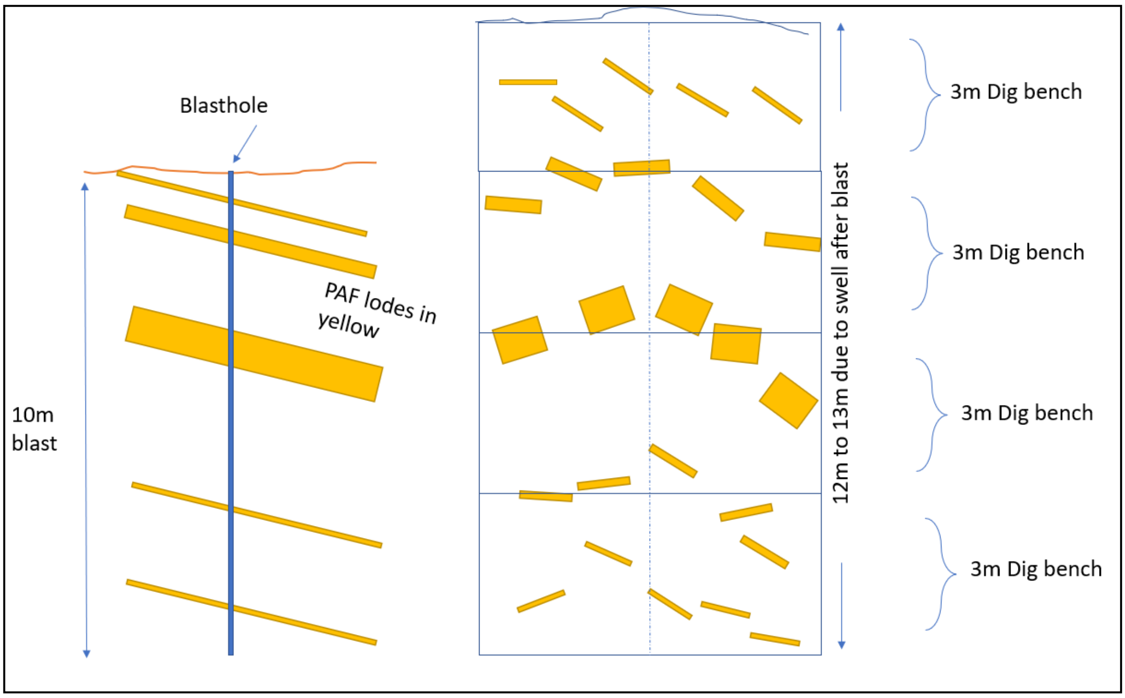


Figure 2 Mixture of total sulphur % after blasting and normal mining bench mining

Sub horizontal bands of sulphur bearing waste will be mixed by blasting, then further mixed and averaged out by mining in 2.5 m to 3 m thick benches.

The modelling of individual thin high S% lodes is not representative of how the pit will be mined, as they will be mixed into the pit material after blasting and mining in the three metre thick benches.

Consequently the use of curve fitting formulae is being used with depth (mRL) as the controlling variable. The curve fitting in the memo section below averages out (dilutes) the total sulphur %.

Estimation of Sulphur % in the Block Model

Total Sulphur % of 0.2% is the amount sulphur before material would be considered as PAF.

Below is a diagram of the drill holes and the five polygon zones used to estimate the Sulphur % in the waste of the designed pit.

The sulphur model used a polygonal estimation method to place Total sulphur values into the block model.

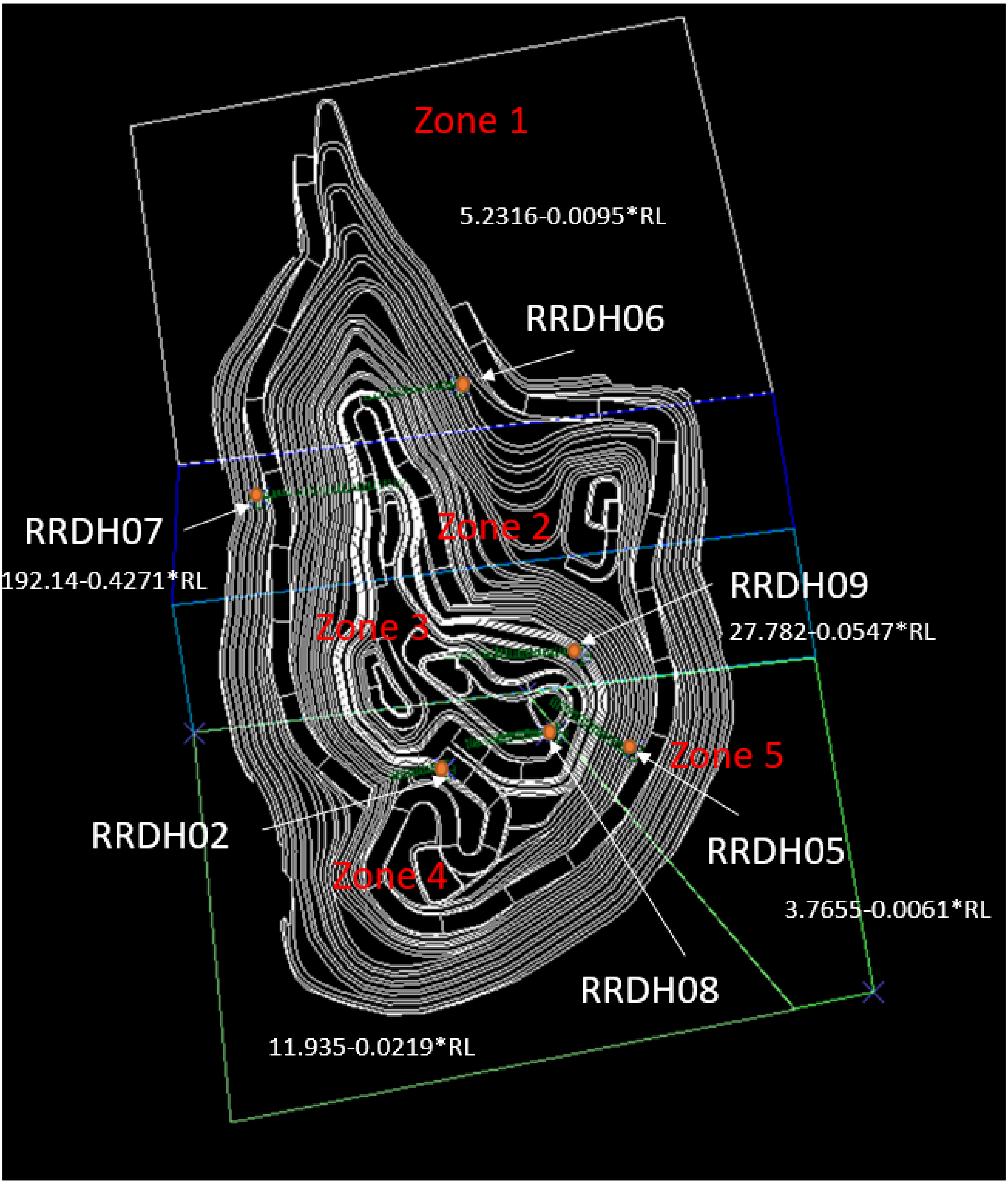


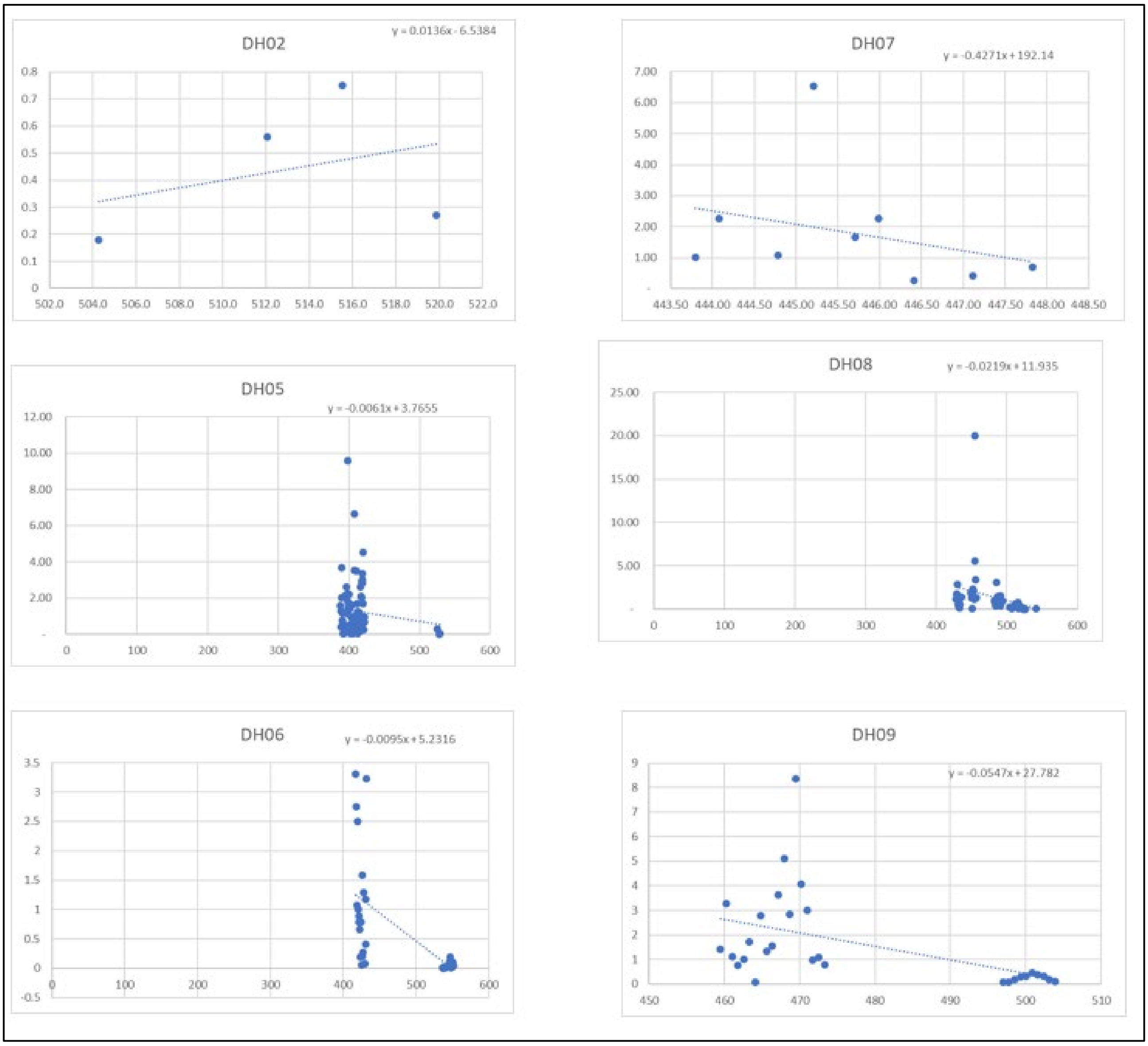
Figure 1 Pit polygon zones, drill holes and the designed Rustlers Roost pit

Weathering is generally controlled by the vertical distance the rock material is from the surface. Also exposure to oxygen, water table and faults in the rock itself contributes to weathering.

The sulphur model is constructed on polygonal methods, with the depth estimating sulphur content.

The total sulphur % results were graphed against vertical mRL (in this case the reduced level is “m AHD plus 500m” to get rid of negative numbers when describing the vertical position). A curve of best fit was created and a formula using mRL was derived.

Below are the graphed total sulphur % results from the six drillholes. It can be seen that the curve fitting averages out the S%



Graph1 Various sulphur % vs mRL

In the Sulphur model, the curve of best fit formulae was applied in the zones using the mRL (height) as the controlling variable.

The geologically logged oxide layer in the geological database has the intense weathering, complete oxidation of sulphides and low density. The oxide layer is deemed to be NAF as evident from the 30 year old existing oxide WRD that has not recorded any low pH readings through multiple years of water sampling.

The Sulphur model has >0.2% total sulphur results below the geological oxide zone, confirming the oxide material is NAF.

Figure 4 shows an isometric diagram of the waste sulphur model above 0.2% S within the design pit.

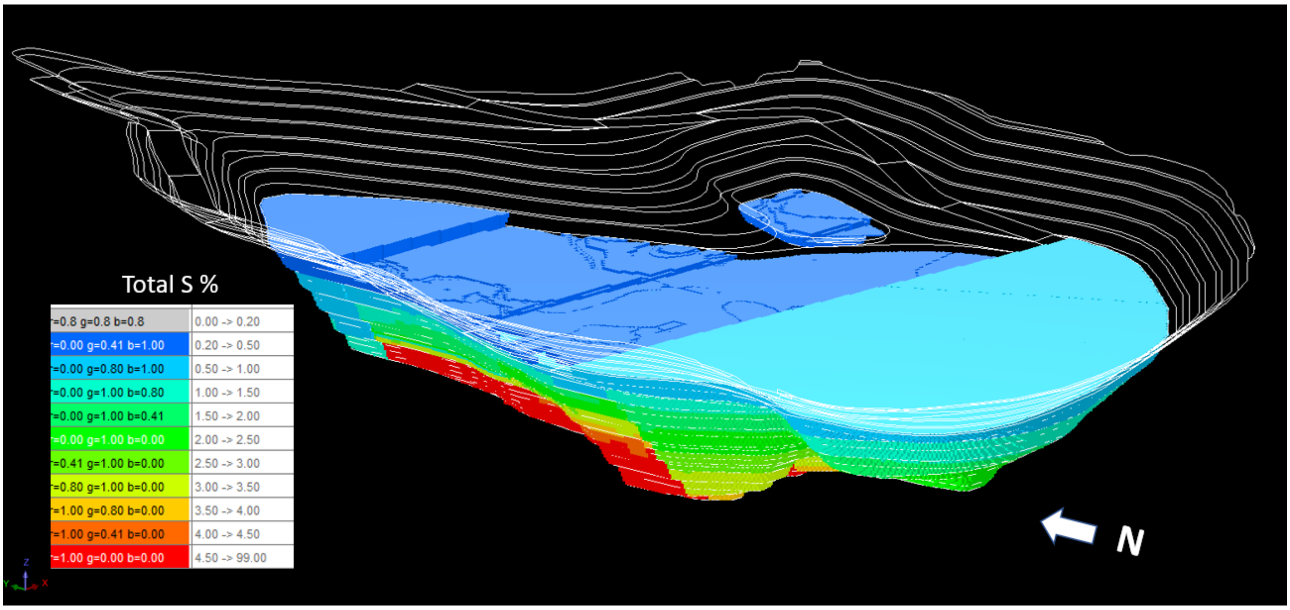


Figure 4 Isometric of the designed pit with sulfide waste above 0.2% total sulphur

Evaluation of the Sulphur model usingx0.2% total sulphur as a cutoff the following tonnages of NAF and PAF are estimated from the sulphur model.

Item	**Tonnes Mt**	**Total sulphur %**	**% of pit waste**
PAF waste >0.2% S	19.6	1.46	38%
NAF waste <0.2% S	33.3	0.00	62%

Table 2 Waste tonnages designated as PAF (+0.2% S) and NAF

In the designed pit, the PAF waste tonnes with a sulphur S% above 0.2% amounts to 19.6 Mt at an average percentage of 1.46% Total sulphur.

There is approximately 0.29 Mt of sulphur material in the PAF pit waste. In the Sulphur model 62% of the waste is classed as NAF and 38% is PAF.

As mining is progressed, continuous total sulphur sampling will have to be conducted to regularly update the sulphur model.

Rustlers Roost Oxidization Class Verses the Sulphur Model >0.2% S

Item	**Mt by oxidation**	**Mt Sulphur model**
Oxide assume NAF	21.4 (40%)	33.3 (62%) <0.2%S
Trans/Fresh assume PAF	32.2 (60%)	19.6 (38%) >0.2%S

Table 3 Oxidation class vs Sulphur model - PAF and NAF quantities

The Sulphur model indicates that there is also NAF material in the transitional and fresh zones. By assuming any material that is classed as transitional or fresh is classed as PAF leads to a conservative building of the waste rock dumps (WRDs).

The construction of the WRDs presented in a separate attachment to the Supplement of the Draft EIS is extremely conservative using the oxidation class to estimate PAF material.

Data Used for Estimation in the Sulphur Model

Below is a list of the data used to estimate the total sulphur in the Rustlers Roost Sulphur model.

DataSet	Hole_ID	From_Depth	To_Depth	S%
RUSTLERS_ROOST	RRDH05	56	57	0.02
RUSTLERS_ROOST	RRDH05	55	56	0.03
RUSTLERS_ROOST	RRDH05	60	61	0.30
RUSTLERS_ROOST	RRDH05	178.5	179.05	0.98
RUSTLERS_ROOST	RRDH05	179.05	179.5	0.67
RUSTLERS_ROOST	RRDH05	179.5	180	0.65
RUSTLERS_ROOST	RRDH05	180	180.5	0.26
RUSTLERS_ROOST	RRDH05	180.5	181	4.53
RUSTLERS_ROOST	RRDH05	181	181.5	1.70
RUSTLERS_ROOST	RRDH05	181.5	182	2.84
RUSTLERS_ROOST	RRDH05	182	182.5	3.02
RUSTLERS_ROOST	RRDH05	182.5	183	3.35
RUSTLERS_ROOST	RRDH05	183	183.5	2.02
RUSTLERS_ROOST	RRDH05	183.5	184	2.90
RUSTLERS_ROOST	RRDH05	184	184.5	2.09
RUSTLERS_ROOST	RRDH05	184.5	185	0.48
RUSTLERS_ROOST	RRDH05	185	185.5	0.18
RUSTLERS_ROOST	RRDH05	185.5	186	2.60
RUSTLERS_ROOST	RRDH05	186	186.5	0.50
RUSTLERS_ROOST	RRDH05	186.5	187	1.07
RUSTLERS_ROOST	RRDH05	187	187.5	0.78
RUSTLERS_ROOST	RRDH05	187.5	188	1.20
RUSTLERS_ROOST	RRDH05	188	188.5	1.09
RUSTLERS_ROOST	RRDH05	188.5	189	0.58
RUSTLERS_ROOST	RRDH05	189	189.5	0.38
RUSTLERS_ROOST	RRDH05	189.5	190	1.26
RUSTLERS_ROOST	RRDH05	190	190.5	0.03
RUSTLERS_ROOST	RRDH05	190.5	191	1.69
RUSTLERS_ROOST	RRDH05	191	191.5	0.36
RUSTLERS_ROOST	RRDH05	191.5	192	0.92
RUSTLERS_ROOST	RRDH05	192	192.5	3.49
RUSTLERS_ROOST	RRDH05	192.5	193	0.60
RUSTLERS_ROOST	RRDH05	193	193.4	0.85
RUSTLERS_ROOST	RRDH05	193.4	194	0.78
RUSTLERS_ROOST	RRDH05	194	194.5	1.05
RUSTLERS_ROOST	RRDH05	194.5	195	0.21
RUSTLERS_ROOST	RRDH05	195	195.5	6.65
RUSTLERS_ROOST	RRDH05	195.5	196	3.53
RUSTLERS_ROOST	RRDH05	196	197	0.37
RUSTLERS_ROOST	RRDH05	197	197.5	0.93
RUSTLERS_ROOST	RRDH05	197.5	198	0.04
RUSTLERS_ROOST	RRDH05	198	198.5	0.08
RUSTLERS_ROOST	RRDH05	198.5	199	0.45
RUSTLERS_ROOST	RRDH05	199	199.5	0.38
RUSTLERS_ROOST	RRDH05	199.5	200	1.58
RUSTLERS_ROOST	RRDH05	200	200.5	0.28
RUSTLERS_ROOST	RRDH05	200.5	201	0.07
RUSTLERS_ROOST	RRDH05	201	201.5	0.95
RUSTLERS_ROOST	RRDH05	201.5	202	0.06
RUSTLERS_ROOST	RRDH05	202	202.5	0.57
RUSTLERS_ROOST	RRDH05	202.5	203	0.24
RUSTLERS_ROOST	RRDH05	203	203.5	1.67
RUSTLERS_ROOST	RRDH05	203.5	204	1.37
RUSTLERS_ROOST	RRDH05	204	204.5	2.19
RUSTLERS_ROOST	RRDH05	204.5	205	1.52
RUSTLERS_ROOST	RRDH05	205	205.5	0.46
RUSTLERS_ROOST	RRDH05	205.5	206	1.80
RUSTLERS_ROOST	RRDH05	206	206.5	9.60
RUSTLERS_ROOST	RRDH05	206.5	207	2.24
RUSTLERS_ROOST	RRDH05	207	207.5	1.15
RUSTLERS_ROOST	RRDH05	207.5	208	0.13
RUSTLERS_ROOST	RRDH05	208	208.5	2.59
RUSTLERS_ROOST	RRDH05	208.5	209	0.37
RUSTLERS_ROOST	RRDH05	209	209.5	0.18
RUSTLERS_ROOST	RRDH05	209.5	210	0.35
RUSTLERS_ROOST	RRDH05	210	210.5	2.12
RUSTLERS_ROOST	RRDH05	210.5	211	0.44
RUSTLERS_ROOST	RRDH05	211	211.5	0.13
RUSTLERS_ROOST	RRDH05	211.5	212	0.19
RUSTLERS_ROOST	RRDH05	212	213	0.03
RUSTLERS_ROOST	RRDH05	213	213.5	0.02
RUSTLERS_ROOST	RRDH05	213.5	214	0.05
RUSTLERS_ROOST	RRDH05	214	214.5	0.64
RUSTLERS_ROOST	RRDH05	214.5	215	1.17
RUSTLERS_ROOST	RRDH05	215	215.5	0.78
RUSTLERS_ROOST	RRDH05	215.5	216	2.01
RUSTLERS_ROOST	RRDH05	216	216.5	3.68
RUSTLERS_ROOST	RRDH05	216.5	217	0.41
RUSTLERS_ROOST	RRDH05	217	217.5	1.28
RUSTLERS_ROOST	RRDH05	217.5	218	1.60
RUSTLERS_ROOST	RRDH06	51	52	-
RUSTLERS_ROOST	RRDH06	208	209	3.31
RUSTLERS_ROOST	RRDH06	189	190	3.23
RUSTLERS_ROOST	RRDH06	207	208	2.75
RUSTLERS_ROOST	RRDH06	205	206	2.50
RUSTLERS_ROOST	RRDH06	196	197	1.58
RUSTLERS_ROOST	RRDH06	194	195	1.29
RUSTLERS_ROOST	RRDH06	190	191	1.18
RUSTLERS_ROOST	RRDH06	206	207	1.08
RUSTLERS_ROOST	RRDH06	204	205	1.00
RUSTLERS_ROOST	RRDH06	202	203	0.89
RUSTLERS_ROOST	RRDH06	203	204	0.79
RUSTLERS_ROOST	RRDH06	199	200	0.79
RUSTLERS_ROOST	RRDH06	201	202	0.66
RUSTLERS_ROOST	RRDH06	191	192	0.41
RUSTLERS_ROOST	RRDH06	195	196	0.27
RUSTLERS_ROOST	RRDH06	197	198	0.21
RUSTLERS_ROOST	RRDH06	200	201	0.20
RUSTLERS_ROOST	RRDH06	39.8	40.6	0.19
RUSTLERS_ROOST	RRDH06	40.6	41	0.11
RUSTLERS_ROOST	RRDH06	34	35	0.11
RUSTLERS_ROOST	RRDH06	192	194	0.08
RUSTLERS_ROOST	RRDH06	198	199	0.05
RUSTLERS_ROOST	RRDH06	33	34	0.04
RUSTLERS_ROOST	RRDH06	35	36	0.03
RUSTLERS_ROOST	RRDH06	39	39.8	0.03
RUSTLERS_ROOST	RRDH06	36	37	0.03
RUSTLERS_ROOST	RRDH06	50	51	0.02
RUSTLERS_ROOST	RRDH06	49	50	0.02
RUSTLERS_ROOST	RRDH06	37	38	0.02
RUSTLERS_ROOST	RRDH06	48	49	0.02
RUSTLERS_ROOST	RRDH06	38	39	0.01
RUSTLERS_ROOST	RRDH06	52	53	0.01
RUSTLERS_ROOST	RRDH06	53	54	0.01
RUSTLERS_ROOST	RRDH07	182	183	0.70
RUSTLERS_ROOST	RRDH07	183	184	0.42
RUSTLERS_ROOST	RRDH07	184	184.6	0.26
RUSTLERS_ROOST	RRDH07	184.6	185	2.27
RUSTLERS_ROOST	RRDH07	185	185.7	1.65
RUSTLERS_ROOST	RRDH07	185.7	186.3	6.54
RUSTLERS_ROOST	RRDH07	186.3	187.3	1.07
RUSTLERS_ROOST	RRDH07	187.3	187.7	2.27
RUSTLERS_ROOST	RRDH07	187.7	188	1.00
RUSTLERS_ROOST	RRDH08	57	58	-
RUSTLERS_ROOST	RRDH08	58	59	-
RUSTLERS_ROOST	RRDH02	57	58	0.27
RUSTLERS_ROOST	RRDH02	62	63	0.75
RUSTLERS_ROOST	RRDH02	66	67	0.56
RUSTLERS_ROOST	RRDH02	75	76	0.18
RUSTLERS_ROOST	RRDH08	94	95	0.91
RUSTLERS_ROOST	RRDH08	96.9	97.5	1.49
RUSTLERS_ROOST	RRDH08	97.5	98	0.32
RUSTLERS_ROOST	RRDH08	99	100	1.03
RUSTLERS_ROOST	RRDH08	105	106	0.38
RUSTLERS_ROOST	RRDH08	106	107	1.09
RUSTLERS_ROOST	RRDH08	107	108	0.93
RUSTLERS_ROOST	RRDH08	139.4	140.25	20.02
RUSTLERS_ROOST	RRDH08	139	139.4	5.55
RUSTLERS_ROOST	RRDH08	138	139	3.39
RUSTLERS_ROOST	RRDH08	104	104.5	3.04
RUSTLERS_ROOST	RRDH08	167	168	2.83
RUSTLERS_ROOST	RRDH08	142	143	2.28
RUSTLERS_ROOST	RRDH08	141	142	2.07
RUSTLERS_ROOST	RRDH08	145	145.7	1.84
RUSTLERS_ROOST	RRDH08	169	170	1.78
RUSTLERS_ROOST	RRDH08	168	169	1.63
RUSTLERS_ROOST	RRDH08	102	103	1.47
RUSTLERS_ROOST	RRDH08	162	163	1.36
RUSTLERS_ROOST	RRDH08	161	162	1.33
RUSTLERS_ROOST	RRDH08	137	138	1.30
RUSTLERS_ROOST	RRDH08	144	145	1.29
RUSTLERS_ROOST	RRDH08	140.25	141	1.15
RUSTLERS_ROOST	RRDH08	170	171	1.12
RUSTLERS_ROOST	RRDH08	103	104	1.04
RUSTLERS_ROOST	RRDH08	163	164	0.54
RUSTLERS_ROOST	RRDH08	104.5	105	0.52
RUSTLERS_ROOST	RRDH08	166	167	0.51
RUSTLERS_ROOST	RRDH08	165	166	0.26
RUSTLERS_ROOST	RRDH08	164	165	0.13
RUSTLERS_ROOST	RRDH08	39	40	0.05
RUSTLERS_ROOST	RRDH08	143	144	0.04
RUSTLERS_ROOST	RRDH08	78	79	0.04
RUSTLERS_ROOST	RRDH08	67	68	0.02
RUSTLERS_ROOST	RRDH08	59	60	0.02
RUSTLERS_ROOST	RRDH08	60	61	0.01
RUSTLERS_ROOST	RRDH09	96	97	0.09
RUSTLERS_ROOST	RRDH09	97	98	0.18
RUSTLERS_ROOST	RRDH09	98	99	0.33
RUSTLERS_ROOST	RRDH09	99	100	0.37
RUSTLERS_ROOST	RRDH09	100	101	0.45
RUSTLERS_ROOST	RRDH09	101	102	0.33
RUSTLERS_ROOST	RRDH09	102	103	0.28
RUSTLERS_ROOST	RRDH09	103	104	0.18
RUSTLERS_ROOST	RRDH09	104	105	0.06
RUSTLERS_ROOST	RRDH09	105	106	0.06
RUSTLERS_ROOST	RRDH09	141	142	8.36
RUSTLERS_ROOST	RRDH09	143	144	5.10
RUSTLERS_ROOST	RRDH09	140	141	4.05
RUSTLERS_ROOST	RRDH09	144	145	3.64
RUSTLERS_ROOST	RRDH09	153	154	3.26
RUSTLERS_ROOST	RRDH09	139	140	3.01
RUSTLERS_ROOST	RRDH09	142	143	2.83
RUSTLERS_ROOST	RRDH09	147	148	2.77
RUSTLERS_ROOST	RRDH09	149	150	1.70
RUSTLERS_ROOST	RRDH09	145	146	1.54
RUSTLERS_ROOST	RRDH09	154	155	1.41
RUSTLERS_ROOST	RRDH09	146	147	1.33
RUSTLERS_ROOST	RRDH09	152	153	1.10
RUSTLERS_ROOST	RRDH09	137	138	1.08
RUSTLERS_ROOST	RRDH09	150	151	1.01
RUSTLERS_ROOST	RRDH09	138	139	0.98
RUSTLERS_ROOST	RRDH09	136	137	0.77
RUSTLERS_ROOST	RRDH09	151	152	0.75
RUSTLERS_ROOST	RRDH09	148	149	0.06

