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Appendix S: Geochemistry Report

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Reko Diq Mining Project, Pakistan

Environmental Geochemistry Assessment

Prepared for:
Reko Diq Mining Company

Project Number:
BAR7212

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EXECUTIVE SUMMARY

Project Overview

Barrick Gold Corporation, through its subsidiary Reko Diq Mining Company (RDMC), is developing the Reko Diq Mining Project. This project is in the Chagai District of Balochistan Province, Pakistan, and is one of the largest global copper and gold reserves. The project site is situated between the borders of Iran and Afghanistan, with the nearest town, Nok Kundi, approximately 70 kilometres southeast of the mine site, and the closest community, Humai, about 20 kilometres away.

Assessment Scope

Digby Wells Environmental conducted an Environmental and Social Impact Assessment (ESIA) and an Environmental and Social Management Plan (ESMP) for the project. This report specifically addresses the potential geochemical impacts of waste rock and tailings from the mine site.

Sampling and Analysis

The study includes the results of previous sampling and analysis, as well as the recent analysis of 62 waste rock samples (22 from Western Porphyry and 40 from Tanjeel) to close identified gaps. The assessment included static tests such as Acid Base Accounting (ABA) and Contact Leach tests.

Western Porphyry

The geochemical test work indicates that the majority (more than 90%) of extracted rock is predicted to be potentially acid forming (PAF). The current results indicate that the paste pH of Western Porphyry waste rock and pit wall samples ranges from neutral to alkaline, with 11% classified as LNAG and 88% as highly potentially acid generating (HPAG). The waste rock and pit wall samples exhibit low acid neutralization capacity for both major and minor lithologies.

However, the encapsulated nature of sulphides at Western Porphyry suggests that this potential impact will take a considerable amount of time to manifest, likely in the order of four decades. This is further compounded by the region's low humidity and high evaporation conditions.

To determine the leaching characteristics, a 3:1 contact leach test using deionized water was conducted on 13 Western Porphyry and 24 Tanjeel waste rock samples. The leachate concentrations were compared to the background groundwater quality (BGWQ). Reason being the low precipitation and high precipitation seepage is not expected, and leachate cannot be compared to effluent guidelines.

The waste rock leachate pH ranges from acidic to neutral pH (pH 6.58 – 7.28). The pH values for VFL SCC and VFL PHY lithologies fall below the minimum BGWQ pH limit of 7.20, while other lithologies are within the acceptable range. Several parameters, such as aluminium, antimony, barium, cobalt, copper, iron, potassium, manganese, thorium and thallium, exceed BGWQ standards.

The leachate pH from the Western Porphyry pit wall waste rock samples ranges from acidic to neutral (pH 4.91 – 5.23). VFL SCC and VFL PHY lithologies have leachate pH values below the minimum limit BGWQ. The parameters of concern include aluminium, antimony, barium, cobalt, copper, iron, potassium, manganese, thorium thallium and nitrates.

Tanjeel

In contrast to Western Porphyry, the material at Tanjeel exhibits a more oxidized nature, with greater exposure of Sulphides in waste rock, pit walls, and stockpiled ore. This increases the potential for acid generation.

Additionally, groundwater at Tanjeel utilizes the same fractures as the mineralization, resulting in in-situ partial oxidation. Consequently, the material displays a higher reactivity, even though its total potential for acid generation is lower when compared to Western Porphyry.

The current waste rock classification showed that the pH of Tanjeel waste rock and pit wall samples demonstrate mildly acidic to alkaline with waste rocks indicating 98% of samples HPAG and 2% LNAG. The pit wall samples are 100% HPAG. Like Western Porphyry, the samples demonstrated low Acid Neutralisation Capacity.

The Tanjeel waste rock sample results show that leachate pH ranges from 4.16 to 8.58. PFQ PHY, PQF PHY, and VIN PHY samples have pH values below the minimum limit of 6.0 set by Pakistan and IFC guidelines. Several parameters exceed Pakistan's effluent guidelines, including total dissolved solids, Sulphate, cadmium, copper, iron, manganese, and zinc. Copper, iron, and zinc levels also surpass IFC effluent guidelines. Additionally, multiple parameters, such as low pH, Sulphate, aluminium, antimony, barium, cadmium, cerium, chromium, cobalt, copper, iron, manganese, lead, scandium, strontium, thorium, thallium, yttrium, and zinc, BGWQ levels.

The Tanjeel pit wall waste rock samples show leachate pH ranging from 5.07 to 6.24, with PFQ PHY falling below the minimum pH limit of 6.0 set by both Pakistan and IFC guidelines. Copper and manganese levels in PFQ PHY exceed Pakistan's effluent guidelines, while both copper and zinc levels surpass IFC guidelines. Additionally, several parameters, including low pH, antimony, barium, cadmium, cerium, cobalt, copper, manganese, scandium, thorium, thallium, yttrium, and zinc, exceed BGWQ levels.

Tailings

The geochemical characteristics of the tailings are variable depending on the fraction of the tailings. Cleaner tailings contain between 6% and 23% sulphide have a high potential for acid generation and are characterised by concentrations of leachable metals above comparative water quality and risk assessment guidelines. The cleaner tailings are also characterised by very high Sulphate concentrations (above 2 g/L) and a low leachate pH (pH ~2).

Rougher tailings typically contain less than 0.5% Sulphide and as such have negligible acid-generating potential. The rougher tailings also have negligible buffering, so appear to be potentially acid forming in NNP, but are better classed as inert. Leachable metals are generally below comparative water quality guidelines and risk assessment guideline values. Sulphate values are generally below 500 mg/L, and the pH is mildly acidic to circum-neutral (pH 6).

Potential Environmental Risk

Acidic metal drainage is expected within the Western Porphyry pit and waste rock dump. However, due to the encapsulated nature of Sulphides and the site's low humidity and high evaporation environment, this process will take four decades to manifest. The low reactivity of the material and the site's hydrogeological conditions will limit any impact of Acid Rock Drainage and Metal Leaching (ARDML).

In contrast, the Tanjeel site has a higher potential for acid generation due to the more oxidized material and greater exposure of Sulphides, with groundwater flowing through mineralized fractures causing partial in-situ oxidation. Despite this, the extremely low infiltration rates, depth of groundwater, and saline nature of the groundwater minimize the risk of ARDML impacting groundwater. Additionally, no groundwater receptors are at risk at either site. However, routine monitoring is recommended and part of the monitoring will include identified constituents of concern, such as acidity, total dissolved solids, sulphate, aluminium, antimony, barium, cadmium, cerium, cobalt, copper, iron, manganese, lead, scandium, strontium, and zinc, in both surface and groundwater.

The potential for environmental impacts to groundwater from rougher tailings is low due to the extremely low infiltration rates predicted by hydrogeological modelling, the depth of groundwater across the site, and the highly mineralized, saline nature of the groundwater. Additionally, there are no groundwater receptors at risk at this site. Therefore, a liner is not necessary for the deposition of these tailings, and no specific ARDML management measures are required.

Natural weathering of cleaner tailings will produce acidic mine drainage, with concerning constituents including low pH, high electrical conductivity, Sulphate, copper, lead, manganese, molybdenum, strontium, and uranium. These substances may be mobilized during operations and could impact groundwater quality. Therefore, installing an impermeable HDPE liner as currently planned is recommended to control and manage seepage from the TSF.

The impacts of climate change on mine geochemistry may include increased reaction rates of chemical processes, such as the oxidation of Sulphide minerals and the subsequent release of acidic components. Higher evaporation rates can concentrate dissolved substances, potentially worsening the acidic conditions caused by Acid Mine Drainage (AMD). Additionally, climate change can accelerate mineral weathering, leading to the release of heavy metals and other contaminants. However, the release of heavy metals will not be transported with runoff into surface or groundwater due to low precipitation rates.

Management Measures

The environmental management measures for geochemistry required for the Project are outlined in Table 10-2 and summarized broadly as follows:

- Lining Systems: Install impermeable HDPE liner in the cleaner tailings TSF to minimize seepage.
- Cover Systems: Apply waste rock covers to the TSFs as part of closure.
- Water Management: Control seepage and runoff water during operations during rainfall events.

Climate change risks, and management measures have been incorporated into the Environmental Management Plan.

Conclusion

The proactive management measures outlined in the report collectively contribute to mitigating geochemical risks associated with waste rock and tailings. They foster environmentally responsible practices and ensure the protection of surrounding ecosystems. The report's findings and recommendations demonstrate a commitment to environmental stewardship and regulatory compliance, ensuring that potential geochemical impacts are appropriately managed and mitigated in accordance with relevant standards, guidelines, and laws set forth by competent authorities.

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ACRONYMS, ABBREVIATIONS AND DEFINITIONS

ABA	Acid-Base Accounting
ALS	Australian Laboratory Services Pty Ltd
AMD/ML	Acid Mine Drainage/Metal Leaching
AMIRA	Australian Minerals Industry Research Association Limited
ANC	Acid Neutralising Capacity
Barrick	Barrick Gold Corporation
BGWQ	Background Groundwater Quality
DDH	Diamond Drilled Hole
Digby Wells	Digby Wells Environmental
EC	Electrical Conductivity
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
HPAG	High Potential Acid Generating
IC	Ion Chromatography
ICP	Inductively Coupled Plasma
IFC	International Finance Corporation
LNAG	Low Potential Acid Generating
LOM	Life of Mine
MPA	Maximum Potential Acidity
MWMP	Meteoric Water Mobility Procedure
NAG	Net Acid Generation
NAPP	Net Acid Producing Potential
PAF	Potentially Acid Forming
QA/QC	Quality Assurance and Quality Control
RC	Reverse Circulation
RDMC	Reko Diq Mining Company
S.R.O	Statutory Notification
SCC	sericitic, chloritic, and clay
TDS	Total Dissolved Solids
TIC	Total Inorganic Carbon
TOC	Total Organic Carbon
TSF	Tailings Storage Facility
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
WRD	Waste Rock Dumps
XRD	X-Ray Diffraction

1. Introduction

Barrick Gold Corporation (Barrick), through its subsidiary Reko Diq Mining Company (RDMC), is developing the Reko Diq Mining Project (the Project). Reko Diq is one of the largest global copper and gold reserves with an estimated 5.1 billion tons of ore, grading 0.41% of copper and containing 36.4 million ounces of gold (RDMC, 2023).

The Project is in the Chagai District of Balochistan Province of Pakistan, between the Iran (approximately 40 km away) and Afghanistan (approximately 35 km away) borders (Figure 1-1). The nearest town is Nok Kundi, approximately 70 kilometres (km) southeast of the mine site. The nearest community to the mine is Humai, which is approximately 20 km away.

1.1. Study Objectives

Digby Wells Environmental (hereinafter Digby Wells) is undertaking an Environmental and Social Impact Assessment (ESIA) as well as developing an Environmental and Social Management Plan (ESMP) for the project, which needs to comply with the Pakistan environmental and mining legislations as well as align with other international standards and guidelines.

This report provides the specialist geochemistry impact assessment as supporting input for the ESIA and ESMP. The scope of this report is focused on the potential geochemical impact from waste rock and tailings.

1.2. Project Description

The project will involve the mining of porphyry copper-gold deposits located in various mineralization areas. The proposed mine site will consist of two main pits: Western Porphyry and Tanjeel (Figure 1-2). The Western Porphyry deposit is a complex of four adjacent porphyry centres (H13, H14, H15 and H79) with the highest grades in the H14 and H15 complexes. The Tanjeel deposit represents a minor component of the ore body and will be brought into production after the first 10 years of mining.

The mineral deposits were formed under different geological processes (SMEC, 2010). Tanjeel is a supergene-enriched deposit formed over a much older porphyry system while the Western Porphyry is a multiple intrusive classic porphyry system. Although close in proximity, the geology, mineralogy and age of both systems are different.

The project has a 38-year Life of Mine (LOM) in terms of identified resources. The mine infrastructure that is relevant to the geochemical impact assessment includes the open pits, Waste Rock Dumps (WRD) and Tailings Storage Facility (TSF). The position of the infrastructure is displayed in Figure 1-2.

The mining sequence at the Western Porphyry and Tanjeel pits is summarized in Table 1-1. The final shape and depth of the pits are displayed in Figure 1-3.

Table 1-1: A Summary of the Pit Floor Depth and Elevation

		Pit floor depth (mbgl)		Pit floor elevation (mamsl)	
Year	**Period**	**Western Porphyry**	**Tanjeel**	**Western Porphyry**	**Tanjeel**
1	2027	60		960	
2	2028	60		960	
3	2029	105		915	
4	2030	180		840	
5	2031	285		735	
6	2032	285		735	
7	2033	285		735	
8	2034	345		675	
9	2035	360		660	
10	2036	360		660	
11	2037	390	105	630	915
16	2042	495	165	525	855
21	2047	570	195	450	825
26	2052	660	195	360	825
31	2057	690	195	330	825
36	2062	840	195	180	825

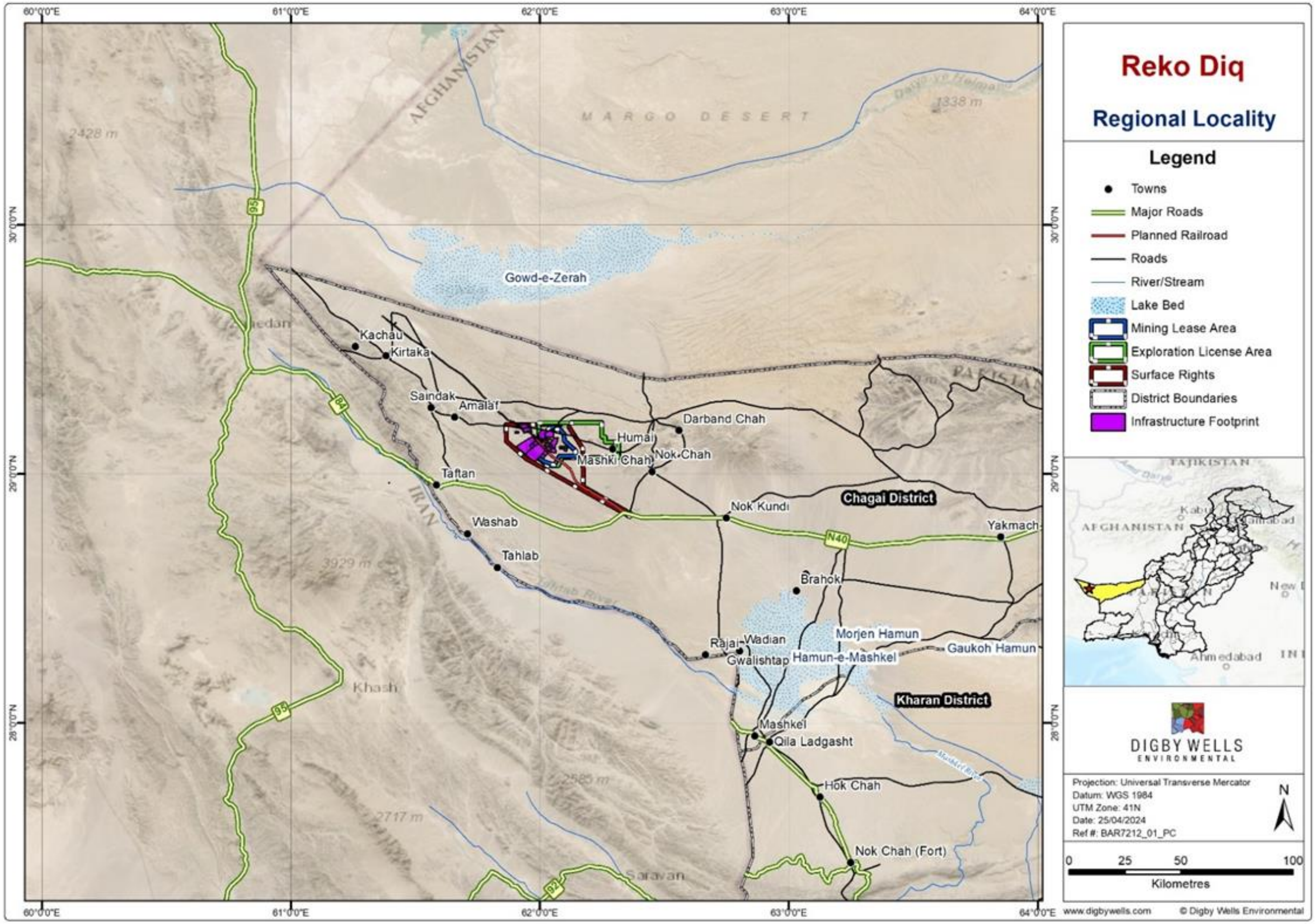

Figure 1-1: Regional Locality

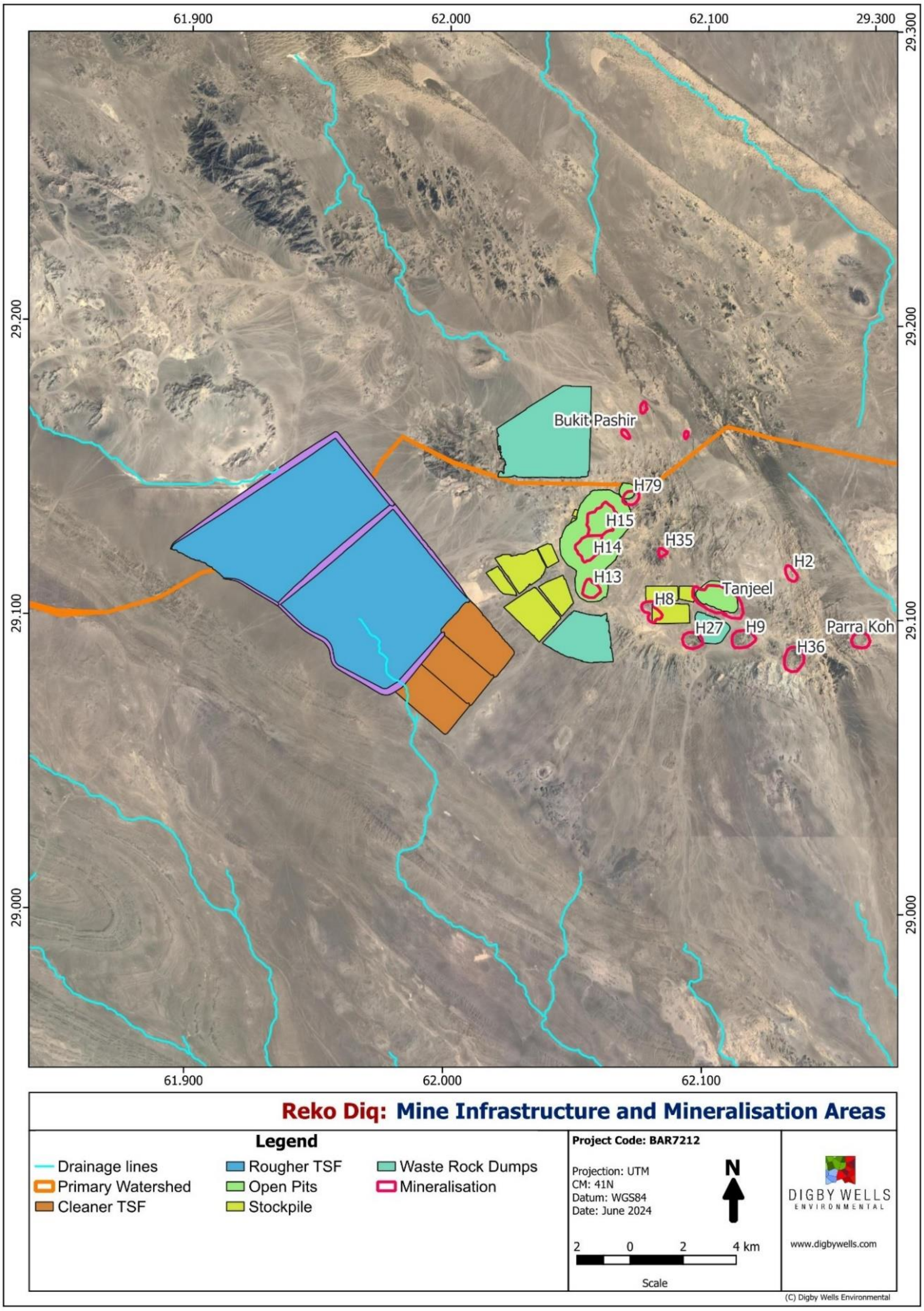

Figure 1-2: Project Infrastructure Including Mineralization Areas

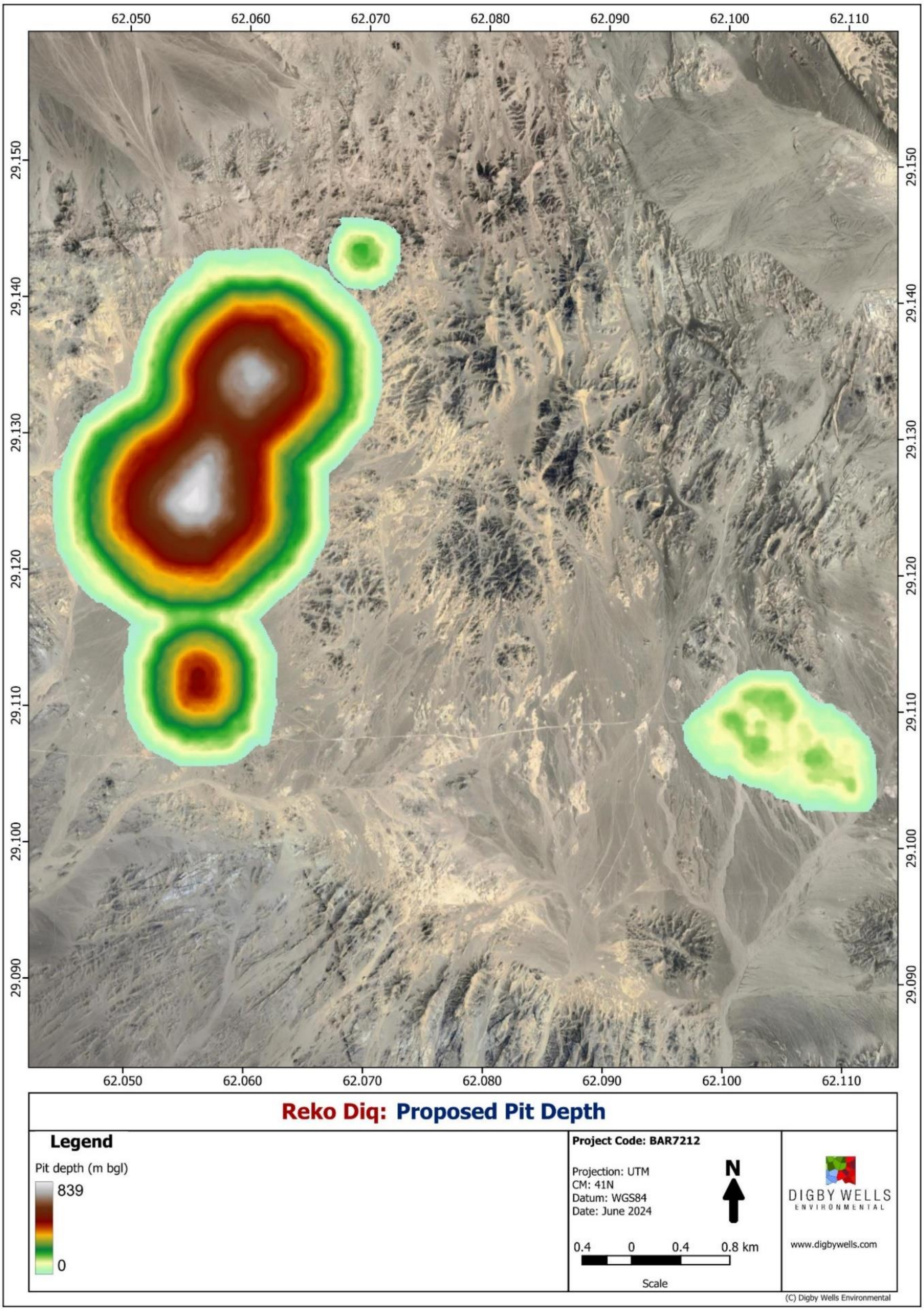

Figure 1-3: Proposed Final Shape and Depth of the Two Pits

2. Relevant Legislation, Standards and Guidelines

This section describes relevant legislation, standards and guidelines utilised in the reporting.

2.1. Pakistan Environmental Protection Act 1997 (XXXIV of 1997)

This Act provides for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution and promotion of sustainable development.