Table 4 List of data for the estimation of the Rustlers Roost Sulphur model

Appendix B – Quest 29 Waste Block Model

HANKING AUSTRALIA INVESTMENT

MEMORANDUM

TO:	Mark Qiu
COPY:	Fan Wu, John Zimmermann, Leon He,
FROM:	Charles Hastie
DATE:	31/05/2022
SUBJECT:	Description of the Waste Model for Quest29

Introduction

Quest 29 has had total sulphur % values added to the geological model to assist in scheduling and locating waste for encapsulating potentially acid forming (PAF) material.

Total sulphur is used because it is reliable and provides a conservative estimate of the sulphide S content and hence the acid potential of a sample (ANC).

During operations waste rock geochemistry testing and Acid base accounting will continue including sulphide sulphur, NAG and metals content in waste for mining planning, mapping, and marking out on ground and for closure planning.

Local Geology

The Quest 29 area is mostly underlain by the metasediments of the Koolpin Formation. Minor, though economically important sills of Zamu Dolerite occur within the area. The Mount Bundy Granite underlies the north-eastern most portion of the property.

The Koolpin Formation is comprised mainly of pyritic and pyrrhotitic, carbonaceous siltstone with andalusite porphyroblasts. Bands of re-crystallised laminated and nodular chert are common along the main ridge running up the western side of the property. The enveloping carbonaceous siltstones are more strongly silicified along this ridge. Thin green-grey layers within the siltstones are possibly iron formations.

The sediments, tuffs and dolerites occupy the core of a regional anticline (the Quest 29 Anticline). The axis of this anticline plunges to the south-southeast at a shallow angle. Gold mineralisation occurs in both the dolerite and the carbonaceous siltstones. The host dolerite dips to the east at 50°-70°.

Block Models

A block model was created by Cube Consulting Pty Ltd in 2021.

Quest29 **"cube_q29_bm_2021_12_05.mdl"** – 12/12/2021 .

This block model had an additional field added called "sul". This represents the total sulphur % in the material.

The modified geological and waste model is called "**mining_q29_2021_2.mdl**".

There were six recently drilled holes tested for sulphur % in 2021.

The holes were named **QTNRC014A, QTNRC016, QTNRC018, QTNRC019A, QTNRC020, and QTNRC021.**

Determination of Oxide Transitional and Fresh

Rocks near the earth surface have undergone weathering process which has resulted the breakdown of rocks and minerals. It is caused by chemical and physical interactions of air, water and living organisms.

Rocks are categorised in three domains based on the degree of weathering: fresh, transitional and oxide:

- **Fresh** rock has undergone no weathering.
- The weathering front is the boundary between fresh rock and material that has undergone weathering. The first signs of weathering are generally oxidation of sulphides and dissolution of carbonates, because these minerals are highly unstable within the weathering profile.

- **Transitional** material is only weakly weathered, and the destruction of primary sulphides and carbonates is only partially completed.

- When the destruction is complete the material is referred to as **oxide** a zone found near the surface that forms as a result of chemical decomposition of unstable minerals under the action of surface waters and groundwater, as well as the oxygen and carbon dioxide present in the air and dissolved in these waters**.**

An increase in the degree of weathering coincides with a decrease in the density.

At Mount Bundy area, oxide zone is characterised as generally brown to red colour due to oxidation of Fe, broken core from the logging, no sulphide present and lighter weight.

	Degree of weathering		**Oxidation of primary sulphides**	**Dissolution of primary carbonates**	**Density**
Oxide	↑ Increase in the degree of weathering	Moderately to intensely weathered	Complete oxidation and destruction	Complete dissolution	↑ Decrease in density
Transitional		Weakly to moderately weathered	Partial oxidisation	Partial dissolution	
Fresh		No weathering	No oxidation	No dissolution	

Table 1 Oxidation class definition

The geologically logged oxide layer in the geological database has the intense weathering, complete oxidation of sulphides and low density. The oxide layer is deemed to the NAF as evident from the sulphur sampling recently conducted.

Effects of Blasting on Total Sulphur % Estimation

The material in the pit will be blasted. When blasted, the waste, including PAF lodes, will be mixed together. When the waste is excavated, the waste material will be mined in 2.5 m to 3 m thick mining levels (benches), which will average out the total sulphur percentage in each mining bench. The sulphur model created simulates the sulphur % that will be mined out after blasting and excavation of a normal mining bench.

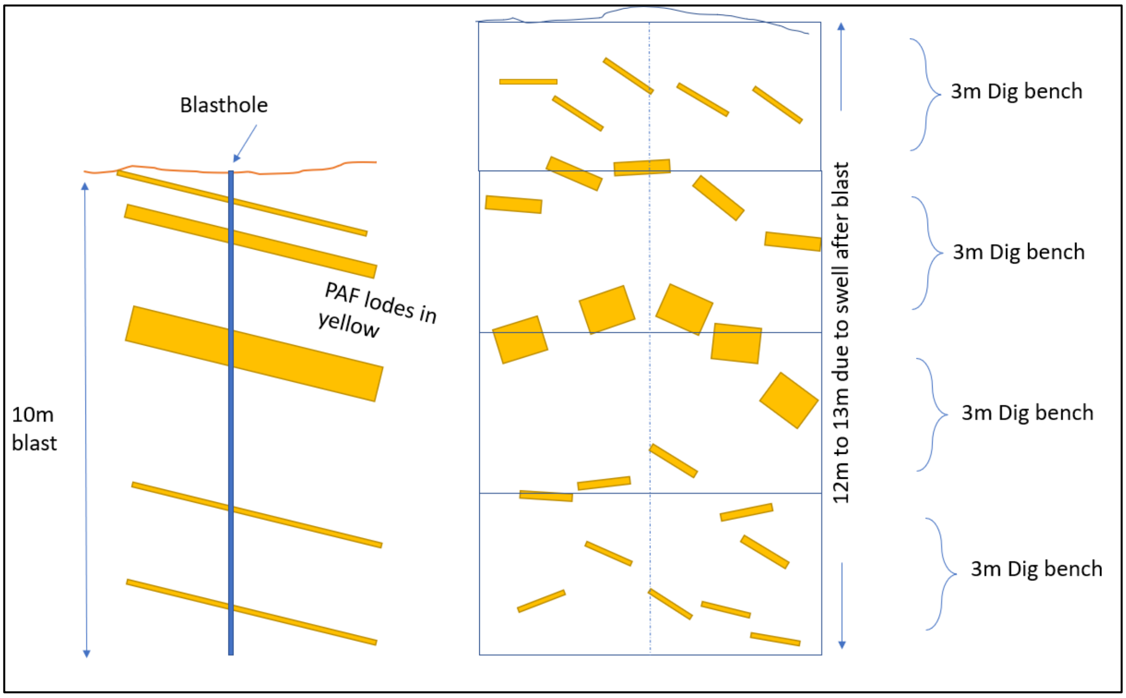


Figure 1 Mixture of total sulphur % after blasting and normal mining bench mining

Sub horizontal bands of sulphur bearing waste will be mixed by blasting, then further mixed and averaged out by mining in 2.5 m to 3 m thick benches.

The modelling of individual thin high S% lodes is not reprehensive of how the pit will be mined, as they will be mixed into the pit material after blasting and mining in the three metre thick benches.

Consequently, the use of curve fitting formulae is being used with depth (mRL) as the controlling variable. The curve fitting in the section below does average out (dilutes) the total sulphur %.

Estimation of Total Sulphur % in the Block Model

Total Sulphur % of 0.2% is the level before material would be considered as PAF.

Below is a diagram of the drill holes and the polygon zones used to estimate the Sulphur % in the waste of the designed pits.

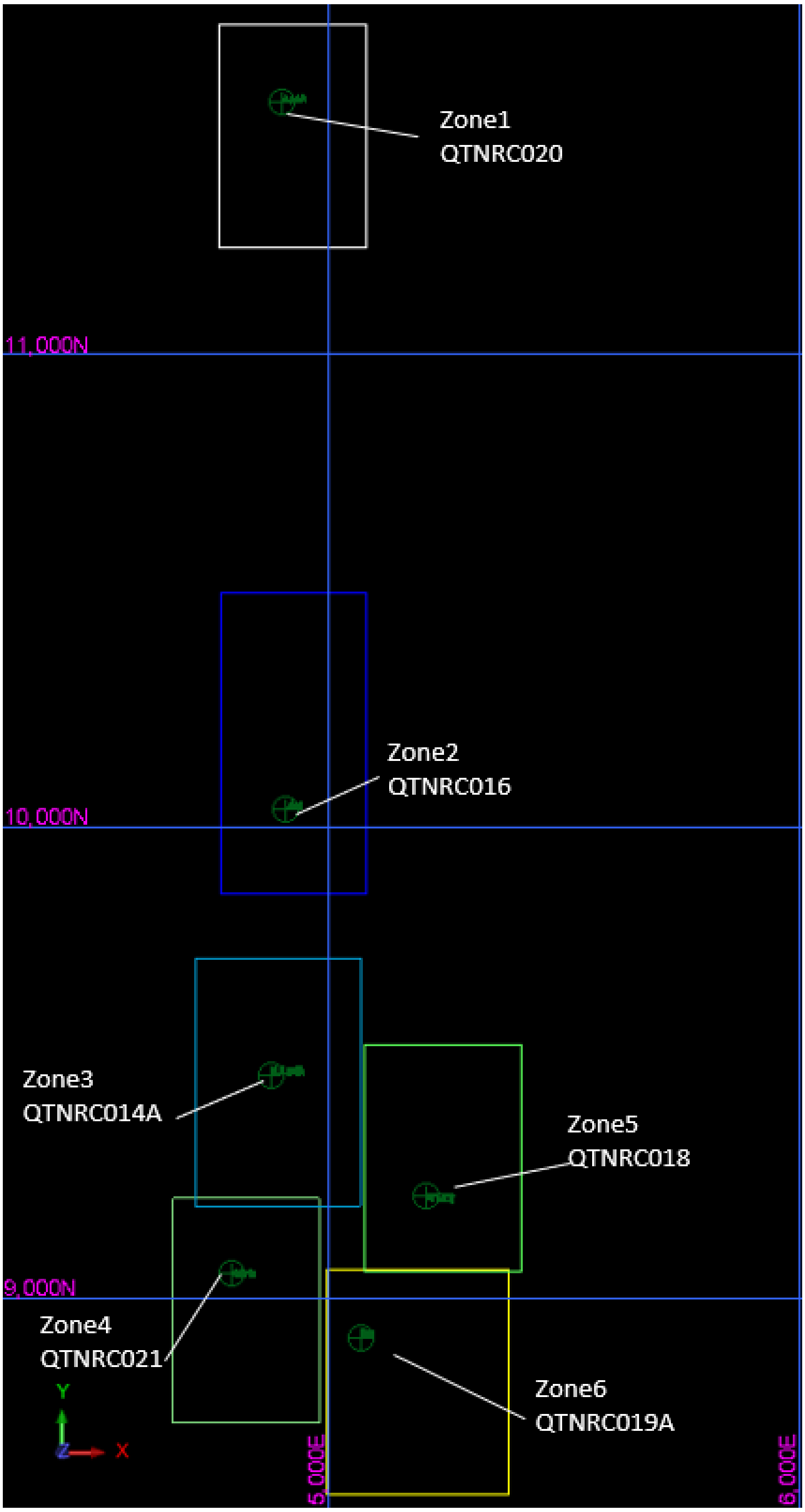


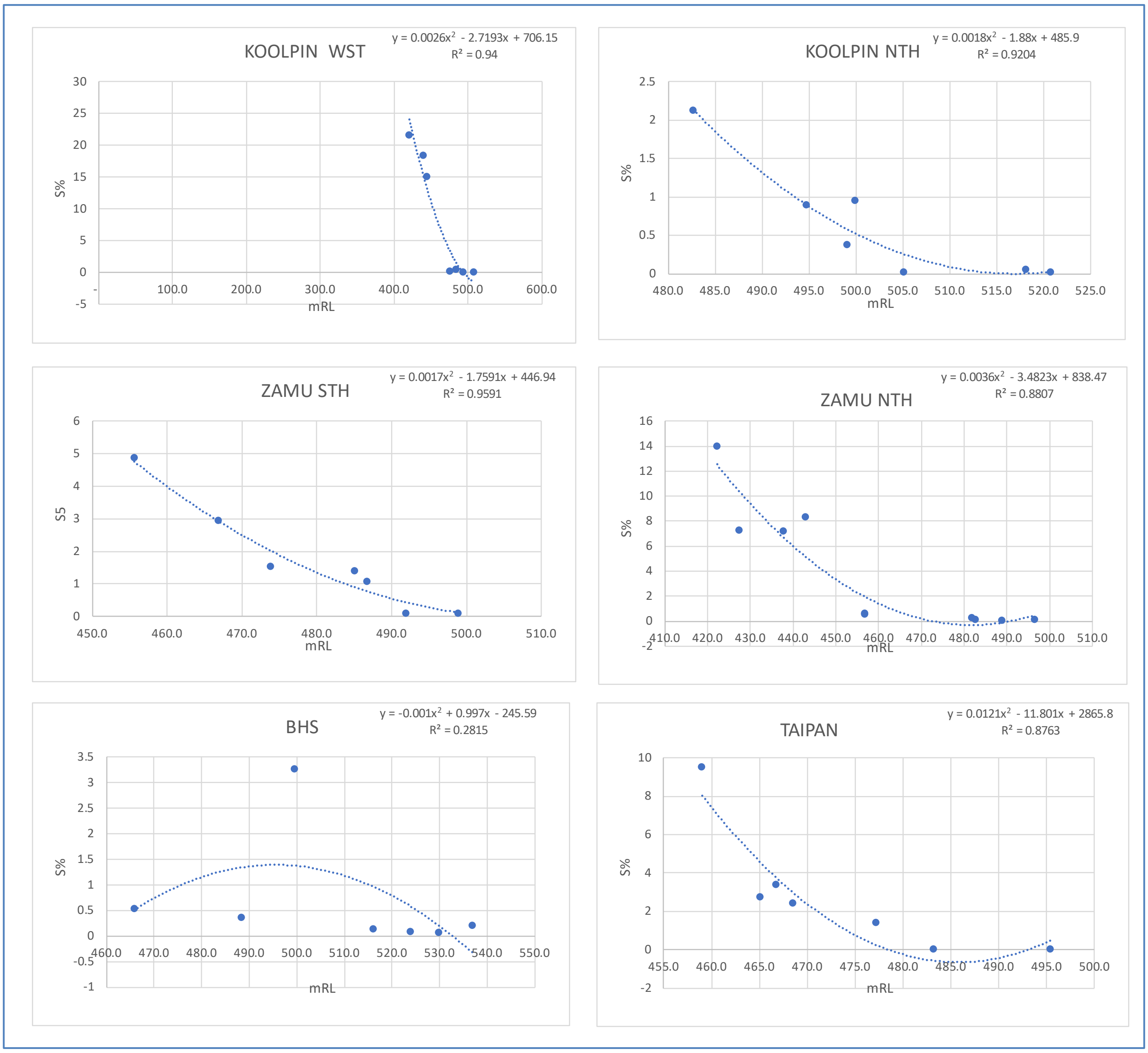
Figure 1 Pit zone polygon zones, with drillholes

Weathering is generally controlled by the vertical distance the rock material is from the surface. Also exposure to oxygen, water table and the faults in the rock itself contributes to weathering.

The Sulphur model is constructed on polygonal methods, with the depth estimating sulphur content.

The sulphur % results were graphed against vertical mRL (in this case the reduced level is “m AHD plus 500 m” to get rid of negative numbers when describing the vertical position). A curve of best fit was created and a formula using mRL was derived. The R2 has a high correlation, 0.85 to 0.96. The curve fit is good as the lodes are sub vertical and not broken up much as seen in Rustlers Roost.

Below are the graphed total sulphur % results from six drillholes.



Graph1 Various sulphur % vs mRL for Quest29

In the Sulphur block model, the curve of best fit formulae were applied in the zones using the mRL as the controlling variable.

The Sulphur model has >0.2% total sulphur results below the geological oxide zone, confirming the oxide material is NAF.

Below is an isometric diagram of the waste sulphur model above 0.2% S within the design pits.

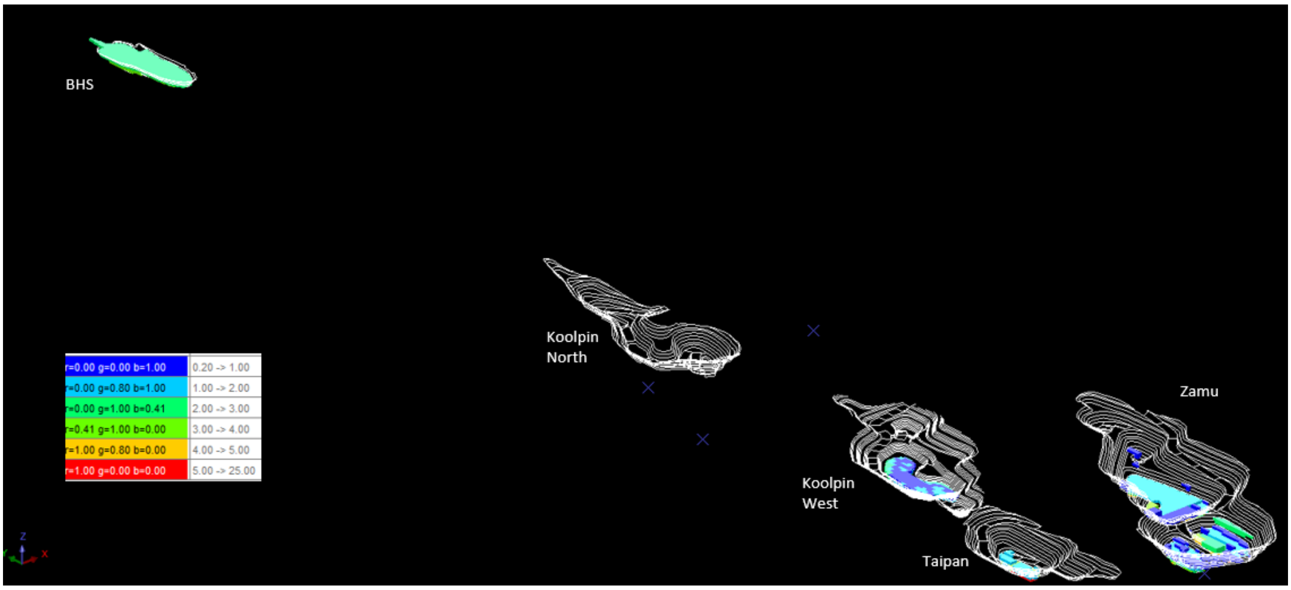


Figure 2 Isometric of the designed pits with sulfide waste above 0.2% Total Sulphur

The high S% material occurs in the base of the pits. The exceptions being BHS pit has a high total S% of 3% to 4% from near surface. Koolpin North pit has no high total S% (PAF material).

In the figure below the base of oxide is shown with the S% above 0.2%. It can be seen that in the oxide layer there is no PAF material (exception BHS and the bottom of Koolpin West pit at depth).

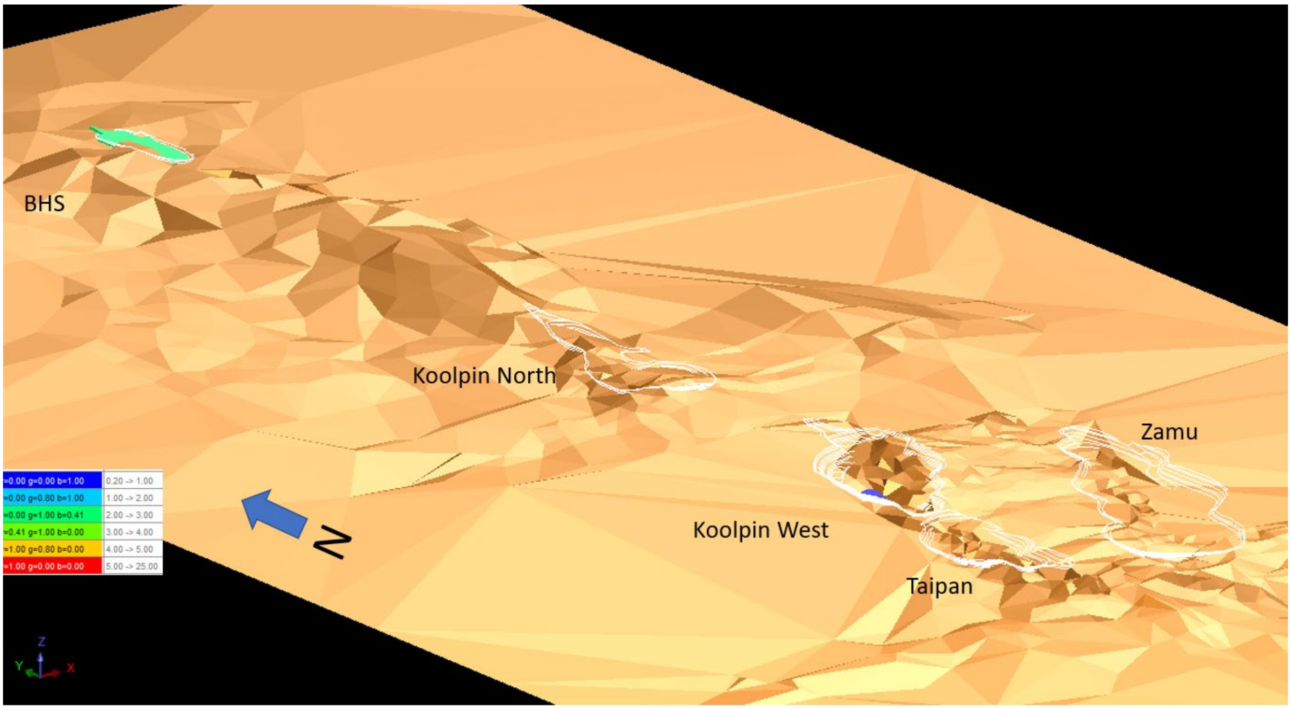


Figure3 Isometric diagram showing the base of oxide with S%

In the mine planning oxide material will encapsulate the transitional and fresh material. Most of the >0.2% S material is below the base of oxide.