For this report, the Statutory Notification (S.R.O) 549 (I)/2000 under clause (c) of sub-section (1) of section 6 of the Pakistan Environmental Protection Act 1997 (XXXIV of 1997) amendments were made in its Notification No S.R.O 742 (I)/93 dated the 24th August 1993 Annexure I is the National Environmental Standards for Municipal and Liquid Industrial Effluents. The standards are indicated in Table 2-1 with the focus being effluents discharged into inland waters.

2.2. International Finance Corporation Guidelines

The International Finance Corporation (IFC), a member of the World Bank Group, has adopted a suite of performance standards on social and environmental sustainability. The IFC applies these performance standards to manage project-related social and environmental risks and impacts, as well as to enhance development opportunities in its private sector financing. The IFC performance standards are widely regarded as international best practice regarding the management of impacts associated with large project developments. The IFC Environmental, Health, and Safety Guidelines for Mining are indicated in Table 2-1.

Effluent guidelines are applicable for site runoff and treated effluents to surface waters for general use. Site-specific discharge levels may be established based on the availability and conditions in the use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the General EHS Guideline.

Table 2-1: Effluent and Wastewater Standards and Limits

Parameter	Units	National Environmental Standards for Municipal and Liquid Industrial Effluents 2000			IFC 2007 Guideline for Mining
		Into Inland Waters	Into Sewage Treatment	Into Sea	
Physiochemical Parameters					
pH	s.u.	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0
Total dissolved solids	mg/L	3500	3500	3500	

Parameter	Units	National Environmental Standards for Municipal and Liquid Industrial Effluents 2000			IFC 2007 Guideline for Mining
		Into Inland Waters	Into Sewage Treatment	Into Sea	
Sulphate	mg/L	600	600	1000	
Chloride	mg/L	1000	1000	1000	
NO_3-N	mg/L				
NO_2-N	mg/L				
NH_3-N	mg/L	40	40	40	
Cyanide Free					0.1
Cyanide WAD					0.5
Total Cyanide	mg/L	1	1	1	1
PO4-P	mg/L				
Fluoride		10	10	10	
Metals/Metalloids					
Aluminium	mg/L				
Antimony	mg/L				
Arsenic	mg/L	1	1	1	0.1
Barium	mg/L	1.5	1.5	1.5	
Beryllium	mg/L				
Boron	mg/L	6	6	6	
Cadmium	mg/L	0.1	0.1	0.1	0.05
Total Chromium	mg/L	1	1	1	
Chromium (V)					0.1
Cobalt	mg/L				
Copper	mg/L	1	1	1	0.3
Iron	mg/L	8	8	8	2
Lead	mg/L	0.5	0.5	0.5	0.2
Magnesium	mg/L				
Manganese	mg/L	1.5	1.5	1.5	
Mercury	mg/L	0.01	0.01	0.01	0.002

Parameter	Units	National Environmental Standards for Municipal and Liquid Industrial Effluents 2000			IFC 2007 Guideline for Mining
		Into Inland Waters	Into Sewage Treatment	Into Sea	
Molybdenum	mg/L				
Nickel	mg/L	1	1	1	0.5
Selenium	mg/L	0.5	0.5	0.5	
Silver	mg/L	1	1	1	
Thallium	mg/L				
Tin	mg/L				
Zinc	mg/L	5	5	5	0.5

However, based on the climatic conditions onsite with high evaporation and low precipitation rates little or no seepage and absence of pit lake is expected. The guidelines are ideal for situations with seepage and pit lakes and will not be utilised for this study.

2.3. Barrick Global Guidance for Acid Mine Drainage and Metal Leaching Management

The Guidance methodology requires an integration of the Acid Mine Drainage/Metal Leaching (AMD/ML) characterisation into advanced exploration projects. The AMD/ML characterisation includes, but is not limited to, the following:

- Assaying of major and minor elements associated with neutralisation and acid potential including calcium, magnesium, manganese, iron, carbon species and sulphur species.
- Application of neutralisation and acid potential towards the neutralisation-acidification balance calculation that defines the AMD/ML risk of earth materials in block models. The typical risk classification criteria are shown in Figure 2-1.
- Assessment of the presence of toxic trace elements should be done by selecting a subset of samples (drill core, pulps, reject or similar) that represent lithologies/alterations spatially, including at minimum antimony, arsenic, cadmium, chromium, copper, cobalt, mercury, molybdenum, nickel, lead, selenium, thallium, uranium and zinc. Potential methods to evaluate are expanding the assay suite for a subset of spatially and lithologic/alteration representative inventoried drill core or pulp samples.

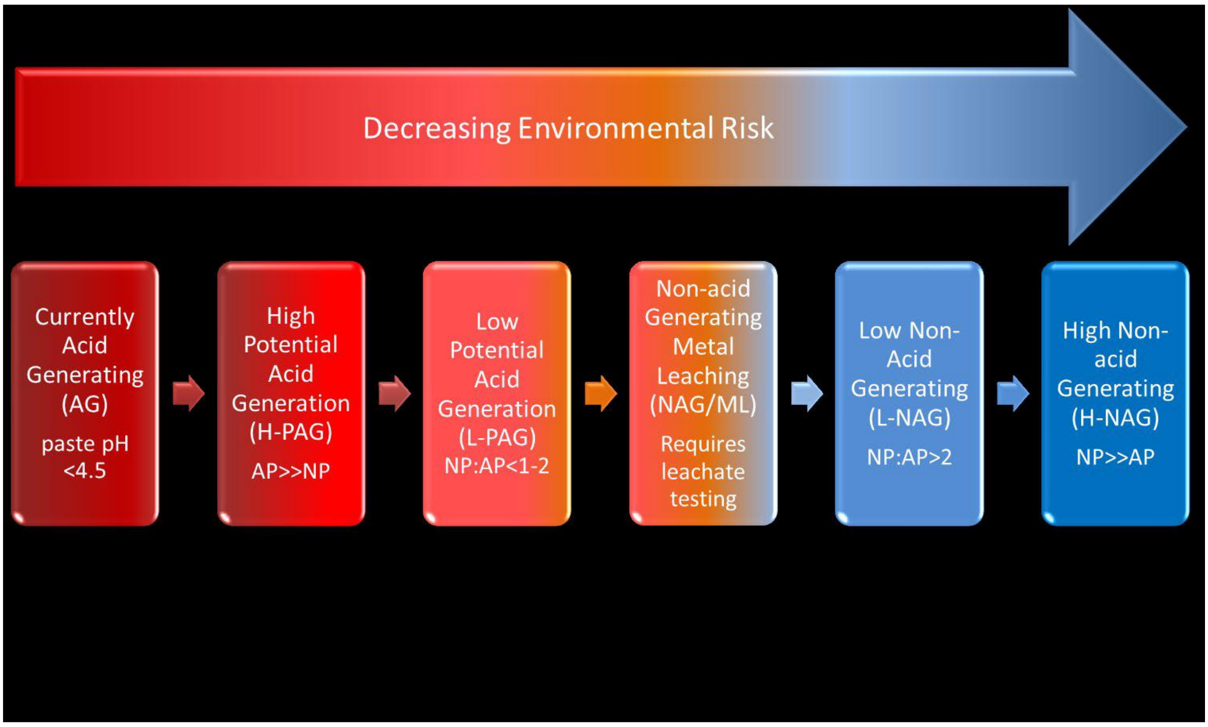

Figure 2-1: AMD/ML Risk Classification

- Implementation of a Quality Assurance and Quality Control (QA/QC) program for AMD/ML parameters. Particular attention should be placed on procuring or generating a matrix-specific sulphide-sulphur standard at appropriate concentrations to validate the neutralisation and acid potential.
- Commissioning of mineralogical studies of neutralising and acid-generating phases. Note that net-neutral carbonates, such as those incorporating reduced Fe or Mn, limit the overall neutralisation potential of earth materials in oxidising environments. Therefore, carbonate studies should include quantifying cationic ratios.
- Definition of the spatial resolution of AMD/ML data shall be dependent on deposit characteristics, type, size, variability of waste: ore ratios, lithology/alteration distribution and paragenetic sequence of AMD/ML minerals of interest. AMD/ML data and physical samples shall be kept and stored according to standard Mineral Resource Management procedures for subsequent AMD/ML assessments.

2.4. Acid-Base Accounting and Net Acid Generation

The acid-base assessment uses standardized laboratory methods to measure the equilibrium between acid-producing processes (such as the oxidation of Sulphide minerals) and acid-neutralizing processes (like the dissolution of alkaline carbonates, displacement of exchangeable bases, and the weathering of silicates). Acid-Base Accounting (ABA) according to Australian Minerals Industry Research Association Limited (AMIRA) comprises the following (AMIRA International Limited, 2002):

- **Chromium reducible sulphide** refers to the portion of sulphide minerals that can be chemically reduced using a chromium (II) reagent under controlled laboratory conditions. This method is commonly employed in geochemical analyses to quantify sulphide minerals, especially pyrite (FeS_2) and other metal sulphides, in geological samples. It provides a specific measurement of Sulphide minerals, distinguishing them from other forms of sulphur like Sulphate or organic sulphur. However, since not all sulphide minerals are equally reducible by chromium (II), this method may underestimate the total sulphide content in samples containing resistant sulphides.
- **Maximum Potential Acidity (MPA)** is determined by the Sulphur content which is assumed that Sulphur content occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid.
- **Acid Neutralising Capacity (ANC)** is the acid buffering quantified which reacts to the acid formed from pyrite oxidation within the sample. The ANC is commonly determined by a modified Sobek method (Sobek, et al., 1978). This method involves the addition of a known amount of standardised hydrochloric acid (HCl) to an accurately weighed sample, allowing the sample time to react (with heating), then back titrating the mixture with standardised sodium hydroxide (NaOH) to determine the amount of unreacted HCl. The amount of acid consumed by the reaction with the sample is then calculated.
- **Net Acid Producing Potential (NAPP)** is a theoretical calculation which represents the balance between the capacity of a sample to generate acid (MPA) and its capacity to neutralise acid (ANC). If the MPA is less than the ANC then the NAPP is negative, which indicates that the sample may have sufficient ANC to prevent acid generation. Conversely, if the MPA exceeds the ANC then the NAPP is positive, which indicates that the material may be acid-generating indicated in Table 2-2.
- **The ANC/MPA Ratio** purpose is to indicate the relative margin of safety (or lack thereof) within a material by assessing the risk of acid generation from mine waste materials. A positive NAPP is equivalent to an ANC/MPA ratio less than 1, and a negative NAPP is equivalent to an ANC/MPA ratio greater than 1. A NAPP of zero is equivalent to an ANC/MPA ratio of 1 indicated in Table 2-2.
- **Single Addition NAG Test** is used in association with the NAPP to classify the acid-generating potential of a sample. The Net Acid Generation (NAG) test involves the reaction of a sample with hydrogen peroxide to rapidly oxidise any sulphide minerals contained within a sample. During the NAG test, acid generation and acid neutralisation reactions can occur simultaneously. Therefore, the result represents a direct measurement of the net amount of acid generated by the sample.
- **$pH_{1:2}$ and Electrical Conductivity $(EC)_{1:2}$** of a sample is determined by equilibrating the sample in deionised water for 12 –16 hours (or overnight), at a solid-to-water ratio of 1:2 (w/w). This indicates the inherent acidity and salinity of the waste material when initially exposed in a waste emplacement area.

- **Carbon Speciation:** determines the amount of carbon in a sample such as total carbon, Total Organic Carbon (TOC) and Total Inorganic Carbon (TIC). Total carbon focuses on all the carbon in the sample, including both inorganic and organic carbon. TOC materials are derived from decaying vegetation, bacterial growth and metabolic activities of living organisms or chemicals. TIC is referred to as inorganic carbon, carbonate, bicarbonate and dissolved carbon.

Table 2-2: Criteria for Interpreting ABA Results (AMIRA International Limited, 2002)

Classification	NAPP	ANC/MPA	NAG-pH
Potentially Acid Generating (PAG) or Acid Generating (AG)	NAPP is positive	ANC/MPA < 1	NAG-pH <4.5
Uncertain and requires further characterization	NAPP = 0	ANC/MPA = 1	NAG-pH <4.5 and NAG-pH >4.5
Potentially Acid Neutralising (PAN)	NAPP is negative	ANC/MPA > 1	NAG-pH >4.5

2.5. Background Groundwater Quality

This section includes a discussion of the water monitoring programme that was conducted historically. One upgradient borehole and three boreholes for Western Porphyry and Tanjeel respectively were selected as Background Groundwater Quality (BGWQ) sampled between 2008 and 2009. The location and the summary of the results are indicated in Figure 2-2 and Table 2-3 respectively. The following is noted from the BGWQ:

- Neutral pH is observed in the Western Porphyry while in the Tanjeel area pH is acidic. The acidic nature of Tanjeel is due to the supergene depositional environment of the Tanjeel ore, where Sulphide minerals are oxidized in the process.
- The TDS ranges between 9 450 mg/L and 11 488 mg/L for Western Porphyry while for Tanjeel the ranges are between 11 900 mg/L to 14 515 mg/L. The contributors of Total Dissolved Solids (TDS) are salts (calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and Sulphates) with chlorides, sodium and Sulphates major contributors, which is a typical signature of groundwater that has had a long residence time within an aquifer and receives little to no recharge.

In summary, the natural groundwater is saline, predominantly with a neutral pH (except at Tanjeel, which is influenced by the oxidation of sulphide) with high total dissolved solids (more than 10,000 mg/L).

Table 2-3: Background Groundwater Quality

Parameters	WP		Tanjeel	
	Min	Max	Min	Max
Physicochemical Parameters				

Parameters	WP		Tanjeel	
	Min	Max	Min	Max
pH	7.20	7.75	3.20	3.70
EC mS/m	1420	1470	1790	20100
TDS mg/L	9450	11488	11900	16600
MALK mg/L	94	143	<2	<2
Cl mg/L	3450	4260	3580	4100
SO_4 mg/L	2520	3040	7290	9840
NO_3-N mg/L	<0.5	29	<5	3.25
NO_2-N mg/L	<0.5	17	<2	16
F mg/L	<0.5	3.29	<5	5.28
NH4 mg/L	<0.02	0.58	0.02	0.11
PO4 mg/L	<2	<0.05	<4	23.7
Metals/Metalloids				
Ag mg/L	<0.02	<0.002	20	223
Al mg/L	<0.02	0.44	<0.02	0.002
Sb mg/L	<0.0001	0.0008	<0.0001	0.0004
As mg/L	<0.005	0.007	<0.0003	0.0094
B mg/L	0.004	5.08	1.91	3.19
Ba mg/L	0.036	0.043	<0.01	0.014
Be mg/L	<0.01	<0.01	0.022	0.031
Bi mg/L	<0.03	<0.003	<0.03	<0.003
Ca mg/L	0.69	890	200	640
Cd mg/L	<0.0001	0.0003	0.11	0.16
Ce mg/L	<0.00001	0.001	0.001	0.008
Co mg/L	0.00005	0.004	1.04	1.27
Cr mg/L	<0.05	<0.005	<0.05	0.007
Cu mg/L	<0.02	0.041	2	16
Fe mg/L	<0.1	2.8	100	492
Hg mg/L	<0.02	<0.000001	<0.02	<0.0001
K mg/L	0.01	20	<3	23

Parameters	WP		Tanjeel	
	Min	Max	Min	Max
Li mg/L	0.16	0.23	67.1	87
Mg mg/L	0.22	283	200	1640
Mn mg/L	0.0009	2.67	0.46	0.64
Mo mg/L	<0.01	0.071	<0.01	0.005
Na mg/L	2.59	2620	350	3190
Ni mg/L	<0.03	0.10	1.41	1.84
Pb mg/L	0.0001	0.007	0.0037	0.27
Sc mg/L	<0.1	<0.01	<0.1	0.05
Se mg/L	<0.01	0.029	<0.02	0.031
Si mg/L	<20	16	50	69
Sn mg/L	<0.01	0.003	<0.01	0.004
Sr mg/L	0.18	4.78	0.0248	0.164
Ta mg/L	<0.0001	<0.00001	<0.0001	0.00007
Th mg/L	<0.0001	0.00064	0.0055	0.0088
Ti mg/L	<0.01	0.028	0.009	0.035
Tl mg/L	<0.0001	0.00002	0.002	0.002
U mg/L	0.00075	0.002	0.082	0.10
V mg/L	<0.01	0.005	0.004	0.025
W mg/L	0.0014	0.003	<0.002	0.0006
Y mg/L	<0.0003	0.00067	0.21	0.24
Yb mg/L	<0.0001	0.00004	0.0163	0.0198
Zn mg/L	0.00003	0.09	2.5	59
Zr mg/L	<0.0001	0.0005	<0.0001	28
WAD_CN mg/L	<0.0002	<0.0002	<0.0002	0.0003
CN Total mg/L	<0.00015	0.00015	<0.00015	0.00022

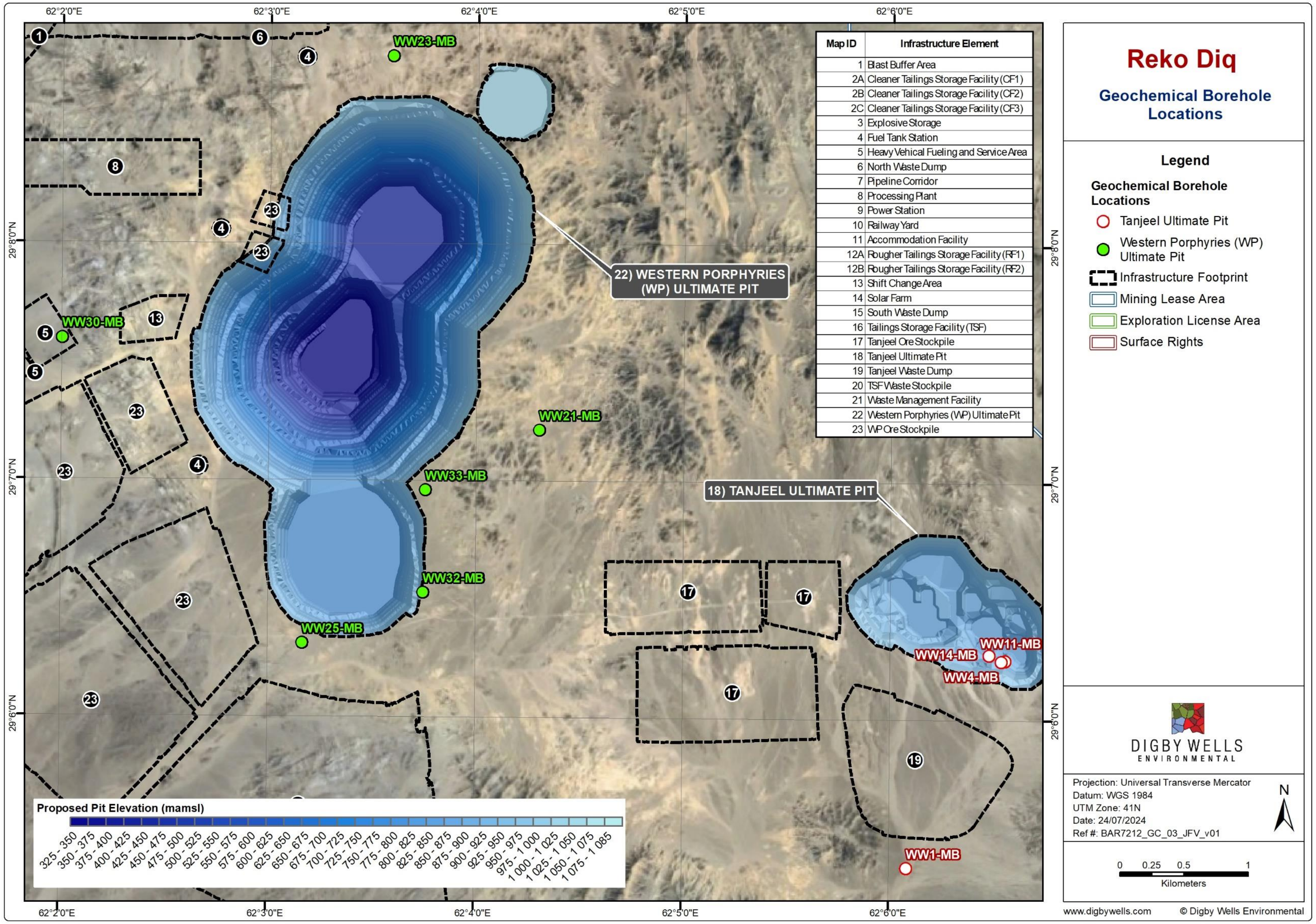

Figure 2-2: Borehole Locations

3. Geology

This section describes the regional geology of Balochistan and the local geology of the project area.

3.1. Regional Geology

Balochistan, Pakistan is in the Balochistan Super Basin consisting of volcanic, sedimentary, metasedimentary and marine environments from the Cretaceous to Pleistocene Period [23 – 0.01 million years (Ma)]. The basin is subdivided into Chagai-Raskoh magmatic arc, Wazhdad magmatic arc, Mashkel (Inter arcs basin), Kakar Khurasan (back-arc marginal flysch and molasses basin) and Makran-Siahan (arc-trench gap) basin (Geological Survey of Pakistan, 2017).

Pishin back-arc basin hosts sediments and metasediments including Cretaceous 2000 m thick Sharan Jogezai Group (hosting carbonates, mudstone and shale), 100m thick Paleocene Nisai Group (hosting limestone, marl and shale with subordinate sandstone and conglomerate), and Eocene Shagala Group including Eocene Murgha Faqirzai (marine shale and slates), Mina Formation (marine green shale and sandstone) and Shagala Formation (terrestrial mottled and maroon to red shale and sandstone with Pakitherium large rhino bearing) (Malkani, 2020; Malkani, 2022).

Chagai-Raskoh Basin are magmatic arc and the Chagai Desert shows Cretaceous to recent deposition with the Sinjrani Volcanic Group consisting of agglomerate, volcanic conglomerate, tuff and lava with subordinate shale, sandstone and limestone. It includes Basaltic-andesitic lava flows and volcaniclastics, with minor shale, sandstone, siltstone, and lenticular bodies of limestone and mudstone. Chagai Intrusions include quartz hornblende diorite, normal diorite and biotite granite. Humai Rakhshani Formation consists of conglomerate at the base, intercalations of shale, sandstone, siltstone and limestone in the middle and thick bedded to massive limestone at the top reported (Malkani, 2020; Malkani, 2022).

Hamuns Mashkela are inter arcs basin and represents exposed aeolian dunes covering the fluvial Pleistocene formations with conglomerate, sandstone and clays. The older rocks may be like Chagai-Raskoh magmatic arc and Wazhdad magmatic arc.

Wazhdad-Zurati Basin is a magmatic arc that represents the Eocene Siahan Group, and this includes slates and shale ophiolites intrusions and sandstone and shale and subrecent to recent alluvial, colluvial and eolian deposits (Malkani, 2020; Malkani, 2022).

Makran-Siahan Basin comprises of Cretaceous Sharan Jogezai Group consisting of Parh-like porcellaneous limestone, marl and shale. The Paleocene Nisai Group consists of Ispikan conglomerate and Wakai limestone and shale. Ispikan conglomerate consists of pebbles of quartz, granite, andesite, and other igneous rocks. The Matrix of conglomerate is chloritic (green). Siahan Group represents slates and shales of siltstone, sandstone and quartzite. Some thin limestone beds yielded fossils which show Eocene age. Wazhdad Volcaniclastic Group consists of tuff, agglomerate, tuff breccias, tuffaceous sandstone and shale. These rocks are dark green in colour and weather into dark grey to black colour, hard and resistant, forming high peaks. In Washuk Ophiolite Complex the rocks are granite, peridotite, bronze dunite, asbestos, (serpentine), soapstone (talc), and chromite. Toe Koh Intrusions consists of acidic rocks like granite. The possible age is Eocene or late Eocene. Makran Group: It is represented by Late Eocene to Oligocene and comprises shale with minor siltstone and sandstone. (Malkani, 2020; Malkani, 2022)

3.2. Local Geology

Western Porphyry is an intrusive rock complex consisting of several multiphase porphyritic diorite and tonalite intrusions emplaced with extensive hydrothermal alteration, veining and copper sulphide mineralisation. Several multiple-generation andesitic dykes and late-stage quartz veins also occur in this area. Drilling away from the intrusive cores intersect thick (250 to 280 meters) volcanics (oxidised and fresh andesite, trachyte and pyroclastics) overlying a sequence of sandstone, conglomerate, siltstone and limestone. Both volcanic and sedimentary rocks comprise the Reko Diq Formation (Figure 3-1). The Western Porphyry pit will be mined to a depth of 839 m and has a water level of 55 mbgl (Figure 1-3) (Digby Wells Environmental, 2024).

Tanjeel is a supergene enrichment deposit and is older than the Western Porphyry deposit. The rock is composed of quartz feldspar porphyry, felsic volcanics and intermediate volcanics. Some dykes and breccias are present. NW-SE and NE-SW-orientated structural lineations cross this supergene deposit. The fractures are infilled with pyrite, which in the oxidised zone leaches to produce low pH groundwater. The groundwater is currently around pH 3.5 and the deposit is still considered to be actively forming. The Tanjeel pit will be mined to a depth of 165 m and has a water level of 60 mbgl.

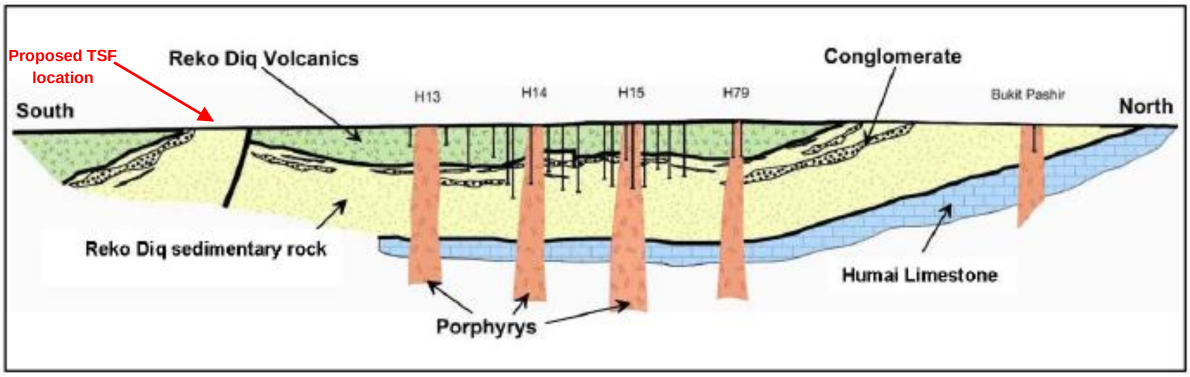

Figure 3-1: A simplified Cross Section of the Western Porphyry ((SMEC International (Pty) Ltd, 2010))

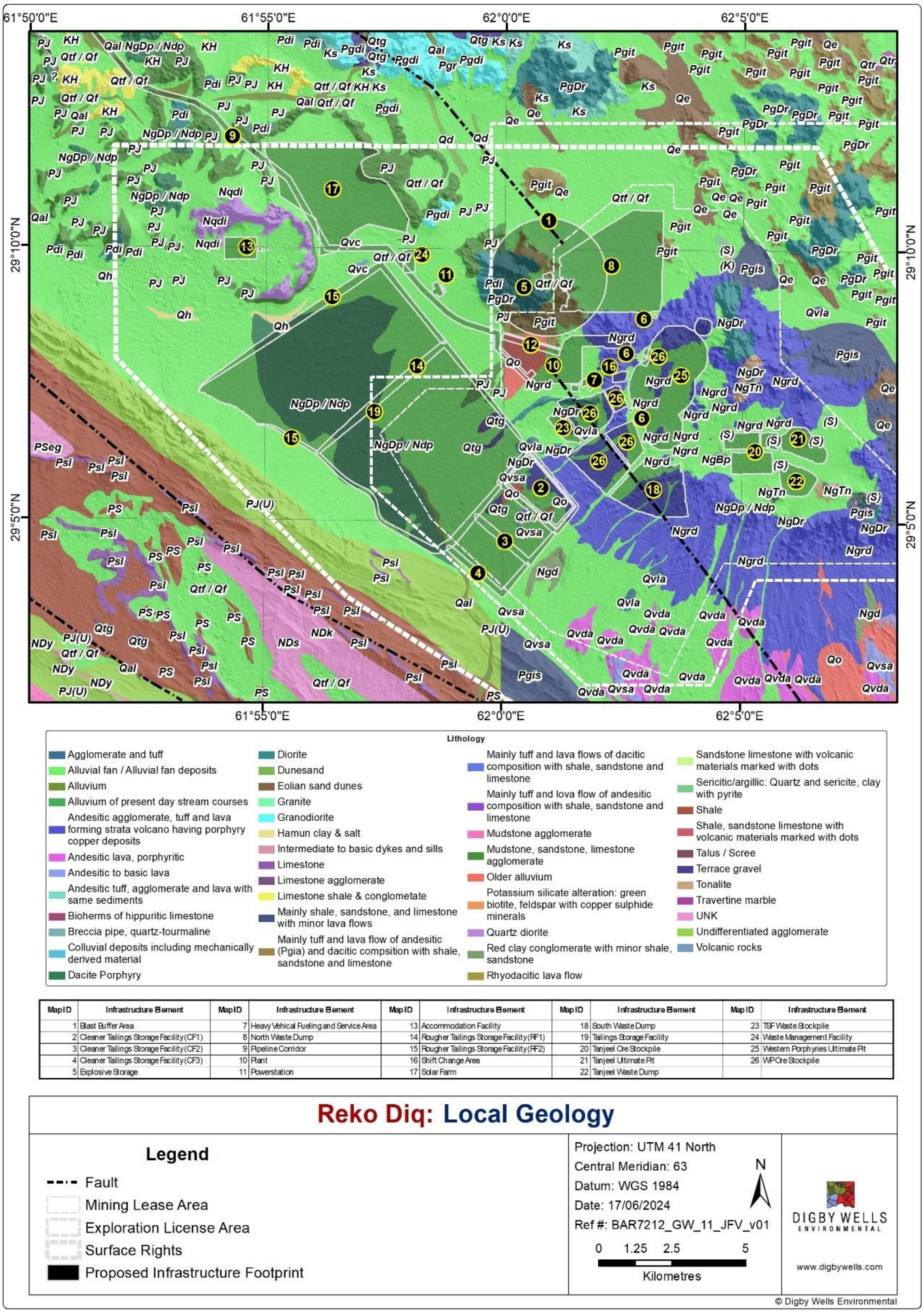

Figure 3-2: Geological Map of the Mine Site Area

4. Geochemistry

4.1. Introduction

An intensive geochemical study was conducted by SRK between 2009 and 2010. The project aimed to assess the potential for acid generation and metal leaching from stockpiled ore, waste rock, and tailings for the proposed Reko Diq project. Samples were collected from two proposed open pits, Western Porphyry and Tanjeel. SRK selected these samples to represent the pit material based on the projected tonnages to be extracted from each material type (SRK Consulting, 2010). Static test work was carried out on 413 samples from the Western Porphyry and Tanjeel prospects. This study has reviewed the results of the 2009 and 2010 study.

4.2. Reviewed documents

The reviewed documents included the following:

- Geochemical Characterisation and Prediction, Reko Diq Project, Pakistan Report (2010) by SRK:
    - Appendix A: Sampling Procedures and Summary;
    - Appendix B: Mineralogical Study;
    - Appendix C: Acid-Base Accounting;
    - Appendix D: Net Acid Generation Test;
    - Appendix E: Whole Rock Assay;
    - Appendix F: Static Leach Test;
    - Appendix G: Humidity Cell Testwork;
    - Appendix H: Kappa Testing;
    - Appendix J: Geochemical Modelling; and
    - Appendix K: Tailings Geochemical Characterisation.

4.3. Characteristics of Waste Rock: Western Porphyry 2010

4.3.1. Mineralogy

Western Porphyry consists of a potassic core surrounded by Phyllic fringes. The primary composition includes euhedral coarse-grained assemblages of feldspars, quartz, mica, and Sulphides. This core is often overprinted with sericitic, chloritic, and clay (SCC) alteration, resulting in a predominantly fine-grained replacement texture. The SCC alteration extends beyond the core or the intrusive body. Additionally, there are later formations of gypsum and quartz veins associated with Sulphides, primarily pyrite and chalcopyrite. The Sulphides are mostly encapsulated in silicates or tightly bound within a euhedral framework.

4.3.2. Acid Rock Drainage potential

Table 4-1 presents a summary of the ABA results for Western Porphyry waste rock, which showed the following:

- Most samples, 98%, fall into the Potentially Acid Forming (PAF) category. The only exceptions are minor breccia and oxide lithologies.
- The lithologies with the highest Sulphide content are VIN SCC, PFB SCC, and VIN MIX. For most samples, Sulphides account for less than 60% of the total Sulphur content, indicating that while Sulphides are the dominant form of Sulphur, significant amounts of Sulphate are also present.
- Microscopy and X-Ray Diffraction (XRD) analysis of selected samples have determined that anhydrite is the primary Sulphate phase.
- There is significantly less carbon compared to Sulphur, particularly Sulphide Sulphur. This general deficiency in carbonate, which neutralizes acid, poses a problem for managing acid generation in bulk storage of consolidated waste rock material.

In summary, more than 90% of the extracted rock is anticipated to be PAF. In the presence of water and oxygen, it is likely to generate metal-bearing acidic Sulphate leachate.

However, the encapsulated nature of sulphides at Western Porphyry suggests that this potential impact will take a considerable amount of time to manifest, likely in the order of decades. This is further compounded by the region's low humidity and high evaporation conditions.

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Table 4-1: Summary of Western Porphyry Waste Rock ABA Results (SRK Consulting, 2010)

ABA																	
Lithology	Alteration	no. of samples	Sulfur wt%			Sulfide wt%			Inorganic Carbon wt%			NPR			NNP (eq.kg(CaCO3)/t)		
			AVERAGE	MIN	MAX	AVERAGE	MIN	MAX	AVERAGE	MIN	MAX	AVERAGE	MIN	MAX	AVERAGE	MIN	MAX
VFL	SCC	n=5	2.8	1.2	5.0	1.2	0.5	1.8	0.0	0.0	0.1	0.0	0.0	0.1	-36.2	-55.3	-15.2
VIN	SCC	n=65	4.0	0.8	0.2	1.6	0.2	4.2	0.0	0.0	0.2	0.0	0.0	0.6	-48.4	-132.7	-5.3
PFB	SCC	n=37	2.9	0.3	5.8	1.4	0.0	2.9	0.0	0.0	0.2	0.1	0.0	0.6	-41.5	-85.8	0.9
PFB	POT	n=26	3.3	0.0	7.3	1.0	0.2	2.5	0.1	0.0	0.2	0.2	0.0	1.3	-26.1	-78.1	1.7
VFL	MIX	n=10	2.5	0.3	4.7	1.0	0.2	3.3	0.0	0.0	0.1	0.0	0.0	0.1	-30.9	-101.8	-6.8
VIN	MIX	n=21	3.8	0.0	7.0	1.6	0.2	3.3	0.0	0.0	0.1	0.0	0.0	0.6	-48.4	-103.8	-5.3
PFB	MIX	n=16	3.0	0.5	8.4	1.3	0.1	3.1	0.0	0.0	0.1	0.1	0.0	0.3	-39.8	-96.4	-4.3
VFL	POT	n=3	4.6	1.6	8.7	0.8	0.3	1.2	0.1	0.0	0.2	0.1	0.0	0.4	-18.9	-24.7	-10.1
VIN	POT	n=10	3.2	1.0	5.5	1.0	0.3	2.1	0.0	0.0	0.1	0.1	0.0	0.5	-28.5	-61.9	-7.0
LEA		n=1	0.8	0.8	0.8	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-1.6	-1.6	-1.6
Other Material Types		n=175	3.5	0.0	11.7	1.6	0.0	8.7	0.0	0.0	0.4	0.2	0.0	5.1	-45.9	-269.8	14.3

= PAF
= Field of Uncertainty
= NAF

4.3.3. Leaching potential

To determine the leaching characteristics, a suite of static tests was conducted, including two commonly used 24-hour leach tests: the Meteoric Water Mobility Procedure (MWMP) and a modified United States Environmental Protection Agency (USEPA) Synthetic Precipitation Leachate Protocol (EPA1312). The solutions from these tests were then analysed using multi-element Inductively Coupled Plasma (ICP) for cations and Ion Chromatography (IC) for anions. This analysis identified potential mobile chemical phases that are likely to be environmentally available due to their reactivity.

The leachate concentrations were evaluated against the World Health Organization's (WHO) drinking water guidelines or guidelines for the protection of aquatic life in the case of Ag, Al, Sn and Zn. The results are summarised in Table 4-4. The identified constituents of concern in the leachates from Western Porphyry waste rock included aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulphate, nitrate, lead, fluoride, boron, silver, and tin.

In summary, there is little potential for environmental impacts to groundwater at Reko Diq due to the extremely low infiltration rates predicted from hydrogeological modelling, the depth of groundwater across the site and the highly mineralized, saline nature of groundwater. Despite some of the static test work predictions (such as ABA), acid generation and metal leaching are not considered to be a major environmental issue at Western Porphyry.

Table 4-2: Summary of Leachate Components from Western Porphyry and Tanjeel Waste Rock ((SRK Consulting, 2010)

	Lithology	Alteration	Material Type	ARD Class	Constituents Commonly Elevated in Leachates
Western Porphyry	Volcanic fine laminated	Sericitic+Chlorite+Clay	VFL-SCC	NAF/LPAF	Aluminium, cadmium, manganese, selenium, silver, tin
	Volcanic intermediate	Sericitic+Chlorite+Clay	VIN-SCC	NAF/LPAF	Cadmium, copper, manganese, silver, tin, zinc
	Porphyry feldspar	Sericitic+Chlorite+Clay	PFB-SCC	LPAF/HPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, lead, selenium, silver, tin
	Porphyry feldspar	Potassic	PFB-POT	LPAF/HPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, fluoride, silver, tin
	Volcanic fine laminated	Mixed between Potassic & SCC	VFL-MIX	NAF/LPAF	Aluminium, manganese, silver, tin
	Volcanic intermediate	Mixed between Potassic & SCC	VIN-MIX	NAF/LPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, fluoride, silver, tin
	Porphyry feldspar	Mixed between Potassic & SCC	PFB-MIX	NAF/LPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, silver, tin
	Volcanic intermediate	Potassic	VIN-POT	LPAF/HPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, fluoride, silver, tin
	Other		Others	NAF/LPAF/HPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, fluoride, silver, tin
	Volcanic fine laminated	Potassic	VFL-POT	NAF/LPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, lead, silver, tin
	Leached overburden		Leach cap	NAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, lead, fluoride, boron, silver, tin
Tanjeel	Volcanic mafic-andersite	Sericitic+Chlorite+Clay	VMA-SCC	NAF	
	Volcanic intermediate	Sericitic+Chlorite+Clay	VIN-SCC	NAF/LPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, antimony, mercury, silver, tin
	Volcanic intermediate	Phyllite	VIN-PHY	LPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, mercury, silver, tin
	Volcanic intermediate	Leached cap	VIN-LEA	NAF/LPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, mercury, silver, tin
	Porphyry breccia tectonic	Leached cap	PBT-LEA	LPAF/HPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, antimony, lead, mercury, selenium, silver, tin
	Porphyry breccia tectonic	Sericitic+Chlorite+Clay	PBT-SCC	NAF/LPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, mercury, selenium, silver, tin
	Other		Other	NAF/LPAF/HPAF	Aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulfate, nitrate, antimony, silver, tin
Based on 75th percentile being greater than the World Health Organisation (WHO) drinking water guidelines or for the protection of aquatic life in the case of Ag, Al, Sn, and Zn					

4.4. Characteristics of Waste Rock: Tanjeel 2010

4.4.1. Mineralogy

The Tanjeel deposit is characterised by highly oxidized and leached alteration assemblages, as indicated by the increased presence of iron oxides such as hematite and goethite in most samples. While some sulphides appear as massive crystals, they are generally found as disseminated phases within the fine-grained matrix.

4.4.2. Acid Rock Drainage Potential

The 2010 study analysed 42 samples from 16 different material types from the Tanjeel (H4) prospect. Table 4-3 presents a summary of the ABA results, which showed the that the majority, 95%, of the samples fall in the PAF field.

In contrast to Western Porphyry, the material at Tanjeel exhibits a more oxidized nature, with greater exposure of Sulphides in waste rock, pit walls, and stockpiled ore. This increases the potential for acid generation.

Additionally, groundwater at Tanjeel utilizes the same fractures as the mineralization, resulting in in-situ partial oxidation. Consequently, the material displays a higher reactivity, even though its total potential for acid generation is lower when compared to Western Porphyry.

4.4.3. Leaching Potential

SRK evaluated the predicted drainage and surface runoff water quality concentrations at the Reko Diq Project site against specific project design criteria for drinking water supply, as outlined in the Environmental Design Criteria and Guidance Report (SRK, 2009b).The leachate concentrations were evaluated against the World Health Organization's (WHO) drinking water guidelines or guidelines for the protection of aquatic life in the case of Ag, Al, Sn and Zn. The results are summarised in Table 4-2. The identified constituents of concern in the leachates from Tanjeel waste rock included aluminium, iron, manganese, low pH, arsenic, copper, zinc, cadmium, cobalt, nickel, molybdenum, sulphate, nitrate, lead, selenium, antimony, mercury, fluoride, boron, silver, and tin.

Tanjeel's materials exhibit a propensity for early acid generation due to factors such as increased exposure of Sulphide to oxygen and water, as well as the presence of secondary Sulphide mineralization within water-conducting fractures. In addition, Tanjeel baseline groundwater contains high trace metals and is acidic due to in-situ oxidation of Sulphide by contacted groundwater.

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Table 4-3: Summary of the 2010 ABA Results for Tanjeel (SRK Consulting, 2010)

Reko Diq Static Database - Tanjeel | Leco

Core	Prospect	Material Type	Lith	Alt	Depth (m)		Sulfur (weight % as S)			Carbon (weight % as C)			AP (Calculated from Sulfide	NP (Calculated from	NPR	NNP
					From	To	Total Sulfur	Total Sulfide	Total Sulfate	Total Carbon	Total Org C	Total Inorg	kg (CaCO3)/t			kg (CaCO3)/t
RDRC130	H4	Porphyry Tectonic Breccia - Leach cap	PBT	LEA	5	20	3.54	2.50	1.05	0.09	0.08	0.01	78.03	0.90	0.01	-77.14
RDRC130	H4	Porphyry Tectonic Breccia - Leach cap	PBT	LEA	30	45	3.57	3.31	0.26	0.03	0.04	0.00	103.51	0.00	0.00	-103.51
RDRC130	H4	Porphyry Tectonic Breccia - Sericite + Chlorite + Clay	PBT	SCC	60	80	2.86	2.35	0.51	0.07	0.08	0.00	73.54	0.00	0.00	-73.54
RDDC229	H4	Porphyry Feldspar Biotite - Leach Cap	PFB	LEA	1	3	2.03	2.46	0.00	0.06	0.07	0.00	76.88	0.00	0.00	-76.88
RDDC229	H4	Porphyry Feldspar Biotite - Leach Cap	PFB	LEA	34	36	1.92	1.72	0.20	0.09	0.09	0.00	53.60	0.00	0.00	-53.60
RDDC229	H4	Porphyry Feldspar Biotite - Phyllic	PFB	PHY	75	77	1.05	0.18	0.87	0.33	0.11	0.22	5.51	18.72	3.40	13.21
RDRC162	H4	Porphyry Feldspar Quartz - Leach Cap	PFQ	LEA	0	9	3.95	2.50	1.44	0.04	0.05	0.00	78.28	0.00	0.00	-78.28
RDRC162	H4	Porphyry Feldspar Quartz - Leach Cap	PFQ	LEA	33	35	3.36	1.82	1.54	0.03	0.06	0.00	56.89	0.00	0.00	-56.89
RDDC220	H4	Porphyry Feldspar Quartz - Leach Cap	PFQ	LEA	1	3	5.33	6.16	0.00	0.30	0.29	0.01	192.37	0.71	0.00	-191.66
RDDC220	H4	Porphyry Feldspar Quartz - Leach Cap	PFQ	LEA	33	35	6.17	5.41	0.76	0.16	0.15	0.01	169.08	1.14	0.01	-167.94
RD541	H4	Porphyry Feldspar Quartz - Oxidised	PFQ	OXI	5	20	1.87	0.79	1.08	0.08	0.05	0.04	24.77	2.96	0.12	-21.80
RD542	H4	Porphyry Feldspar Quartz - Oxidised	PFQ	OXI	5	20	1.57	0.54	1.04	0.11	0.10	0.00	16.74	0.31	0.02	-16.43
RD542	H4	Porphyry Feldspar Quartz - Oxidised	PFQ	OXI	30	45	1.04	0.18	0.85	0.06	0.07	0.00	5.76	0.00	0.00	-5.76
RD541	H4	Porphyry Feldspar Quartz - Phyllic	PFQ	PHY	25	35	5.03	4.36	0.67	0.04	0.08	0.00	136.39	0.00	0.00	-136.39
RD541	H4	Porphyry Feldspar Quartz - Phyllic	PFQ	PHY	95	105	4.77	4.22	0.54	0.07	0.09	0.00	131.99	0.00	0.00	-131.99
RDRC162	H4	Porphyry Feldspar Quartz - Potassic	PFQ	POT	72	74	3.03	2.26	0.77	0.03	0.04	0.00	70.69	0.00	0.00	-70.69
RDDC220	H4	Porphyry Feldspar Quartz - Sericite + Chlorite + Clay	PFQ	SCC	74	76	3.37	2.94	0.43	0.18	0.22	0.00	91.75	0.00	0.00	-91.75
RD542	H4	Porphyry Feldspar Quartz - Sericite + Chlorite + Clay	PFQ	SCC	50	60	3.50	2.57	0.92	0.02	0.10	0.00	80.41	0.00	0.00	-80.41
RD542	H4	Porphyry Feldspar Quartz - Sericite + Chlorite + Clay	PFQ	SCC	70	85	4.31	3.68	0.63	0.10	0.09	0.01	114.91	0.82	0.01	-114.09
RD542	H4	Porphyry Feldspar Quartz - Sericite + Chlorite + Clay	PFQ	SCC	100	115	2.58	1.82	0.76	0.05	0.08	0.00	56.87	0.00	0.00	-56.87
RD542	H4	Porphyry Feldspar Quartz - Sericite + Chlorite + Clay	PFQ	SCC	135	150	2.21	1.56	0.65	0.25	0.27	0.00	48.80	0.00	0.00	-48.80
RD543	H4	Porphyry Quartz Feldspar - Leach Cap	PQF	LEA	5	20	1.10	0.25	0.85	0.12	0.12	0.00	7.89	0.07	0.01	-7.81
RD543	H4	Porphyry Quartz Feldspar - Leach Cap	PQF	LEA	27	37	1.56	0.70	0.86	0.06	0.11	0.00	21.83	0.00	0.00	-21.83
RD543	H4	Porphyry Quartz Feldspar - Phyllic	PQF	PHY	40	55	4.57	4.06	0.51	0.08	0.08	0.00	126.76	0.00	0.00	-126.76
RD543	H4	Porphyry Quartz Feldspar - Phyllic	PQF	PHY	75	90	7.41	7.89	0.00	0.04	0.08	0.00	246.65	0.00	0.00	-246.65
RD543	H4	Porphyry Quartz Feldspar - Sericite + Chlorite + Clay	PQF	SCC	110	125	4.13	3.59	0.54	0.05	0.06	0.00	112.15	0.00	0.00	-112.15
RDDT171	H4	Volcanic Intermediate-Coarse Porphyritic - Leach cap	VIN	LEA	5	20	4.69	4.02	0.67	0.06	0.08	0.00	125.66	0.00	0.00	-125.66
RDDT171	H4	Volcanic Intermediate-Coarse Porphyritic - Leach cap	VIN	LEA	30	40	4.34	3.42	0.91	0.02	0.05	0.00	107.01	0.00	0.00	-107.01
RDRC167	H4	Volcanic Intermediate-Coarse Porphyritic - Leach cap	VIN	LEA	5	20	5.00	4.37	0.63	0.08	0.04	0.04	136.43	2.96	0.02	-133.46
RDDC221	H4	Volcanic Intermediate-Coarse Porphyritic - Leach cap	VIN	LEA	1	3	2.42	0.02	2.40	0.17	0.08	0.10	0.67	8.22	12.32	7.55
RDDC221	H4	Volcanic Intermediate-Coarse Porphyritic - Leach cap	VIN	LEA	33	35	3.93	3.72	0.21	0.30	0.30	0.00	116.32	0.00	0.00	-116.32
RD540	H4	Volcanic Intermediate-Coarse Porphyritic - Oxidised	VIN	OXI	5	25	0.82	0.13	0.69	0.02	0.04	0.00	4.03	0.00	0.00	-4.03
RD540	H4	Volcanic Intermediate-Coarse Porphyritic - Oxidised	VIN	OXI	30	45	1.24	0.34	0.90	0.04	0.08	0.00	10.74	0.00	0.00	-10.74
RDDT176	H4	Volcanic Intermediate-Coarse Porphyritic - Phyllic	VIN	PHY	102	113	6.19	5.62	0.57	0.01	0.03	0.00	175.64	0.00	0.00	-175.64
RDRC167	H4	Volcanic Intermediate-Coarse Porphyritic - Phyllic	VIN	PHY	65	72	3.55	3.02	0.53	0.10	0.05	0.04	94.49	3.54	0.04	-90.95
RDRC167	H4	Volcanic Intermediate-Coarse Porphyritic - Phyllic	VIN	PHY	140	165	6.51	5.67	0.85	0.04	0.10	0.00	177.05	0.00	0.00	-177.05
RDDC221	H4	Volcanic Intermediate-Coarse Porphyritic - Phyllic	VIN	PHY	72	74	8.07	6.73	1.34	0.16	0.21	0.00	210.40	0.00	0.00	-210.40
RD540	H4	Volcanic Intermediate-Coarse Porphyritic - Phyllic	VIN	PHY	60	75	2.89	2.35	0.53	0.03	0.05	0.00	73.56	0.00	0.00	-73.56
RD540	H4	Volcanic Intermediate-Coarse Porphyritic - Phyllic	VIN	PHY	110	120	3.68	3.05	0.63	0.05	0.09	0.00	95.45	0.00	0.00	-95.45
RDDT171	H4	Volcanic Intermediate-Coarse Porphyritic - Sericite + Chlorite + Clay	VIN	SCC	105	125	5.24	4.97	0.27	0.03	0.04	0.00	155.41	0.00	0.00	-155.41
RD540	H4	Volcanic Intermediate-Coarse Porphyritic - Sericite + Chlorite + Clay	VIN	SCC	85	95	2.95	2.43	0.52	0.04	0.06	0.00	75.98	0.00	0.00	-75.98
RD541	H4	Volcanic Intermediate-Coarse Porphyritic - Sericite + Chlorite + Clay	VIN	SCC	120	135	5.32	4.71	0.61	0.08	0.10	0.00	147.16	0.00	0.00	-147.16

= High Sulfur
= High Carbon

= PAF
= Field of Uncertainty
= NAF

4.5. Tailings Characteristics

4.5.1. Mineralogy

The Rougher tailings primarily consist of insoluble silicates, including feldspar and quartz, as well as iron oxides, mainly hematite and goethite. There are also small amounts of barite and celestine, often found within the silicates. Additionally, there are minor traces of Sulphides, which are encapsulated within silicates and Sulphates.