The pits that have fresh sulphide material are BHS and the bottom of Koolpin West. This material will be backfilled into the Zamu pit.

In the designed pits the PAF waste tonnes with a sulphur S% above 0.2% amounts to 0.8 Mt at an average percentage of 2.30% Sulphur. The pits are relatively shallow, consequently the low tonnages of PAF material.

There is approximately 18.8 kt of Sulphur in the PAF pits waste.

Pit	Tonnes kt	Total Sulphur %
BHS	204.6	2.92
Koolpin Nth	0.0	0
Koolpin West	192.3	1.81
Taipan	7.2	3.63
Zamu	416.1	2.19

Table 2 Tonnes of waste material above 0.2% Total Sulphur classed as PAF

.

Pit	Waste kt PAF +0.2% S	Waste Kt NAF	% PAF in pit
BHS	204.6	152.2	57.4%
Koolpin Nth	0.0	1,428.8	0.0%
Koolpin West	192.3	1,877.2	9.3%
Taipan	7.2	1,265.6	0.6%
Zamu	416.1	6,583.1	5.9%

Table 3 Percentage of PAF in each pit at Quest29

As mining is progressed continuous Total sulphur sampling will have to be conducted to update the sulphur model.

Quest 29 Oxidization Class Verses Sulphur Model >0.2% S

In the construction of the Quest 29 WRD the proponent has used the oxidation class of Zamu pit as an indicator of PAF. Oxide material is classed as NAF and transitional and fresh material is classed as PAF.

Below is a comparison of the oxidation assumption and the Sulphur model PAF and NAF tonnages.

Item	Mt by oxidation	Mt Sulphur model
Oxide assumed NAF	0.4 (6%)	6.6 (94%)
Trans and fresh assumed PAF	6.0 (94%)	0.4 (6%)

Table 4 Zamu Pit (only contributor to the Quest29 WRD) oxidation vs Sulphur model

It can be concluded from the above table that using oxidation class to determine PAF is over conservative and the sulphide model has substantially less PAF. Thus, the method of building the Quest 29 WRD detailed in a separate attachment to the Supplement of the Draft EIS is extremely conservative using the oxidation class to estimate PAF.

Data Used for Estimation in the Sulphur Model

Below is a list of the data used to estimate the total sulphur in the Quest 29 Sulphur model.

Data Set	Hole_ID	From_Depth	To_Depth	S%
Quest29	QTNRC014A	8	9	0.02
Quest29	QTNRC014A	24	25	0.05
Quest29	QTNRC014A	35	36	0.44
Quest29	QTNRC014A	45	46	0.15
Quest29	QTNRC014A	80	81	14.97
Quest29	QTNRC014A	86	87	17.69
Quest29	QTNRC014A	86	87	18.36
Quest29	QTNRC014A	108	109	21.56
Quest29	QTNRC014A	108	109	21.49
Quest29	QTNRC016	13	14	0.02
Quest29	QTNRC016	16	17	0.05
Quest29	QTNRC016	31	32	0.02
Quest29	QTNRC016	37	38	0.95
Quest29	QTNRC016	38	39	0.37
Quest29	QTNRC016	43	44	0.89
Quest29	QTNRC016	57	58	2.12
Quest29	QTNRC017	9	10	0.04
Quest29	QTNRC017	19	20	0.04
Quest29	QTNRC017	37	38	0.06
Quest29	QTNRC017	39	40	0.3
Quest29	QTNRC017	55	56	1.14
Quest29	QTNRC017	55	56	1.31
Quest29	QTNRC017	57	58	5.24
Quest29	QTNRC017	62	63	2.84
Quest29	QTNRC017	67	68	1.27
Quest29	QTNRC018	1	2	0.08
Quest29	QTNRC018	10	11	0.06
Quest29	QTNRC018	17	18	0.1
Quest29	QTNRC018	18	19	0.22
Quest29	QTNRC018	47	48	0.57
Quest29	QTNRC018	47	48	0.56
Quest29	QTNRC018	63	64	8.32
Quest29	QTNRC018	69	70	7.19
Quest29	QTNRC018	81	82	7.28
Quest29	QTNRC018	87	88	13.99
Quest29	QTNRC019A	2	3	0.08
Quest29	QTNRC019A	10	11	0.08
Quest29	QTNRC019A	16	17	1.07
Quest29	QTNRC019A	18	19	1.4
Quest29	QTNRC019A	31	32	1.54
Quest29	QTNRC019A	39	40	2.93
Quest29	QTNRC019A	52	53	4.87
Quest29	QTNRC020	2	3	0.21
Quest29	QTNRC020	10	11	0.07
Quest29	QTNRC020	17	18	0.09
Quest29	QTNRC020	26	27	0.13
Quest29	QTNRC020	45	46	3.27
Quest29	QTNRC020	58	59	0.36
Quest29	QTNRC020	84	85	0.53
Quest29	QTNRC021	3	4	0.03
Quest29	QTNRC021	17	18	0.02
Quest29	QTNRC021	24	25	1.4
Quest29	QTNRC021	34	35	2.39
Quest29	QTNRC021	36	37	3.39
Quest29	QTNRC021	38	39	2.72
Quest29	QTNRC021	45	46	9.48
Quest29	QTNRC022	8	9	0.06
Quest29	QTNRC022	53	54	5.15

Appendix C – Kinetic Column 12 Month Update

TECHNICAL MEMO

To: Paul Davey and Tim Kinney

Company: CDM Smith **Date**: 29 July 2022 (FR001)

From: Karen Mackenzie **Pages: 27**

CC:

Re: **Rustlers Roost and Quest 29 gold deposits, Pine Creek, Northern Territory Kinetic column 12 month update**

☐ **Urgent** x **For Review** ☐ **Please Comment** ☐ **For Update Only** ☐ **Info Request**

1.0 Introduction

A static geochemical program was completed on the lithologies representing the largest proportion of the mined volumes at both the Rustlers Roost (RR) and Quest 29 (Q29) gold deposits, Pine Creek, Northern Territory.

The primary lithologies of interest are summarised in Table 1 for RR and Table 2 for Q29 with the total number of samples selected from each of these lithologies for static geochemical testing.

Table 1 Primary lithologies of interest at Rustlers Roost for the static geochemical assessment

Weathering zone	Pct	Psh	Psl	Pst	Rsl	Scs	Ss	Total
Lithology	Possible chert	Shale	Siltstone	Sandstone	Lower saprolite	Cherty shale	Shale	
Oxide		150	40	31	46		159	426
Transition	1	13	44	2		1	83	144
Fresh		229	313	65		3	821	1431
Total no. samples selected	1	23	32	5	2	1	67	131

Table 2 Primary lithologies of interest at Quest 29 for the static geochemical assessment

Weathering zone	Psh	Rc	Rsr	Pst	Pdz	Psl	Sbs	Total
Lithology	Shale	Clay	Saprock	Sandstone	Dolerite	Siltstone	Black shale	
Oxide	1	40	16	21				78
Transition	11		32	11	18	1	3	76
Fresh	17			34	191	44	198	480
Samples selected	5	4	8	7	16	4	16	60

At RR the total sulfur content of the samples assessed ranged from below limit of reporting (LOR) (<0.01%S) to 1.3 %S. The highest values were reported in Psh (shale) in the transition zone.

Fresh zone lithologies have significant acid neutralising capacity (ANC) and thus most samples were Non-acid forming (NAF) The net acid production potential (NAPP) of ‘fresh’ samples ranged from -39.41 to 0.82 kg H_2SO_4/t. In the oxide and transition zone the potential acid forming (PAF) risk was low with the exception of the Shales (Ss) where PAF was possible (lithology with highest NAPP value), NAPP range for transition and oxide lithologies: -3.7 to 39.18 kg H_2SO_4/t.

Geochemical classification of 29 samples selected for testing demonstrated that none of the oxide or transition zone samples were NAF. The lithologies within the transition zone present the highest PAF risk, most samples assessed were classified as uncertain (UC), three samples classified as PAF. In the fresh zone, the majority of the samples analysed were classified as NAF (13 out of 16), one sample was uncertain (UC) and two were PAF.

Six (6) UC samples from RR were further assessed for their acid neutralising capacity availability through Acid buffering characterisation curves (ABCC) and kinetic net acid generation (NAG). The results of these tests demonstrated an increase in ANC from that measured by the ANC modified Sobek method. This was interpreted as demonstrating the role of low solubility carbonates such as dolomite in the ANC. The presence of dolomite in the samples was confirmed by the mineralogical assessment (Tables A and B at the end of this report).

Kinetic NAG re-classified two samples from UC to PAF as a lower pH was reported during the kinetic test.

The tailings samples were classified as PAF.

At Q29 the lithologies were generally more sulfidic than those collected at Rustlers Roost, with total S ranging from 0.05 to 21.56 %S, with the highest value in black shale (S bs) in the fresh zone.

The shales at Q29 are also more organic rich compared to those at RR, with the presence of organic-sulfur in addition to inorganic forms of sulfur postulated.

Geochemical classification of the 20 samples assessed for this phase of testing found that no lithologies classified as UC, the sandstones (Pst) can be either PAF or NAF, as can the shales (Sbs). The dolerite (Pdz) and siltstones (Psl) was classified as PAF and the residual saprock (Rsr) in both the oxide and transition zones was classified as NAF. The ore sample was classified as PAF. Given no samples classified as UC, further characterisation of the ANC was not completed.

Based on these results, all lithologies assessed in the program at both deposits had one or more samples within the sample set classify as PAF. Given the limited sample size of each lithology, the conservative approach was taken that if one sample within the sample set was PAF then for waste management purposes that unit is designated as PAF.

2.0 Sample selection for kinetic testing

Kinetic testing of rock samples is an experiment designed to assess the rate of oxidation of the sulfides present and the rate of utilisation of the ANC content to buffer the acid production from the sulfide oxidation. Detailed chemical analysis of the leachates produced from the columns provides an indication of the water quality that could potentially develop when the oxidised materials come into contact with water.

For this project an allowance for 10 kinetic columns was provided in the proposal. Thus, two lithologies from each deposit in two separate weathering zones (transition and fresh) could be assessed along with a sample of tailings and a sample of the ore.

Consideration was given to both the static test results and the regional geochemical data when selecting samples. Regional reports had concluded that the cut off sulfur value for acid generation in the Pine Creek Inlier may be around 0.2%S as total sulfur (S) (EGi 2011 referenced in GHD 2015). The lowest total sulfur content of a PAF sample in the sample set tested in this current study was 0.06%S. The highest sulfur content of a NAF sample was 0.49 %S in RR and 2.12 %S in Q29.

Thus, the kinetic program undertaken focusses on low sulfur samples (total sulfur less than 2%) for the units classified as PAF. Any sample with a sulfur content above 2% was considered to be PAF and therefore will generate acidic drainage.

The following sample attributes were considered for the kinetic column sample selection

- Actual classification of the sample as UC or PAF
- Major lithology (based on representation in the drilling program data)
- Mass of sample available for further testing (1kg of material required for each column)
- Total S content
- ANC

An initial selection of samples was made for the columns, however, insufficient sample remained for many of the samples with static geochemical data. Thus, samples were selected from the drilling data base at the same hole id and lithology directly above or below the interval previously tested. Cores in the drill data base were samples at 1m intervals, each sample of chips remaining and available for the analysis weighed around 50g. Thus, a 20m interval composite was required of each lithology to make the 1kg required for each column.

For Q29, the ore samples initially selected from the drill core data base were not available and thus an alternative ore sample was provided by Hanking. This sample was not in the drill core data base. The remainder of the Q29 samples were generally highly sulfidic compared to the RR deposit. The samples selected from Q29 were all from the major lithologies in the deposit, but at the lower total sulfur content range (1-8 wt%S) with varying ANC and degree of weathering.

Static testing was completed on all composites generated for the kinetic program prior to the column being packed.

Table 3 Rustlers Roost column sample details

Static CoC #	Chem Centre ID/column no	Bore hole ID/interval (m)	Hanking Sample ID	Lithology
RR038	20S4611/001	RRDH02 75-76	HKR02253	Psl fr
RR084		RRDH06 14-142	HKR00953	
RR036	20S4611/002	RRDH02 62-63	HKR02238	Psl tr
RR125		RRDH09 105-106	HKR01171	
RR102	20S4611/003	RRDH08 94-95	HKR00684	Psh tr
RR103		RRDH08 96.9-97.5	HKR00685	
RR127	20S4611/004	RRDH09 158-159	HKR01302	Psh fr
RR130		RRDH09 247-248	HKR01413	
A20823	20S4611/005	NA	A20823	Tailing

Table 4 Quest 29 column sample details

Static CoC #	Chem Centre ID/column no	Bore hole ID/interval (m)	Hanking Sample ID	Lithology
Q29053	20S4605/001	QTNRC021	HKR34252	Pdz fr
Q29054		QTNRC021	HKR34263	
Q29047	20S4605/002	QTNRC020	HKR34157	S bs fr
Q29043		QTNRC019A	HKR34078	
New sample	20S4605/003	QTNRC019A	HKR34078	Pdz fr (LGO)
New sample		QTNRC019A	HKR34085	
New sample	20S4605/004	QTNRC021 57-61	MTS248-251	Ore (shale)
Q29039	20S4605/005		HKR34049	Pdz tr
Q29055			HKR34265	

3.0 Kinetic analytical program

All samples created for the columns underwent a limit suite of static tests, the static suite was as follows:

- Total sulfur (S_T),
- Total sulfate
- ANC
- Total oxidisable sulfur
- NAG (single addition)

Those columns where new samples had been selected were also assessed for their paste pH and EC, and sulfide sulfur content.

All column composite samples were also assessed for their mineralogy, the results were presented it eh static geochemical report and are reproduced here for completeness (refer to Tables A and B at the end of this report).

The Amira kinetic leach method was adopted (AMIRA 2002) where approximately 1kg of crushed sample is packed into a column and subjected to monthly leaching with deionised water. Cyclical heating is applied daily.

The columns were flushed once prepared, this leachate represents time period 0. Once wet the columns were left for 4 weeks, and the second leachate Month 1 was collected. A total of 12 months of data have been received to date.

4.0 Results

4.1 Static test work

Static testing results for each column composite are presented in Table 5. The data provide the starting composition for the depletion calculations.

Each lithology was geochemically classified using the total sulfur and ANC values, using the NAGpH, and the net acid production potential (NAPP) which is the balance of the maximum potential acidity, MPA calculated using total sulfur (S_T), and ANC; MPA (S_T) – ANC, and the neutralising potential ratio (NPR) which is the ratio of ANC to MPA (S_T). The criteria used were as follows:

Classifying using NAG pH

NAGpH ≥ 4.5 = NAF
NAGpH < 4.5 = PAF

Classification using NAPP

If NAPP ≥ 10 kg H_2SO_4/t = PAF
If NAPP is between 10 and 0 kg H_2SO_4/t = UC
If NAPP less than 0 kg H_2SO_4/t, is therefore negative = NAF

Classification using NPR

If NPR > 2 = NAF
If NPR > 1 < 2 = UC
If NPR < 1 = PAF

The results of the preliminary classification of the column composite samples (Table 6), demonstrate that the composite samples selected for Q29, all samples classify as PAF. For Rustlers Roost, samples with a negative NAPP (NAF) have an insufficient safety factor of ANC, thus NPR is less than 2, so they are classified as UC. For a PAF sample with a positive NAPP of 5 kg H_2SO_4/t or less this sample is classified as PAF low capacity (PAF LC).

Table 5 Results of static testing on column composites

Lab ID	Column #	Sample ID	Pit	Lith	Weathering	ANC (sobek) kg H_2SO_4/t	S total (S_T) wt %	S (SO_4) wt %	S (sulfide) wt %	NAGpH	NAPP (MPA S_T – ANC) kg H_2SO_4/t
20S4605/001	1	HKR35252 & HKR34263	Quest29	Pdz	fr	14	1.79	0.09	1.7	2.3	40.8
20S4605/002	2	HKR34157 & HKR34089	Quest29	S bs	fr	0.5	2.53	0.28	2.25	2.1	76.9
20S4605/003	3	HKR034078 & HKR034085	Quest29	Pdz	fr	10	1.65	0.07	1.58	2.3	40.5
20S4605/004	4	MTS_248-251	Quest29	S bs	fr	14	7.51	0.05	7.46	1.9	215.7
20S4605/005	5	HKR34049 & HKR34265	Quest29	Pdz	tr	7.8	2.54	0.15	2.39	2.1	69.9
20S4611/001	1	RR038 & RR084	Rustler Roost	Psl	fr	8.1	0.22	0.01	0.21	3	-1.4
20S4611/002	2	RR036 & RR125	Rustler Roost	Psl	tr	8.4	0.3	0.03	0.27	2.8	0.8
20S4611/003	3	RR102 & RR103	Rustler Roost	Psh	tr	1.2	1.26	0.21	1.05	2.2	37.3
20S4611/004	4	RR127 & RR130	Rustler Roost	Psh	fr	33	0.54	0.01	0.53	7.2	-16.5
20S4611/005	5	A20823	Rustler Roost	Tailing		27	1.76	0.02	1.74	2.4	26.8

Table 6 Geochemical classification of column samples from static test results

Lab ID	Column #	Sample ID	Pit	Lith	Weathering	NPR	NAPP	NAGpH
20S4605/001	1	HKR35252 & HKR34263	Quest29	Pdz	fr	PAF	PAF	PAF
20S4605/002	2	HKR34157 & HKR34089	Quest29	S bs	fr	PAF	PAF	PAF
20S4605/003	3	HKR034078 & HKR034085	Quest29	Pdz	fr	PAF	PAF	PAF
20S4605/004	4	MTS_248-251	Quest29	S bs	fr	PAF	PAF	PAF
20S4605/005	5	HKR34049 & HKR34265	Quest29	Pdz	tr	PAF	PAF	PAF
20S4611/001	1	RR038 & RR084	Rustler Roost	Psl	fr	UC	NAF	PAF
20S4611/002	2	RR036 & RR125	Rustler Roost	Psl	tr	PAF	PAF (LC)/UC	PAF
20S4611/003	3	RR102 & RR103	Rustler Roost	Psh	tr	PAF	PAF	PAF
20S4611/004	4	RR127 & RR130	Rustler Roost	Psh	fr	UC	NAF	NAF
20S4611/005	5	A20823	Rustler Roost	Tailing		PAF	PAF	PAF

4.2 Leachates

All leachates generated were assessed for a range of components (Table 7).

Table 7 Analytes assessed in each leachate

Group	Analyte
Physical chemical	pH, electrical conductivity
Major ions	Acidity, alkalinity, sulfate (as S), chloride, fluoride, bicarbonate, carbonate, hydroxide, calcium, magnesium, sodium, potassium
Nutrients	Phosphate as P
Metals and metalloids	Arsenic, As, Boron, B, Barium, Ba, Beryllium, Be, Cadmium, Cd, Cobalt, Co, Chromium, Cr, Caesium, Cs, Copper, Cu, Iron, Fe, Mercury, Hg, Lithium, Li, Manganese, Mn, Molybdenum, Mo, Nickel, Ni, Lead, Pb, Rubidium, Rb, Antimony, Sb, Selenium, Se, Silica, Si, Silver, Ag, Strontium, Sr, Thorium, Th, Thallium, Tl, Uranium, U, Vanadium, V and Zinc, Zn

The first flush for all columns generally produced the highest EC values for all leachates generated with values ranging from 142-805 mS/m (µS/cm) for the Rustlers Roost (Figure 1) and between 376-580 mS/m (µS/cm) for Quest 29 samples (Figure 2). Noting the excursion in EC in the Quest 29 column 2 Sbs fr in month 11.

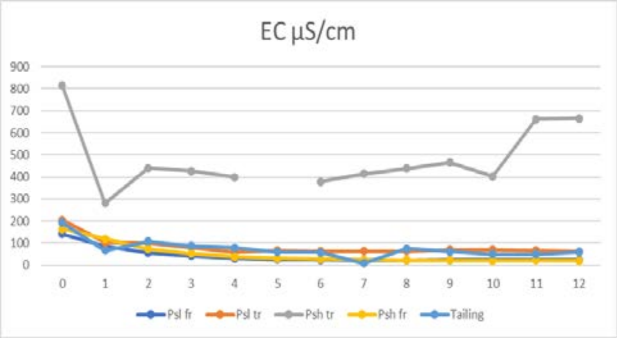


Figure 1 EC trend for Rustlers Roost

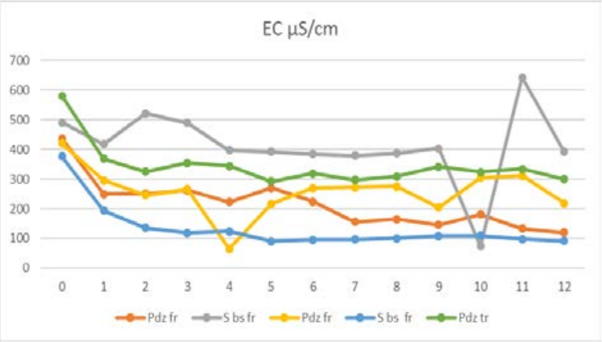


Figure 2 EC trend for Quest 29

Over the past 12 months, the pH of the columns has been relatively stable, with the exception of column 3 (Pdz fr) at Q29 which has decreased in pH by almost 3 pH units (Figure 4), and column 1 (Psl fr) at RR which has decreased by 2 pH units (Figure 3).

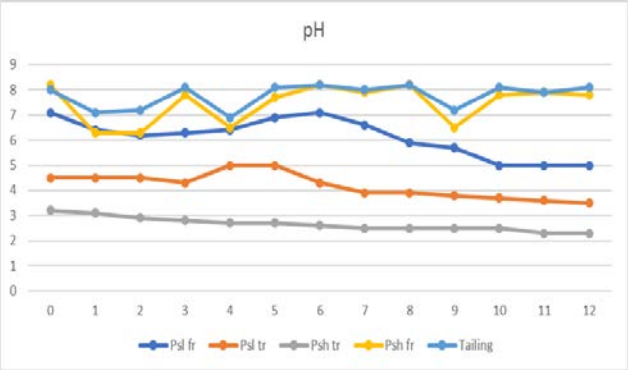


Figure 3 pH trend for Rustlers Roost

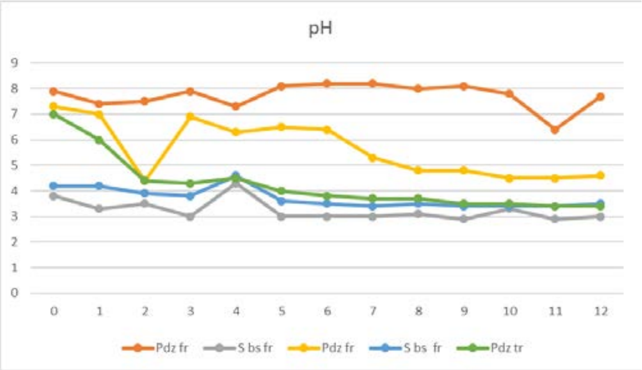
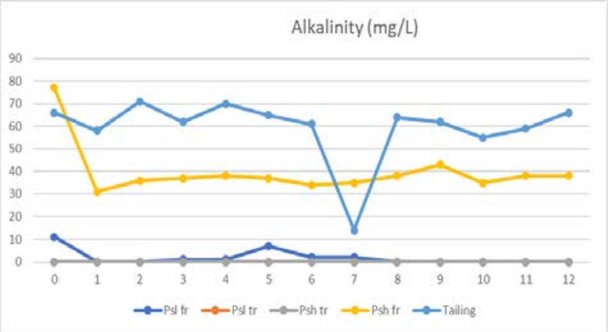


Figure 4 pH trend for Quest 29

The reason for the stable pH and EC for the majority of the columns is the presence of alkalinity. Soluble alkalinity has now depleted in those columns with a decreasing trend in the pH of the leachates; values are below the limit of reporting, LOR, refer to Figures 5 and 6. Alkalinity levels are decreasing in column 3 (Pdz fr) from Q29, with a concomitant decrease in pH. It is noted that there was a further release of alkalinity in month 11 and thus the pH recovered slightly in RR column Psh fr and the tailings sample and in the Q29 Pdz fr column.



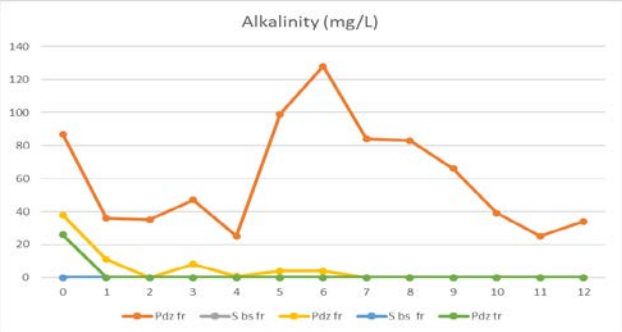
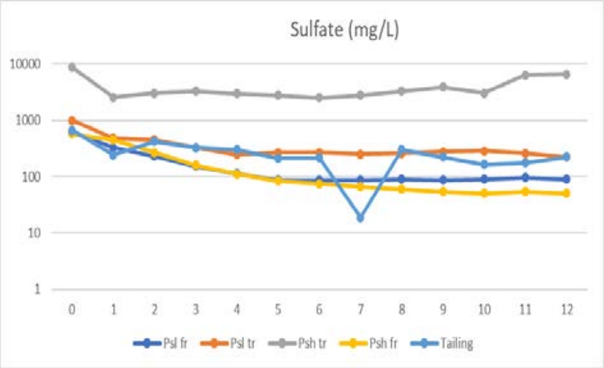


Figure 5 Alkalinity trend for Rustlers Roost **Figure 6 Alkalinity trend for Quest 29**

Sulfate concentrations released from the columns have in the most part decreased over the 12 month period, for RR columns the sulfate concentrations released ranged from 600-8700 mg/L first flush to 30-2200 for month 12 (Figure 7). For Q29, the sulfate concentrations released are more stable, first flush ranged between 2040-4800 mg/L, by month 12, these have decreased to a range between 480-3000 mg/L, Figure 8.