The Cleaner Tailings contain a high concentration of Sulphide material, with pyrite constituting about 12% of the total mass.

4.5.2. Acid Mine Drainage Potential

Table 4-4 presents a summary of the 2010 ABA results for tailings samples. The results indicated the following:

- Both the rougher and cleaner tailings samples lack carbonate buffering capacity.
- Cleaner tailings contain between 6% and 23% Sulphide, indicating a high potential for acid generation. They are also characterised by very high Sulphate concentrations, exceeding 2 g/L.
- Rougher tailings generally contain less than 0.5% Sulphide, which means they have a negligible potential for generating acid. Although they lack significant buffering capacity and may seem potentially acid forming based on their Net Neutralization Potential (NNP), they are more accurately classified as inert.

Table 4-4: Summary of the 2010 ABA Results for Tailings Samples

		Sulfur (weight % as S)				Carbon (weight % as C)				AP	NP	NPR	NNP
		Total Sulfur	Total Sulfide	Total Sulfate		Total Carbon	Total Org C	Total Inorg C		kg (CaCO3)/t			kg (CaCO3)/t
Tailings	Cleaner	9.9	10.41	0.0		0.1	0.1	0.0		325.4	0.0	0.000	-325
Tailings	Rougher	0.2	0.11	0.1		0.2	0.2	0.0		3.5	0.0	0.000	-3

4.5.3. Leaching Potential

The leachate concentrations were evaluated against the WHO drinking water guidelines or guidelines for the protection of aquatic life in the case of silver, aluminium, tin and zinc. The results are summarised in Table 4-5. The geochemical characteristics of the tailings exhibit variability, contingent upon their composition.

Table 4-5: Leachate Results for Tailings (the concentrations in red are at detection limits)

Tailings	pH	Electrical Conductivity	Fluoride	Chloride	Alkalinity	Sulfate	Aluminium	Antimony	Arsenic	Beryllium	Bismuth	Boron	Cadmium	Calcium
	pH Units	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Cleaner Tailings	8.10	5390.00	1.10	824.00		2340.00	0.06	0.00	0.00	0.01	0.01	3.80	0.00	616.00
Rougher Tailings	8.10	5270.00	0.80	830.00	78.30	2120.00	0.06	0.00	0.00	0.01	0.01	3.30	0.00	658.00

Tailings	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Sodium	Strontium	Tellurium	Uranium	Zinc
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Cleaner Tailings	0.01	0.01	0.08	0.05	0.01	2.50	0.00	0.25	0.10	611.00	17.20	0.10	6.70	0.02
Rougher Tailings	0.01	0.01	0.01	0.05	0.01	1.10	0.00	0.04	0.03	649.00	8.20	0.10	7.60	0.02

4.5.3.1. Cleaner Tailings

The leachate results for Cleaner Tailings indicate the following:

- They are characterised by concentrations of leachable metals that exceed established water quality and risk assessment guidelines.
- Additionally, cleaner tailings exhibit very high sulphate concentrations, surpassing 2 g/L, and have a low leachate pH, typically around pH 2.

4.5.3.2. Rougher Tailings

Leachable metal levels in rougher tailings generally fall below comparative water quality guidelines, with sulphate values below 500 mg/L. The pH of these tailings typically ranges from mildly acidic to circum-neutral, around pH 6.

By comparison the lower Sulphide content in the rougher tailings results in a lower overall metal release and higher pH and a much slower evaluation of acidic metal-leaching conditions than with the cleaner tailings.

4.5.3.3. Mixed Tailings

Mixed tailings tend to exhibit leaching characteristics like cleaner tailings, suggesting that the chemistry of cleaner tailings prevails and influences the solute chemistry in mixed tailings.

In summary, the geochemical characteristics of the tailings exhibit significant variation based on their composition and Sulphide content. Cleaner tailings pose a higher risk of acid generation and leaching of metals, while rougher tailings are relatively inert in this regard. Mixed tails tend to inherit the leaching characteristics of cleaner tailings.

4.6. Ore Characteristics

The ore material directed to the stockpiles will exhibit a copper grade ranging from 0.18 to 0.4 wt%. The test results indicated that all samples from the stockpiles possess the potential for acid generation. Consequently, any leachate produced will exhibit low pH levels and elevated concentrations of Sulphate, aluminium, iron, copper, cadmium, zinc, and manganese.

It is worth noting that materials with lower copper grades tend to exhibit a more pronounced level of acid generation and lower pH values in the leachate. This phenomenon can be attributed to the increased pyrite content present in the lower-grade material.

4.7. Humidity Cell Tests

Phase 1 humidity cell samples were run for a total of 60 weeks. The results of the humidity cell tests indicated the following:

- The initial leachate chemistry predicted from the humidity cell tests are consistent with the predictions from the static leachate tests with acidic to neutral pH accompanied by high Sulphate concentrations and the presence of trace metals such as aluminium, iron, manganese, copper, cadmium, lead and zinc as well as trace fluoride.

- The limited availability of buffering material for the Reko Diq material is reflected in the fact that sixteen of the twenty humidity cell tests indicate complete consumption of available buffering by week 20 of the 60-week test work period. This loss of neutralising capability manifests in decreasing pH values, which correspondingly causes metal concentrations in the leachate to increase. Sulphate is shown to be mostly controlled by gypsum dissolution for most cells. Those with Sulphate/calcium + magnesium values higher than 1 indicate the occurrence of Sulphide oxidation.
- Tanjeel Sulphide waste rock and the cleaner tailings all produce acidic, metal-Sulphate rich leachates throughout much of the humidity cell program, indicating the reactivity is higher from this material. The reason for this is the higher proportion of Sulphide that is exposed to oxygen and water. In addition, at Tanjeel, the secondary Sulphide mineralisation is located within fractures that also channel water so shows greater in-situ oxidation than similar mineralisation in Western Porphyry that are either encapsulated in gangue or located in dry fractures.
- Consequently, although empiric analysis such as ABA implies a high potential for acid generation, the “reactive” portion of acid generating materials is much less and the acid-generating potential is greatly reduced. The remaining Sulphides identified in the humidity sample test residues were encapsulated in silicates or secondary iron oxyhydroxides (or in one case in gypsum cement). These remaining Sulphides are likely to be released only after some period of weathering of the silicates.
- The results of static reactive tests and kinetic tests show that the material at Western Porphyry will require long periods of exposure to create acidic conditions. In comparison, acidic conditions may be generated early in the mining cycle at Tanjeel.
- The lower sulphide content in the rougher tailings results in a lower overall metal release and higher pH and a much slower evolution of acidic metal-leaching conditions than with the cleaner tailings.

4.8. Summary

A total of 369 samples were analysed: 194 samples from the 10 major lithologies and 175 samples from 50 minor lithologies. A summary the Western Porphyry geochemistry is presented Table 4-6 and a summary of Tanjeel and Tailings geochemistry are presented in Table 4-7. The following observations are noted:

- **Western Porphyry**
  - The geochemical test work indicates that the majority (more than 90%) of extracted rock is predicted to be PAF and given sufficient water and oxygen will eventually generate metal-bearing acidic Sulphate leachate. Due to the encapsulated nature of Sulphides at Western Porphyry, this potential will take a

long time to be realized (on the order of decades) especially given the low humidity and high evaporation environment. The Western Porphyry material generates neutral, low metal moderate Sulphate leachate in the static tests and for most of the kinetic tests, it takes more than 30 weeks to generate higher metal concentrations and lower pH conditions.

- In summary, although acidic metal drainage will occur with the Western Porphyry waste rock, stockpiles and pit walls the low moisture content in the waste rock, the depth to groundwater and groundwater chemistry coupled with low reactivity of the material will limit the potential for AMD/ML to have an impact at this site. Consequently, despite some of the static test work predictions (such as ABA), acid generation and metal leaching are not considered to be an environmental issue at Western Porphyry.

- **Tanjeel**
  - At Tanjeel, by contrast, the more oxidised nature of the material and greater exposure of Sulphide in waste rock, pit wall and stockpiled ore results in a higher potential for realization of acid generation. Coupled with this, groundwater utilises the same fractures as the mineralisation and so in-situ partial oxidation has occurred thus the material has a higher reactivity even if it has a lower total potential when compared to the Western Porphyry material types.
  - Overall, there is little potential for environmental impacts on groundwater at Reko Diq due to the extremely low infiltration rates predicted from hydrogeological modelling, the depth of groundwater across the site and the highly mineralised, saline nature of groundwater. In the case of Tanjeel, baseline groundwater contains high trace metals and is acidic due to in-situ oxidation of Sulphides by contacted groundwater.

- **Tailings**
  - The geochemical characteristics of the tailings are variable depending on the fraction of the tailings. Cleaner tailings contain between 6% and 23% sulphide have a high potential for acid generation and are characterised by concentrations of leachable metals above comparative water quality and risk assessment guidelines. The cleaner tailings are also characterised by very high Sulphate concentrations (above 2 g/L) and a low leachate pH (pH ~2).
  - Rougher tailings typically contain less than 0.5% Sulphide and as such have negligible acid-generating potential. The rougher tailings also have negligible buffering, so appear to be potentially acid forming in NNP, but are better classed as inert. Leachable metals are generally below comparative water quality guidelines and risk assessment guideline values. Sulphate values are generally below 500 mg/L, and the pH is mildly acidic to circum-neutral (pH 6). Mixed tails (Phase IV only) generally show leaching characteristics like cleaner tailings,

indicating that the chemistry of the cleaner tailings dominates the solute chemistry in the mixed tails. Humidity Cell tests indicate a lag time between acid generation and initial leaching of tailings in the cells (more than 10 weeks in the humidity cells) Addition of lime to the mixed tails would require a high dose (above 2% lime) for some neutralisation of the mixed tailings.

  - Judging by static data, the rate of metal release and acid generation from the cleaner tailings is higher than observed with the wall rocks, presumably related to the finer grain size and higher Sulphide content resulting from the concentration process. By comparison, the lower Sulphide content in the rougher tailings results in a lower overall metal release and higher pH and a much slower evaluation of acidic metal-leaching conditions than with the cleaner tailings.

- The ore material sent to the stockpiles will have a copper grade between 0.18 to 0.4 wt.%. Test results show that all stockpile samples are potentially acid-forming and that any leachate generated will be characterised by low pH and elevated concentrations of Sulphate, aluminium, iron, copper, cadmium, zinc and manganese. Material with a low copper grade will typically result in a higher magnitude of acid generation and lower leachate pH values. This is a function of the higher pyrite content of the low-grade material.

Table 4-6: Summary of Western Porphyry Geochemistry

Lithology	Lithology Code	Sample Number	ABA					NAG			GAI (>=3)	Leachate (seepage) quality	
			Total Sulphur	Total Sulphate	Total Sulphide (%)	Total Carbon (%)	NPR	NAG pH	NAG kg H_2SO_4/t	Class.		pH	CoCs
Volcanic Fine Laminated – Sericite+Chlorite+Clay	VFL SCC	5	1.2 – 5.0	0.7 – 3.2	0.5 - 1.9	1.2 - 5.0	0.01-0.1	Acidic (NAG pH 2.90 - 3.50)	8.3 - 18	100% PAF	Cu, Mo, Re, S, Se, Te	neutral pH (6.90 - 7.40)	SO_4
Volcanic Intermediate - Coarse Porphyritic – Sericite+Chlorite+Clay	VIN SCC	65	0.8 – 8.2	0 – 7.8	0.2 - 4.3	0 - 0.6	0 - 0.6	Acidic to neutral (NAG pH 2.20 - 7.10)	4.5 - 20	100% PAF	Cu, Mo, Re, S, Se, Te	acidic to neutral pH (3.90 - 7.40)	SO_4, Cl
Porphyry Feldspar Biotite – Sericite+Chlorite+Clay	PFB SCC	37	0.3 – 5.8	0.1 – 4.8	0 - 2.9	0 - 0.6	0 - 0.6	Acidic (NAG pH 2.40 - 6.10)	0.3 - 16.5	100% PAF	Cu, Mo, Re, S, Se, Te	acidic to neutral pH (4.50 - 7.90)	SO_4, Cl
Porphyry Feldspar Biotite – Potassic	PFB - POT	26	0 – 7.3	0 – 5.5	0.2 - 2.5	0.1 - 0.5	0 - 1.3	Acidic (NAG pH 3.70 - 5.50)	1.4 - 10.4	100% PAF	Ag, Cu, Mo, Re, S, Se, Te	acidic to mildly alkaline pH (5.00 - 7.80)	SO_4, Cl
Volcanic Fine Laminated – Mixed	VFL MIX	10	0.3 – 4.7	0 – 3.8	0.2 - 3.3	0 - 0.1	0 - 0.14	Acidic (NAG pH 2.70 - 5.10)	8.0 - 21.0	100% PAF	Cu, Mo, Re, S, Se	neutral pH (6.80 - 7.40)	SO_4
Volcanic Intermediate - Coarse Porphyritic – Mixed	VIN MIX	21	0 – 7.0	0 – 5.5	0.2 - 3.3	0 - 0.7	0 - 0.59	Acidic (NAG pH 2.40 - 5.70)	2.5 - 21.0	100% PAF	Cu, Mo, Re, S, Se, Te	acidic to neutral pH (4.90 -7.40)	SO_4, Cl
Porphyry Feldspar Biotite – Mixed	PFB MIX	16	0.5 – 8.4	0 – 7.3	0.1 - 3.1	0 - 0.4	0 - 0.3	Acidic (NAG pH 2.50 - 5.20)	5.0 - 31.6	100% PAF	Ag, Cu, Mo, Re, S, Se, Te	neutral pH (7.10 - 7.70)	SO_4, Cl
Volcanic Fine Laminated – Potassic	VFL - POT	3	1.6 – 8.7	0.8 – 7.6	0.3 - 1.2	0 - 0.2	0 - 0.4	Acidic (NAG pH 3.40 - 5.70)	1.1 - 7.9	100% PAF	Ag, Bi, Cu, Mo, Re, S, Se, Te	neutral pH (6.90 - 7.20)	SO_4
Volcanic Intermediate - Coarse Porphyritic – Potassic	VIN - POT	10	1.6 – 5.5	0.3 – 4.6	0.3 - 2.1	0 - 0.1	0 - 0.5	Acidic (NAG pH 2.60 - 7.20)	6.9 - 14.8	100% PAF	Ag, Cu, Mo, Re, S, Se, Te	neutral pH (6.70 - 7.50)	SO_4, Cl
Volcanic Intermediate - Coarse Porphyritic - Leach cap	VIN LEA	1	0.8	0.7	0.05	0	0	Acidic (NAG pH 5.00)	10.9	100% PAF	Ag, Bi, Cu, S, Se, Te	neutral pH of 7.90	SO_4
Other Material Types	50 lithology codes	175	0 - 12	0 – 6.2	0 – 8.	0 - 0.5	0 - 5.1	Acidic to neutral (NAG pH 2.20 - 7.70)	0.3 - 17.5	100% PAF			

Table 4-7: Summary of Tanjeel and Tailings Geochemistry

Lithology	Lithology Code	Sample Number	ABA			NAG			GAI (>=3)	Leachate (seepage) quality	
			Total Sulphide (%)	Total Carbon (%)	NPR	NAG pH	NAG kg H2SO4/t	Class.		pH	CoCs
Porphyry Tectonic Breccia - Leach cap	PBT LEA	2	2.5 - 3.3	0.03 - 0.09	0 - 0.01	Acidic (NAG pH 2.50 - 3.50)	5.7 - 7.4	100% PAF	Ag, Cd, Re, S, Se, Ta	acidic to neutral pH (4.20 - 7.20)	SO_4, Cl, Cu
Porphyry Tectonic Breccia - Sericite + Chlorite + Clay	PBT SCC	1	2.4	0.07	0	Acidic (NAG pH 2.30)	4.9	100% PAF	Cd, Re, S Se, Te, Zn	neutral pH of 7.00	SO_4, Cl, Cu
Porphyry Feldspar Biotite - Leach Cap	PFB LEA	2	1.7 - 2.5	0.06 - 0.09	0	Acidic (NAG pH 3.50 - 3.60)	4.3 - 5.9	100% PAF	Cu, Mo, Re, S, Se, W	acidic to neutral pH (5.90 - 7.70)	SO_4, Cu
Porphyry Feldspar Biotite - Phyllic	PFB PHY	1	0.2	0.33	3.4	Acidic (NAG pH 5.80)	3.5	100% PAF	S, Se	neutral pH of 7.10	SO_4, Cu
Porphyry Feldspar Quartz - Leach Cap	PFQ LEA	4	1.8 - 6.2	0.03 - 0.30	0 - 0.01	Acidic (NAG pH 2.60 - 4.10)	6.1 - 21.2	100% PAF	Ag, As, Bi, Cu, Re, S, Sb, Se, Te, W	acidic to neutral pH (4.60 - 7.60)	SO_4, Cu
Porphyry Feldspar Quartz - Oxidised	PFQ OXI	3	0.2 - 0.8	0.06 - 0.11	0 - 0.12	Acidic (NAG pH 2.70 - 3.30)	0.8 - 6.5	100% PAF	Re, S, Se, Te	acidic pH (3.30 - 5.50)	SO_4, Cu
Porphyry Feldspar Quartz - Phyllic	PFQ PHY	2	4.2 - 4.4	0.04 - 0.07	0	Acidic (NAG pH 2.30)	9.0 - 9.6	100% PAF	Ag, As, Cu, Re, S, Sb, Se, Te	acidic pH (4.60 - 5.80)	Cu
Porphyry Feldspar Quartz - Potassic	PFQ POT	1	2.3	0.03	0	Acidic (NAG pH 2.90)	8.4	100% PAF	Ag, Bi, Cu, Re, S, Se, Te	acidic pH of 4.30	SO_4, Cu
Porphyry Feldspar Quartz - Sericite + Chlorite + Clay	PFQ SCC	5	1.6 - 2.9	0.02 - 0.25	0 - 0.01	Acidic (NAG pH 2.30 - 2.70)	5.1 - 9.6	100% PAF	Cu, Re, S, Se, Te	acidic pH (4.60 -5.90)	SO_4, Cu
Porphyry Quartz Feldspar - Leach Cap	PQF LEA	2	0.3 - 0.7	0.06 - 0.12	0 - 0.07	Acidic (NAG pH 2.60 - 3.30)	1.6 - 5.7	100% PAF	Ag, As, Bi, Mo, Re, S, Sb, Se, Te	acidic pH (4.20 - 5.20)	SO_4, Cu
Porphyry Quartz Feldspar - Phyllic	PQF PHY	2	4.1 - 7.9	0.04 - 0.08	0	Acidic (NAG pH 2.30 - 2.40)	10.0 - 11.6	100% PAF	Bi, Cu, Mo, Re, S, Se, Te	acidic pH (5.10 - 5.50)	SO_4, Cu
Porphyry Quartz Feldspar - Sericite + Chlorite + Clay	PQF SCC	1	3.6	0.05	0	Acidic (NAG pH 2.30)	7.1	100% PAF	Cd, Cu, Mo, Re, S, Se, Te	acidic p of 5.50	Cu
Volcanic Intermediate - Coarse Porphyritic - Leach cap	VIN LEA	2	0.02 - 4.4	0.02 - 0.30	0 - 12.3	Acidic to mildly acidic (NAG pH 2.50 - 6.8)	0.6 - 10.8	100% PAF	Ag, Mo, Re, S, Se, Te	acidic to neutral pH (3.80 - 7.50)	SO_4, Cl, Cu
Volcanic Intermediate - Coarse Porphyritic - Oxidised	VIN OXI	3	0.1 - 0.3	0.02 - 0.04	0	Acidic (NAG pH 2.90 - 3.40)	4.7 - 7.1	100% PAF	Ag, Cu, Re, S, Se, Te	neutral pH of 7.00	Cu
Volcanic Intermediate - Coarse Porphyritic - Phyllic	VIN PHY	5	2.4 - 6.7	0.01 - 0.16	0. - 3.5	Acidic (NAG pH 2.20 - 3.80)	3.1 - 10.4	100% PAF	Ag, Re, S, Se, Re	acidic to neutral pH (4.30 - 7.60)	SO_4, Cu
Volcanic Intermediate - Coarse Porphyritic - Sericite + Chlorite + Clay	VIN SCC	6	2.4 – 5.0	0.03 - 0.08	0	Acidic (NAG pH 2.10 - 2.80)	3.9 - 11.6	100% PAF	Ag, Cu, Re, S, Se, Te	acidic to neutral pH (5.60 - 7.40)	SO_4, Cu
Tailings											
Tailings (Cleaner)		1	10	0	0	Acidic (NAG-pH 3.49)	2.03	100% PAF	Cd, Cu, Mo, Pb, Se	Alkaline pH (8.10)	SO_4, Mn
Tailings (Rougher)		1	0.11	0	0	Acidic (NAG-pH 2.10)	20	100% PAF	Cr, Cu, Mo, Pb	Alkaline pH (8.10)	SO_4, Mn

NPR - Neutralisation Potential Ratio

CoCs – Constituents of Concerns

Class. – Classification

5. Sampling

Additional sampling was undertaken to address gaps identified in the 2010 sampling. This new sampling effort focused on waste rock from the Western Porphyry and Tanjeel pit areas. The samples were to be collected from the core samples available in the field, guided by information from the core logs, specifically total Sulphur assays. The sampling aimed to ensure representativity in terms of lithology, spatial distribution, depth, and pit wall coverage.

5.1. Sample Selection

The objective of sample selection was to collect core sections that indicate the magnitude and variability of the targeted material properties. This process was guided by the need to ensure good spatial, geological, and geochemical representation.

5.1.1. Desktop Review

The desktop review examined available geological and geochemical reports to understand the previous sampling program. The previous study involved a sampling program of 369 samples for geochemical characterization, collected from either drill core sections or Reverse Circulation (RC) drill chip rejects. This information was used to identify gaps and ensure that sample duplication was avoided.

5.1.1.1. *Description of the Data*

The Diamond Drilled Hole (DDH) database was used and included 6685.37 meters of core intervals from 84 exploration holes, representing 37 lithologies (Table 5-1). The DDH database contained information such as exploration hole ID, depths, lithologies and lithology codes, alteration, chalcopyrite-pyrite ratios, estimated copper percentage, estimated Sulphide percentage, and total Sulphur percentage (visually represented). Figures 5-1 and 5-2 show the relative distribution of drill core intervals based on lithologies in the Western Porphyry and Tanjeel pits. The dominant lithology in the Western Porphyry pit was VIN SCC, while in the Tanjeel pit, they were PFQ PHY, VIN PHY, and PQF PHY.

Table 5-1: Summary of DDH and 2010 Databases

	DDH Database		2010 Database (SRK)	
	Western Porphyry	**Tanjeel**	**Western Porphyry**	**Tanjeel**
Count (n)	5035	619	369	42
Lithologies	37	17	59	16
Intervals Total of Core	12314.3	2589.63		
Sub Total	5654		411	
Total	6065			

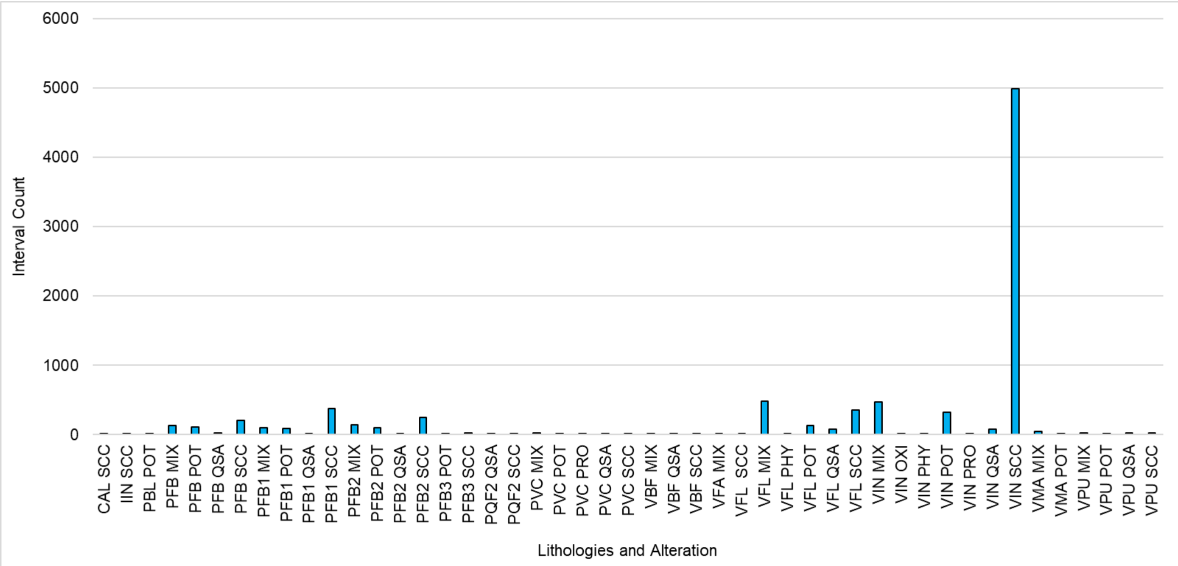

Figure 5-1: Lithological distribution of drill core intervals for Western Porphyry

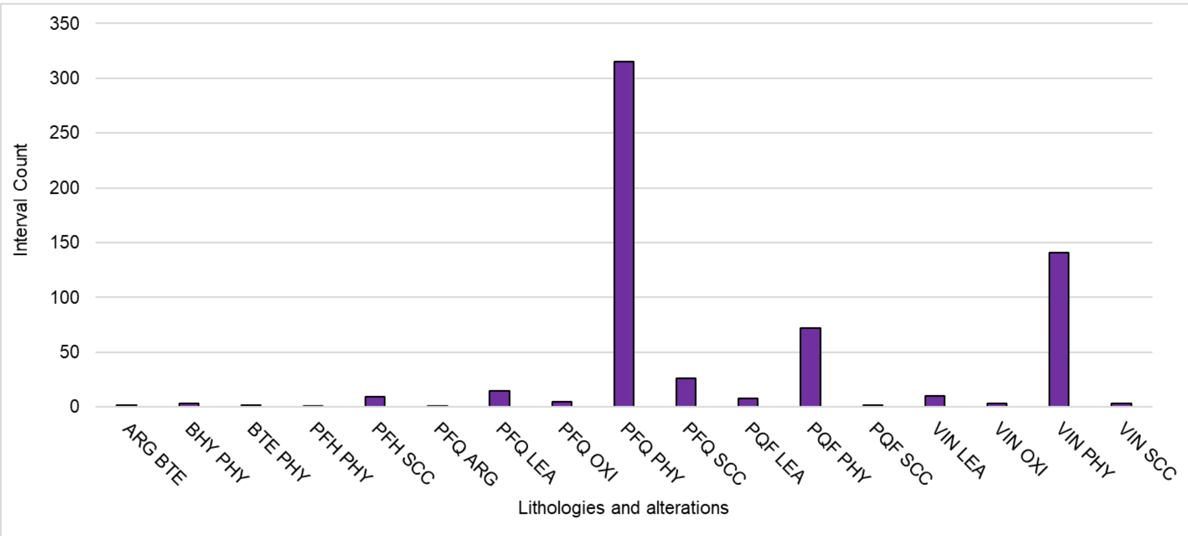

Figure 5-2: Lithological distribution of drill core intervals for Tanjeel

5.1.2. Total Sulphur (ABA and Visual Analysis)

5.1.2.1. Western Porphyry

A total of 369 ABA sulphur data points and 2,200 DDH visual sulphur data points were assessed. The assessment of ABA data showed that sulphur content ranged from 0.3% to 8.4% (Table 5-2), with 95% of the samples having sulphur concentrations above 1.0%. The mean and median sulphur content for ABA were 4.0%, and the 95th percentile was 7.5%. For DDH, sulphur content ranged from 1.2% to 7.4%, with all samples having sulphur concentrations above 1.0%. The mean sulphur content for DDH was 3.8%, the median was 3.6%, and the 95[Th] percentile was 5.2%.

The two data sets had different shapes of distribution, with a kurtosis of -0.39 for ABA TS and 1.48 for DDH TS. These kurtosis values indicate distinct distribution shapes. The ABA TS data set has a platykurtic distribution, meaning it is flatter and more spread out than a normal distribution, with fewer values in the tails and more values clustered around the mean of 4.02. This suggested that sampling should focus on the tails of the distribution. As a result, three ranges of total sulphur data were identified for sampling: 0.9-2.2%, 3.3-4.9%, and 6-7%. The cumulative percentage plots in Figure 5-3 further support these total sulphur ranges.

Table 5-2: Statistical Analysis Interpretation for Western Porphyry

Statistical Analysis	Western Porphyry		Statistical Analysis	Western Porphyry	
	ABA TS	DDH TS		ABA TS	DDH TS
Mean	4.02	3.84	Skewness	0.27	0.83
Median	4.00	3.64	Minimum	0.3	1.06
Mode	2.30	3.18	Maximum	8.4	7.38
Kurtosis	-0.39	1.48	Confidence Level (95.0%)	0.61	0.05

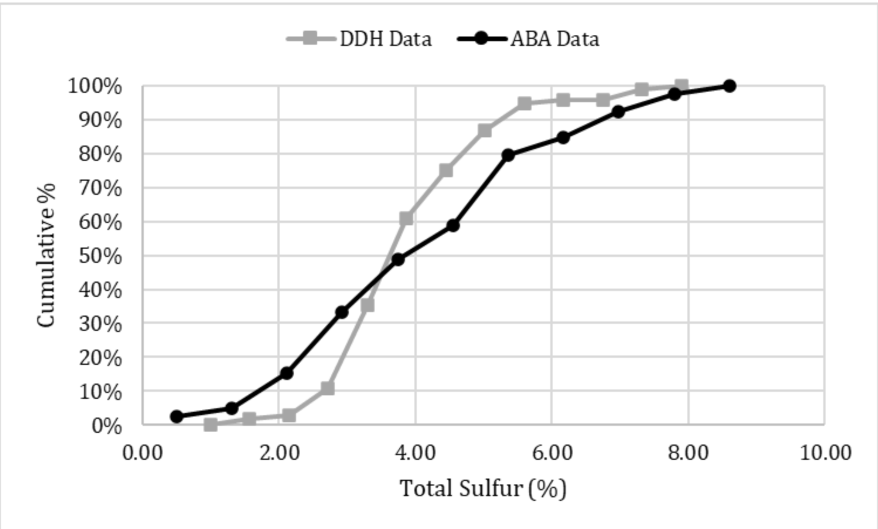

Figure 5-3: Cumulative Frequency Plot for ABA and DDH Databases for Western Porphyry

The DDH TS data shows a leptokurtic distribution, meaning it has more values in the tails compared to a normal distribution. This results in a higher peak and thicker tails, with more extreme values. To normalize the distribution curve, additional total Sulphur values are needed.

Box and whisker plots were used to identify boreholes and lithologies not represented in the existing total sulphur dataset. These plots visually display the central tendency, variability, and skewness of the data. Boreholes that required additional sampling included RD198, RD231, RD248, and RD272 (Figure 5-4).

The dominant lithology in the data set was identified as VIN SCC (Figure 5-1). Therefore, no additional samples were required to represent VIN SCC. From the ABA database, a total of 70 samples represented this lithology. The lithologies that required additional samples to improve total sulphur representativity included BHY PRO, PFQ PHY, IMA SSC, PBL OXI, VBC MIX, VBC OXI, VFL PHYLL, PQFZ, VIN LEA and VFL SSC (Figure 5-1).

Some total sulphur values in the DDH data were estimated visually instead of being determined through laboratory analysis. These visually estimated values required confirmation via lab analysis. Consequently, samples (PVC QSA, VFL SCC, VFL SSC, VPU MIX, and VPU SCC) with visually estimated sulphur values were chosen for verification through laboratory analysis.

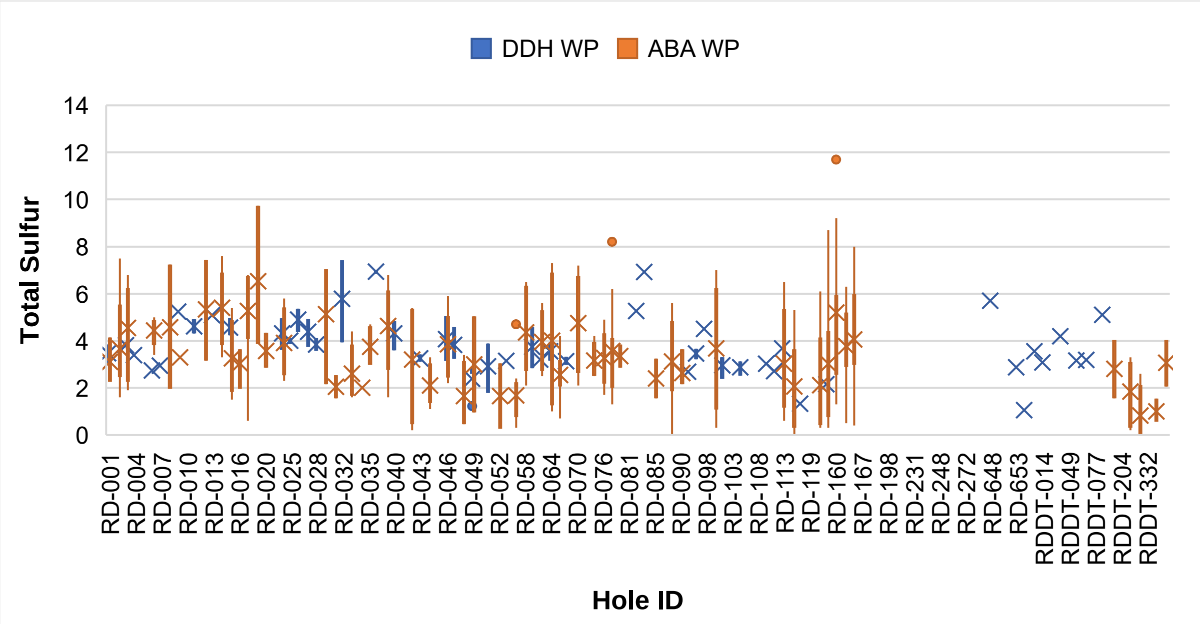

Figure 5-4: Total Sulphur versus Exploration Holes for Western Porphyry

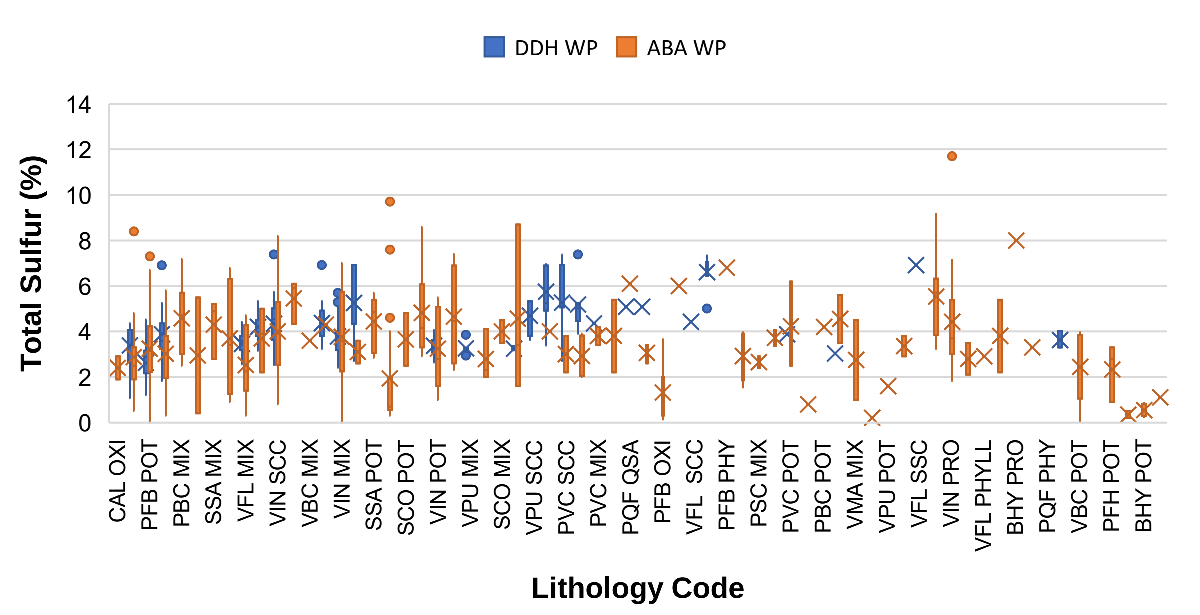

Figure 5-5: Total Sulphur versus Lithologies for Western Porphyry

5.1.2.2. *Tanjeel*

A total of 42 ABA sulphur data points and 35 DDH visual sulphur data points were assessed. The ABA data showed that total sulphur ranged from 0.82% to 8.07% (Table 5-3), with 98% of the samples having sulphur concentrations above 1.0%. The mean total sulphur was 3.64%, the median was 3.55%, and the 95th percentile was 7.55%. The median and mean suggest that the data is skewed to the left, as indicated in Figure 5-6.

For DDH, total Sulphur ranged from 4.11% to 4.87%, with all data points exceeding 1.0%. The mean was 3.84%, the median was 3.64%, and the 95th percentile was 4.87%. Only two distinct data sets were visually identified (Figure 5-7), which limits the usefulness of total sulphur for sample selection for Tanjeel.

Table 5-3: Statistical Analysis Interpretation for Tanjeel

Statistical Analysis	Tanjeel		Statistical Analysis	Tanjeel	
	ABA TS	DDH TS		ABA TS	DDH TS
Mean	4.02	3.84	Skewness	0.27	0.83
Median	4	3.64	Minimum	0.3	1.06
Mode	2.3	3.18	Maximum	8.4	7.38
Kurtosis	-0.39	1.48	Confidence Level (95.0%)	0.61	0.05

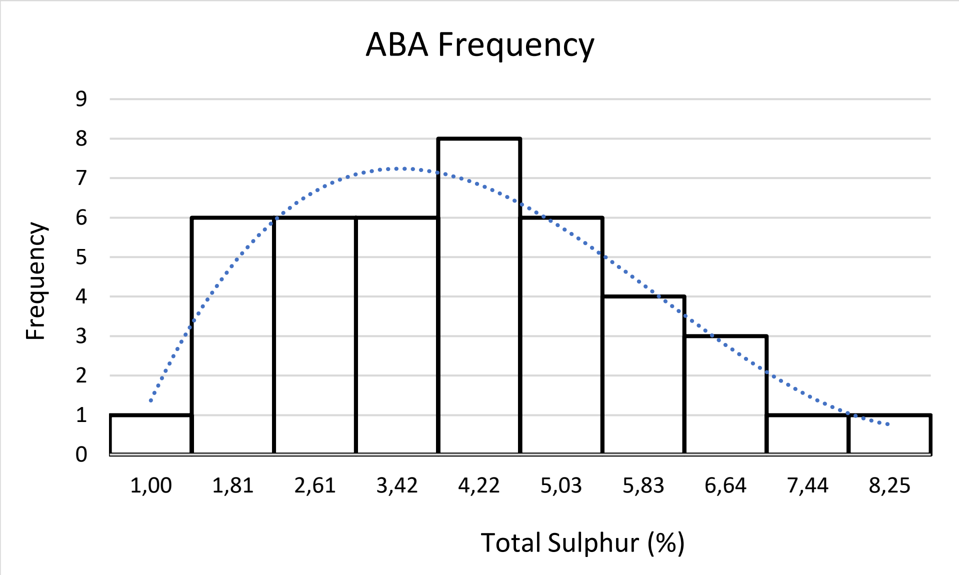

Figure 5-6: Frequency of ABA Total Sulphur in Tanjeel

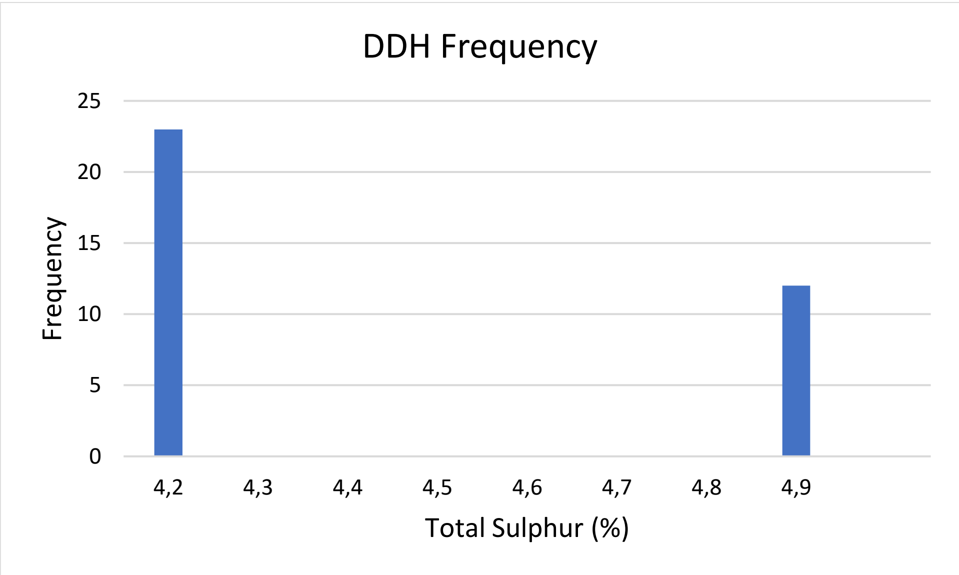

Figure 5-7: Frequency of DDH Total Sulphur in Tanjeel

From the box and whisker plots (Figure 5-8), the boreholes that required additional sampling included RD657, RD659, RD622 – RD665, and RD668 – RD671. The dominant lithology in Tanjeel pit were PFQ PHY, VIN PHY, and PQF PHY (Figure 5-2). The lithologies that required additional samples to improve total sulphur representativity included PBT LEA, PBT SCC, PFB LEA, PFB PHY, PFQ LEA, PFQ OXI, PFQ PHY, PFQ POT, PFQ SCC, PQF LEA, PQF PHY, PQF SCC, VIN OXI, VIN SCC and VIN LEA (Figure 5-9).

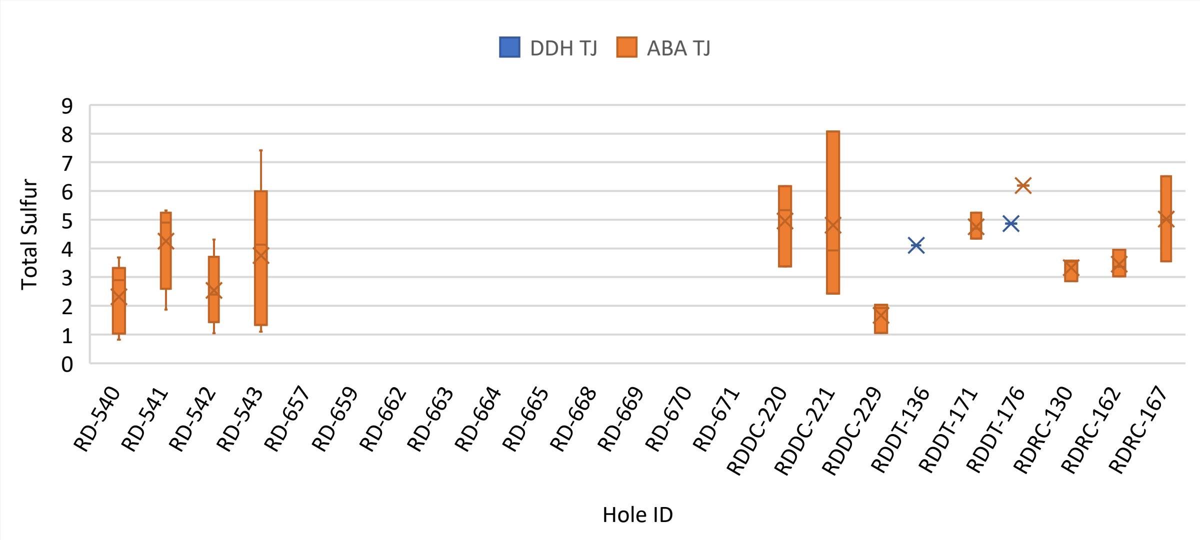

Figure 5-8: Total Sulphur versus Exploration Holes for Tanjeel

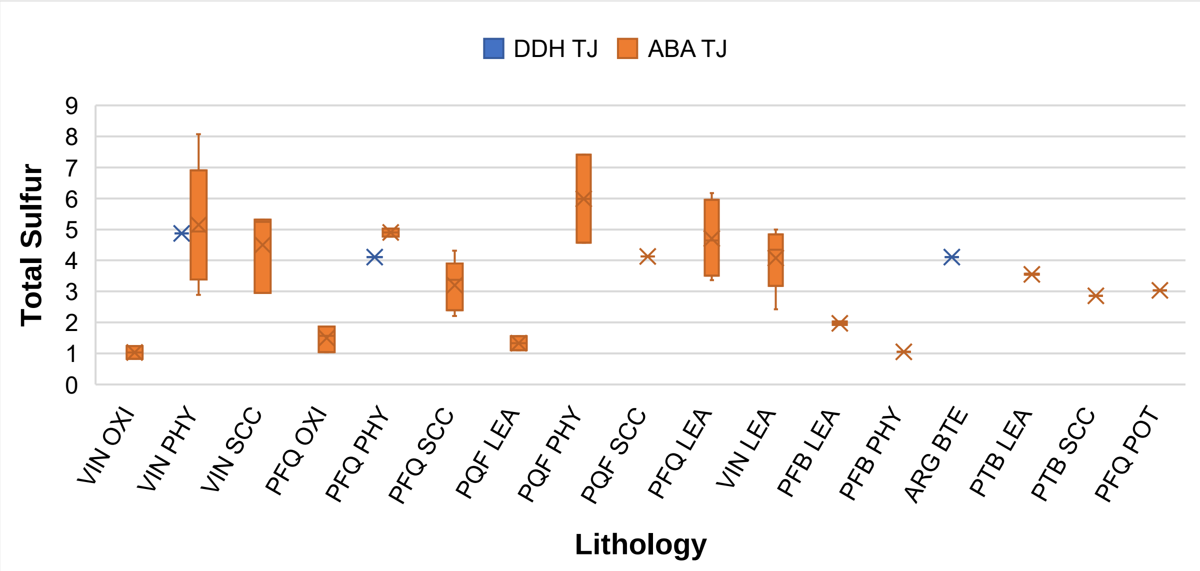

Figure 5-9: Total Sulphur versus Lithologies for Tanjeel

5.1.3. Pit Wall Samples

The pit wall samples were selected using 3-dimensional block models generated by Leapfrog software (Figure 5-10). These samples are significant as they represent the geochemistry of the rocks, which will influence the water quality of the pit lake. The samples were chosen by visually picking sections of the drill core that intersected the pit wall.