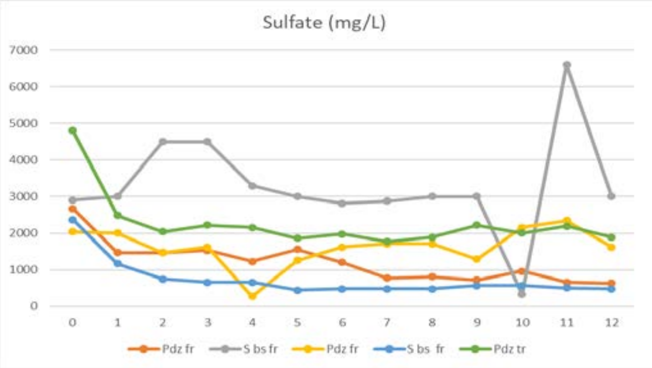


Figure 7 Sulfate trend for Rustlers Roost **Figure 8 Sulfate trend for Quest 29**

Quest 29 (Q29) columns 2-5 (Sbs fr, Pdz fr, Sbs fr ore, and Pdz tr) have all acidified (Figure 4), thus the steady release of sulfate is likely due to the sulfide minerals in the samples oxidising as the column experiment progresses. For column 1 RR (Psl fr), the pH has been at pH 5 for the last two leach events. Alkalinity is depleted (concentrations are below LOR), the sulfate release has stabilised. It may be that for this material there is another mineral, other than a carbonate which is buffering the pH. Also of note in the Q29 columns is the spike in sulfate at month 11 in column 2, Sbs fr. This sulfate spike correlates with a drop in pH (down to 2.9), increase in EC (2200 mS/m) and decrease in alkalinity export for this material. This is interpreted as indicating an increase in sulfide oxidation. It may be that microbial communities have had sufficient time to grow in the column, these communities may now be affecting mineral oxidation kinetics.

For the RR samples, 3 out of the 5 columns have acidified (Figure 3), the alkalinity in the two remaining neutral columns (column 4, Psh fr and column 5, tailings) has stabilised (Figure 5). For these columns in particular, it is important to assess whether there is sufficient neutralising capacity remaining to buffer the pH from the sulfide still present in the sample. To do this we have calculated the total sulfide oxidation based on the export of sulfate from the columns and the percentage of carbonate ANC utilised based on bicarbonate export from the columns. The results of this assessment are presented in section 4.3.

4.3 Sulfide depletion rate

Using the rate of sulfate export from the columns we have calculated the depletion rate of sulfides present in the samples. In addition, we have also calculated the rate of depletion of the ANC present in the samples based on the rate of release/depletion of the alkalinity in the same leachates (Table 8).

In samples where the ANC is depleted faster than the sulfide oxidises, the final classification of the material is PAF. Where the sulfide is depleted and ANC remains, the samples are classified as NAF or UC.

The results demonstrate that PAF from Q29 will continue to leach acidic drainage for a considerable period of time, noting that there may be less PAF at Q29 than the static results indicated when the release rates for sulfate and ANC are considered. Although the ore sample has one of the longest sulfide depletion times (>500 years), which is reflected in the results for the tailings >500 years for sulfide depletion, the ANC depletion rates are longer (Table 8), thus the sample is classified as NAF.

Although there is no measurable alkalinity being released from the Q29 ore sample, Ca and Mg continue to be released in the leachates. A constant steady release of silica is reported for all columns (Table C at the back of this report) thus it is possible that the presence of calc-silicates is buffering the samples. This long term buffering process may be sufficient to manage the slow oxidation of the sulfides in the ore leading to the current NAF classification (Table 8).

The waste rock generated at RR may contain also less PAF than previously thought given additional NAF material may be present at RR in the transition zone with the PAF(LC) sample (Psl tr, column 2) currently classifying as NAF.

Table 8 Time to depletion after 12 months of kinetic program

Lab ID	Column #	Sample ID	Pit	Lith	Weathering	ANC depletion yrs	S(sulfide) depletion years	Current Class
20S4605/001	1	HKR35252 & HKR34263	Quest29	Pdz	fr	23	101	PAF
20S4605/002	2	HKR34157 & HKR34089	Quest29	S bs	fr	-1	57	PAF
20S4605/003	3	HKR034078 & HKR034085	Quest29	Pdz	fr	17	83	PAF
20S4605/004	4	MTS_248-251	Quest29	S bs	fr	655	534	NAF
20S4605/005	5	HKR34049 & HKR34265	Quest29	Pdz	tr	9	78	PAF
20S4611/001	1	RR038 & RR084	Rustler Roost	Psl	fr	99	90	NAF
20S4611/002	2	RR036 & RR125	Rustler Roost	Psl	tr	98	65	NAF
20S4611/003	3	RR102 & RR103	Rustler Roost	Psh	tr	-2	30	PAF
20S4611/004	4	RR127 & RR130	Rustler Roost	Psh	fr	282	230	NAF
20S4611/005	5	A20823	Rustler Roost	Tailing		159	503	PAF

These rates may not represent the rates observed in the field. It has been well documented that depletion rates calculated from laboratory experiments are often 1-2 orders of magnitude different from those observed. Consequently, these rates will need to be scaled using site specific factors such as temperature, rainfall and likely particle size of the waste.

The percentage of the total sulfur exported from the columns to date is between 1 and 4% of the column sulfur content, and thus the rates calculated above are based on a very small amount of sulfide oxidation.

4.4 Drainage quality

The EC of the leachates indicates that the drainage from the waste from both Q29 and RR will be brackish (500-1500 mg/L TDS). The water quality will be dominated by sulfate. All elements of interest in the leachates were measured above the limits of reporting in one or more leachate sample.

The metals and metalloids displaying the highest concentrations in the leachates from Q29 are aluminium (Al, 860 mg/L), arsenic (As, 75mg/L), iron (Fe, 260 mg/L) and zinc (Zn, 78mg/L). Silica (Si) is also one of the dominant ions in the leachates with a maximum concentration of 33 mg/L.

For RR, the metals and metalloids displaying the highest concentrations in the leachates are aluminium (Al, 1100 mg/L), iron (Fe, 1400 mg/L), and manganese (Mn, 44 mg/L). Silica is also present in the leachates with a maximum concentration of 35 mg/L.

For RR, although pH is relatively stable for all columns, a number of columns display increasing concentrations of trace element release over time indicating that minerals within these columns are slowly dissolving in the acidic porewaters. It is likley that the transitional zone materials will produce drainage with a higher EC than their fresh zone counterparts, atleast initially (refer to RR column 3 Psh fr) and a lower pH. The elements displaying increasing trends in concentration are Al, Be, Cr, Co, Fe, Li, Ni, Se, Th, V and Zn, particularly from Psh in both the transition and fresh zones (RR columns 3 and 4, Table C at the back of this report).

Given the release of Al, Fe, Mn and Si in the leachates it is likley that a number of mineral phases are controlling the drainage chemisty, such as clays (aluminium silicates), iron and manganese phases (oxides and hydroxides), not just the oxidation of sulfides. The pH is likely being buffered by the clays and other silicates present given that alkalinity is depleted and silica is being released into solution.

Quest 29 also has a number of columns displaying increasing elemental concentrations over the course of the experiment. As, Al, Be, Co, Cd, Cr, Cu, F, Fe, Li, Ni, Si, Tl, U and Zn all noted to increase particularly from samples collected in the fresh zone. It is likley that the transitional zone materials are already partially leached, the fresh zone materials still contain the majority of their leachable content.

Thus, although pH has stabilised for 3 out of the 5 columns from Q29 (also likely being buffered by the clays and other silicates), drainage quality is decreasing over time. Given the sulfate export has also stabilised, the increased release of these elements may be due a slow oxidation of pyrite and the dissolution of iron oxides/hydroxides, manganese phases and or clays, pyrite typically contains entrained elements other than Fe in its crystal lattice which will be contributing to the leachate signature. For the clays, oxides and hydroxides, elements sorbed onto the surface of these phases and those within the crystal lattice will be released.

Thus, for both RR and Quest 29 there are likely to be two processes occuring which lead to evolving drainage quality; oxidation of sulfides leading to acidification and dissolution of clays and iron and manganese phases. Both mechanisms contribute to increases in the dissolved metal concentrations of the leachates.

5.0 Preliminary ecological risk assessment

All leachate concentrations were screened against both generic and site specific surface water quality guidelines to assess the potential risk the drainage may pose to aquatic and terrestrial environments surrounding the pits.

The concentrations eminating from the columns have been used without any scaling factor applied. As with the oxidation rates at the site, the concentrations released at anypoint in time from the mine waste may differ from the concentrations measured in the controlled laboratory experiments discussed here. Nevertheless, the concentrations measured in the column leachates provide an indication of the drainage quality which may develop at the site.

5.1 Adopted guidelines

The guideline values relevant to the site and surrounding receptors are as follows:

- ANZECC 2000 stockwatering trigger values

- J.L. Stauber and G.E. Batley, 2018. Toms Gully Underground Project EIS Supplement. Appendix F, Update Site Specific Trigger Values. January 2018. Report prepared for Primary Gold.

The primary receiving environment for which the site specific guidelines developed by Stauber and Batley 2018 are designed to protect is the Mt Bundy Creek, and the aquatic environments downstream of the Toms Gully Mine site during the wet season. Toms Gully Mine site is within Pine Creek Inlet geology which is considered to be part of the same geological event which generated the Q29 and RR gold deposits.

5.2 Comparison of drainage quality to water quality guidelines

All data collected for the leachates are presented in Tables C and D at the end of this report.

5.2.1 Site specific criteria

The physical parameters, elements and compounds which exceed the available site specific surface water criteria for any lithology assessed in the column program for Q29 are Cd, Cu, EC, Pb, Ni ,sulfate (SO_4) and Zn. It is also noted that two of the columns were already reporting acidic pH at the first flush and thus this acidic pH may cause additional release of elements and compounds along the pathway of the drainage.

The physical parameters, elements and compounds which exceed the available site specific surface water criteria for any lithology assessed in the column program for RR are As, Cd, Co, Cu, Mn, Pb and Zn. As noted for Quest 29, the pH of leachates from two of the five columns were already acidic at month 0, thus this acidic pH may cause additional release of elements and compounds along the pathway of the drainage.

5.2.2 Livestock watering

The following physical parameters, elements and compounds exceed the available assessment criteria designed to protect surface water for use as a livestock stockwatering resource in leachates from Q29:
Al, As, Cd, Co, Cu, Fe, Mn, Mo, Ni, Se, U and Zn.

The following physical parameters, elements and compounds exceed the available assessment criteria designed to protect surface water for use as a livestock stockwatering resource at RR: Al, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Se, U and Zn.

6.0 Conclusions and recommendations

There has been limited oxidation of the total sulfur content within the columns to date for both sites, nevertheless this small proportion of oxidation has led to acidic conditions being generated in most columns with the drainage quality exceeding acceptable limits for a range of elements and compounds from the materials tested at both deposits. ANC from silicates may offer long term buffering capacity, noting however that the pH at which silicates buffer is acidic it is not in the neutral pH range (GARD Guide 2018).

For both deposits, the drainage chemistry emanating from the waste will relate to the mineralogy of the host sediments and mafic lithologies which inturn is dictated by the sedimentary environment and subsequent alteration by hydrothermal fluids which passed through the host lithologies to create the deposits.

What can be ascertained in the drainage generated is likely to be fresh, acidic and dominated by Al and Fe at RR with trace elements typically associated with sulfides being released at low, but gradually increasing concentrations over time. The waste generated from the transition zone will likley generate acidic drainage as soon as it is placed above ground. Given the transitional zone is already depleted in terms of available neutralising material, noting that the pH will likley be buffered by silicate dissolution and therefore will not decrease in pH over the long term. Within the fresh zone, although alkalinity levels are higher than the transition zone, there is insufficient alkalinity available to maintain neutral conditions and acidic conditions will develop. Sulfide oxidation along with mineral dissolution are the likely cause of the gradual increase in elemental content of the drainage over time. Again the pH will likely be buffered by silicate dissolution long term.

At Q29, the drainage is likely to be fresh and acidic possibly as soon as the material is place above ground. The elemental content of the drainage likely to be dominated by Al, Fe and Mn. Concentrations of trace elements in the drainage will increase over time. The Mn phases and the higher concentrations of sulfides present at Q29 likely act as an additional source of trace elements to the drainage chemistry compared to the RR deposit. Noting that ore processed from Q29 at RR will therefore generate tailings that differ in their elemental content to the geology at RR. The primary element that differentiates Q29 from RR units is their Mn content. It is also noted here that Q29 lithologies are more sulfidic in nature than those at RR. The samples included in this kinetic program from Q29 were those with low S content the high S content samples were not selected for testing as it was assumed they would generate acidic leachates. Should the ore at Q29 have a higher S content that the samples used to generate the tailings sample tested in this program, it is possible that the tailings from Q29 ore will be acid forming. As with other PAF samples in this assessment, the pH of the tailngs will likely be buffered at an acidic pH by the silicates present.

Given the limited oxidation, at a minimum we would recommend that for materials where acidic conditions are predicted, but have not yet eventuated, these columns should be continued. The columns with neutral pH are RR column 4 Psh fr and column 5, the tailings sample. The column from Quest 29 which is neutral is column 1 Pdz Fr.

It is also recommended to continue column 1 of the RR materials is continued given the increasing Al and Fe release over time and its decreasing trend in pH.

7.0 Next steps

- Complete post kinetic static testing on the contents of teminated columns (6 out of 10 columns) to validate the sulfur depletion.
- Continue kinetic leach program for 4 out of the 10 columns.

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TABLES

Mineralogical results

Table A - Rustlers Roost column composite x-ray diffraction (XRD) results

Sample Mineral	Siltstone (Psl) fresh zone	Siltstone (Psl) transition zone	Shale (Psh) transition zone	Shale (Psh) fresh zone	Tailings
Quartz	4	43	9	24	17
Muscovite	4	27	5	14	12
Clinochlore	44	17	54	46	42
Microcline	17	5	13	3	8
Pyrite	1	3	4	3	2
Calcite (Mg bearing)	1	2	1	1	1
Maghemite		2		1	1
Albite	13	1	4	1	4
Magnesio – ferro hornblende	14		11		12
Vermiculite	2				
Grossular				2	1
Fluorapatite (Th bearing)				6	1

Table B - Quest 29 column composite x-ray diffraction (XRD) results

Sample Mineral	Pdz fr	Sbs fr	Pdz (LG) Ore	Sbs Ore	Pdz tr
	Dolerite	Black Shale	Dolerite	Black shale	Dolerite
Quartz	38	44	38	30	24
Muscovite	27	31	13	19	17
Clinochlore	28	18	28	31	53
Microcline	2	1			2
Pyrite		1	2	1	2
Dolomite				12	2
Albite	2	1	trace	3	1
Kaolinite	3	5	19	2	

Project: Rustlers Roost
Job Number: W-AA
Table C- Rustlers Roost Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Rustlers Roost
Job Number: W-AA-06
Client: CDM Smith

							M0					M1				
						ChemCentre ID	**20S4984/001**	**20S4984/002**	**20S4984/003**	**20S4984/004**	**20S4984/005**	**20S4984/006**	**20S4984/007**	**20S4984/008**	**20S4984/009**	**20S4984/010**
						Client ID	**RR038 & RR084 M0**	**RR036 & RR125 M0**	**RR102 & RR103 M0**	**RR127 & RR130 M0**	**A20823 M0**	**RR038 & RR084 M1**	**RR036 & RR125 M1**	**RR102 & RR103 M1**	**RR127 & RR130 M1**	**A20823 M1**
						Lithology	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**
						Sampled	**not provided**	**not provided**	**not provided**	**not provided**	**not provided**	**not provided**	**not provided**	**not provided**	**not provided**	
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**										
Acidity	iACID1WATI	2	mg/L				3	94	7700	<2	6	<2	20	2500	10	<2
Ag	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Al	iMET1WCICP	0.005	mg/L	Al (pH>6.5) 295	**20**	5	0.038	3.6	**1100**	0.034	0.051	0.031	1.8	**360**	0.068	0.035
Alkalin	iALK1WATI	1	mg/L				11	<1	<1	77	66	<1	<1	<1	31	58
As	iMET1WCMS	0.001	mg/L	0.042	**2**	0.1	0.01	0.006	0.021	0.007	0.039	0.009	0.032	0.006	0.017	0.058
B	iMET1WCICP	0.02	mg/L												0.07	
B	iMET1WCMS	0.005	mg/L				0.077	0.11	0.064	0.062	0.071	0.12	0.12	0.053		0.049
Ba	iMET1WCMS	0.0001	mg/L				0.064	0.053	0.038	0.092	0.08	0.028	0.064	0.0048	0.022	0.03
Be	iMET1WCICP	0.001	mg/L													
Be	iMET1WCMS	0.0001	mg/L				<0.0001	0.0041	0.26	<0.0001	<0.0001	<0.0001	0.004	0.13	<0.0001	<0.0001
CO3	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	0.1	mg/L				48.2	51.6	147	71.1	169	25.8	28.3	36.2	61	76.9
Cd	iMET1WCMS	0.0001	mg/L	0.0004	**0.05**	0.01	0.0001	0.0046	**0.079**	0.0002	<0.0001	<0.0001	0.0043	**0.067**	<0.0001	<0.0001
Cl	iCO1WCDA	1	mg/L				21	29	13	46	143	11	13	6	20	21
Co	iMET1WCICP	0.005	mg/L						**10**					**2.9**		
Co	iMET1WCMS	0.0001	mg/L		**0.1**	0.05	**0.18**	**2.2**		0.033	0.017	0.013	**0.96**		0.0008	0.0034
Cr	iMET1WCMS	0.0005	mg/L		**1**	0.1	<0.0005	0.0008	0.5	<0.0005	0.0009	<0.0005	0.0008	0.12	<0.0005	0.0007
Cs	iMET1WCMS	0.0001	mg/L				0.0017	0.0026	0.0022	0.0046	0.0002	0.0005	0.0008	0.0003	0.0019	<0.0001
Cu	iMET1WCICP	0.002	mg/L						**82**				1.2	**30**		
Cu	iMET1WCMS	0.0001	mg/L	0.0018	**5**	0.2	0.0023	0.8		0.002	0.0051	0.0009			0.0021	0.0012
ECond	iEC1WZSE	0.2	mS/m	41			142	205	814	163	193	84.7	103	281	120	66.6
F	iF1WASE	0.05	mg/L				0.17	1.2	0.41	0.71	0.59	0.34	0.54	0.12	<0.05	0.46
Fe	iMET1WCICP	0.005	mg/L	2.7**	**10**	0.2	<0.005	**27**	**450**	<0.005	0.28	<0.005	0.19	**49**	<0.005	0.064
HCO3	iALK1WATI	1	mg/L				13	<1	<1	93	80	<1	<1	<1	37	71
Hg	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	iMET1WCICP	0.1	mg/L				81.5	80	21.4	166	27.2	50.6	53	2.6	104	12.1
Li	iMET1WCICP	0.005	mg/L													
Li	iMET1WCMS	0.0001	mg/L				0.035	0.095	0.66	0.031	0.0028	0.0088	0.051	0.48	0.022	0.0025
Mg	iMET1WCICP	0.1	mg/L				87.6	182	595	70.5	23.6	50.7	78	155	48.3	13.7
Mn	iMET1WCICP	0.001	mg/L				5.7	8.2	**44**			2.7	4.6	**18**	0.15	0.1
Mn	iMET1WCMS	0.0001	mg/L	2.5**	**10**	0.2				0.9	0.11					
Mo	iMET1WCMS	0.001	mg/L		**0.05**	0.01	0.002	<0.001	<0.001	**0.16**	0.037	0.002	<0.001	<0.001	**0.062**	0.021
Na	iMET1WCICP	0.1	mg/L				29.3	26.3	8.5	16.2	180	15.4	12.5	0.9	11.7	35.3
Ni	iMET1WCICP	0.01	mg/L						**8**					**2.5**		
Ni	iMET1WCMS	0.001	mg/L	0.013	**2**	0.2	0.23	1.5		0.054	0.18	0.009	0.66		0.002	0.005
OH	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	0.1	mg/L				<0.1	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Pb	iMET1WCMS	0.0001	mg/L	0.0056	**5**	2	<0.0001	0.0028	0.0049	0.0005	0.0004	0.0005	0.0016	0.0061	0.0002	<0.0001
Rb	iMET1WCMS	0.0001	mg/L				0.12	0.16	0.1	0.28	0.03	0.057	0.075	0.018	0.17	0.012
S	iMET1WCICP	0.1	mg/L	70*			200	330	2900	190	220	110	160	850	150	81
SO4		Calculated	mg/L	210*			600	990	8700	570	660	330	480	2550	450	243
Sb	iMET1WCMS	0.0001	mg/L				0.0006	0.0003	0.0002	0.0017	0.0018	0.0005	<0.0001	<0.0001	0.0032	0.0017
Se	iMET1WCMS	0.001	mg/L		**0.05**	0.02	0.014	**0.15**	**0.14**	0.032	0.002	0.005	**0.054**	**0.1**	0.029	0.002
Si	iMET1WCICP	0.05	mg/L				4.4	12	35	2	2.3	5.8	9.4	13	2.5	2.1
Sr	iMET1WCICP	0.002	mg/L				0.11	0.11	0.2	0.11	0.38	0.066	0.073	0.045	0.073	0.19
Th	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	0.18	<0.0001	<0.0001	<0.0001	<0.0001	0.051	<0.0001	<0.0001
Tl	iMET1WCMS	0.0001	mg/L				0.0005	0.0005	0.0003	0.0003	0.0001	0.0002	0.0002	<0.0001	0.0002	<0.0001
U	iMET1WCMS	0.0001	mg/L		**0.1**	0.01	<0.0001	0.0015	**0.32**	0.002	0.003	<0.0001	0.0012	**0.15**	0.0008	0.0015
V	iMET1WCICP	0.005	mg/L		**0.5**	0.1	<0.005	<0.005	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Volume	iVOLUME	0.1	mL				210	210	200	200	220	230	170	160	230	190
Zn	iMET1WCICP	0.005	mg/L						**12**					4.1		
Zn	iMET1WCMS	0.001	mg/L	0.014	**5**	2	0.13	1.9		0.17	0.17	0.014	0.9		0.003	0.003
pH	iPH1WASE	0.1		5.8-8.0			7.1	4.5	3.2	8.2	8	6.4	4.5	3.1	6.3	7.1

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Project: Rustlers Roost
Job Number: W-AA
Table C- Rustlers Roost Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Rustlers Roost
Job Number: W-AA-06
Client: CDM Smith