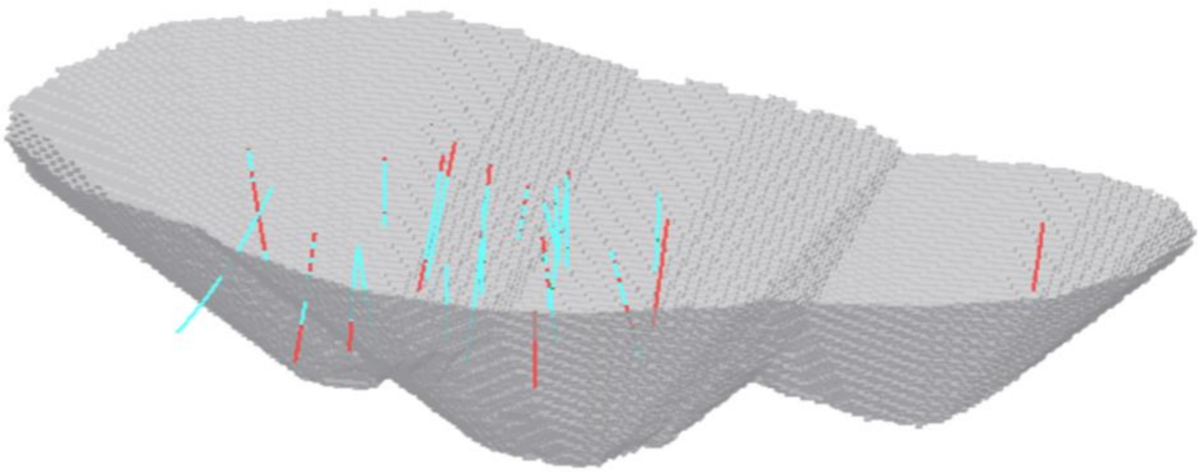

Figure 5-10: Illustration of the Leapfrog model used for selecting pit wall samples

5.1.4. Spatial Representativity

The selected samples were plotted on a scatter plot showing exploration hole ID versus depth (Figure 5-11). This visualization tool ensured that the selected samples not only covered gaps identified in the total Sulphur and lithologies steps but also represented the depth profile of the pit. The figure displays a small number of selected samples from the 84 exploration holes because some holes were already selected in the previous study, or their cores were not available.

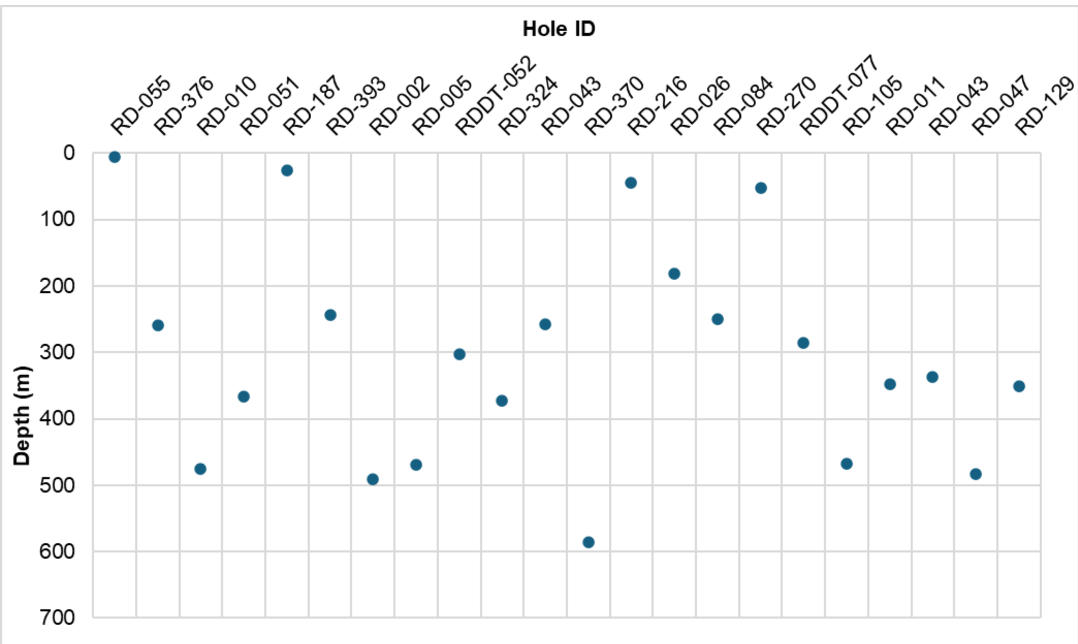

Figure 5-11: Spatial representativity relative to depth for Western Porphyry samples

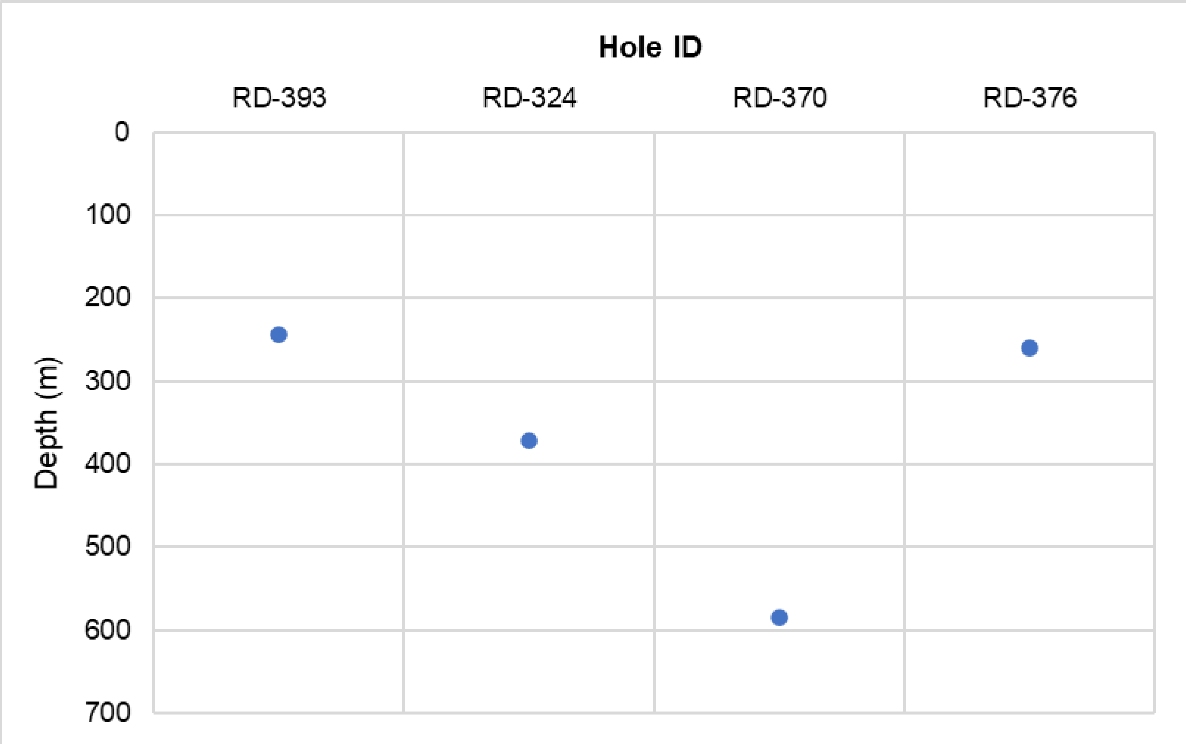

Figure 5-12: Spatial representativity relative to depth for Western Porphyry Pit Wall samples

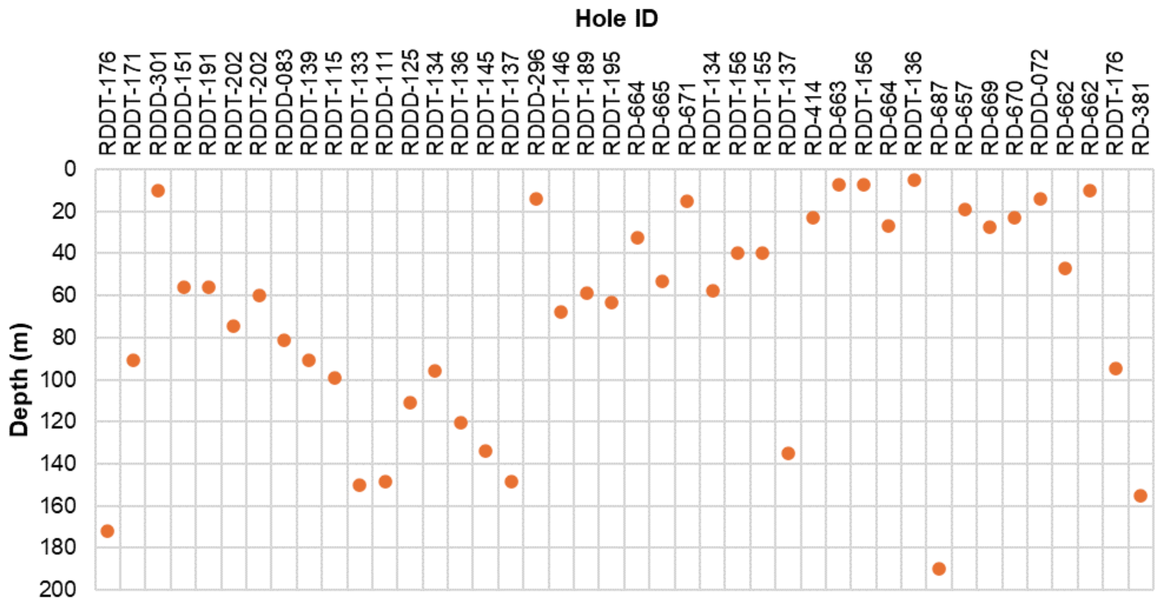

Figure 5-13: Spatial representativity relative to depth for Tanjeel samples

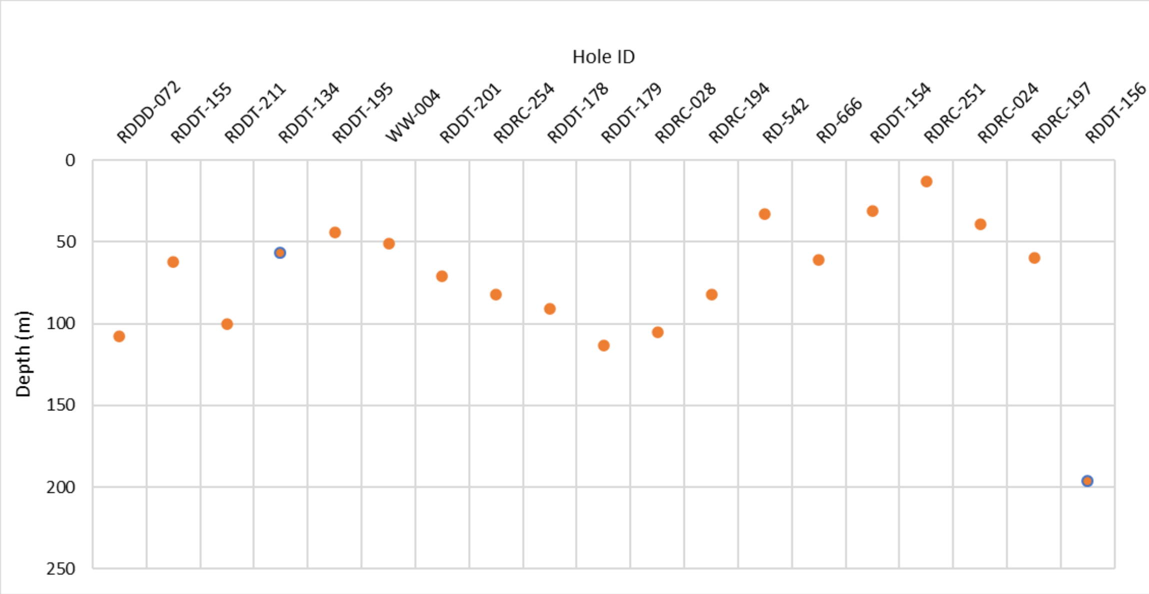

Figure 5-14: Spatial Representativity Relative to Depth for Tanjeel Pit Wall Samples

5.1.5. Liaison with the Project Geologist

Lastly, an experienced exploration site geologist reviewed the selected samples. The geologist provided essential guidance, geological data, and information, and identified anomalies throughout the sample selection process. This review ensured that the selected samples and the approach accurately reflected the geology and potential mineralization of Western Porphyry. With a thorough understanding of Western Porphyry geological characteristics, the geologist offered valuable insights into the area's mineralization, alteration, and geological processes. Additionally, the geologist identified holes without samples to be excluded from collection.

In conclusion, DWE's approach to selecting samples was systematic and focused on identifying gaps. This strategy optimized sampling to efficiently cover a large area while minimizing costs, effectively allocating resources, and reducing unnecessary efforts in areas less likely to yield valuable results. As a result, representative samples were collected, leading to improved accuracy and reliability of the data.

5.1.6. Sample List and Locations

A total of 64 waste rock samples were selected, including 22 from Western Porphyry and 42 from Tanjeel. The list of samples is provided in Table 6.9. Maps showing the locations of the drill core boreholes within the two pits are presented in Figure 6-1 and Figure 1-2. The list was submitted to Reko Diq geologist to collect the samples.

Table 5-4 Sample List for Western Porphyry

Western Porphyry				
Sample ID	**Hole ID**	**Depth Interval (m)**	**Lithological Code**	**Lithological Description**
RD-055 (5.5 to 7)	RD-055	5.5 - 7	CAL SCC	
RD-376 (259.5 to 261)	RD-376	259.5 - 261	IIN SCC	
RD-010 (476 to 477.5)	RD-010	476 - 477.5	PFB1 QSA	Porphyry Feldspar Biotite- Quartz + Sericite + Aduluria
RD-051 (366 to 367)	RD-051	366 - 367	PVC MIX	Porphyry-Volcanics Contact Breccia-Mixed
RD-187 (26 to 28)	RD-187	26 - 28	PVC POT	Porphyry-Volcanics Contact Breccia – Potassic
RD-393 (244.5 to 246)	RD-393	244.5 - 246	PVC PRO	Porphyry-Volcanics Contact Breccia – Propylitic
RD-002 (491m-492.5m)	RD-002	491 - 492.5	VFL MIX	Volcanic Fine Laminated – Mixed
RD-005 (468.5m-470m)	RD-005	468.5 - 470	VFL MIX	Volcanic Fine Laminated – Mixed
RDDT-052 (303 to 304.5)	RDDT-052	303 - 304.5	VFL MIX	Volcanic Fine Laminated – Mixed
RD-324 (372 to 3730	RD-324	372 - 3730	VFL PHY	Volcanic Fine Laminated – Phyllic
RD-043 (258 to 259)	RD-043	258 - 259	VFL SCC	Volcanic Fine Laminated – Sericite+Chlorite+Clay
RD-370 (585 to 586.5)	RD-370	585 - 586.5	VFL SCC	Volcanic Fine Laminated – Sericite+Chlorite+Clay
RD-216 (44 to 44.77)	RD-216	44 - 44.77	VIN PRO	Volcanic Intermediate-Coarse Porphyritic – Propylitic
RD-026 (182 to 183)	RD-026	182 - 183	VIN QSA	Volcanic Intermediate-Coarse Porphyritic-Quartz + Sericite + Aduluria
RD-084 (250m-251.5m)	RD-084	250 - 251.5	VIN QSA	Volcanic Intermediate-Coarse Porphyritic-Quartz + Sericite + Aduluria
RD-270 (52 to 53)	RD-270	52 - 53	VIN QSA	Volcanic Intermediate-Coarse Porphyritic-Quartz + Sericite + Aduluria
RDDT-077 (268m-269.5m)	RDDT-077	268 - 269.5	VIN QSA	Volcanic Intermediate-Coarse Porphyritic-Quartz + Sericite + Aduluria
RD-105 (468m-469.5m)	RD-105	468 - 469.5	VPU POT	Volcanic Pebble Unit-Sericite - Potassic
RD-011 (348 to 349)	RD-011	348 - 349	VPU QSA	Volcanic Pebble Unit-Quartz + Sericite + Aduluria
RD-043 (337.5m-339m)	RD-043	337.5 - 339	VPU QSA	Volcanic Pebble Unit-Quartz + Sericite + Aduluria
RD-047 (483 to 484)	RD-047	483 - 484	VPU SCC	Volcanic Pebble Unit-Sericite+Chlorite+Clay
RD-129 (351m-352.5m)	RD-129	351 - 352.5	VPU SCC	Volcanic Pebble Unit-Sericite+Chlorite+Clay

Table 5-5: Sample List for Tanjeel

Tanjeel				
Sample ID	**Hole ID**	**Depth Interval (m)**	**Lithological Code**	**Lithological Description**
RDDT-176 (172m - 173.5m)	RDDT-176	172 - 173.5	VIN PHY	Volcanic Intermediate-Coarse Porphyritic - Phyllic
RDDT-171 (90.5m -92m)	RDDT-171	90.5 - 92	VIN PHY	Volcanic Intermediate-Coarse Porphyritic - Phyllic
RDDD-301 (10m-10.5m)	RDDD-301	10 - 10.5	VIN OXI	Volcanic Intermediate-Coarse Porphyritic - Oxidised
RDDD-151 (56m - 57.5m)	RDDD-151	56 - 57.5	VIN LEA	Volcanic Intermediate-Coarse Porphyritic - Leach
RDDT-191 (56m-57.5m)	RDDT-191	56 - 57.5	VIN LEA	Volcanic Intermediate-Coarse Porphyritic - Leach
RDDT-202 (74.5m-76m)	RDDT-202	74.5 - 76	VIN LEA	Volcanic Intermediate-Coarse Porphyritic - Leach
RDDT-202 (60m-61.5m)	RDDT-202	60 - 61.5	VIN LEA	Volcanic Intermediate-Coarse Porphyritic - Leach
RDDD-083 (81m-82.5m)	RDDD-083	81 - 82.5	PQF PHY	Porphyry Quartz Feldspar - Phyllic
RDDT-139 (91m-92.5m)	RDDT-139	91 - 92.5	PQF PHY	Porphyry Quartz Feldspar - Phyllic
RDDT-115 (99m-100.5m)	RDDT-115	99 - 100.5	PQF PHY	Porphyry Quartz Feldspar - Phyllic
RDDT-133 (150m-151.5m)	RDDT-133	150 - 151.5	PQF PHY	Porphyry Quartz Feldspar - Phyllic
RDDD-111 (148.5m-150m)	RDDD-111	148.5 -150	PFQ SCC	Porphyry Feldspar Quartz - Sericite + Chlorite + Clay
RDDD-125 (111m-112m)	RDDD-125	111 - 112	PFQ SCC	Porphyry Feldspar Quartz - Sericite + Chlorite + Clay
RDDT-134 (95.5m-97m)	RDDT-134	95.5 - 97	PFQ PHY	Porphyry Feldspar Quartz - Phyllic
RDDT-136 (120.5m-122m)	RDDT-136	120.5 -122	PFQ PHY	Porphyry Feldspar Quartz - Phyllic
RDDT-145 (134m-135.5m)	RDDT-145	134 - 135.5	PFQ PHY	Porphyry Feldspar Quartz - Phyllic
RDDT-137 (148.5m-150m)	RDDT-137	148.5 -150	PFQ PHY	Porphyry Feldspar Quartz - Phyllic
RDDD-296 (14m-14.5m)	RDDD-296	14 - 14.5	PFQ OXI	Porphyry Feldspar Quartz - Oxidised
RDDT-146 (68m-69.5m)	RDDT-146	68 - 69.5	PFQ LEA	Porphyry Feldspar Quartz - Leach Cap
RDDT-189 (59m-57.5m)	RDDT-189	59 - 57.5	PFQ LEA	Porphyry Feldspar Quartz - Leach Cap
RDDT-195 (63.5m-65m)	RDDT-195	63.5 - 65	PFQ LEA	Porphyry Feldspar Quartz - Leach Cap
RD-664 (32.5 to 33)	RD-664	32.5 - 33	PFQ LEA	Porphyry Feldspar Quartz - Leach Cap
RD-665 (53 to 53.5)	RD-665	53 - 53.5	PFQ LEA	Porphyry Feldspar Quartz - Leach Cap

Tanjeel				
Sample ID	**Hole ID**	**Depth Interval (m)**	**Lithological Code**	**Lithological Description**
RD-671 (15 to 15.5)	RD-671	15 - 15.5	PFQ LEA	Porphyry Feldspar Quartz - Leach Cap
RDDT-134 (57.5 to 59)	RDDT-134	57.5 - 59	PFQ LEA	Porphyry Feldspar Quartz - Leach Cap
RDDT-156 (40 to 41)	RDDT-156	40 - 41	PFQ LEA	Porphyry Feldspar Quartz - Leach Cap
RDDT-155 (40 to 41)	RDDT-155	40 - 41	BHY LEA	
RDDT-137 (135 to 136)	RDDT-137	135 - 136	BTE PHY	
RD-414 (23 to 23.5)	RD-414	23 - 23.5	PFQ OXI	Porphyry Feldspar Quartz - Oxidised
RD-663 (7 to 7.5)	RD-663	7 - 7.5	PFQ OXI	Porphyry Feldspar Quartz - Oxidised
RDDT-156 (196.5 to 198)	RDDT-156	196.5 - 198	PFQ PHY	Porphyry Feldspar Quartz - Phyllic
RD-664 (133.5 to 134)	RD-664	133.5 - 134	PFQ PHY	Porphyry Feldspar Quartz - Phyllic
RDDT-136 (167.5 to 169)	RDDT-136	167.5 - 169	PFQ PHY	Porphyry Feldspar Quartz - Phyllic
RD-687 (190 to 190.5)	RD-687	190 - 190.5	PFQ SCC	Porphyry Feldspar Quartz - Sericite + Chlorite + Clay
RD-657 (19 to 19.5)	RD-657	19 - 19.5	PQF LEA	Porphyry Quartz Feldspar - Leach Cap
RD-669 (27.5 to 28)	RD-669	27.5 - 28	PQF LEA	Porphyry Quartz Feldspar - Leach Cap
RD-670 (23 to 23.5)	RD-670	23 - 23.5	PQF LEA	Porphyry Quartz Feldspar - Leach Cap
RDDD-072 (14 to 15)	RDDD-072	14 - 15	PQF LEA	Porphyry Quartz Feldspar - Leach Cap
RD-662 (47 to 47.5)	RD-662	47 - 47.5	PQF PHY	Porphyry Quartz Feldspar - Phyllic
RD-662 (10 to 10.5)	RD-662	10 - 10.5	VIN OXI	Volcanic Intermediate-Coarse Porphyritic - Oxidised
RDDT-176 (94.5 to 96)	RDDT-176	94.5 - 96	VIN PHY	Volcanic Intermediate-Coarse Porphyritic - Phyllic
RD-381 (155 to 155.5)	RD-381	155 - 155.5	VIN PHY	Volcanic Intermediate-Coarse Porphyritic - Phyllic