							M2					M3				
						ChemCentre ID	**20S4984/011**	**20S4984/012**	**20S4984/013**	**20S4984/014**	**20S4984/015**	**20S4984/016**	**20S4984/017**	**20S4984/018**	**20S4984/019**	**20S4984/020**
						Client ID	**RR038 & RR084 M2**	**RR036 & RR125 M2**	**RR102 & RR103 M2**	**RR127 & RR130 M2**	**A20823 M2**	**RR038 & RR084 M3**	**RR036 & RR125 M3**	**RR102 & RR103 M3**	**RR127 & RR130 M3**	**A20823 M3**
						Lithology	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**
						Sampled	**not provided**	**not provided**	**not provided**	**not provided**	**not provided**	**30/08/2021**	**30/08/2021**	**30/08/2021**	**30/08/2021**	**30/08/2021**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**										
Acidity	iACID1WATI	2	mg/L				6	25	3400	2	4	<2	32	3200	<2	<5
Ag	iMET1WCMS	0.0001	mg/L				0.0004	<0.0001	0.0003	0.0012	0.0013	<0.0001	0.0002	0.0001	0.009	0.001
Al	iMET1WCICP	0.005	mg/L	Al (pH>6.5) 295	**20**	5	0.01	2.1	**500**	0.043	0.037	0.012	1.5	**420**	0.048	0.036
Alkalin	iALK1WATI	1	mg/L				<1	<1	<1	36	71	1	<1	<1	37	62
As	iMET1WCMS	0.001	mg/L	0.042	**2**	0.1	0.006	0.029	0.015	0.022	*0.056*	0.006	0.023	0.022	0.017	*0.045*
B	iMET1WCICP	0.02	mg/L											0.07		
B	iMET1WCMS	0.005	mg/L				0.049	0.054	0.046	0.048	0.041	0.044	0.043		0.039	0.033
Ba	iMET1WCMS	0.0001	mg/L				0.018	0.046	0.0019	0.015	0.042	0.015	0.044	0.0012	0.016	0.041
Be	iMET1WCICP	0.001	mg/L											0.14		
Be	iMET1WCMS	0.0001	mg/L				<0.0001	0.0054	0.16	<0.0001	<0.0001	<0.0001	0.0055		<0.0001	<0.0001
CO3	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<2
Ca	iMET1WCICP	0.1	mg/L				16.4	23.6	40.2	37.3	102	9.7	14.4	29.5	22.8	94.6
Cd	iMET1WCMS	0.0001	mg/L	0.0004	**0.05**	0.01	0.0001	*0.0055*	***0.09***	0.0002	0.0001	0.0001	*0.004*	***0.068***	<0.0001	<0.0001
Cl	iCO1WCDA	1	mg/L				3	8	7	6	32	2	7	6	5	8
Co	iMET1WCICP	0.005	mg/L						**3.9**					**3.2**		
Co	iMET1WCMS	0.0001	mg/L		**0.1**	0.05	0.011	**0.92**		0.0004	0.0075	0.0078	**0.48**		0.0001	0.0033
Cr	iMET1WCMS	0.0005	mg/L		**1**	0.1	<0.0005	0.0007	0.22	<0.0005	0.001	<0.0005	<0.0005	0.19	<0.0005	0.0031
Cs	iMET1WCMS	0.0001	mg/L				0.0003	0.0006	0.0002	0.001	<0.0001	0.0002	0.0005	0.0003	0.0006	<0.0001
Cu	iMET1WCICP	0.002	mg/L						***37***					***30***		
Cu	iMET1WCMS	0.0001	mg/L	0.0018	**5**	0.2	*0.013*	*1.9*		*0.011*	*0.016*	0.0017	*1.3*		*0.0023*	*0.014*
ECond	iEC1WZSE	0.2	mS/m	41			*55.3*	*99.7*	*441*	*72.8*	*108*	*42.8*	*79.2*	*426*	*52.4*	*87.1*
F	iF1WASE	0.05	mg/L				0.31	0.57	0.09	2.2	0.61	0.34	0.43	0.08	2.4	0.62
Fe	iMET1WCICP	0.005	mg/L	2.7**	**10**	0.2	<0.005	0.13	**100**	<0.005	0.12	<0.005	0.11	**130**	<0.005	0.11
HCO3	iALK1WATI	1	mg/L				<1	<1	<1	44	87	2	<1	<1	45	75
Hg	iMET1WCMS	0.0001	mg/L				0.0004	<0.0001	<0.0001	0.0014	0.0014	0.0003	<0.0001	<0.0001	0.0001	**0.0066**
K	iMET1WCICP	0.1	mg/L				42.4	54.8	1.4	78.1	14.1	29.8	43.3	1.2	54	14.4
Li	iMET1WCICP	0.005	mg/L											0.35		
Li	iMET1WCMS	0.0001	mg/L				0.0084	0.042	0.4	0.0087	0.0025	0.0077	0.037		0.029	0.002
Mg	iMET1WCICP	0.1	mg/L				31.8	77.7	231	28.2	23.3	19.6	52.9	207	14.8	18.7
Mn	iMET1WCICP	0.001	mg/L				1.8	4.4	**22**	0.071	0.19	1.3	3	**19**	0.035	0.17
Mn	iMET1WCMS	0.0001	mg/L	2.5**	**10**	0.2										
Mo	iMET1WCMS	0.001	mg/L		**0.05**	0.01	0.001	<0.001	<0.001	0.049	0.043	<0.001	<0.001	<0.001	0.043	0.034
Na	iMET1WCICP	0.1	mg/L				7.3	10.3	0.5	5.5	85.6	3.8	5.3	0.4	3	40.8
Ni	iMET1WCICP	0.01	mg/L						**3.5**							
Ni	iMET1WCMS	0.001	mg/L	0.013	**2**	0.2	0.005	0.7		<0.001	0.002	0.004	0.35	**2.5**	<0.001	0.001
OH	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<2
P	iMET1WCICP	0.1	mg/L				<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1
Pb	iMET1WCMS	0.0001	mg/L	0.0056	**5**	2	0.0004	*0.013*	*0.059*	0.0004	0.0006	0.0003	0.0054	*0.06*	0.0002	0.0008
Rb	iMET1WCMS	0.0001	mg/L				0.041	0.069	0.016	0.093	0.013	0.029	0.053	0.019	0.069	0.012
S	iMET1WCICP	0.1	mg/L	70*			*77*	*150*	*1000*	*89*	*140*	51	*110*	*1100*	53	*110*
SO4		Calculated	mg/L	210*			*231*	*450*	*3000*	*267*	*420*	153	*330*	*3300*	159	*330*
Sb	iMET1WCMS	0.0001	mg/L				0.0004	<0.0001	<0.0001	0.0028	0.0019	0.0005	<0.0001	<0.0001	0.0023	0.0018
Se	iMET1WCMS	0.001	mg/L		**0.05**	0.02	0.002	**0.058**	**0.13**	0.012	0.004	0.001	0.039	**0.085**	0.005	0.002
Si	iMET1WCICP	0.05	mg/L				7.5	9.4	13	2.9	2.6	8.1	8.8	13	2.9	2.5
Sr	iMET1WCICP	0.002	mg/L				0.04	0.06	0.026	0.044	0.26	0.026	0.04	0.015	0.028	0.24
Th	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	0.14	<0.0001	<0.0001	<0.0001	<0.0001	0.099	<0.0001	<0.0001
Tl	iMET1WCMS	0.0001	mg/L				0.0002	0.0002	<0.0001	0.0001	<0.0001	0.0001	0.0002	<0.0001	<0.0001	<0.0001
U	iMET1WCMS	0.0001	mg/L		**0.1**	0.01	<0.0001	0.0015	**0.24**	0.001	0.0023	<0.0001	0.0015	**0.2**	0.0003	0.0013
V	iMET1WCICP	0.005	mg/L		**0.5**	0.1	<0.005	<0.005	0.014	<0.005	<0.005	<0.005	<0.005	0.024	<0.005	<0.005
Volume	iVOLUME	0.1	mL				230	180	150	240	210	240	180	150	240	210
Zn	iMET1WCICP	0.005	mg/L						**5.7**					4.6		
Zn	iMET1WCMS	0.001	mg/L	0.014	**5**	2	*0.026*	*1.1*		*0.019*	*0.029*	0.009	*0.58*		0.005	*0.026*
pH	iPH1WASE	0.1		5.8-8.0			6.2	*4.5*	*2.9*	6.3	7.2	6.3	*4.3*	*2.8*	7.8	*8.1*

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Project: Rustlers Roost
Job Number: W-AA
Table C- Rustlers Roost Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Rustlers Roost
Job Number: W-AA-06
Client: CDM Smith

Analyte	Method Code	*Limits of Reporting*	Units	Bundy Creek TV's	ANZECC & ARMCANZ 2000 Short-Term Irrigation Water	ANZECC & ARMCANZ 2000 Long-Term Irrigation Water	M4					M5				
						ChemCentre ID	**20S4984/021**	**20S4984/022**	**20S4984/023**	**20S4984/024**	**20S4984/025**	**20S4984/026**	**20S4984/027**	**20S4984/028**	**20S4984/029**	**20S4984/030**
						Client ID	**RR038 & RR084 M4**	**RR036 & RR125 M4**	**RR102 & RR103 M4**	**RR127 & RR130 M4**	**A20823 M4**	**RR038 & RR084 M5**	**RR036 & RR125 M5**	**RR102 & RR103 M5**	**RR127 & RR130 M5**	**A20823 M5**
						Lithology	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**
						Sampled	**27/09/2021**	**27/09/2021**	**27/09/2021**	**27/09/2021**	**27/09/2021**	**25/10/2021**	**44494**	**44494**	**44494**	**44494**
Acidity	iACID1WATI	*2*	mg/L				18	15	3100	<2	<2	3	20	2800	<2	3
Ag	iMET1WCMS	*0.0001*	mg/L				0.0098	0.015	0.0028	0.0081	0.0017	0.001	0.0063	0.0019	0.0025	0.01
Al	iMET1WCICP	*0.005*	mg/L	*Al (pH>6.5) 295*	**20**	5	0.008	1.2	**380**	0.056	0.028	0.011	1.8	**360**	0.046	0.034
Alkalin	iALK1WATI	*1*	mg/L				1	<1	<1	38	70	7	<1	<1	37	65
As	iMET1WCMS	*0.001*	mg/L	*0.042*	**2**	0.1	0.009	0.022	0.027	0.022	*0.055*	0.011	0.029	0.026	0.029	*0.096*
B	iMET1WCICP	*0.02*	mg/L													
B	iMET1WCMS	*0.005*	mg/L				0.041	0.038	0.056	0.037	0.035	0.033	0.034	0.043	0.032	0.029
Ba	iMET1WCMS	*0.0001*	mg/L				0.015	0.041	0.0019	0.02	0.037	0.016	0.031	0.0016	0.025	0.034
Be	iMET1WCICP	*0.001*	mg/L													
Be	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0061	0.12	<0.0001	<0.0001	<0.0001	0.0089	0.082	<0.0001	<0.0001
CO3	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	*0.1*	mg/L				7.9	10.9	27	19.4	95.2	5.3	11.4	20.6	16.7	70
Cd	iMET1WCMS	*0.0001*	mg/L	*0.0004*	**0.05**	0.01	0.0001	*0.0024*	***0.059***	<0.0001	<0.0001	<0.0001	*0.0034*	*0.047*	<0.0001	<0.0001
Cl	iCO1WCDA	*1*	mg/L				2	2	5	2	4	1	2	4	1	2
Co	iMET1WCICP	*0.005*	mg/L													
Co	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.05	0.0081	**0.45**	**2.7**	0.0006	0.0038	0.0087	**0.61**	**2.1**	0.0005	0.0017
Cr	iMET1WCMS	*0.0005*	mg/L		**1**	0.1	<0.0005	0.001	0.21	0.001	0.0036	<0.0005	0.0011	0.18	0.0008	0.0022
Cs	iMET1WCMS	*0.0001*	mg/L				0.0002	0.0003	0.0004	0.0005	<0.0001	0.0026	0.0004	0.0002	0.0005	<0.0001
Cu	iMET1WCICP	*0.002*	mg/L						**23**					**16**		
Cu	iMET1WCMS	*0.0001*	mg/L	*0.0018*	**5**	0.2	*0.0032*	1.5		*0.0043*	*0.0019*	0.0013	2.1		*0.0038*	*0.0049*
ECond	iEC1WZSE	*0.2*	mS/m	*41*			30.3	*57.9*	*400*	37.2	*77.7*	24.5	*65.6*	ISS	30.2	*59.6*
F	iF1WASE	*0.05*	mg/L				0.32	0.22	4.5	2.3	0.6	0.4	0.31	4.3	2.1	0.93
Fe	iMET1WCICP	*0.005*	mg/L	*2.7***	**10**	0.2	<0.005	0.093	**150**	0.006	0.12	<0.005	0.23	**220**	<0.005	0.062
HCO3	iALK1WATI	*1*	mg/L				2	<1	<1	46	86	8	1	<1	45	80
Hg	iMET1WCMS	*0.0001*	mg/L				0.0005	0.0009	0.001	0.0011	0.0005	0.0002	0.0004	0.0003	0.0002	**0.0052**
K	iMET1WCICP	*0.1*	mg/L				25	35.4	0.6	41.3	14.1	20.5	38.4	0.2	34	12
Li	iMET1WCICP	*0.005*	mg/L													
Li	iMET1WCMS	*0.0001*	mg/L				0.0069	0.03	0.26	0.018	0.0022	0.0067	0.042	0.24	0.0086	0.0021
Mg	iMET1WCICP	*0.1*	mg/L				14.9	39.6	178	10	19.6	10.5	43.4	143	7.8	13.8
Mn	iMET1WCICP	*0.001*	mg/L				1	2.2	**16**	0.02	0.17	0.76	2.5	**14**	0.025	0.14
Mn	iMET1WCMS	*0.0001*	mg/L	*2.5***	**10**	0.2										
Mo	iMET1WCMS	*0.001*	mg/L		**0.05**	0.01	<0.001	0.002	0.001	**0.052**	0.035	0.002	0.001	<0.001	0.04	0.026
Na	iMET1WCICP	*0.1*	mg/L				2.5	5.9	2.3	2	26.1	4.9	6.1	0.2	1.4	19.1
Ni	iMET1WCICP	*0.01*	mg/L													
Ni	iMET1WCMS	*0.001*	mg/L	*0.013*	**2**	0.2	0.003	0.32	**2.4**	<0.001	0.002	0.005	0.43	**2**	<0.001	<0.001
OH	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	*0.1*	mg/L				<0.1	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1
Pb	iMET1WCMS	*0.0001*	mg/L	*0.0056*	**5**	2	0.0003	0.0019	0.006	0.0003	0.0001	0.0001	0.0022	*0.024*	0.0004	0.0008
Rb	iMET1WCMS	*0.0001*	mg/L				0.026	0.044	0.019	0.053	0.012	0.026	0.056	0.015	0.054	0.012
S	iMET1WCICP	*0.1*	mg/L	*70**			38	*82*	*990*	37	*100*	29	*90*	*930*	28	*71*
SO4		*Calculated*	mg/L	*210**			114	*246*	*2970*	111	*300*	87	*270*	*2790*	84	*213*
Sb	iMET1WCMS	*0.0001*	mg/L				0.0004	<0.0001	<0.0001	0.0021	0.0016	0.0004	<0.0001	<0.0001	0.0022	0.0015
Se	iMET1WCMS	*0.001*	mg/L		**0.05**	0.02	0.001	0.037	**0.088**	0.005	0.002	0.002	0.041	**0.077**	0.003	0.002
Si	iMET1WCICP	*0.05*	mg/L				8.5	7.8	12	2.8	2.8	7.9	7	11	2.9	2.5
Sr	iMET1WCICP	*0.002*	mg/L				0.022	0.031	0.011	0.023	0.24	0.016	0.034	0.006	0.02	0.18
Th	iMET1WCMS	*0.0001*	mg/L				<0.0001	<0.0001	0.19	<0.0001	<0.0001	<0.0001	<0.0001	0.2	<0.0001	<0.0001
Tl	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0002	<0.0001	<0.0001	<0.0001
U	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.01	<0.0001	0.0028	**0.17**	0.0005	0.0015	0.0016	0.0048	**0.13**	0.0007	0.0032
V	iMET1WCICP	*0.005*	mg/L		**0.5**	0.1	<0.005	<0.005	0.03	<0.005	<0.005	<0.005	<0.005	0.042	<0.005	<0.005
Volume	iVOLUME	*0.1*	mL				240	180	160	240	190	260	200	160	250	240
Zn	iMET1WCICP	*0.005*	mg/L						3.7					3		
Zn	iMET1WCMS	*0.001*	mg/L	*0.014*	**5**	2	0.012	*0.54*		0.005	0.003	0.008	*0.71*		0.008	0.012
pH	iPH1WASE	*0.1*		*5.8-8.0*			6.4	*5*	*2.7*	6.5	6.9	6.9	*5*	*2.7*	7.7	*8.1*

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Project: Rustlers Roost
Job Number: W-AA
Table C- Rustlers Roost Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Rustlers Roost
Job Number: W-AA-06
Client: CDM Smith

							M6					**M7**				
						ChemCentre ID	**20S4984/031**	**20S4984/032**	**20S4984/033**	**20S4984/034**	**20S4984/035**	**20S4984/036**	**20S4984/037**	**20S4984/038**	**20S4984/039**	**20S4984/040**
						Client ID	**RR038 & RR084 M6**	**RR036 & RR125 M6**	**RR102 & RR103 M6**	**RR127 & RR130 M6**	**A20823 M6**	**RR038 & RR084 M7**	**RR036 & RR125 M7**	**RR102 & RR103 M7**	**RR127 & RR130 M7**	**A20823 M7**
						Lithology	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**
						Sampled	**44522**	**44522**	**44522**	**44522**	**44522**	**20/12/2021**	**20/12/2021**	**20/12/2021**	**20/12/2021**	**20/12/2021**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**										
Acidity	iACID1WATI	*2*	mg/L				<2	27	2900	<2	<2	2	31	3200	<2	<2
Ag	iMET1WCMS	*0.0001*	mg/L				0.0006	0.0008	0.0013	0.0053	0.0007	0.0004	0.001	0.0002	0.0013	0.0002
Al	iMET1WCICP	*0.005*	mg/L	*Al (pH>6.5) 295*	**20**	5	0.017	2	**310**	0.042	0.024	0.031	2.3	**330**	0.056	0.08
Alkalin	iALK1WATI	*1*	mg/L				2	<1	<1	34	61	2	<1	<1	35	14
As	iMET1WCMS	*0.001*	mg/L	*0.042*	**2**	0.1	0.011	0.031	0.029	0.028	*0.046*	0.008	0.026	*0.052*	0.027	0.034
B	iMET1WCICP	*0.02*	mg/L													
B	iMET1WCMS	*0.005*	mg/L				0.031	0.034	0.042	0.031	0.027	0.026	0.032	0.043	0.03	<0.005
Ba	iMET1WCMS	*0.0001*	mg/L				0.017	0.027	0.001	0.023	0.033	0.017	0.022	0.0013	0.021	0.0025
Be	iMET1WCICP	*0.001*	mg/L													
Be	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0096	0.049	<0.0001	<0.0001	0.0001	0.013	0.049	<0.0001	<0.0001
CO3	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	*0.1*	mg/L				5.5	10.9	14.4	15.6	76.3	5.7	10.5	11.8	15.4	10
Cd	iMET1WCMS	*0.0001*	mg/L	*0.0004*	**0.05**	0.01	<0.0001	*0.0029*	*0.03*	<0.0001	<0.0001	<0.0001	*0.0028*	*0.025*	<0.0001	<0.0001
Cl	iCO1WCDA	*1*	mg/L				<1	1	3	<1	2	<1	1	3	<1	<1
Co	iMET1WCICP	*0.005*	mg/L													
Co	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.05	0.011	**0.56**	**1.4**	0.0002	0.0022	0.012	**0.52**	**1.1**	0.0002	0.0002
Cr	iMET1WCMS	*0.0005*	mg/L		**1**	0.1	<0.0005	0.001	0.14	<0.0005	0.0021	0.0008	0.0009	0.15	<0.0005	<0.0005
Cs	iMET1WCMS	*0.0001*	mg/L				0.0001	0.0003	0.0002	0.0004	<0.0001	0.0001	0.0004	0.0002	0.0004	<0.0001
Cu	iMET1WCICP	*0.002*	mg/L						**10**					**8.4**		
Cu	iMET1WCMS	*0.0001*	mg/L	*0.0018*	**5**	0.2	0.0011	2.1		0.0011	0.0016	0.0013	2.1		0.0008	0.0007
ECond	iEC1WZSE	*0.2*	mS/m	*41*			23.1	*63.5*	*379*	26.3	*57.8*	22.7	*62.3*	*414*	24.4	7.6
F	iF1WASE	*0.05*	mg/L				0.27	0.48	4.6	1.8	0.72	<0.50	<0.50	3.8	1.7	0.05
Fe	iMET1WCICP	*0.005*	mg/L	*2.7***	**10**	0.2	<0.005	0.25	**240**	<0.005	0.053	0.012	0.46	**330**	0.007	0.005
HCO3	iALK1WATI	*1*	mg/L				2	<1	<1	42	74	3	<1	<1	42	17
Hg	iMET1WCMS	*0.0001*	mg/L				0.0002	0.0005	0.0004	0.0007	0.0004	<0.0001	<0.0001	<0.0001	0.0008	<0.0001
K	iMET1WCICP	*0.1*	mg/L				19	37.1	0.1	29.9	11.7	20.3	37.2	<0.1	28	1.2
Li	iMET1WCICP	*0.005*	mg/L													
Li	iMET1WCMS	*0.0001*	mg/L				0.0071	0.035	0.22	0.0083	0.0025	0.0088	0.045	0.21	0.0086	0.0005
Mg	iMET1WCICP	*0.1*	mg/L				11	43.5	119	7.1	14.9	11	40.8	123	6.3	1.3
Mn	iMET1WCICP	*0.001*	mg/L				0.8	2.3	**11**	0.016	0.16	0.84	2.3	**12**	0.013	0.006
Mn	iMET1WCMS	*0.0001*	mg/L	*2.5***	**10**	0.2										
Mo	iMET1WCMS	*0.001*	mg/L		**0.05**	0.01	<0.001	<0.001	0.002	0.047	0.027	<0.001	<0.001	<0.001	0.052	0.005
Na	iMET1WCICP	*0.1*	mg/L				1.9	3.5	3.4	1	11	2.5	1.8	0.2	0.9	0.5
Ni	iMET1WCICP	*0.01*	mg/L													
Ni	iMET1WCMS	*0.001*	mg/L	*0.013*	**2**	0.2	0.005	0.4	1.3	<0.001	<0.001	0.007	0.39	1.1	<0.001	<0.001
OH	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	*0.1*	mg/L				<0.1	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	0.7	<0.1	<0.1
Pb	iMET1WCMS	*0.0001*	mg/L	*0.0056*	**5**	2	0.0001	0.0053	*0.0087*	0.0005	<0.0001	0.0011	0.0039	*0.015*	0.0005	<0.0001
Rb	iMET1WCMS	*0.0001*	mg/L				0.021	0.05	0.011	0.042	0.011	0.02	0.047	0.0099	0.038	0.0013
S	iMET1WCICP	*0.1*	mg/L	*70**			29	*89*	*840*	25	*72*	29	*84*	*930*	22	6.3
SO4		*Calculated*	mg/L	*210**			87	*267*	*2520*	75	*216*	87	*252*	*2790*	66	18.9
Sb	iMET1WCMS	*0.0001*	mg/L				0.0003	<0.0001	<0.0001	0.0019	0.0012	0.0004	<0.0001	<0.0001	0.0028	0.0002
Se	iMET1WCMS	*0.001*	mg/L		**0.05**	0.02	0.001	0.047	**0.056**	0.003	0.002	0.001	0.032	**0.051**	0.002	<0.001
Si	iMET1WCICP	*0.05*	mg/L				8.5	7.3	12	3.1	2.6	8.5	7.5	13	3.5	0.57
Sr	iMET1WCICP	*0.002*	mg/L				0.017	0.033	0.006	0.018	0.2	0.018	0.031	0.005	0.017	0.019
Th	iMET1WCMS	*0.0001*	mg/L				<0.0001	<0.0001	0.14	<0.0001	<0.0001	<0.0001	<0.0001	0.27	<0.0001	<0.0001
Tl	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
U	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.01	0.0004	0.0041	0.083	0.0005	0.0009	0.0011	0.005	0.072	0.0006	0.0001
V	iMET1WCICP	*0.005*	mg/L		**0.5**	0.1	<0.005	<0.005	0.043	<0.005	<0.005	<0.005	<0.005	0.055	<0.005	<0.005
Volume	iVOLUME	*0.1*	mL				240	200	170	240	220	240	190	160	250	370
Zn	iMET1WCICP	*0.005*	mg/L													
Zn	iMET1WCMS	*0.001*	mg/L	*0.014*	**5**	2	0.007	*0.67*	2.1	0.002	0.001	0.009	*0.58*	*1.6*	0.002	0.003
pH	iPH1WASE	*0.1*		*5.8-8.0*			7.1	*4.3*	*2.6*	*8.2*	*8.2*	6.6	*3.9*	*2.5*	7.9	8

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Project: Rustlers Roost
Job Number: W-AA
Table C- Rustlers Roost Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Rustlers Roost
Job Number: W-AA-06
Client: CDM Smith

							M8					M9				
						ChemCentre ID	**20S4984/041**	**20S4984/042**	**20S4984/043**	**20S4984/044**	**20S4984/045**	**20S4984/046**	**20S4984/047**	**20S4984/048**	**20S4984/049**	**20S4984/050**
						Client ID	**RR038 & RR084 M8**	**RR036 & RR125 M8**	**RR102 & RR103 M8**	**RR127 & RR130 M8**	**A20823 M8**	**RR038 & RR084 M9**	**RR036 & RR125 M9**	**RR102 & RR103 M9**	**RR127 & RR130 M9**	**A20823 M9**
						Lithology	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**
						Sampled	**17/01/2022**	**17/01/2022**	**17/01/2022**	**17/01/2022**	**17/01/2022**	**14/02/2022**	**14/02/2022**	**14/02/2022**	**14/02/2022**	**14/02/2022**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**										
Acidity	iACID1WATI	*2*	mg/L				3	39	3600	<2	<2	2	100	4000	<2	<2
Ag	iMET1WCMS	*0.0001*	mg/L				0.0013	0.0006	0.0004	0.0009	0.0003	<0.0001	0.0001	0.0003	0.0004	0.0002
Al	iMET1WCICP	*0.005*	mg/L	*Al (pH>6.5) 295*	**20**	5	0.034	3	**370**	0.042	0.023	0.049	3.5	**390**	0.043	0.019
Alkalin	iALK1WATI	*1*	mg/L				<1	<1	<1	38	64	<1	<1	<1	43	62
As	iMET1WCMS	*0.001*	mg/L	*0.042*	**2**	0.1	0.005	0.032	0.11	0.027	*0.044*	0.01	*0.043*	0.23	0.034	*0.048*
B	iMET1WCICP	*0.02*	mg/L													
B	iMET1WCMS	*0.005*	mg/L				0.032	0.038	0.047	0.035	0.032	0.023	0.031	0.031	0.029	0.027
Ba	iMET1WCMS	*0.0001*	mg/L				0.02	0.024	0.0009	0.022	0.037	0.025	0.039	0.0008	0.024	0.038
Be	iMET1WCICP	*0.001*	mg/L													
Be	iMET1WCMS	*0.0001*	mg/L				0.0003	0.017	0.049	<0.0001	<0.0001	0.0003	0.017	0.036	<0.0001	<0.0001
CO3	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	*0.1*	mg/L				6.2	11.4	10.7	15.5	108	5.9	12.5	7.8	15.6	83.8
Cd	iMET1WCMS	*0.0001*	mg/L	*0.0004*	**0.05**	0.01	<0.0001	*0.0027*	*0.022*	<0.0001	<0.0001	0.0001	*0.0031*	*0.017*	<0.0001	<0.0001
Cl	iCO1WCDA	*1*	mg/L				<1	2	5	<1	2	<1	1	8	<1	2
Co	iMET1WCICP	*0.005*	mg/L													
Co	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.05	0.017	**0.57**	**1.2**	0.0001	0.003	0.025	**0.69**	**1.2**	0.0003	0.0023
Cr	iMET1WCMS	*0.0005*	mg/L		**1**	0.1	<0.0005	0.0011	0.2	<0.0005	0.0017	<0.0005	0.0015	0.24	<0.0005	0.0015
Cs	iMET1WCMS	*0.0001*	mg/L				0.0001	0.0003	0.0001	0.0003	<0.0001	0.0001	0.0003	<0.0001	0.0003	<0.0001
Cu	iMET1WCICP	*0.002*	mg/L						**7**				2.7	**5.3**		
Cu	iMET1WCMS	*0.0001*	mg/L	*0.0018*	**5**	0.2	*0.0024*	2.4		0.0007	0.0016	*0.0043*			0.0013	*0.0029*
ECond	iEC1WZSE	*0.2*	mS/m	*41*			22.6	*63.5*	*439*	22.2	*74.9*	23.1	*69.4*	*466*	21.9	*60.5*
F	iF1WASE	*0.05*	mg/L				0.17	0.53	3.6	1.3	0.65	0.12	0.47	3.4	1.3	0.64
Fe	iMET1WCICP	*0.005*	mg/L	*2.7***	**10**	0.2	0.005	0.64	**410**	<0.005	0.074	0.008	0.84	**510**	<0.005	0.037
HCO3	iALK1WATI	*1*	mg/L				<1	<1	<1	46	79	<1	<1	<1	52	76
Hg	iMET1WCMS	*0.0001*	mg/L				0.0002	0.0002	0.0004	0.0002	0.0001	<0.0001	<0.0001	0.0002	0.0002	0.0003
K	iMET1WCICP	*0.1*	mg/L				19.8	35.2	<0.1	24.4	12.4	19.4	37.1	<0.1	20.7	11.6
Li	iMET1WCICP	*0.005*	mg/L													
Li	iMET1WCMS	*0.0001*	mg/L				0.012	0.052	0.26	0.013	0.0027	0.009	0.05	0.19	0.0068	0.003
Mg	iMET1WCICP	*0.1*	mg/L				11.5	41	144	6	20.8	11	43.4	152	5.6	15.6
Mn	iMET1WCICP	*0.001*	mg/L				0.94	2.3	**14**	0.006	0.23	0.93	2.4	**14**	0.002	0.18
Mn	iMET1WCMS	*0.0001*	mg/L	*2.5***	**10**	0.2										
Mo	iMET1WCMS	*0.001*	mg/L		**0.05**	0.01	<0.001	<0.001	<0.001	0.052	0.037	<0.001	<0.001	<0.001	0.036	0.029
Na	iMET1WCICP	*0.1*	mg/L				1.1	1.4	0.2	0.7	11.7	0.9	1.1	0.1	0.6	6.5
Ni	iMET1WCICP	*0.01*	mg/L													
Ni	iMET1WCMS	*0.001*	mg/L	*0.013*	**2**	0.2	0.01	0.44	1.2	<0.001	<0.001	*0.014*	0.54	1.3	<0.001	0.005
OH	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	*0.1*	mg/L				<0.1	<0.1	0.9	<0.1	<0.1	<0.1	<0.1	1.1	<0.1	<0.1
Pb	iMET1WCMS	*0.0001*	mg/L	*0.0056*	**5**	2	0.0003	*0.0082*	*0.0071*	<0.0001	0.0001	0.0055	0.0019	0.0037	0.0001	0.0004
Rb	iMET1WCMS	*0.0001*	mg/L				0.021	0.047	0.0079	0.035	0.01	0.023	0.053	0.0052	0.035	0.012
S	iMET1WCICP	*0.1*	mg/L	*70**			30	*86*	*1100*	20	*100*	29	*93*	*1300*	18	*74*
SO4		*Calculated*	mg/L	*210**			90	*258*	*3300*	60	*300*	87	*279*	*3900*	54	*222*
Sb	iMET1WCMS	*0.0001*	mg/L				0.0003	<0.0001	<0.0001	0.0017	0.0011	0.0003	<0.0001	<0.0001	0.0019	0.0011
Se	iMET1WCMS	*0.001*	mg/L		**0.05**	0.02	<0.001	0.033	0.051	0.002	0.002	0.001	0.041	**0.053**	0.002	0.002
Si	iMET1WCICP	*0.05*	mg/L				8.1	6.8	12	3.1	2.9	7.4	6.6	12	3.2	2.4
Sr	iMET1WCICP	*0.002*	mg/L				0.02	0.033	0.005	0.017	0.26	0.019	0.038	0.004	0.016	0.23
Th	iMET1WCMS	*0.0001*	mg/L				<0.0001	<0.0001	0.21	<0.0001	<0.0001	<0.0001	<0.0001	0.21	<0.0001	<0.0001
Tl	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0001	0.0002	<0.0001	<0.0001	<0.0001
U	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.01	<0.0001	0.0052	0.053	0.0005	0.0012	<0.0001	0.0066	0.04	0.0005	0.0009
V	iMET1WCICP	*0.005*	mg/L		**0.5**	0.1	<0.005	<0.005	0.065	<0.005	<0.005	<0.005	<0.005	0.08	<0.005	<0.005
Volume	iVOLUME	*0.1*	mL				240	200	160	250	260	240	210	170	300	180
Zn	iMET1WCICP	*0.005*	mg/L													
Zn	iMET1WCMS	*0.001*	mg/L	*0.014*	**5**	2	0.012	*0.7*	*1.8*	<0.001	0.002	*0.018*	*0.82*	*1.8*	0.002	0.005
pH	iPH1WASE	*0.1*		*5.8-8.0*			5.9	*3.9*	*2.5*	*8.2*	*8.2*	*5.7*	*3.8*	*2.5*	6.5	7.2

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Project: Rustlers Roost
Job Number: W-AA
Table C- Rustlers Roost Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Rustlers Roost
Job Number: W-AA-06
Client: CDM Smith

Analyte	Method Code	Limits of Reporting	Units	Bundy Creek TV's	ANZECC & ARMCANZ 2000 Short-Term Irrigation Water	ANZECC & ARMCANZ 2000 Long-Term Irrigation Water	M10					M11				
						ChemCentre ID	**20S4984/051**	**20S4984/052**	**20S4984/053**	**20S4984/054**	**20S4984/055**	**20S4984/056**	**20S4984/057**	**20S4984/058**	**20S4984/059**	**20S4984/060**
						Client ID	**RR038 & RR084 M10**	**RR036 & RR125 M10**	**RR102 & RR103 M10**	**RR127 & RR130 M10**	**A20823 M10**	**RR038 & RR084 M11**	**RR036 & RR125 M11**	**RR102 & RR103 M11**	**RR127 & RR130 M11**	**A20823 M11**
						Lithology	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**
						Sampled	**14/03/2022**	**14/03/2022**	**14/03/2022**	**14/03/2022**	**14/03/2022**	**11/04/2022**	**11/04/2022**	**11/04/2022**	**11/04/2022**	**11/04/2022**
Acidity	iACID1WATI	2	mg/L				3	49	3800	4	<2	3	61	6700	<2	<2
Ag	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Al	iMET1WCICP	0.005	mg/L	Al (pH>6.5) 295	**20**	5	0.077	4.6	**340**	0.11	0.03	0.071	4.9	**580**	0.038	0.26
Alkalin	iALK1WATI	1	mg/L				<1	<1	<1	35	55	<1	<1	<1	38	59
As	iMET1WCMS	0.001	mg/L	0.042	**2**	0.1	0.007	0.04	0.13	0.029	0.039	0.003	0.043	0.37	0.023	0.023
B	iMET1WCICP	0.02	mg/L													
B	iMET1WCMS	0.005	mg/L				0.034	0.038	0.019	0.037	0.039	0.016	0.027	0.01	0.02	0.014
Ba	iMET1WCMS	0.0001	mg/L				0.025	0.026	0.0015	0.018	0.023	0.026	0.021	0.001	0.017	0.019
Be	iMET1WCICP	0.001	mg/L													
Be	iMET1WCMS	0.0001	mg/L				0.0004	0.017	0.026	<0.0001	<0.0001	0.0005	0.018	0.022	<0.0001	<0.0001
CO3	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	0.1	mg/L				6.3	13.6	4.6	15.2	67	7.2	12.5	5	16.4	67.2
Cd	iMET1WCMS	0.0001	mg/L	0.0004	**0.05**	0.01	0.0002	0.003	0.01	<0.0001	<0.0001	0.0001	0.0025	0.008	<0.0001	<0.0001
Cl	iCO1WCDA	1	mg/L				<1	<1	9	<1	<1	<1	<1	29	<1	<1
Co	iMET1WCICP	0.005	mg/L													
Co	iMET1WCMS	0.0001	mg/L		**0.1**	0.05	0.034	**0.74**	**0.82**	0.0003	0.0016	0.032	**0.48**	**1.1**	0.0001	0.0011
Cr	iMET1WCMS	0.0005	mg/L		**1**	0.1	<0.0005	0.0013	0.17	<0.0005	<0.0005	<0.0005	0.0018	0.3	<0.0005	<0.0005
Cs	iMET1WCMS	0.0001	mg/L				0.0001	0.0003	0.0001	0.0003	<0.0001	0.0001	0.0003	<0.0001	0.0002	<0.0001
Cu	iMET1WCICP	0.002	mg/L					2.7	2.6					3.3		
Cu	iMET1WCMS	0.0001	mg/L	0.0018	**5**	0.2	0.0042			0.0012	0.0005	0.005	2		0.0007	0.0014
ECond	iEC1WZSE	0.2	mS/m	41			23.7	69.7	402	20.6	48.5	25.7	66.3	662	21.2	49.9
F	iF1WASE	0.05	mg/L				0.09	0.73	2.5	1.1	0.62	<0.50	<0.50	2.7	0.89	0.51
Fe	iMET1WCICP	0.005	mg/L	2.7**	**10**	0.2	0.043	1.2	**460**	0.058	0.019	0.028	1.7	**1200**	<0.005	0.45
HCO3	iALK1WATI	1	mg/L				<1	<1	<1	42	68	<1	<1	<1	46	72
Hg	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	iMET1WCICP	0.1	mg/L				18.9	33	<0.1	20.1	9.5	19.3	29.8	<0.1	18.4	9.1
Li	iMET1WCICP	0.005	mg/L													
Li	iMET1WCMS	0.0001	mg/L				0.01	0.053	0.18	0.0051	0.0027	0.0098	0.047	0.28	0.0025	0.0018
Mg	iMET1WCICP	0.1	mg/L				11.4	42.9	110	5.7	13.6	12.4	36.9	196	6.2	14.7
Mn	iMET1WCICP	0.001	mg/L				0.98	2.5	**10**	0.005	0.16	1.1	2.2	**18**	0.005	0.2
Mn	iMET1WCMS	0.0001	mg/L	2.5**	**10**	0.2										
Mo	iMET1WCMS	0.001	mg/L		**0.05**	0.01	<0.001	<0.001	<0.001	**0.055**	0.036	<0.001	<0.001	<0.001	0.04	0.02
Na	iMET1WCICP	0.1	mg/L				0.7	0.8	<0.1	0.4	3.6	0.7	0.7	<0.1	0.5	2.7
Ni	iMET1WCICP	0.01	mg/L													
Ni	iMET1WCMS	0.001	mg/L	0.013	**2**	0.2	0.019	0.58	0.89	<0.001	<0.001	0.031	0.4	1.3	<0.001	<0.001
OH	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	0.1	mg/L				<0.1	<0.1	0.5	<0.1	<0.1	<0.1	<0.1	1.5	<0.1	<0.1
Pb	iMET1WCMS	0.0001	mg/L	0.0056	**5**	2	0.0005	0.0026	0.0058	0.0001	<0.0001	0.0004	0.0036	0.011	<0.0001	<0.0001
Rb	iMET1WCMS	0.0001	mg/L				0.021	0.05	0.0022	0.028	0.0076	0.018	0.047	0.0013	0.021	0.0061
S	iMET1WCICP	0.1	mg/L	70*			30	95	1000	17	55	32	86	2100	18	59
SO4		Calculated	mg/L	210*			90	285	3000	51	165	96	258	6300	54	177
Sb	iMET1WCMS	0.0001	mg/L				0.0002	<0.0001	<0.0001	0.0015	0.0007	0.0001	<0.0001	<0.0001	0.0011	0.0005
Se	iMET1WCMS	0.001	mg/L		**0.05**	0.02	0.001	0.042	**0.05**	0.002	0.001	<0.001	0.031	**0.037**	0.002	<0.001
Si	iMET1WCICP	0.05	mg/L				6.8	6.3	8.8	3.6	2.4	6.4	5.9	13	3.4	2.2
Sr	iMET1WCICP	0.002	mg/L				0.021	0.042	0.006	0.015	0.18	0.023	0.039	0.004	0.016	0.19
Th	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	0.12	<0.0001	<0.0001	<0.0001	<0.0001	0.19	<0.0001	<0.0001
Tl	iMET1WCMS	0.0001	mg/L				<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
U	iMET1WCMS	0.0001	mg/L		**0.1**	0.01	<0.0001	0.0068	0.021	0.0006	0.0004	<0.0001	0.008	0.017	0.0005	0.0004
V	iMET1WCICP	0.005	mg/L		**0.5**	0.1	<0.005	<0.005	0.056	<0.005	<0.005	<0.005	<0.005	0.14	<0.005	<0.005
Volume	iVOLUME	0.1	mL				260	210	180	250	260	250	210	170	250	240
Zn	iMET1WCICP	0.005	mg/L													
Zn	iMET1WCMS	0.001	mg/L	0.014	**5**	2	0.017	0.9	1.2	0.003	0.001	0.017	0.57	1.4	0.002	0.002
pH	iPH1WASE	0.1		5.8-8.0			5	3.7	2.5	7.8	8.1	5	3.6	2.3	7.9	7.9

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Project: Rustlers Roost
Job Number: W-AA
Table C- Rustlers Roost Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Rustlers Roost
Job Number: W-AA-06
Client: CDM Smith

							M12					
						ChemCentre ID	**20S4984/061**	**20S4984/062**	**20S4984/063**	**20S4984/064**	**20S4984/065**	**20S4984/066**
						Client ID	**RR038 & RR084 M12**	**RR036 & RR125 M12**	**RR102 & RR103 M12**	**RR127 & RR130 M12**	**A20823 M12**	**Blank**
						Lithology	**Psl fr**	**Psl tr**	**Psh tr**	**Psh fr**	**Tailings**	
						Sampled	**9/05/2022**	**9/05/2022**	**9/05/2022**	**9/05/2022**	**9/05/2022**	
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**						
Acidity	iACID1WATI	2	mg/L				5	180	7500	<2	<2	<3
Ag	iMET1WCMS	0.0001	mg/L				0.0001	<0.0001	0.0003	0.0002	0.0003	<0.0001
Al	iMET1WCICP	0.005	mg/L	Al (pH>6.5) 295	**20**	5	0.081	4.4	**620**	0.041	0.024	<0.005
Alkalin	iALK1WATI	1	mg/L				<1	<1	<1	38	66	<1
As	iMET1WCMS	0.001	mg/L	0.042	**2**	0.1	0.006	0.043	0.71	0.035	0.038	<0.001
B	iMET1WCICP	0.02	mg/L									
B	iMET1WCMS	0.005	mg/L				0.016	0.024	0.015	0.022	0.018	<0.005
Ba	iMET1WCMS	0.0001	mg/L				0.028	0.02	0.0005	0.02	0.032	<0.0001
Be	iMET1WCICP	0.001	mg/L									
Be	iMET1WCMS	0.0001	mg/L				0.0006	0.015	0.035	<0.0001	<0.0001	<0.0001
CO3	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	0.1	mg/L				6.6	10.4	4.8	15.6	81.9	<0.1
Cd	iMET1WCMS	0.0001	mg/L	0.0004	**0.05**	0.01	0.0001	0.0023	0.0096	<0.0001	<0.0001	<0.0001
Cl	iCO1WCDA	1	mg/L				<1	<1	39	<1	<1	<1
Co	iMET1WCICP	0.005	mg/L									
Co	iMET1WCMS	0.0001	mg/L		**0.1**	0.05	0.038	**0.58**	**1.3**	0.0001	0.0017	<0.0001
Cr	iMET1WCMS	0.0005	mg/L		**1**	0.1	<0.0005	0.0022	0.39	<0.0005	0.0006	<0.0005
Cs	iMET1WCMS	0.0001	mg/L				<0.0001	0.0003	<0.0001	0.0003	<0.0001	<0.0001
Cu	iMET1WCICP	0.002	mg/L						2.7			
Cu	iMET1WCMS	0.0001	mg/L	0.0018	**5**	0.2	0.0074	2.6		0.0008	0.002	0.013
ECond	iEC1WZSE	0.2	mS/m	41			24.4	60.5	666	20.3	60	<0.2
F	iF1WASE	0.05	mg/L				0.07	0.46	2.8	0.81	0.42	<0.05
Fe	iMET1WCICP	0.005	mg/L	2.7**	**10**	0.2	0.036	1.7	**1400**	<0.005	0.015	<0.005
HCO3	iALK1WATI	1	mg/L				<1	<1	<1	47	81	<1
Hg	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	0.0002	<0.0001	0.0002	<0.0001
K	iMET1WCICP	0.1	mg/L				17.2	25.9	<0.1	16.8	9	<0.1
Li	iMET1WCICP	0.005	mg/L									
Li	iMET1WCMS	0.0001	mg/L				0.012	0.039	0.31	0.0045	0.0025	<0.0001
Mg	iMET1WCICP	0.1	mg/L				12.2	30.8	211	6.1	19	<0.1
Mn	iMET1WCICP	0.001	mg/L						**18**			
Mn	iMET1WCMS	0.0001	mg/L	2.5**	**10**	0.2	1.2	1.9		0.0063	0.26	0.0005
Mo	iMET1WCMS	0.001	mg/L		**0.05**	0.01	<0.001	<0.001	<0.001	**0.051**	0.031	<0.001
Na	iMET1WCICP	0.1	mg/L				0.6	0.4	<0.1	0.4	2.4	<0.1
Ni	iMET1WCICP	0.01	mg/L									
Ni	iMET1WCMS	0.001	mg/L	0.013	**2**	0.2	0.048	0.5	1.5	<0.001	<0.001	<0.001
OH	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1
P	iMET1WCICP	0.1	mg/L				<0.1	<0.1	1.8	<0.1	<0.1	<0.1
Pb	iMET1WCMS	0.0001	mg/L	0.0056	**5**	2	0.0009	0.0011	0.0053	<0.0001	<0.0001	0.0003
Rb	iMET1WCMS	0.0001	mg/L				0.019	0.045	0.0018	0.026	0.0086	<0.0001
S	iMET1WCICP	0.1	mg/L	70*			30	74	2200	17	74	<0.1
SO4		Calculated	mg/L	210*			90	222	6600	51	222	
Sb	iMET1WCMS	0.0001	mg/L				0.0002	<0.0001	0.0002	0.0016	0.0008	<0.0001
Se	iMET1WCMS	0.001	mg/L		**0.05**	0.02	0.001	0.029	**0.061**	0.002	0.001	<0.001
Si	iMET1WCICP	0.05	mg/L				6.6	5.8	13	3.3	2.3	<0.05
Sr	iMET1WCICP	0.002	mg/L				0.02	0.033	0.003	0.015	0.22	<0.002
Th	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	0.21	<0.0001	<0.0001	<0.0001
Tl	iMET1WCMS	0.0001	mg/L				<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
U	iMET1WCMS	0.0001	mg/L		**0.1**	0.01	0.0001	0.0083	0.025	0.0008	0.001	<0.0001
V	iMET1WCICP	0.005	mg/L		**0.5**	0.1	<0.005	<0.005	0.12	<0.005	<0.005	<0.005
Volume	iVOLUME	0.1	mL				250	210	180	250	210	200
Zn	iMET1WCICP	0.005	mg/L									
Zn	iMET1WCMS	0.001	mg/L	0.014	**5**	2	0.021	0.74	1.7	0.002	0.004	0.006
pH	iPH1WASE	0.1		5.8-8.0			5	3.5	2.3	7.8	8.1	

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Table D - Quest 29 Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Quest29
Job Number: W-AA-06
Client: CDM Smith

							M0					**M1**				
						ChemCentre Id	**20S4886/001**	**20S4886/002**	**20S4886/003**	**20S4886/004**	**20S4886/005**	**20S4886/006**	**20S4886/007**	**20S4886/008**	**20S4886/009**	**20S4886/010**
						Client Id	**HKR35252 & HKR34263 M0**	**HKR34157 & HKR34089 M0**	**HKR34078 & HKR34085 M0**	**MTS_248-251 M0**	**HKR34049 & HKR34265 M0**	**HKR35252 & HKR34263 M1**	**HKR34157 & HKR34089 M1**	**HKR34078 & HKR34085 M1**	**MTS_248-251 M1**	**HKR34049 & HKR34265 M1**
						Lithology	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**
						Sampled	**31/05/2021**	**31/05/2021**	**31/05/2021**	**31/05/2021**	**31/05/2021**	**28/06/2021**	**28/06/2021**	**28/06/2021**	**28/06/2021**	**28/06/2021**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**										
Acidity	iACID1WATI	*2*	mg/L				6	1000	4	320	5	4	2100	7	170	14
Ag	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0003	<0.0001	<0.0001	<0.0001	0.0001	0.0011	0.0003	0.0001	<0.0001
Al	iMET1WCICP	*0.005*	mg/L	*Al (pH>6.5) 295*	**20**	5	0.019	**110**	0.038	**22**	0.027	0.19	**290**	0.22	8.7	0.46
Alkalin	iALK1WATI	*1*	mg/L				87	<1	38	<1	26	36	<1	11	<1	<1
As	iMET1WCICP	*0.05*	mg/L							**16**				**2.7**	**36**	
As	iMET1WCMS	*0.001*	mg/L	*0.042*	**2**	0.1	0.021	**0.14**	**0.32**		*0.053*	0.014	0.12			*0.082*
B	iMET1WCICP	*0.02*	mg/L													
B	iMET1WCMS	*0.005*	mg/L				0.021	0.11	0.11	0.12	0.077	0.032	0.048	0.071	0.06	0.072
Ba	iMET1WCMS	*0.0001*	mg/L				0.049	0.014	0.055	0.014	0.048	0.054	0.0029	0.067	0.016	0.077
Be	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.025	<0.0001	0.009	<0.0001	<0.0001	0.083	<0.0001	0.0066	0.0005
CO3	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	*0.1*	mg/L				560	270	368	238	461	385	212	339	98.7	453
Cd	iMET1WCMS	*0.0001*	mg/L	*0.0004*	**0.05**	0.01	*0.0017*	**0.18**	*0.0007*	**0.62**	0.011	*0.0005*	**0.15**	*0.0007*	**0.28**	0.02
Cl	iCO1WCDA	*1*	mg/L				89	ISS	ISS	38	94	26	13	261	32	77
Co	iMET1WCICP	*0.005*	mg/L										**4.2**			
Co	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.05	0.0075	**3.7**	0.0079	**3.3**	**0.49**	0.0013		0.0086	**1.7**	**0.88**
Cr	iMET1WCMS	*0.0005*	mg/L		**1**	0.1	0.0049	0.02	0.0008	0.021	<0.0005	0.0017	0.075	0.0006	0.0085	0.0018
Cs	iMET1WCMS	*0.0001*	mg/L				0.0001	0.0002	0.0008	0.0022	0.0001	0.0001	0.0001	0.0006	0.001	<0.0001
Cu	iMET1WCICP	*0.002*	mg/L					**32**					**69**		2.9	
Cu	iMET1WCMS	*0.0001*	mS/m	*0.0018*	**5**	0.2	0.011		*0.0072*	**5.5**	*0.025*	*0.0042*		*0.011*		*0.098*
ECond	iEC1WZSE	*0.2*	mg/L	*41*			*437*	*491*	*420*	*376*	*580*	*249*	*417*	*296*	*194*	*369*
F	iF1WASE	*0.05*	mg/L				1	11	2.7	1.7	0.27	1.2	0.28	2.5	1.1	0.23
Fe	iMET1WCICP	*0.005*	mg/L	2.7**	**10**	0.2	0.016	**62**	0.031	**25**	0.015	0.01	**64**	0.01	*9.9*	0.13
HCO3	iALK1WATI	*1*	mg/L				107	<1	46	<1	31	43	<1	13	<1	<1
Hg	iMET1WCMS	*0.0001*	mg/L		**0.002**	0.002	<0.0001	<0.0001	0.0002	0.0004	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	iMET1WCICP	*0.1*	mg/L				58.8	69.6	61	51.8	81.3	29.4	2	47.7	22.1	53
Li	iMET1WCMS	*0.0001*	mg/L				0.043	0.21	0.095	0.33	0.11	0.026	0.42	0.057	0.086	0.093
Mg	iMET1WCICP	*0.1*	mg/L				395	469	349	334	797	138	338	238	159	369
Mn	iMET1WCICP	*0.001*	mg/L					**16**		**15**	**16**		**13**		*7.4*	**14**
Mn	iMET1WCMS	*0.0001*	mg/L	2.5**	**10**	0.2	**0.6**		**0.25**			0.17		0.27		
Mo	iMET1WCMS	*0.001*	mg/L		**0.05**	0.01	**0.017**	<0.001	**0.01**	<0.001	<0.001	0.014	<0.001	0.017	<0.001	<0.001
Na	iMET1WCICP	*0.1*	mg/L				114	28.3	72.9	164	64.6	28.4	7.7	38.1	56.5	19.7
Ni	iMET1WCICP	*0.01*	mg/L					**11**		**11**			**13**		**5.2**	
Ni	iMET1WCMS	*0.001*	mg/L	*0.013*	**2**	0.2	*0.022*		*0.057*		0.92	0.004		*0.03*		1.1
OH	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	*0.1*	mg/L				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb	iMET1WCICP	*0.02*	mg/L												3.3	
Pb	iMET1WCMS	*0.0001*	mg/L	*0.0056*	**5**	2	<0.0001	*0.018*	0.0007	2.5	*0.0082*	0.0013	0.0018	0.0004		*0.044*
Rb	iMET1WCMS	*0.0001*	mg/L				0.05	0.11	0.11	0.089	0.045	0.021	0.014	0.11	0.052	0.021
S	iMET1WCICP	*0.1*	mg/L	70*			*890*	*970*	*680*	*790*	*1600*	*490*	*1000*	*670*	*390*	*830*
SO4	Calculated		mg/L	210*			*2670*	*2910*	*2040*	*2370*	*4800*	*1470*	*3000*	*2010*	*1170*	*2490*
Sb	iMET1WCMS	*0.0001*	mg/L				0.0013	0.0001	0.0017	0.011	0.0008	0.0009	0.0002	0.0022	0.0088	0.0005
Se	iMET1WCMS	*0.001*	mg/L		**0.05**	0.02	**0.66**	**0.18**	**0.18**	**0.099**	**0.055**	**0.11**	**0.2**	**0.13**	**0.065**	**0.055**
Si	iMET1WCICP	*0.05*	mg/L				11	33	6.8	15	13	6	21	9.3	3.4	19
Sr	iMET1WCICP	*0.002*	mg/L				0.77	0.34	0.46	0.15	0.81	0.41	0.029	0.41	0.044	0.51
Th	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0025	<0.0001	0.0002	<0.0001	<0.0001	0.0081	<0.0001	0.0001	<0.0001
Tl	iMET1WCMS	*0.0001*	mg/L				0.0001	0.0012	0.0004	0.0014	0.0008	<0.0001	0.0002	0.0003	0.0006	0.0003
U	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.01	0.0014	**0.11**	<0.0001	0.02	<0.0001	0.0006	**0.31**	<0.0001	0.0068	0.0002
V	iMET1WCICP	*0.005*	mg/L		**0.5**	0.1	0.006	<0.005	<0.005	<0.005	<0.005	0.006	0.006	0.006	<0.005	<0.005
Volume	iVOLUME	*0.1*	mL				200	160	150	230	210	160	230	210	290	220
Zn	iMET1WCICP	*0.005*	mL					**21**		**78**			**20**		**35**	
Zn	iMET1WCMS	*0.001*	mg/L	*0.014*	**5**	2	0.008		*0.022*		*0.95*	*0.016*		*0.014*		2.3
pH	iPH1WASE	*0.1*	mg/L	*5.8-8.0*			7.9	*3.8*	7.3	*4.2*	7	7.4	*3.3*	7	*4.2*	6