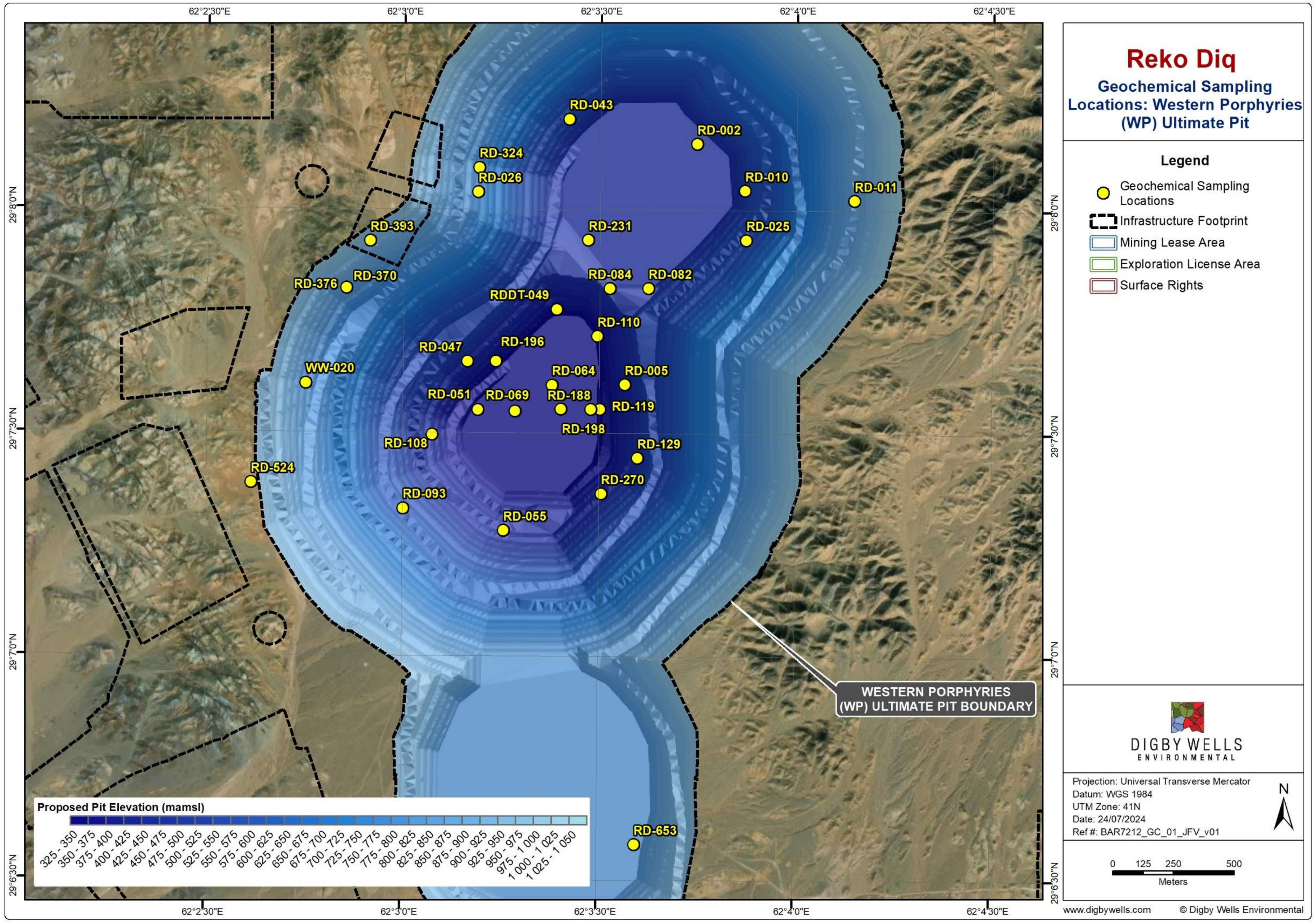

Figure 5-15: Map Showing the Locations of Samples for Western Porphyry

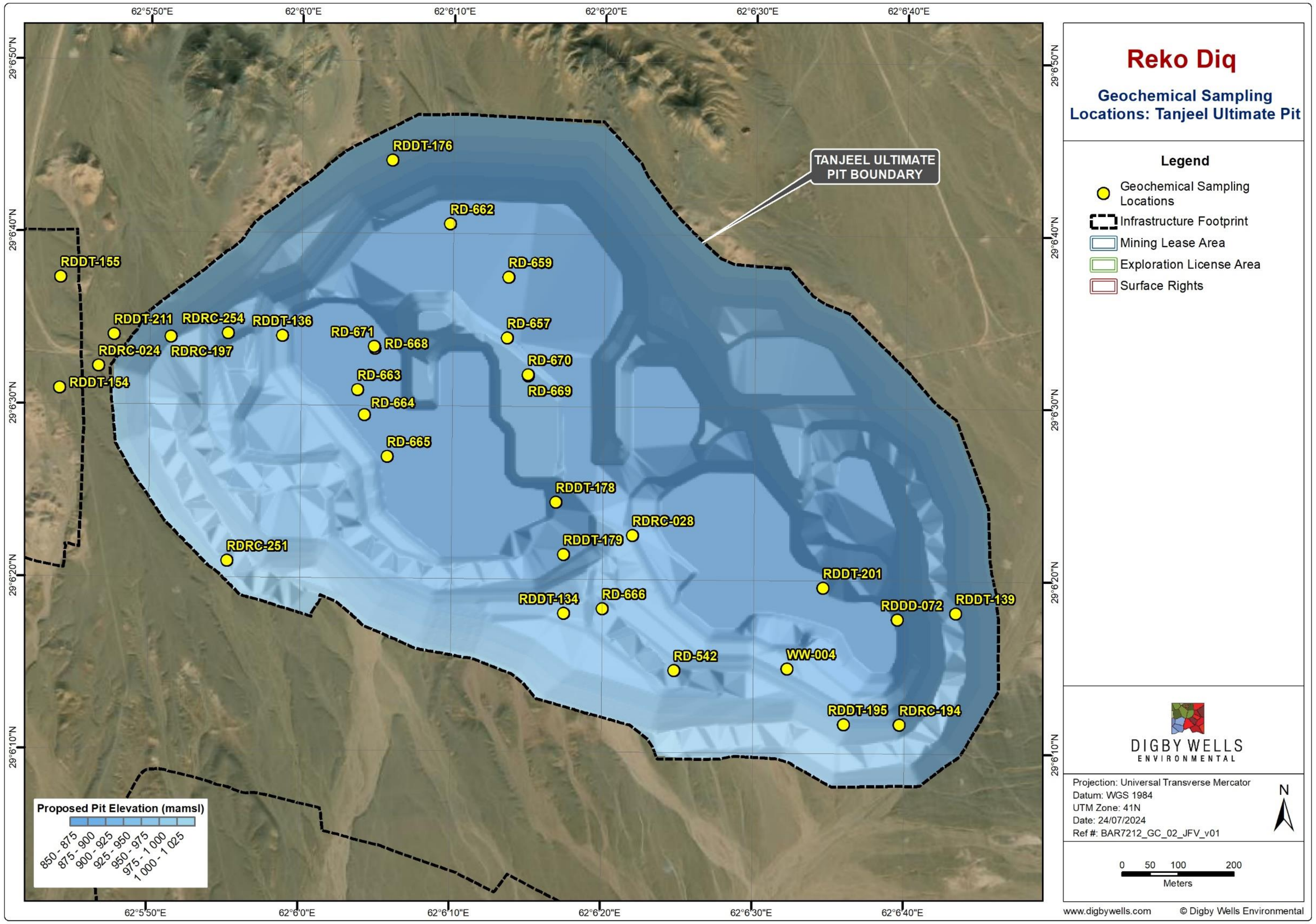

Figure 5-16: Map Showing the Locations of Samples for Tanjeel

5.2. Sample Collection

Reko Diq personnel conducted waste rock sampling from April to June 2023. Samples were collected from exploration core samples stored in the core shed at the site. As shown in Figure 5-17, the samples were packaged appropriately and sent directly from the site to ALS laboratory in Australia for testing.

Figure 5-17: Image of Packaged Samples at Site

6. Laboratory Analysis

Laboratory analysis was conducted by Australian Laboratory Services Pty Ltd (ALS) in Australia. The analytical suite included drill core analysis and short-term leachates, as detailed in Table 6-1 and Table 6-2. X-Ray Diffraction (XRD) mineralogical analysis is currently being conducted at the Brisbane Metallurgical Laboratory. The XRD results will be documented in a technical memorandum, which will be added to the report to enhance its accuracy over time.

Table 6-1: Drill Core Analysis

Parameter	ALS Code	Technique/ Method Reference	Limit Of Reference (LOR)
Completed Analyses			
pH (1:2 pulp slurry)	EA002ARD	APHA 4500-H+ B	0.1 pH Unit
Electrical Conductivity (1:2 pulp slurry)	EA010ARD	APHA 2510 B	1 µS/cm
1:2 Leach	EN40	In house	0.1 g
Bagging and labelling (ASS)	EN020PR	In house	0.1 g
Net Acid Generation (NAG)	EA011	Miller	0.1 kg H_2SO_4/t 0.1 pH Unit
NAPP (Including Acid Neutralising Capacity (ANC) and Total S)	ASS-1	Coastech Research (Canada)	0.5 kg H_2SO_4 equiv. /t 0.01% S
4M HCl extractable Sulphur	EA029 S(HCl)	Ahern et al (2004)	0.02 % S
Chromium Reducible Sulphide (CRS)	EA026	Sullivan et al	0.005 % S
Particle Size Analysis by Sieving (Default sieves from 75 µm)	EA150	AS1289.3.6.1	1%
Total Organic Carbon (TOC)/Total Inorganic Carbon (TIC)/Total Carbon (TC) (Leco) Combined Suite	IN-3S	In house	0.02%
Outstanding Analysis			
XRD (Quantitative)	XRAY_SOL	Subcontracted to Brisbane MET Laboratory	

Table 6-2: Short Term Leachates

Parameter	ALS Code	Technique/ Method Reference	Limit Of Reference (LOR)
Miscellaneous Leaches (1:3 DI Water, tumble time 48 hrs)	EN35	In house	0.1 g
pH (Auto Titrator)	EA005P	APHA 4500-H+ B	0.01 pH Unit
Electrical Conductivity (Auto Titrator)	EA010P	APHA 2510 B	1 µS/cm
Total Dissolved Solids - Standard Level	EA015H	APHA 2540 C	10 mg/l
Acidity as $CaCO_3$ only	ED038P $CaCO_3$	APHA 2310 B	1 mg/l
Dissolved Major Anions (Silicon)	ED040F	APHA 3120	0.05 mg/l

Parameter	ALS Code	Technique/ Method Reference	Limit Of Reference (LOR)
15 Metals (NEPM Suite (As, Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, V, Zn, Hg)	W-03	USEPA 6020, APHA 3112-Hg B	0.0001 - 0.05 mg/l
Additional Dissolved Metals by ICP/MS (Al, Sb, Bi, Ce, Fe, La, Mo, Nd, Ag, Sr, Tl, Th, Sn, Ti, U, Y)	EG020F	USEPA 6020	0.001 - 0.05 mg/l
Dissolved Miscellaneous Metals (Sc)	EG021F	USEPA 6020	0.1 µg/l
Dissolved Hexavalent Chromium	EG050G-F	APHA 3500-Cr B	0.01 mg/l
Ammonia as N by Discrete Analyser	EK055G	APHA 4500-NH_3 G	0.01 mg/l
Nitrate as N by Discrete Analyser	EK058G	APHA 4500-NH_3 APHA 4500-NO_2 B	0.01 mg/l
Total Phosphorus as P By Discrete Analyser	EK067G	APHA 4500-P B&F	0.01 mg/l
Major Cations (Ca, Mg, Na, K)	NT-01	USEPA 6010	1 mg/l
Major Anions (Cl, SO_4, Fluoride, Alkalinity)	NT-02A	APHA 2320 B APHA 4500-Cl APHA 4500-F APHA 4500-SO_4	0.1 - 1 mg/l

7. Data Quality Check

The data QA/QC was conducted by the ALS laboratory.

7.1. Relative Percent Difference

ABA: Laboratory duplicates were conducted by randomly selected split with the focus being the Relative Percent Difference (RPD). A quality check was conducted on twenty-five samples which include the pH, conductivity, NAG-pH, NAG, Acid Neutralising Capacity, chromium reducible Sulphur, hydrochloric acid extractable Sulphur, total Sulphur and/or total carbon. Acceptable RPD is between 0% - 20%, the results RPD indicates the range between 0% and 18% demonstrating that the results are acceptable.

Leachates: Laboratory duplicates were conducted by randomly selected split with the focus being the Relative Percent Difference (RPD). A quality check was conducted on nineteen samples which include the physicochemical, metals and/or metalloids parameters. Acceptable RPD is between 0% - 20%, the results RPD indicates the range between 0% and 11%, with most physicochemical parameters not having any RPD limit but demonstrating that the results are acceptable.

7.2. Method Blank

A method blank is an analyte media (usually deionised water) utilised by the laboratory to calibrate its instruments and to confirm the absence of interferences in the analytical signal.

ABA: Method blanks were conducted for pH, conductivity, NAG-pH, NAG, Acid Neutralising Capacity, chromium reducible Sulphur, hydrochloric acid extractable Sulphur, total Sulphur and/or total carbon. Acceptable method blank analytes should all be below the detection limit which is indicated in the laboratory certificates.

Leachates: Method blanks were conducted for physicochemical, metal and/or metalloid parameters. Acceptable method blank analytes should all be below the detection limit which is indicated in the laboratory certificates.

7.3. Ionic Charge Balance

Ionic Charge Balance (ICB) was utilized to verify the accuracy and completeness of the analytical data. This assessment ensures that the sum of cations and anions in the chemical analysis is balanced, aligning with the principles of charge neutrality. The purpose of the ICB assessment is to identify any potential errors or inconsistencies in the data related to charge imbalances.

An imbalance exceeding ±20% was deemed unacceptable for solid samples, except samples exhibiting an electrical conductivity (EC) lower than 20 mS/m. This threshold was established to account for potential variability in low-conductivity samples.

Out of the 37 waste rock samples (13 Western Porphyry and 24 Tanjeel), all samples displayed an imbalance below 10% (except two Tajeel samples),

By applying these criteria, the QA/QC process aimed to uphold data integrity and reliability, ensuring that analytical results met the required standards for precision and charge balance.

8. Results and Discussion

This section presents a summary of the geochemical characteristics of the waste rock samples.

8.1. Western Porphyry

8.1.1. Acid Generation Potential

Table 8-1 presents a summary of the ABA, sulphur speciation carbon speciation and NAG results for the waste rock and pit wall samples. A total of 22 samples, consisting of 18 waste rock samples and 4 pit wall samples, have undergone ABA and NAG testing.

8.1.1.1. Waste Rock

The acid-generating and neutralising characteristics of the waste rock are as follows:

- The paste pH ranges from neutral to alkaline, between 7.20 and 9.00.
- Sulphur compounds are the main contributors to acid, acidity, and potentially harmful elements in the drainage from materials. In the waste rock, total sulphur content ranges from 0.06% to 14%. On average, chromium-reducible Sulphur (or sulphide sulphur) makes up 36% of the total sulphur concentration, HCl-extractable sulphur (or sulphate sulphur) constitutes 66%, and the remaining 3% consists of unaccounted sulphur species.
- The MPA, which measures the capacity of minerals in the waste rock to produce acidity, ranges from 2.1 kg H_2SO_4/t (PVC POT) to 441 kg H_2SO_4/t (PFB1 QSA). The minor lithology CAL SCC shows an ANC of 1.8 kg H_2SO_4 equivalent/t.
- The ANC, which measures the capacity of minerals in the waste rock to produce base, ranges from 0.9 kg H_2SO_4 equivalent/t (VIN QSA) to 29 kg H_2SO_4 equivalent/t (PVC POT). The minor lithologies show a higher ANC of 21 kg H_2SO_4 equivalent/t in IIN SCC.
- The total carbon content ranges from below the detection limit (<0.02%) to 0.09%. Most of the results are below the detection limit.
- An assessment of the ANC against Total S, shown in the ABA plot, indicates that 11% are PAN, 6% are uncertain, and 83% are PAG (Figure 8-1).
- NAPP is commonly used to determine if a material has the potential to generate ARD. If the MPA is less than the ANC, the NAPP is negative, indicating PAN. Conversely, if the MPA exceeds the ANC, the NAPP is positive, indicating PAG. The geochemical classification plot (Figure 8-2) shows that 11% are PAN and 89% are PAG.
- According to the Barrick guidelines, the classification indicates that 11% is LNAG and 88% is HPAG.

8.1.1.2. Pit Wall

The acid-generating and neutralizing characteristics of the pit wall waste rock are as follows:

- The paste pH ranges from neutral to alkaline (pH 7.00 – 8.20).
- Total Sulphur in the waste rock ranges from 2.8% to 9.3%. On average, chromium-reducible Sulphur makes up 55% of the total Sulphur concentration, HCl-extractable Sulphur constitutes 46%, and 1% is unaccounted Sulphur species.
- The MPA ranges from 84 kg H_2SO_4/t (INN SCC) to 284 kg H_2SO_4/t (VFL SCC).
- The ANC ranges from 6.8 kg H_2SO_4 equivalent/t (VFL PHY) to 21 kg H_2SO_4 equivalent/t (IIN SCC).
- Total carbon content ranges from below the detection limit (<0.02%) to 0.03%.
- Assessment of the ANC indicates that 100% of the samples are PAG (Figure 8-1).
- The geochemical classification plot (Figure 8-2) shows that 33% are uncertain and 67% are PAG.
- According to the Barrick guidelines, the classification indicates that 11% is LNAG and 88% is HPAG.

In summary, the current pH of Western Porphyry waste rock and pit wall samples ranges from neutral to alkaline, with 11% classified as LNAG and 88% as HPAG. The waste rock and pit wall samples exhibit low acid neutralization capacity for both major and minor lithologies.

Figure 8-3 displays the relationship between sulphide-S (%) and Total S (%) for various lithologies of the Western Porphyry waste rock. The box and whisker plot, Figure 8-4, presents the distribution of sulphide sulphur content (%) across various lithologies for the years 2010 and 2024.The results indicate that:

- Both the 2010 and 2024 show significant clustering below the line of equality, indicating a substantial amount of total Sulphur is in the form of sulphide sulphur.
- The 2010 results reported that the sulphide sulphur content ranged from 0.02% to 8.7%, with a 95th percentile of 3.3%. In the current study, using the Australian standard for Chromium Reducible Sulphur (which is like Sulphide-S), the sulphide sulphur content ranged from 0.01% to 9.7%, with a 95th percentile of 4.4%.
- The 2010 results indicated that approximately 90% of the Western Porphyry waste rock samples contained sulphide sulphur. The current study shows a similar trend, with most of the waste rock samples also containing sulphide sulphur.
- The previous assessment showed high sulphide-S concentrations in the major lithologies. The current results confirm that major lithologies like VFL PHY, VFL MIX, and VPU SCC continue to have high sulphide-S concentrations.

- The highest sulphide sulphur concentrations were observed in minor lithologies such as VPU QSA and PFB QSA. The graph shows that these minor lithologies (represented by the lighter colours) continue to exhibit high sulphide sulphur concentrations.
- Both previous and current assessments observed that PFB SCC, VPU SCC, VFL PHY, and VFL MIX lithologies contain significant amounts of sulphate sulphur as well.

In summary, the comparison of previous and current results highlights a consistent trend in the sulphide sulphur content of waste rock samples from Western Porphyry. Both studies indicate a high sulphide sulphur content, with major and minor lithologies showing similar patterns in sulphide and sulphate presence. The use of Chromium Reducible Sulphur in the current study aligns well with the results from the SRK report, confirming the reliability and consistency of the observed data over time.

Table 8-1: Acid-Base Accounting, Sulphur Speciation and NAG Test Results for the Western Porphyry waste rock

Sample ID	Lithology Code	Paste pH	EC	Total Sulphur	Chromium Reducible Sulphur	HCl Extractable Sulphur	NAPP	ANC	ANC	MPA	ANC/MPA	Total Carbon	TOC	TIC	NAG pH	NAG (pH 7.0)	Classification
		-	mS/m	%	%	% S	kg H_2SO_4/t	kg H_2SO_4 /t	% $CaCO_3$	kg H_2SO_4/t		%	%	%			
RD-055 (5.5 to 7)	CAL SCC	9.00	206	0.06	0.01	0.05	-46	48	4.8	1.84	26	0.30	0.05	0.25	10.80	<0.1	HNAG
RD-376 (259.5 to 261)	IIN SCC	8.20	251	2.75	1.22	1.58	63	21	2.1	84	0.25	0.04	<0.02	0.04	3.00	17	HPAG
RD-010 (476 to 477.5)	PFB1 QSA	7.20	255	14	9.72	1.57	438	2.1	0.2	441	0.00	<0.02	<0.02	<0.02	2.30	116	HPAG
RD-051 (366 to 367)	PVC MIX	8.20	246	1.29	0.46	0.93	21	19	1.9	39	0.48	0.03	<0.02	0.03	4.20	4.5	HPAG
RD-187 (26 to 28)	PVC POT	9.00	185	0.07	0.02	0.07	-26	29	2.9	2.14	13	0.02	0.02	<0.02	7.80	<0.1	HNAG
RD-393 (244.5 to 246)	PVC PRO	8.20	239	3.57	2.14	1.69	90	19	2.0	109	0.18	0.03	0.02	<0.02	3.00	17	HPAG
RD-002 (491m-492.5m)	VFL MIX	8.10	253	5.06	1.24	4.07	139	16	1.6	155	0.10	0.02	<0.02	0.02	3.40	18	HPAG
RD-005 (468.5m-470m)	VFL MIX	8.20	252	3.02	0.46	2.90	74	18	1.9	92	0.20	<0.02	<0.02	<0.02	4.00	7.4	HPAG
RDDT-052 (303 to 304.5)	VFL MIX	8.30	249	2.63	0.54	2.21	62	18	1.9	80	0.23	0.06	<0.02	0.06	4.30	4.2	HPAG
RD-324 (372 to 3730	VFL PHY	7.70	241	3.79	2.59	1.43	109	6.8	0.7	116	0.06	<0.02	<0.02	<0.02	2.20	77	HPAG
RD-043 (258 to 259)	VFL SCC	8.40	250	2.82	0.48	2.56	60	26	2.7	86	0.31	0.07	<0.02	0.07	4.70	2.1	HPAG
RD-370 (585 to 586.5)	VFL SCC	7.00	209	9.28	4.38	3.92	276	8.0	0.8	284	0.03	<0.02	<0.02	<0.02	2.10	122	HPAG
RD-216 (44 to 44.77)	VIN PRO	7.20	375	3.38	1.57	2.15	87	16	1.6	103	0.15	0.09	<0.02	0.09	3.10	11	HPAG
RD-026 (182 to 183)	VIN QSA	7.40	252	5.09	2.30	2.48	147	8.4	0.8	156	0.05	<0.02	<0.02	<0.02	3.30	13	HPAG
RD-084 (250m-251.5m)	VIN QSA	7.80	226	5.39	2.89	2.45	162	3	0.3	165	0.02	<0.02	<0.02	<0.02	2.80	25	HPAG
RD-270 (52 to 53)	VIN QSA	6.60	209	5.66	1.32	4.03	172	0.9	<0.1	173	0.01	<0.02	<0.02	<0.02	3.10	17	HPAG
RDDT-077 (268m-269.5m)	VIN QSA	7.80	218	3.96	1.27	2.20	110	11	1.2	121	0.09	<0.02	<0.02	<0.02	2.90	23	HPAG
RD-105 (468m-469.5m)	VPU POT	8.10	227	1.38	0.48	1.02	32	11	1.1	42	0.25	<0.02	<0.02	<0.02	3.80	8.6	HPAG
RD-011 (348 to 349)	VPU QSA	7.20	234	8.30	4.38	2.77	251	3.1	0.3	254	0.01	0.05	0.02	0.03	2.60	56	HPAG
RD-043 (337.5m-339m)	VPU QSA	8.00	223	4.56	2.8	1.68	132	8	0.8	140	0.06	0.05	0.05	<0.02	3.20	18	HPAG
RD-047 (483 to 484)	VPU SCC	8.10	229	2.67	1.37	1.53	73	8.5	0.9	82	0.10	<0.02	<0.02	<0.02	2.90	24	HPAG
RD-129 (351m-352.5m)	VPU SCC	8.20	236	3.44	0.65	3.06	89	16	1.6	105	0.15	<0.02	<0.02	<0.02	3.60	11	HPAG