Long-term irrigation value
Short-term irrigation value

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Table D - Quest 29 Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Quest29
Job Number: W-AA-06
Client: CDM Smith

							M2					M3				
						ChemCentre Id	**20S4886/011**	**20S4886/012**	**20S4886/013**	**20S4886/014**	**20S4886/015**	**20S4886/016**	**20S4886/017**	**20S4886/018**	**20S4886/019**	**20S4886/020**
						Client Id	**HKR35252 & HKR34263 M2**	**HKR34157 & HKR34089 M2**	**HKR34078 & HKR34085 M2**	**MTS_248-251 M2**	**HKR34049 & HKR34265 M2**	**HKR35252 & HKR34263 M3**	**HKR34157 & HKR34089 M3**	**HKR34078 & HKR34085 M3**	**MTS_248-251 M3**	**HKR34049 & HKR34265 M3**
						Lithology	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**
						Sampled	**26/07/2021**	**26/07/2021**	**26/07/2021**	**26/07/2021**	**26/07/2021**	**23/08/2021**	**23/08/2021**	**23/08/2021**	**23/08/2021**	**23/08/2021**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**										
Acidity	iACID1WATI	2	mg/L				10	3300	13	150	46	3	3100	4	160	58
Ag	iMET1WCMS	0.0001	mg/L				0.0002	0.0001	0.0003	0.0004	0.0009	0.0004	0.0003	0.0002	0.0005	0.0004
Al	iMET1WCICP	0.005	mg/L	Al (pH>6.5) 295	20	5	0.075	430	0.033	7.9	2.5	0.008	450	0.023	9.4	4.9
Alkalin	iALK1WATI	1	mg/L				35	<1	<1	<1	<1	47	<1	8	<1	<1
As	iMET1WCICP	0.05	mg/L						2.9	42					51	
As	iMET1WCMS	0.001	mg/L	0.042	2	0.1	0.017	0.078			0.066	0.017	0.049	2.6		0.066
B	iMET1WCICP	0.02	mg/L											0.07		
B	iMET1WCMS	0.005	mg/L				0.016	0.024	0.056	0.024	0.059	0.015	0.016		0.017	0.052
Ba	iMET1WCMS	0.0001	mg/L				0.074	0.0027	0.066	0.026	0.074	0.055	0.0017	0.05	0.016	0.083
Be	iMET1WCMS	0.0001	mg/L				<0.0001	0.12	<0.0001	0.0092	0.0027	<0.0001	0.096	<0.0001	0.0098	0.0045
CO3	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	0.1	mg/L				415	168	271	57.2	379	401	114	247	41.4	400
Cd	iMET1WCMS	0.0001	mg/L	0.0004	0.05	0.01	0.0022	0.14	0.0024	0.17	0.043	0.0019	0.1	0.002	0.15	0.07
Cl	iCO1WCDA	1	mg/L				21	10	99	22	12	18	8	59	14	10
Co	iMET1WCICP	0.005	mg/L					4.7					4.2			2.4
Co	iMET1WCMS	0.0001	mg/L		0.1	0.05	0.0011		0.011	1.3	1.9	0.0009		0.014	1.2	
Cr	iMET1WCMS	0.0005	mg/L		1	0.1	0.0087	0.13	0.0045	0.0083	0.006	0.002	0.12	<0.0005	0.0085	0.0054
Cs	iMET1WCMS	0.0001	mg/L				0.0002	<0.0001	0.0004	0.0008	<0.0001	<0.0001	<0.0001	0.0004	0.0008	<0.0001
Cu	iMET1WCICP	0.002	mg/L					68		3.1			61		3.5	
Cu	iMET1WCMS	0.0001	mS/m	0.0018	5	0.2	0.28		0.34		0.75	0.0092		0.0049		1.6
ECond	iEC1WZSE	0.2	mg/L	41			251	521	246	135	325	262	489	266	119	355
F	iF1WASE	0.05	mg/L				1.4	0.38	2.3	1.1	0.86	1.5	0.11	3.2	0.81	0.82
Fe	iMET1WCICP	0.005	mg/L	2.7**	10	0.2	0.048	180	0.02	12	1.6	<0.005	190	<0.005	16	3.2
HCO3	iALK1WATI	1	mg/L				43	<1	<1	<1	<1	57	<1	10	<1	<1
Hg	iMET1WCMS	0.0001	mg/L		0.002	0.002	0.002	<0.0001	0.0053	0.0014	0.0005	0.0026	0.0002	0.0022	0.0011	0.0005
K	iMET1WCICP	0.1	mg/L				31.5	0.1	39.3	15.4	47.6	32.8	<0.1	43	12.7	53.1
Li	iMET1WCMS	0.0001	mg/L				0.028	0.58	0.048	0.072	0.18	0.029	0.59	0.063	0.084	0.27
Mg	iMET1WCICP	0.1	mg/L				138	415	206	105	308	140	364	261	86.6	336
Mn	iMET1WCICP	0.001	mg/L				0.13	13	0.29	4.6	16		12		3.7	19
Mn	iMET1WCMS	0.0001	mg/L	2.5**	10	0.2						0.12		0.35		
Mo	iMET1WCMS	0.001	mg/L		0.05	0.01	0.024	<0.001	0.015	<0.001	<0.001	0.018	<0.001	0.015	<0.001	<0.001
Na	iMET1WCICP	0.1	mg/L				38	0.6	21.7	23	16.6	51.3	0.3	29.3	13.3	20.8
Ni	iMET1WCICP	0.01	mg/L					16		4.2			16		4	2.5
Ni	iMET1WCMS	0.001	mg/L	0.013	2	0.2	0.003		0.025		1.9	0.002		0.027		
OH	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	0.1	mg/L				0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb	iMET1WCICP	0.02	mg/L												2.6	
Pb	iMET1WCMS	0.0001	mg/L	0.0056	5	2	0.0054	0.014	0.0022	2.7	0.071	0.0049	0.016	0.0028		0.074
Rb	iMET1WCMS	0.0001	mg/L				0.022	0.0039	0.088	0.042	0.018	0.019	0.0018	0.086	0.036	0.016
S	iMET1WCICP	0.1	mg/L	70*			490	1500	490	250	680	510	1500	540	220	740
SO4	Calculated		mg/L	210*			1470	4500	1470	750	2040	1530	4500	1620	660	2220
Sb	iMET1WCMS	0.0001	mg/L				0.001	0.0002	0.0021	0.0069	0.0002	0.0008	0.0001	0.0023	0.0072	0.0002
Se	iMET1WCMS	0.001	mg/L		0.05	0.02	0.14	0.23	0.074	0.046	0.051	0.18	0.22	0.087	0.04	0.066
Si	iMET1WCICP	0.05	mg/L				6.2	19	10	2.2	21	6.1	19	11	2.3	24
Sr	iMET1WCICP	0.002	mg/L				0.43	0.007	0.32	0.025	0.42	0.45	0.006	0.31	0.028	0.46
Th	iMET1WCMS	0.0001	mg/L				<0.0001	0.02	<0.0001	<0.0001	<0.0001	<0.0001	0.025	<0.0001	<0.0001	<0.0001
Tl	iMET1WCMS	0.0001	mg/L				0.0001	<0.0001	0.0003	0.0005	0.0003	0.0001	<0.0001	0.0003	0.0005	0.0003
U	iMET1WCMS	0.0001	mg/L		0.1	0.01	0.0006	0.42	<0.0001	0.0064	0.0015	0.0007	0.4	<0.0001	0.007	0.0024
V	iMET1WCICP	0.005	mg/L		0.5	0.1	0.006	0.024	0.007	<0.005	<0.005	0.006	0.028	0.008	0.005	<0.005
Volume	iVOLUME	0.1	mL				150	220	180	280	220	220	230	210	290	220
Zn	iMET1WCICP	0.005	mL					21		28	6	0.028	20		27	9.8
Zn	iMET1WCMS	0.001	mg/L	0.014	5	2	0.63		0.42					0.032		
pH	iPH1WASE	0.1	mg/L	5.8-8.0			7.5	3.5	4.4	3.9	4.4	7.9	3	6.9	3.8	4.3

Long-term irrigation value

Short-term irrigation value

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Table D - Quest 29 Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Quest29
Job Number: W-AA-06
Client: CDM Smith

							M4					**M5**				
						ChemCentre Id	**20S4886/021**	**20S4886/022**	**20S4886/023**	**20S4886/024**	**20S4886/025**	**20S4886/026**	**20S4886/027**	**20S4886/028**	**20S4886/029**	**20S4886/030**
						Client Id	**HKR35252 & HKR34263 M4**	**HKR34157 & HKR34089 M4**	**HKR34078 & HKR34085 M4**	**MTS_248-251 M4**	**HKR34049 & HKR34265 M4**	**HKR35252 & HKR34263 M5**	**HKR34157 & HKR34089 M5**	**HKR34078 & HKR34085 M5**	**MTS_248-251 M5**	**HKR34049 & HKR34265 M5**
						Lithology	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**
						Sampled	**21/09/2021**	**21/09/2021**	**21/09/2021**	**21/09/2021**	**21/09/2021**	**19/10/2021**	**19/10/2021**	**19/10/2021**	**19/10/2021**	**19/10/2021**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**										
Acidity	iACID1WATI	*2*	mg/L				<2	3000	3	250	99	2	2600	4	160	98
Ag	iMET1WCMS	*0.0001*	mg/L				0.02	0.0008	0.0011	0.0003	0.0033	0.0003	0.0005	<0.0001	0.0028	0.0039
Al	iMET1WCICP	*0.005*	mg/L	*Al (pH>6.5) 295*	**20**	5	0.015	**400**	0.12	15	9	0.007	**320**	0.054	8.8	8
Alkalin	iALK1WATI	*1*	mg/L				25	<1	1	<1	<1	99	<1	4	<1	<1
As	iMET1WCICP	*0.05*	mg/L						**3.4**	**67**				**3**	**45**	
As	iMET1WCMS	*0.001*	mg/L	*0.042*	**2**	0.1	0.027	0.028			*0.082*	0.024	0.03			*0.091*
B	iMET1WCICP	*0.02*	mg/L											0.06		
B	iMET1WCMS	*0.005*	mg/L				0.017	0.008	0.01	0.022	0.045	0.015	0.025		0.014	0.045
Ba	iMET1WCMS	*0.0001*	mg/L				0.035	0.0015	0.013	0.014	0.038	0.045	0.0008	0.048	0.018	0.047
Be	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.061	<0.0001	0.01	0.0077	<0.0001	0.066	<0.0001	0.012	0.011
CO3	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	*0.1*	mg/L				344	72.7	41.1	40.6	340	483	61.7	175	25.7	268
Cd	iMET1WCMS	*0.0001*	mg/L	*0.0004*	**0.05**	0.01	0.0003	**0.055**	*0.0005*	**0.15**	**0.075**	*0.0012*	**0.063**	*0.0009*	**0.1**	**0.11**
Cl	iCO1WCDA	*1*	mg/L				6	8	4	25	6	10	3	15	9	5
Co	iMET1WCICP	*0.005*	mg/L					**2.1**	0.021	**1.2**	**2.7**		**2.2**	0.023	**0.77**	**2.5**
Co	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.05	0.0007					0.0007				
Cr	iMET1WCMS	*0.0005*	mg/L		**1**	0.1	0.0013	0.068	<0.0005	0.01	0.0052	0.012	0.2	<0.0005	0.0084	0.0076
Cs	iMET1WCMS	*0.0001*	mg/L				0.0002	<0.0001	0.0001	0.0004	<0.0001	0.0001	<0.0001	0.0003	0.0006	<0.0001
Cu	iMET1WCICP	*0.002*	mg/L					**31**		3.1			**32**		3.1	2.7
Cu	iMET1WCMS	*0.0001*	mS/m	*0.0018*	**5**	0.2	*0.004*		*0.0059*		1.7	*0.0038*		*0.0037*		
ECond	iEC1WZSE	*0.2*	mg/L	*41*			*222*	*397*	*64.8*	*123*	*345*	*270*	*392*	*216*	*89.5*	*292*
F	iF1WASE	*0.05*	mg/L				1.2	5.2	1.5	0.83	1.3	1.4	5.5	3.3	0.54	0.94
Fe	iMET1WCICP	*0.005*	mg/L	*2.7***	**10**	0.2	0.01	**170**	0.011	**36**	*4.9*	<0.005	**160**	0.007	**17**	*7.8*
HCO3	iALK1WATI	*1*	mg/L				30	<1	1	<1	<1	120	<1	5	<1	<1
Hg	iMET1WCMS	*0.0001*	mg/L		**0.002**	0.002	0.0019	0.0007	**0.0026**	0.0011	**0.0021**	0.0001	<0.0001	0.0001	0.0007	0.0014
K	iMET1WCICP	*0.1*	mg/L				23.1	<0.1	11.9	8.7	47	36.8	<0.1	40.8	8	46.2
Li	iMET1WCMS	*0.0001*	mg/L				0.02	0.46	0.02	0.063	0.25	0.039	0.54	0.081	0.059	0.26
Mg	iMET1WCICP	*0.1*	mg/L				110	192	45.8	84.4	340	123	275	218	56.3	300
Mn	iMET1WCICP	*0.001*	mg/L				0.093	*6*	0.2	*3.4*	**20**	0.067	*8*	0.4	2	**18**
Mn	iMET1WCMS	*0.0001*	mg/L	*2.5***	**10**	0.2										
Mo	iMET1WCMS	*0.001*	mg/L		**0.05**	0.01	0.013	<0.001	0.002	<0.001	<0.001	0.018	<0.001	0.009	<0.001	<0.001
Na	iMET1WCICP	*0.1*	mg/L				32.1	0.1	4.2	6.7	17.9	51	<0.1	17.3	3.6	14.9
Ni	iMET1WCICP	*0.01*	mg/L					**9.7**		**4.4**	**2.9**	<0.01	**10**	0.04	**2.8**	**2.6**
Ni	iMET1WCMS	*0.001*	mg/L	*0.013*	**2**	0.2	0.001		*0.038*							
OH	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	*0.1*	mg/L				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
Pb	iMET1WCICP	*0.02*	mg/L												2.6	
Pb	iMET1WCMS	*0.0001*	mg/L	*0.0056*	**5**	2	0.0003	*0.02*	0.0006	*1.7*	*0.032*	0.001	*0.064*	0.0014		*0.023*
Rb	iMET1WCMS	*0.0001*	mg/L				0.01	0.0012	0.025	0.023	0.014	0.027	0.002	0.091	0.031	0.026
S	iMET1WCICP	*0.1*	mg/L	*70**			*410*	*1100*	*93*	*220*	*720*	*520*	*1000*	*420*	*150*	*620*
SO4	Calculated		mg/L	*210**			*1230*	*3300*	*279*	*660*	*2160*	*1560*	*3000*	*1260*	*450*	*1860*
Sb	iMET1WCMS	*0.0001*	mg/L				0.0004	<0.0001	0.0006	0.0054	0.0001	0.001	<0.0001	0.0029	0.007	0.0001
Se	iMET1WCMS	*0.001*	mg/L		**0.05**	0.02	**0.09**	**0.19**	0.015	**0.05**	**0.068**	**0.057**	**0.13**	**0.057**	0.021	0.048
Si	iMET1WCICP	*0.05*	mg/L				5.6	31	2.4	6.1	25	6.4	13	11	1.6	17
Sr	iMET1WCICP	*0.002*	mg/L				0.36	0.005	0.055	0.036	0.42	0.48	0.003	0.22	0.03	0.33
Th	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.016	<0.0001	<0.0001	0.0001	<0.0001	0.03	<0.0001	<0.0001	<0.0001
Tl	iMET1WCMS	*0.0001*	mg/L				<0.0001	<0.0001	<0.0001	0.0003	0.0004	0.0001	<0.0001	0.0003	0.0004	0.0006
U	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.01	0.0002	**0.21**	<0.0001	0.0051	0.0038	0.0017	**0.28**	<0.0001	0.0068	0.0054
V	iMET1WCICP	*0.005*	mg/L		**0.5**	0.1	0.008	0.013	0.006	0.005	<0.005	0.007	0.01	0.009	0.005	<0.005
Volume	iVOLUME	*0.1*	mL				200	210	330	280	210	250	230	210	310	240
Zn	iMET1WCICP	*0.005*	mL					**9.9**		**30**	**13**		**11**	*0.023*	**17**	**13**
Zn	iMET1WCMS	*0.001*	mg/L	*0.014*	**5**	2	0.004		*0.03*			0.009				
pH	iPH1WASE	*0.1*	mg/L	*5.8-8.0*			7.3	*4.3*	6.3	*4.6*	*4.5*	8.1	*3*	6.5	*3.6*	*4*

Long-term irrigation value
Short-term irrigation value

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Table D - Quest 29 Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Quest29
Job Number: W-AA-06
Client: CDM Smith

							M6					M7				
						ChemCentre Id	**20S4886/031**	**20S4886/032**	**20S4886/033**	**20S4886/034**	**20S4886/035**	**20S4886/036**	**20S4886/037**	**20S4886/038**	**20S4886/039**	**20S4886/040**
						Client Id	**HKR35252 & HKR34263 M6**	**HKR34157 & HKR34089 M6**	**HKR34078 & HKR34085 M6**	**MTS_248-251 M6**	**HKR34049 & HKR34265 M6**	**HKR35252 & HKR34263 M7**	**HKR34157 & HKR34089 M7**	**HKR34078 & HKR34085 M7**	**MTS_248-251 M7**	**HKR34049 & HKR34265 M7**
						Lithology	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**
						Sampled	**16/11/2021**	**16/11/2021**	**16/11/2021**	**16/11/2021**	**16/11/2021**	**14/12/2021**	**14/12/2021**	**14/12/2021**	**14/12/2021**	**14/12/2021**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**										
Acidity	iACID1WATI	2	mg/L				<2	3500	<2	130	110	<2	3200	11	250	170
Ag	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	<0.0001	0.001	0.0009	0.0003	0.0001	0.0003	0.0004	0.0005
Al	iMET1WCICP	0.005	mg/L	Al (pH>6.5) 295	**20**	5	0.007	**340**	0.046	12	13	0.006	**330**	0.36	13	14
Alkalin	iALK1WATI	1	mg/L				128	<1	4	<1	<1	84	<1	<1	<1	<1
As	iMET1WCICP	0.05	mg/L						**3.2**	**53**				**3.9**	**52**	
As	iMET1WCMS	0.001	mg/L	0.042	**2**	0.1	0.025	0.021			**0.11**	0.019	0.014			0.093
B	iMET1WCICP	0.02	mg/L											0.08		
B	iMET1WCMS	0.005	mg/L				0.016	0.031	0.073	0.011	0.051	0.013	0.028		0.007	0.038
Ba	iMET1WCMS	0.0001	mg/L				0.1	0.0012	0.046	0.013	0.042	0.05	0.0015	0.037	0.012	0.031
Be	iMET1WCMS	0.0001	mg/L				<0.0001	0.08	<0.0001	0.012	0.014	<0.0001	0.064	<0.0001	0.014	0.019
CO3	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	0.1	mg/L				395	63.3	208	23.5	301	256	49.9	182	20.1	258
Cd	iMET1WCMS	0.0001	mg/L	0.0004	**0.05**	0.01	0.0005	0.043	0.0013	0.11	0.18	0.0002	0.03	0.0018	**0.096**	**0.2**
Cl	iCO1WCDA	1	mg/L				4	4	35	9	5	2	3	47	9	3
Co	iMET1WCICP	0.005	mg/L								**2.8**					
Co	iMET1WCMS	0.0001	mg/L		**0.1**	0.05	0.0005	**1.9**	0.04	**0.94**		0.0003	**1.3**	0.06	**0.86**	**2.6**
Cr	iMET1WCMS	0.0005	mg/L		**1**	0.1	0.013	0.16	<0.0005	0.0096	0.012	0.0074	0.12	0.0009	0.0078	0.011
Cs	iMET1WCMS	0.0001	mg/L				<0.0001	<0.0001	0.0003	0.0006	<0.0001	<0.0001	<0.0001	0.0003	0.0006	<0.0001
Cu	iMET1WCICP	0.002	mg/L					**27**		3.6	3.8		**19**		3.4	4.2
Cu	iMET1WCMS	0.0001	mS/m	0.0018	**5**	0.2	0.0022		0.0039			0.0013		0.005		
ECond	iEC1WZSE	0.2	mg/L	41			224	384	270	94.9	319	156	379	272	96.6	297
F	iF1WASE	0.05	mg/L				1.4	7	3.4	0.85	1.7	1.6	5.1	2.7	0.65	1.9
Fe	iMET1WCICP	0.005	mg/L	2.7**	**10**	0.2	<0.005	**170**	<0.005	**22**	**13**	<0.005	**180**	0.17	**27**	**16**
HCO3	iALK1WATI	1	mg/L				156	<1	5	<1	<1	103	<1	1	<1	<1
Hg	iMET1WCMS	0.0001	mg/L		**0.002**	0.002	0.0002	<0.0001	0.0017	0.0005	0.0007	<0.0001	<0.0001	**0.002**	0.0005	<0.0001
K	iMET1WCICP	0.1	mg/L				34.5	<0.1	48.2	7.7	47.6	24.4	<0.1	44.8	6.6	43.8
Li	iMET1WCMS	0.0001	mg/L				0.04	0.78	0.14	0.078	0.45	0.04	0.71	0.14	0.066	0.39
Mg	iMET1WCICP	0.1	mg/L				82.9	234	293	59.5	304	49	221	317	59.6	268
Mn	iMET1WCICP	0.001	mg/L					6.8			**20**		6.2			**18**
Mn	iMET1WCMS	0.0001	mg/L	2.5**	**10**	0.2	0.043		0.63	2.1		0.021		0.68	1.6	
Mo	iMET1WCMS	0.001	mg/L		**0.05**	0.01	0.012	<0.001	0.008	<0.001	<0.001	0.011	<0.001	0.006	<0.001	<0.001
Na	iMET1WCICP	0.1	mg/L				40.4	0.2	22.1	2.3	13.2	26.2	0.1	20.1	1.5	9.5
Ni	iMET1WCICP	0.01	mg/L					**8.2**		**3.1**	**3**		**6.9**		**3**	**2.9**
Ni	iMET1WCMS	0.001	mg/L	0.013	**2**	0.2	0.001		0.055			<0.001		0.084		
OH	iALK1WATI	1	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	0.1	mg/L				<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
Pb	iMET1WCICP	0.02	mg/L							2.7					2.6	
Pb	iMET1WCMS	0.0001	mg/L	0.0056	**5**	2	0.0006	0.03	0.0012		0.013	0.0001	0.019	0.0005		0.0057
Rb	iMET1WCMS	0.0001	mg/L				0.021	0.0012	0.098	0.028	0.034	0.016	0.0012	0.076	0.025	0.035
S	iMET1WCICP	0.1	mg/L	70*			400	940	540	160	660	260	960	570	160	590
SO4	Calculated		mg/L	210*			1200	2820	1620	480	1980	780	2880	1710	480	1770
Sb	iMET1WCMS	0.0001	mg/L				0.001	<0.0001	0.0029	0.0073	0.0002	0.0011	<0.0001	0.0039	0.0097	0.0001
Se	iMET1WCMS	0.001	mg/L		**0.05**	0.02	**0.072**	**0.11**	**0.069**	0.025	**0.06**	**0.053**	**0.1**	**0.1**	0.017	0.034
Si	iMET1WCICP	0.05	mg/L				6.7	18	14	1.6	21	6	19	15	1.4	20
Sr	iMET1WCICP	0.002	mg/L				0.4	0.004	0.28	0.032	0.36	0.25	0.004	0.26	0.031	0.29
Th	iMET1WCMS	0.0001	mg/L				<0.0001	0.02	<0.0001	<0.0001	<0.0001	<0.0001	0.029	<0.0001	<0.0001	0.0002
Tl	iMET1WCMS	0.0001	mg/L				0.0001	<0.0001	0.0004	0.0004	0.0008	<0.0001	<0.0001	0.0003	0.0005	0.001
U	iMET1WCMS	0.0001	mg/L		**0.1**	0.01	0.0014	**0.22**	<0.0001	0.0084	0.0073	0.0009	**0.19**	<0.0001	0.01	0.0094
V	iMET1WCICP	0.005	mg/L		**0.5**	0.1	0.008	0.007	0.01	0.009	<0.005	0.007	<0.005	0.01	0.01	<0.005
Volume	iVOLUME	0.1	mL				300	250	220	310	220	290	240	230	300	260
Zn	iMET1WCICP	0.005	mL					**8.1**		**18**	**16**		**6.2**		**17**	**15**
Zn	iMET1WCMS	0.001	mg/L	0.014	**5**	2	0.003		0.037			<0.001		0.1		
pH	iPH1WASE	0.1	mg/L	5.8-8.0			8.2	3	6.4	3.5	3.8	8.2	3	5.3	3.4	3.7

Long-term irrigation value
Short-term irrigation value

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Table D - Quest 29 Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Quest29
Job Number: W-AA-06
Client: CDM Smith

							M8					M9				
						ChemCentre Id	**20S4886/041**	**20S4886/042**	**20S4886/043**	**20S4886/044**	**20S4886/045**	**20S4886/046**	**20S4886/047**	**20S4886/048**	**20S4886/049**	**20S4886/050**
						Client Id	**HKR35252 & HKR34263 M8**	**HKR34157 & HKR34089 M8**	**HKR34078 & HKR34085 M8**	**MTS_248-251 M8**	**HKR34049 & HKR34265 M8**	**HKR35252 & HKR34263 M9**	**HKR34157 & HKR34089 M9**	**HKR34078 & HKR34085 M9**	**MTS_248-251 M9**	**HKR34049 & HKR34265 M9**
						Lithology	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**
						Sampled	**11/01/2022**	**11/01/2022**	**11/01/2022**	**11/01/2022**	**11/01/2022**	**8/02/2022**	**8/02/2022**	**8/02/2022**	**8/02/2022**	**8/02/2022**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**										
Acidity	iACID1WATI	*2*	mg/L				<2	2800	19	240	220	2	2900	17	300	350
Ag	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0001	0.0005	0.0002	0.0002	<0.0001	0.0002	0.0003	0.0003	0.0004
Al	iMET1WCICP	*0.005*	mg/L	*Al (pH>6.5) 295*	**20**	5	0.005	**350**	0.69	15	19	0.008	**390**	1.6	**20**	**29**
Alkalin	iALK1WATI	*1*	mg/L				83	<1	<1	<1	<1	66	<1	<1	<1	<1
As	iMET1WCICP	*0.05*	mg/L						**5.5**	**55**				**5.8**	**65**	
As	iMET1WCMS	*0.001*	mg/L	*0.042*	**2**	0.1	0.025	0.013			0.12	0.023	0.013			0.15
B	iMET1WCICP	*0.02*	mg/L						0.09					0.06		
B	iMET1WCMS	*0.005*	mg/L				0.015	0.024		0.007	0.039	0.015	0.031		0.009	0.042
Ba	iMET1WCMS	*0.0001*	mg/L				0.075	0.0014	0.043	0.014	0.022	0.054	0.0018	0.034	0.014	0.021
Be	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.05	0.0001	0.012	0.023	<0.0001	0.06	0.0002	0.012	0.029
CO3	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	*0.1*	mg/L				269	45.6	171	18.2	279	247	44.5	134	18.7	341
Cd	iMET1WCMS	*0.0001*	mg/L	*0.0004*	**0.05**	0.01	0.0002	0.025	*0.0026*	**0.1**	**0.26**	0.0002	0.023	*0.0028*	**0.11**	**0.33**
Cl	iCO1WCDA	*1*	mg/L				2	2	59	8	3	1	3	58	12	3
Co	iMET1WCICP	*0.005*	mg/L								**2.7**					**3.3**
Co	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.05	0.0003	**1.3**	**0.11**	**1**		0.0003	**1.3**	**0.19**	**1.2**	
Cr	iMET1WCMS	*0.0005*	mg/L		**1**	0.1	0.0069	0.13	<0.0005	0.0087	0.018	0.0083	0.13	<0.0005	0.01	0.033
Cs	iMET1WCMS	*0.0001*	mg/L				<0.0001	<0.0001	0.0003	0.0006	<0.0001	<0.0001	<0.0001	0.0002	0.0005	<0.0001
Cu	iMET1WCICP	*0.002*	mg/L					**15**		3.1	4.7		**14**		3.1	**6.1**
Cu	iMET1WCMS	*0.0001*	mS/m	*0.0018*	**5**	0.2	0.0018		*0.008*			0.0013		*0.016*		
ECond	iEC1WZSE	*0.2*	mg/L	*41*			*164*	*387*	*275*	*100*	*308*	*145*	*404*	*205*	*108*	*342*
F	iF1WASE	*0.05*	mg/L				1.5	5.3	3	0.83	2.1	1.6	5.6	2.8	0.92	3
Fe	iMET1WCICP	*0.005*	mg/L	*2.7***	**10**	0.2	<0.005	**190**	0.013	**36**	**20**	<0.005	**210**	0.069	**47**	**29**
HCO3	iALK1WATI	*1*	mg/L				101	<1	<1	<1	<1	80	<1	<1	<1	<1
Hg	iMET1WCMS	*0.0001*	mg/L		**0.002**	0.002	0.0002	<0.0001	0.0012	<0.0001	0.0005	0.0002	<0.0001	0.0013	<0.0001	0.0002
K	iMET1WCICP	*0.1*	mg/L				23.8	<0.1	44.1	5.6	40.7	23.8	<0.1	35.3	5.4	42.3
Li	iMET1WCMS	*0.0001*	mg/L				0.039	0.74	0.16	0.062	0.4	0.046	0.86	0.14	0.056	0.49
Mg	iMET1WCICP	*0.1*	mg/L				49.3	222	319	59.3	270	45.7	234	224	65.9	307
Mn	iMET1WCICP	*0.001*	mg/L					*6.2*			**18**		*6.2*			**20**
Mn	iMET1WCMS	*0.0001*	mg/L	*2.5***	**10**	0.2	0.034		1.1	1.8		0.03		1.2	1.9	
Mo	iMET1WCMS	*0.001*	mg/L		**0.05**	0.01	0.01	<0.001	0.006	<0.001	<0.001	0.008	<0.001	0.002	<0.001	<0.001
Na	iMET1WCICP	*0.1*	mg/L				25.4	0.1	18.1	1	8	22.6	0.1	11	0.9	8.2
Ni	iMET1WCICP	*0.01*	mg/L					**6.3**		3	3.1		**6.4**		**3.2**	**3.7**
Ni	iMET1WCMS	*0.001*	mg/L	*0.013*	**2**	0.2	<0.001		*0.15*			<0.001		0.24		
OH	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	*0.1*	mg/L				<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb	iMET1WCICP	*0.02*	mg/L													
Pb	iMET1WCMS	*0.0001*	mg/L	*0.0056*	**5**	2	0.0001	*0.013*	0.0004	2.6	0.0045	<0.0001	*0.0064*	0.0006	2.7	0.0025
Rb	iMET1WCMS	*0.0001*	mg/L				0.015	0.0012	0.089	0.026	0.044	0.015	0.0012	0.067	0.025	0.062
S	iMET1WCICP	*0.1*	mg/L	*70**			*270*	*1000*	*570*	*160*	*630*	*240*	*1000*	*430*	*190*	*740*
SO4	Calculated		mg/L	*210**			*810*	*3000*	*1710*	*480*	*1890*	*720*	*3000*	*1290*	*570*	*2220*
Sb	iMET1WCMS	*0.0001*	mg/L				0.001	<0.0001	0.004	0.0093	0.0001	0.0009	<0.0001	0.0031	0.008	0.0001
Se	iMET1WCMS	*0.001*	mg/L		**0.05**	0.02	**0.063**	**0.12**	**0.13**	0.021	0.039	**0.052**	0.15	0.11	0.024	0.048
Si	iMET1WCICP	*0.05*	mg/L				6.1	17	17	1.2	22	6	21	15	1.3	26
Sr	iMET1WCICP	*0.002*	mg/L				0.27	0.004	0.24	0.034	0.28	0.23	0.004	0.18	0.045	0.28
Th	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.029	<0.0001	<0.0001	<0.0001	<0.0001	0.026	<0.0001	<0.0001	0.0001
Tl	iMET1WCMS	*0.0001*	mg/L				<0.0001	<0.0001	0.0004	0.0005	0.0011	<0.0001	<0.0001	0.0003	0.0005	0.0015
U	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.01	0.0007	**0.16**	<0.0001	0.0093	0.011	0.0005	**0.12**	<0.0001	0.0087	0.013
V	iMET1WCICP	*0.005*	mg/L		**0.5**	0.1	0.008	<0.005	0.01	0.012	<0.005	0.008	<0.005	0.008	0.013	<0.005
Volume	iVOLUME	*0.1*	mL				300	220	230	300	240	310	220	240	320	260
Zn	iMET1WCICP	*0.005*	mL					**5.2**		**16**	**17**		4.8		**17**	**21**
Zn	iMET1WCMS	*0.001*	mg/L	*0.014*	**5**	2	0.002		*0.16*			<0.001		*0.26*		
pH	iPH1WASE	*0.1*	mg/L	*5.8-8.0*			8	*3.1*	*4.8*	*3.5*	*3.7*	8.1	*2.9*	*4.8*	*3.4*	*3.5*

Long-term irrigation value

Short-term irrigation value

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Table D - Quest 29 Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Quest29
Job Number: W-AA-06
Client: CDM Smith

							M10					M11					
						ChemCentre Id	**20S4886/051**	**20S4886/052**	**20S4886/053**	**20S4886/054**	**20S4886/055**	**20S4886/056**	**20S4886/057**	**20S4886/058**	**20S4886/059**	**20S4886/060**	**20S4886/061**
						Client Id	**HKR35252 & HKR34263 M10**	**HKR34157 & HKR34089 M10**	**HKR34078 & HKR34085 M10**	**MTS_248-251 M10**	**HKR34049 & HKR34265 M10**	**HKR35252 & HKR34263 M11**	**HKR34157 & HKR34089 M11**	**HKR34078 & HKR34085 M11**	**MTS_248-251 M11**	**HKR34049 & HKR34265 M11**	**HKR35252 & HKR34263 M12**
						Lithology	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**	**Pdz fr**	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**	**Pdz fr**
						Sampled	**8/03/2022**	**8/03/2022**	**8/03/2022**	**8/03/2022**	**8/03/2022**	**5/04/2022**	**5/04/2022**	**5/04/2022**	**5/04/2022**	**5/04/2022**	**3/05/2022**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**											
Acidity	iACID1WATI	*2*	mg/L				3	420	37	340	340	<2	5700	66	350	470	<2
Ag	iMET1WCMS	*0.0001*	mg/L				<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0011	0.0002	0.0003	<0.0001	<0.0001	<0.0001
Al	iMET1WCICP	*0.005*	mg/L	*Al (pH>6.5) 295*	**20**	5	0.007	**35**	4.1	**20**	**30**	<0.005	**860**	8.1	**17**	**42**	0.011
Alkalin	iALK1WATI	*1*	mg/L				39	<1	<1	<1	<1	25	<1	<1	<1	<1	34
As	iMET1WCICP	*0.05*	mg/L						**11**	**75**				**20**	**62**		
As	iMET1WCMS	*0.001*	mg/L	*0.042*	**2**	0.1	0.02	0.002			0.19	0.025	0.014			0.17	0.02
B	iMET1WCICP	*0.02*	mg/L														
B	iMET1WCMS	*0.005*	mg/L				0.033	0.011	0.11	0.019	0.05	0.019	0.011	0.07	<0.005	0.027	0.015
Ba	iMET1WCMS	*0.0001*	mg/L				0.061	0.002	0.044	0.016	0.0083	0.04	0.0006	0.037	0.016	0.0027	0.035
Be	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0059	0.0006	0.012	0.031	<0.0001	0.07	0.0007	0.0089	0.029	<0.0001
CO3	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	*0.1*	mg/L				317	11.1	220	15.4	310	213	57.9	235	9.7	289	192
Cd	iMET1WCMS	*0.0001*	mg/L	*0.0004*	**0.05**	0.01	0.0003	*0.0038*	*0.0068*	**0.097**	**0.33**	0.0003	0.036	*0.0097*	**0.074**	**0.38**	0.0002
Cl	iCO1WCDA	*1*	mg/L				2	<1	141	13	3	2	4	143	11	2	<1
Co	iMET1WCICP	*0.005*	mg/L													**3.7**	
Co	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.05	0.0005	**0.16**	**0.65**	**1.1**	**3**	0.0004	**2.5**	**1.5**	**0.99**		0.0004
Cr	iMET1WCMS	*0.0005*	mg/L		**1**	0.1	0.0036	0.0041	<0.0005	0.0092	0.036	0.0019	0.1	<0.0005	0.007	0.045	0.0017
Cs	iMET1WCMS	*0.0001*	mg/L				0.0002	<0.0001	0.0003	0.0006	0.0001	<0.0001	<0.0001	0.0002	0.0004	<0.0001	<0.0001
Cu	iMET1WCICP	*0.002*	mg/L										**16**			**6.6**	
Cu	iMET1WCMS	*0.0001*	mS/m	*0.0018*	**5**	0.2	0.0012	1.4	0.043	**5.6**		0.0014		*0.063*	**2.3**		*0.0016*
ECond	iEC1WZSE	*0.2*	mg/L	*41*			*181*	*73.7*	*304*	*110*	*324*	*132*	*642*	*311*	*97.2*	*334*	*120*
F	iF1WASE	*0.05*	mg/L				1.1	0.76	4.7	0.89	3	1.1	1.2	7	0.67	3.1	1.3
Fe	iMET1WCICP	*0.005*	mg/L	*2.7***	**10**	0.2	<0.005	**11**	0.24	**56**	**30**	0.005	**260**	0.61	**56**	**37**	<0.005
HCO3	iALK1WATI	*1*	mg/L				47	<1	<1	<1	<1	30	<1	<1	<1	<1	41
Hg	iMET1WCMS	*0.0001*	mg/L		**0.002**	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.002**	<0.0001	<0.0001	0.0003
K	iMET1WCICP	*0.1*	mg/L				23.4	<0.1	47.8	4.7	32	18	<0.1	48.6	3.5	27.1	15.9
Li	iMET1WCMS	*0.0001*	mg/L				0.043	0.069	0.25	0.06	0.46	0.03	1.3	0.26	0.042	0.44	0.032
Mg	iMET1WCICP	*0.1*	mg/L				62	20.6	372	62.8	287	41.9	461	368	58.3	298	39.7
Mn	iMET1WCICP	*0.001*	mg/L										**13**	4.5		**20**	
Mn	iMET1WCMS	*0.0001*	mg/L	*2.5***	**10**	0.2	0.06	0.67		1.6		0.054			1.4		0.052
Mo	iMET1WCMS	*0.001*	mg/L		**0.05**	0.01	0.014	<0.001	0.001	<0.001	<0.001	0.011	<0.001	<0.001	<0.001	<0.001	0.008
Na	iMET1WCICP	*0.1*	mg/L				23	<0.1	12.7	0.8	6.9	17.9	0.1	10.9	0.5	6	15.7
Ni	iMET1WCICP	*0.01*	mg/L										**12**			**4.4**	
Ni	iMET1WCMS	*0.001*	mg/L	*0.013*	**2**	0.2	0.001	0.77	0.82	**3**	**3.6**	0.001		1.9	**2.7**		<0.001
OH	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P	iMET1WCICP	*0.1*	mg/L				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<1.0	<0.1
Pb	iMET1WCICP	*0.02*	mg/L														
Pb	iMET1WCMS	*0.0001*	mg/L	*0.0056*	**5**	2	<0.0001	0.0002	0.0016	2.2	*0.02*	0.0004	0.0011	0.0028	*1.5*	0.0019	<0.0001
Rb	iMET1WCMS	*0.0001*	mg/L				0.01	0.0012	0.086	0.024	0.055	0.0062	0.0012	0.088	0.019	0.053	0.0061
S	iMET1WCICP	*0.1*	mg/L	*70**			*320*	*110*	*720*	*190*	*670*	*220*	*2200*	*780*	*170*	*730*	*210*
SO4	Calculated		mg/L	*210**			*960*	*330*	*2160*	*570*	*2010*	*660*	*6600*	*2340*	*510*	*2190*	*630*
Sb	iMET1WCMS	*0.0001*	mg/L				0.0006	<0.0001	0.0029	0.0075	0.0002	0.0006	<0.0001	0.003	0.0072	0.0001	0.0006
Se	iMET1WCMS	*0.001*	mg/L		**0.05**	0.02	**0.085**	0.02	**0.21**	0.025	0.041	**0.068**	**0.29**	**0.24**	0.02	0.039	**0.059**
Si	iMET1WCICP	*0.05*	mg/L				5.8	1.7	22	1.3	23	6	20	28	1	23	5.8
Sr	iMET1WCICP	*0.002*	mg/L				0.31	0.002	0.31	0.054	0.21	0.2	0.008	0.31	0.04	0.15	0.19
Th	iMET1WCMS	*0.0001*	mg/L				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.025	<0.0001	<0.0001	<0.0001	<0.0001
Tl	iMET1WCMS	*0.0001*	mg/L				<0.0001	<0.0001	0.0004	0.0005	0.0013	<0.0001	<0.0001	0.0003	0.0004	0.0013	<0.0001
U	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.01	0.0002	0.0099	<0.0001	0.0076	0.013	<0.0001	**0.17**	<0.0001	0.0055	0.014	0.0001
V	iMET1WCICP	*0.005*	mg/L		**0.5**	0.1	0.008	<0.005	0.007	0.014	<0.005	0.008	0.006	0.007	0.012	<0.050	0.007
Volume	iVOLUME	*0.1*	mL				230	330	230	290	280	210	260	250	290	250	220
Zn	iMET1WCICP	*0.005*	mL										**8.8**		**12**	**23**	
Zn	iMET1WCMS	*0.001*	mg/L	*0.014*	**5**	2	<0.001	*0.76*	*0.72*	**15**	**20**	0.001		*1.3*			0.002
pH	iPH1WASE	*0.1*	mg/L	*5.8-8.0*			7.8	*3.3*	*4.5*	*3.4*	*3.5*	6.4	*2.9*	*4.5*	*3.4*	*3.4*	7.7

Long-term irrigation value
Short-term irrigation value

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Table D - Quest 29 Leachate Results
Project: Hanking Kinetic Geochemical Assessment - Quest29
Job Number: W-AA-06
Client: CDM Smith

							M12				
						ChemCentre Id	**20S4886/062**	**20S4886/063**	**20S4886/064**	**20S4886/065**	**20S4886/066**
						Client Id	**HKR34157 & HKR34089 M12**	**HKR34078 & HKR34085 M12**	**MTS_248-251 M12**	**HKR34049 & HKR34265 M12**	**Blank**
						Lithology	**S bs fr**	**Pdz fr**	**S bs fr (ore)**	**Pdz tr**	
						Sampled	**3/05/2022**	**3/05/2022**	**3/05/2022**	**3/05/2022**	**31/05/2021**
Analyte	**Method Code**	***Limits of Reporting***	**Units**	**Bundy Creek TV's**	**ANZECC & ARMCANZ 2000 Short-Term Irrigation Water**	**ANZECC & ARMCANZ 2000 Long-Term Irrigation Water**					
Acidity	iACID1WATI	*2*	mg/L				2900	56	270	380	<2
Ag	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0004	<0.0001	<0.0001	<0.0001
Al	iMET1WCICP	*0.005*	mg/L	*Al (pH>6.5) 295*	**20**	5	**420**	9.1	**15**	**38**	0.006
Alkalin	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1
As	iMET1WCICP	*0.05*	mg/L	*0.042*	**2**	0.1		**21**	**64**		
As	iMET1WCMS	*0.001*	mg/L				0.008			0.12	<0.001
B	iMET1WCICP	*0.02*	mg/L								
B	iMET1WCMS	*0.005*	mg/L				0.01	0.047	0.005	0.027	<0.005
Ba	iMET1WCMS	*0.0001*	mg/L				0.0005	0.024	0.016	0.0013	<0.0001
Be	iMET1WCMS	*0.0001*	mg/L				0.042	0.0008	0.0088	0.027	<0.0001
CO3	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1
Ca	iMET1WCICP	*0.1*	mg/L				29.7	158	6.9	252	<0.1
Cd	iMET1WCMS	*0.0001*	mg/L	*0.0004*	**0.05**	0.01	0.015	*0.0088*	**0.069**	**0.36**	<0.0001
Cl	iCO1WCDA	*1*	mg/L				3	124	12	2	<1
Co	iMET1WCICP	*0.005*	mg/L		**0.1**	0.05				**3**	
Co	iMET1WCMS	*0.0001*	mg/L				**1.1**	**1.6**	**0.84**		<0.0001
Cr	iMET1WCMS	*0.0005*	mg/L		**1**	0.1	0.065	<0.0005	0.0067	0.041	<0.0005
Cs	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0003	0.0004	0.0001	<0.0001
Cu	iMET1WCICP	*0.002*	mg/L	*0.0018*	**5**	0.2	**9**			**5.7**	
Cu	iMET1WCMS	*0.0001*	mS/m					*0.091*	**2.2**		<0.0001
ECond	iEC1WZSE	*0.2*	mg/L	*41*			*392*	*219*	*92*	*299*	<0.2
F	iF1WASE	*0.05*	mg/L				3.8	6.9	0.53	2.5	<0.05
Fe	iMET1WCICP	*0.005*	mg/L	*2.7***	**10**	0.2	**160**	0.74	**55**	**36**	<0.005
HCO3	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1
Hg	iMET1WCMS	*0.0001*	mg/L		**0.002**	0.002	<0.0001	0.0008	0.0001	<0.0001	<0.0001
K	iMET1WCICP	*0.1*	mg/L				<0.1	34.2	3.4	26.3	<0.1
Li	iMET1WCMS	*0.0001*	mg/L				0.85	0.24	0.048	0.41	<0.0001
Mg	iMET1WCICP	*0.1*	mg/L				218	240	51.7	263	<0.1
Mn	iMET1WCICP	*0.001*	mg/L	*2.5***	**10**	0.2	5.8	3.7		**16**	
Mn	iMET1WCMS	*0.0001*	mg/L						1.1		<0.0001
Mo	iMET1WCMS	*0.001*	mg/L		**0.05**	0.01	<0.001	<0.001	<0.001	<0.001	<0.001
Na	iMET1WCICP	*0.1*	mg/L				0.1	6.1	0.4	4.6	<0.1
Ni	iMET1WCICP	*0.01*	mg/L	*0.013*	**2**	0.2	**5.7**			**3.7**	
Ni	iMET1WCMS	*0.001*	mg/L					**2**	**2.2**		<0.001
OH	iALK1WATI	*1*	mg/L				<1	<1	<1	<1	<1
P	iMET1WCICP	*0.1*	mg/L				<0.1	<0.1	<0.1	<0.1	<0.1
Pb	iMET1WCICP	*0.02*	mg/L	*0.0056*	**5**	2					
Pb	iMET1WCMS	*0.0001*	mg/L				0.0023	0.001	*1.7*	0.0008	<0.0001
Rb	iMET1WCMS	*0.0001*	mg/L				0.001	0.063	0.019	0.062	<0.0001
S	iMET1WCICP	*0.1*	mg/L	*70**			*1000*	*540*	*160*	*630*	<0.1
SO4	Calculated		mg/L	*210**			*3000*	*1620*	*480*	*1890*	
Sb	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0036	0.007	0.0001	<0.0001
Se	iMET1WCMS	*0.001*	mg/L		**0.05**	0.02	**0.15**	**0.17**	0.02	0.03	<0.001
Si	iMET1WCICP	*0.05*	mg/L				15	22	0.98	23	<0.05
Sr	iMET1WCICP	*0.002*	mg/L				0.007	0.21	0.04	0.084	<0.002
Th	iMET1WCMS	*0.0001*	mg/L				0.011	<0.0001	<0.0001	<0.0001	<0.0001
Tl	iMET1WCMS	*0.0001*	mg/L				<0.0001	0.0003	0.0004	0.0014	<0.0001
U	iMET1WCMS	*0.0001*	mg/L		**0.1**	0.01	**0.1**	<0.0001	0.0051	0.014	<0.0001
V	iMET1WCICP	*0.005*	mg/L		**0.5**	0.1	<0.005	0.008	0.013	<0.005	<0.005
Volume	iVOLUME	*0.1*	mL				240	240	300	250	
Zn	iMET1WCICP	*0.005*	mL	*0.014*	**5**	2	3.5		**9.5**	**19**	
Zn	iMET1WCMS	*0.001*	mg/L					*1.4*			0.001
pH	iPH1WASE	*0.1*	mg/L	*5.8-8.0*			*3*	*4.6*	*3.5*	*3.4*	5.5

Long-term irrigation value
Short-term irrigation value

*	Sulfate	210	*mg/L*	
*	Sulfate as S	70	*mg/L*	
**	Fe	2700	*ug/L*	*based on background Fe data from Bundy Creek*
**	Mn	2500	*ug/L*	*based on background Fe data from Bundy Creek*

Appendix D – Disclaimer and Limitations

Disclaimer and Limitations

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