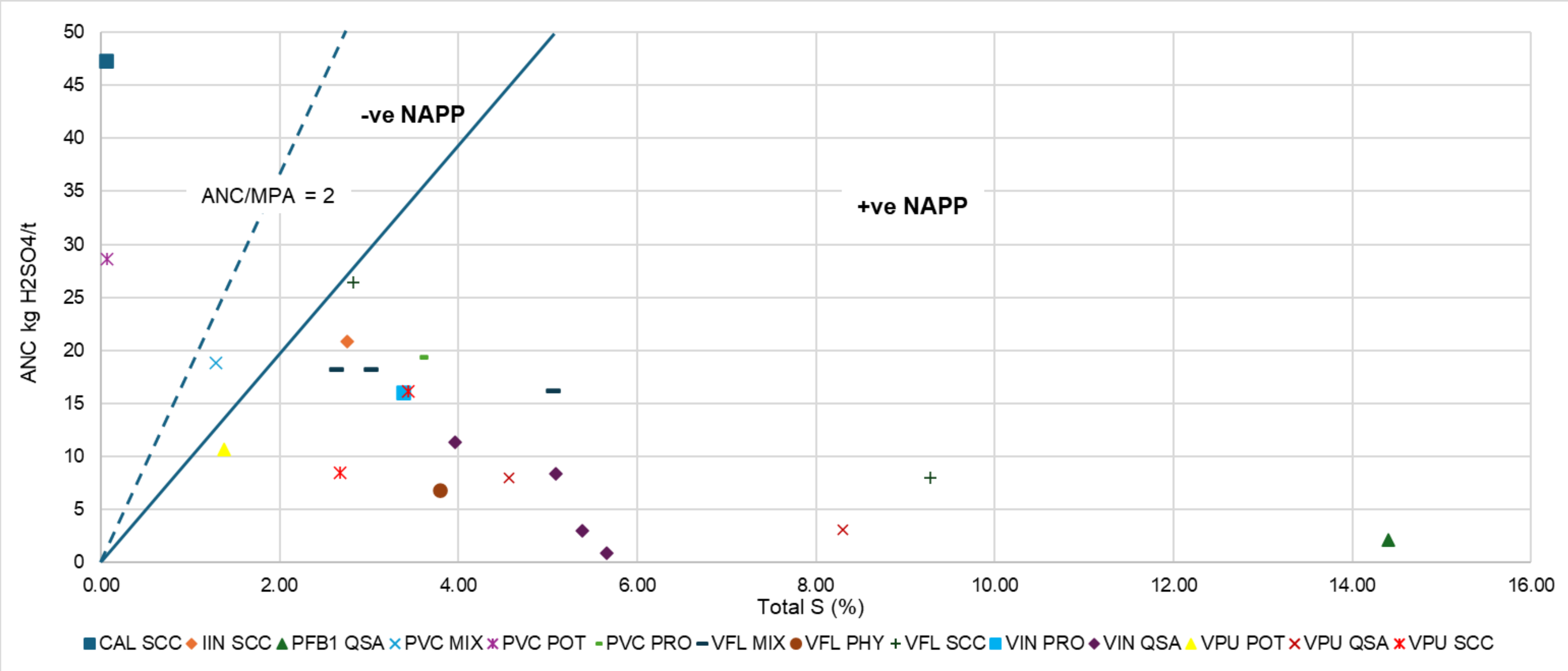

Figure 8-1: Acid Base Accounting Plot for Western Porphyry

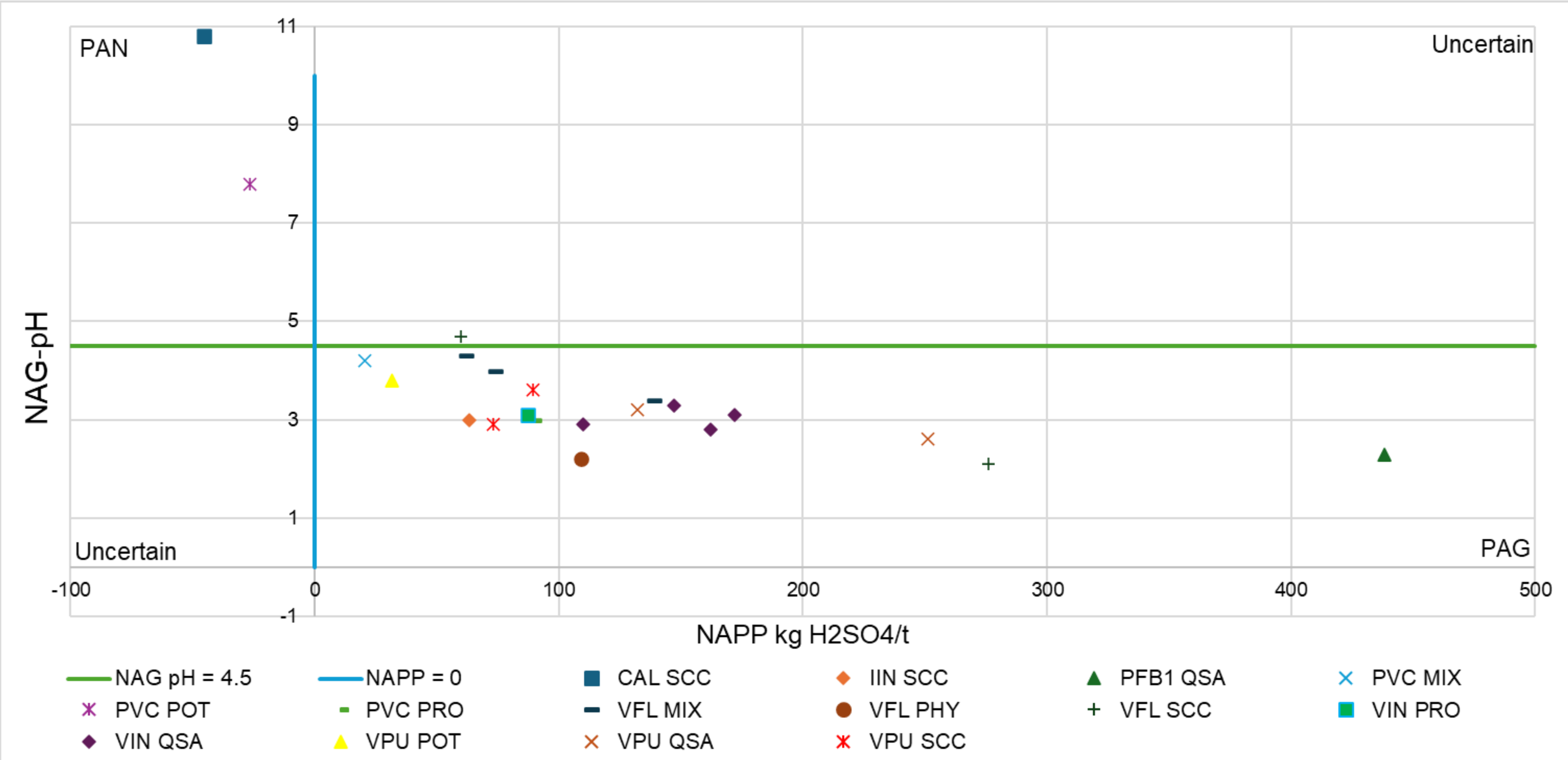

Figure 8-2: Geochemical Classification Plot for Western Porphyry

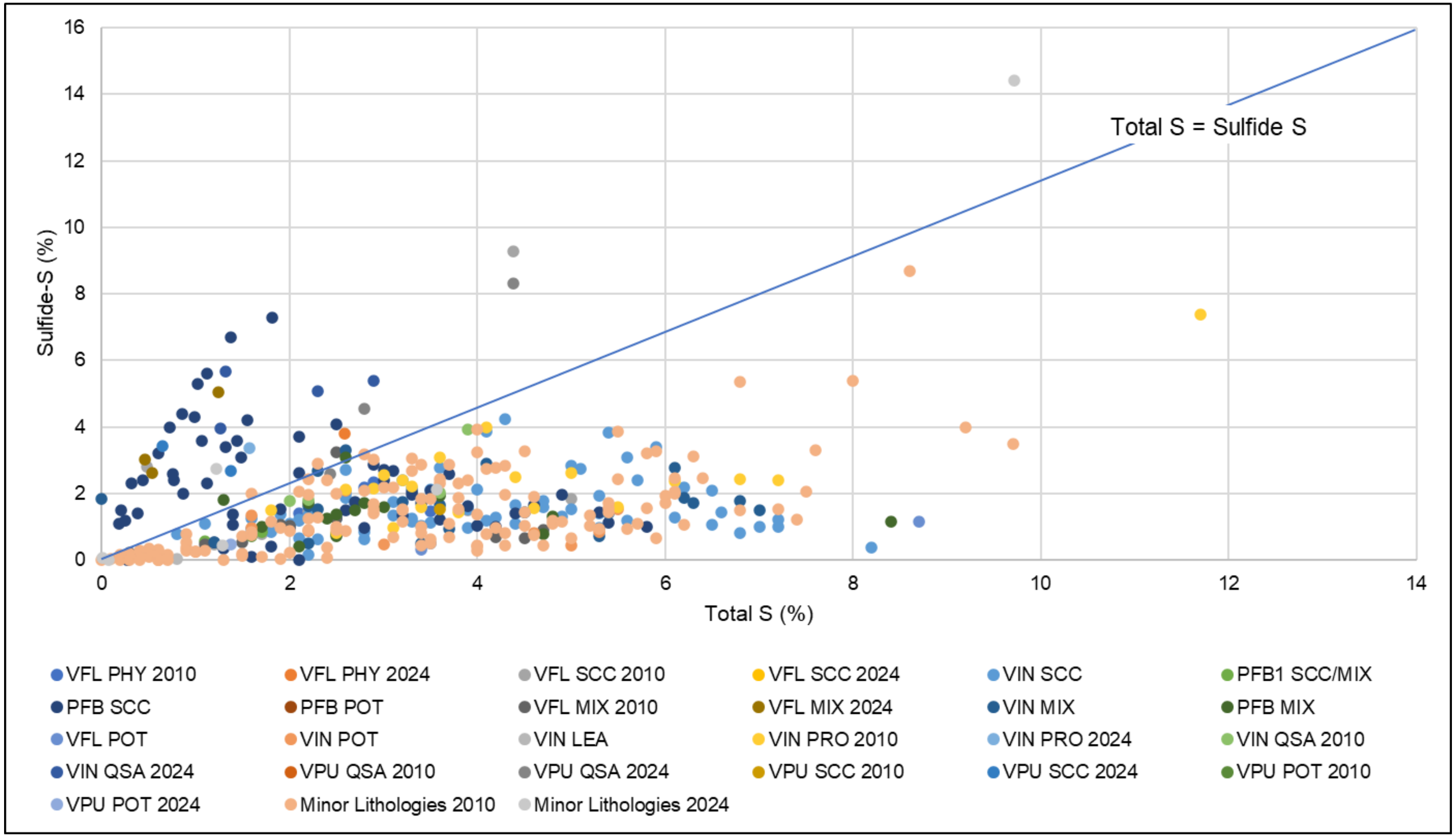

Figure 8-3: Western Porphyry waste rock for Sulphide Sulphur versus total Sulphur for previous and current studies

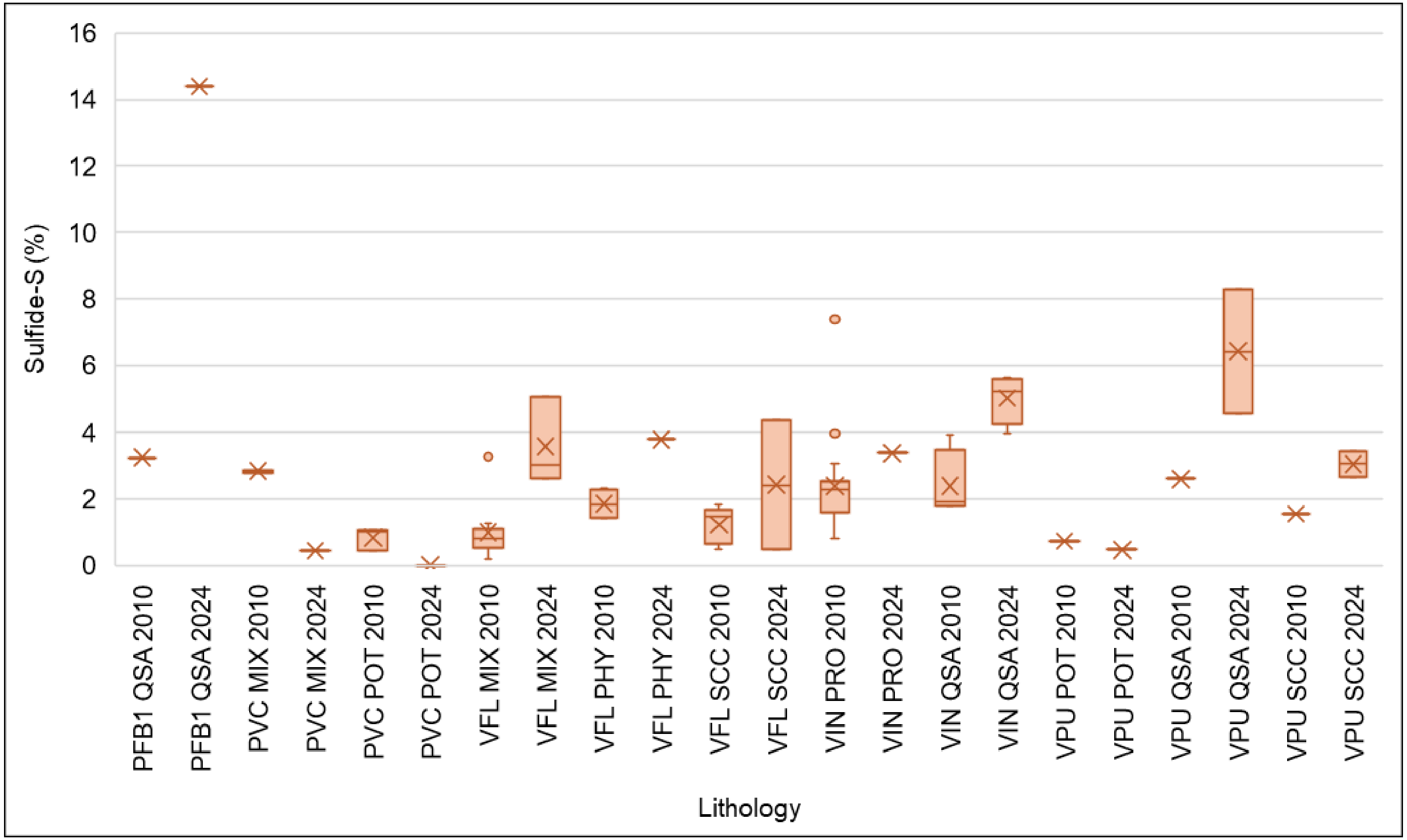

Figure 8-4: Western Porphyry waste rock box and whisker plot of sulphide sulphur content

8.1.2. Leaching Potential

To determine the leaching characteristics, a 3:1 contact leach test using deionized water was conducted on 13 samples representative of the key lithologies. The solutions from these tests were analysed using multi-element inductively coupled plasma (ICP for cations and ion chromatography (IC for anions. This analysis identified potential mobile chemical phases that are likely to be environmentally available due to their reactivity.

The leachate concentrations were evaluated against the background groundwater quality (BGWQ), there is little precipitation expected but should there be any precipitation groundwater is likely to be affected.

8.1.2.1. Waste Rock

The results for the waste rock samples, summarized in Table 8-2, indicate the following:

- The leachate pH is neutral (pH 6.58 – 7.28), with the leachate pH for the lithologies within the acceptable neutral pH range indicated in BGWQ.
- Total dissolved solids range between 2 380 – 3 970 mg/L, with sulphate concentrations being the dominant salt in total dissolved solids ranging between 1 480 – 2 450 mg/L. However, due to the already elevated salt load in the groundwater, should there be circumstances seepage occurs groundwater will not be expected to be altered.
- Parameters exceeding the BGWQ are aluminium, antimony, barium, cobalt, copper, iron, potassium, manganese, thorium and thallium.

In summary, the leachate pH ranges from acidic to neutral (pH 6.58 – 7.28). The pH values for the lithologies are within the acceptable neutral pH range. Several parameters, such as aluminium, antimony, barium, cobalt, copper, iron, potassium, manganese, thorium and thallium, exceed BGWQ levels.

8.1.2.2. Pit Wall

The results for the Western Porphyry pit wall waste rock samples, summarized in Table 8-2, show the following:

- Leachate pH ranges from acidic to mildly acidic (pH 4.91 – 5.23). VFL SCC and VFL PHY lithologies have leachate pH values below the minimum limit BGWQ.
- Due to the acidity Parameters above BGWQ levels include low pH, aluminium, antimony, barium, cobalt, iron, potassium, manganese, lead, strontium, thorium, thallium, yttrium, and zinc.

In summary, the leachate pH from the pit wall waste rock samples ranges from acidic to mildly acidic (pH 4.91 – 5.23). VFL SCC and VFL PHY have pH values below the minimum limit BGWQ. The parameters of concern include low pH, aluminium, antimony, barium, cobalt, iron, potassium, manganese, lead, strontium, thorium, thallium, yttrium, zinc and nitrates.

Table 8-2: ASTM D1987 Leachate Results for Western Porphyry Waste Rock in 1:3 Solid to Liquid Ratio

Analytes	Units	BGWQ (2008-2009)		RD-051 (366m to 367m)	RD-393 (244.5m to 246m)	RD-324 (372m to 373m) – Pit Wall	RD-005 (468.5m-470m)	RD-002 (491m-492.5m)	RDDT-052 (303m to 304.5m)	RD-043 (258m to 259m)	RD-370 (585m to 586.5m) Pit Wall	RD-216 (44m to 44.77m)	RD-084 (250m-251.5m)	RD-105 (468m-469.5m)	RD-043 (337.5m-339m)	RD-129 (351m-352.5m)
		Min	Max	PVC MIX	PVC PRO	VFL PHY	VFL MIX			VFL SCC		VIN PRO	VIN SCC	VPU POT	VPU QSA	VPU SCC
		Physicochemical Parameters														
pH	-	7.20	7.75	6.71	7.11	5.23	6.99	6.42	6.99	6.58	4.91	6.69	6.95	7.11	7.28	6.96
Electrical Conductivity	mS/m	1420	1470	232	245	253	275	250	262	260	245	384	277	270	256	263
TDS	mg/L	9450	11488	2540	2440	2510	2750	2430	2450	2610	2510	3970	2820	2610	2380	2500
Total Alkalinity as $CaCO_3$	mg/L	94	143	13	21	1.0	13	4.0	15	10	1.0	16	15	19	36	13
Chloride	mg/L	3450	4260	48	43	10	31	45	51	28	14	202	34	63	53	33
Sulphate	mg/L	2520	3040	1560	1530	1740	1750	1530	1650	1730	1600	2450	1760	1630	1480	1710
Nitrate as N	mg/L	<0.5	29	0.32	0.17	0.07	0.37	0.22	0.51	0.63	0.08	1.3	0.42	0.68	0.95	0.6
Nitrite as N	mg/L	<0.5	17	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fluoride	mg/L	<0.5	3.29	0.5	0.6	0.3	0.6	0.4	0.06	0.4	0.7	1.9	0.5	0.3	0.4	0.7
Ammonia	mg/L			0.12	0.11	0.05	0.08	0.09	0.02	0.11	0.07	0.38	0.02	0.06	0.16	0.07
		Metals/Metalloids														
Silver	mg/L	<0.02	<0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Aluminium	mg/L	<0.02	0.44	0.01	0.01	0.92	0.01	0.01	0.01	0.01	1.89	0.01	0.01	0.01	0.01	0.01
Antimony	mg/L	<0.0001	0.0008	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.003
Arsenic	mg/L	<0.005	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Boron	mg/L	0.004	5.08	0.08	0.11	0.14	0.07	0.09	0.1	0.09	0.11	0.1	0.09	0.11	0.14	0.1
Barium	mg/L	0.036	0.043	0.20	0.30	0.20	0.25	0.21	0.30	0.21	0.23	0.20	0.28	0.20	0.23	0.24
Beryllium	mg/L		<0.01	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001
Bismuth	mg/L	<0.03	<0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Calcium	mg/L	0.69	890	528	568	627	632	582	598	611	538	505	682	625	594	632
Cadmium	mg/L	<0.0001	0.0003	0.0001	0.0002	0.0004	0.0002	0.0012	0.0001	0.0001	0.005	0.0003	0.0004	0.0002	0.0006	0.0008

Analytes	Units	BGWQ (2008-2009)		RD-051 (366m to 367m)	RD-393 (244.5m to 246m)	RD-324 (372m to 373m) – Pit Wall	RD-005 (468.5m-470m)	RD-002 (491m-492.5m)	RDDT-052 (303m to 304.5m)	RD-043 (258m to 259m)	RD-370 (585m to 586.5m) Pit Wall	RD-216 (44m to 44.77m)	RD-084 (250m-251.5m)	RD-105 (468m-469.5m)	RD-043 (337.5m-339m)	RD-129 (351m-352.5m)
		Min	Max	PVC MIX	PVC PRO	VFL PHY	VFL MIX			VFL SCC		VIN PRO	VIN SCC	VPU POT	VPU QSA	VPU SCC
Cerium	mg/L	<0.00001	0.001	0.001	0.001	0.05	0.001	0.014	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/L	0.00005	0.004	0.001	0.001	0.015	0.001	0.02	0.001	0.001	0.031	0.002	0.001	0.001	0.003	0.002
Chromium	mg/L	<0.05	<0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/L	<0.02	0.041	0.004	0.003	0.016	0.004	0.40	0.006	0.006	0.011	0.003	0.016	0.005	0.11	0.032
Iron	mg/L	<0.1	2.8	0.05	0.05	4.62	0.05	0.05	0.05	0.05	14	0.05	0.05	0.05	0.05	0.05
Potassium	mg/L	0.01	20	25	16	28	38	51	33	32	34	25	36	27	30	42
Magnesium	mg/L	0.22	283	3.0	8.0	4.0	5.0	9.0	8.0	8.0	3.0	226	6.0	5.0	4.0	9.0
Manganese	mg/L	0.0009	2.67	5.14	0.90	2.76	0.17	1.44	0.24	0.42	2.94	1.26	0.40	1.46	3.68	0.49
Mercury	mg/L	<0.02	<0.000001	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
Molybdenum	mg/L	<0.01	0.071	0.019	0.021	0.001	0.041	0.003	0.016	0.02	0.001	0.011	0.022	0.022	0.019	0.041
Neodymium	mg/L			0.001	0.001	0.39	0.001	0.005	0.001	0.001	0.098	0.001	0.001	0.001	0.001	0.001
Sodium	mg/L	2.59	2620	54	44	14	48	43	56	28	18	229	42	58	52	55
Nickel	mg/L	<0.03	0.1	0.001	0.001	0.049	0.001	0.012	0.001	0.001	0.039	0.002	0.001	0.002	0.008	0.001
Phosphorus	mg/L			0.05	0.05	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.05	0.03	0.26	0.04
Lanthanum	mg/L			0.001	0.001	0.026	0.001	0.013	0.001	0.001	0.077	0.001	0.001	0.001	0.001	0.001
Lead	mg/L	0.0001	0.007	0.001	0.004	0.003	0.001	0.001	0.001	0.001	0.008	0.001	0.002	0.001	0.004	0.001
Selenium	mg/L	<0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Scandium	mg/L	<0.1	<0.01	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
Silicon	mg/L	<20	16	4.8	4.11	4.8	5.45	7.81	6.91	4.11	5.45	7.81	6.91	7.8	8.79	3.72
Tin	mg/L	<0.01	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Strontium	mg/L	0.18	4.78	5.49	4.82	4.36	3.7	10.7	3	2.66	11.2	7.82	5.2	2.52	7.92	7.79
Thorium	mg/L	<0.0001	0.0006	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Titanium	mg/L	<0.01	0.028	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Thallium	mg/L	<0.0001	0.00002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Uranium	mg/L	0.0007	0.002	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001

Analytes	Units	BGWQ (2008-2009)		RD-051 (366m to 367m)	RD-393 (244.5m to 246m)	RD-324 (372m to 373m) – Pit Wall	RD-005 (468.5m-470m)	RD-002 (491m-492.5m)	RDDT-052 (303m to 304.5m)	RD-043 (258m to 259m)	RD-370 (585m to 586.5m) Pit Wall	RD-216 (44m to 44.77m)	RD-084 (250m-251.5m)	RD-105 (468m-469.5m)	RD-043 (337.5m-339m)	RD-129 (351m-352.5m)
		Min	Max	PVC MIX	PVC PRO	VFL PHY	VFL MIX			VFL SCC		VIN PRO	VIN SCC	VPU POT	VPU QSA	VPU SCC
Vanadium	mg/L	<0.01	0.005	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Yttrium	mg/L	<0.0003	0.0007	0.001	0.001	0.088	0.001	0.004	0.001	0.001	0.217	0.001	0.001	0.001	0.001	0.001
Zinc	mg/L	0.00003	0.09	0.024	0.11	0.46	0.027	0.26	0.03	0.043	0.305	0.13	0.084	0.042	0.17	0.101

8.1.2.3. Leachate Water Types

Piper plots were used to analyse the chemical characteristics of 2010 and 2023 leachate water quality types. The purpose of the piper was to compare the ion composition of the 2010 and current leachate water samples to identify the distinct water types based on the concentrations of major cations and anions. The piper diagram of leachate from Western Porphyry waste rocks from (a) the current report and (b) 2010 results are presented in Figure 8-5 and indicate the following:

- Both the 2010 and current waste rock leachate water show a dominance of calcium in the cation triangle.
- Sulphate is a significant anion in both leachates.
- Both leachates show predominantly Calcium-Magnesium Sulphate water type and minor Sodium Sulphate water type.

In summary, both the 2010 and the current leachate water samples are characterised by a dominance of calcium and sulphate, suggesting that these waters might be influenced by gypsum or anhydrite dissolution.

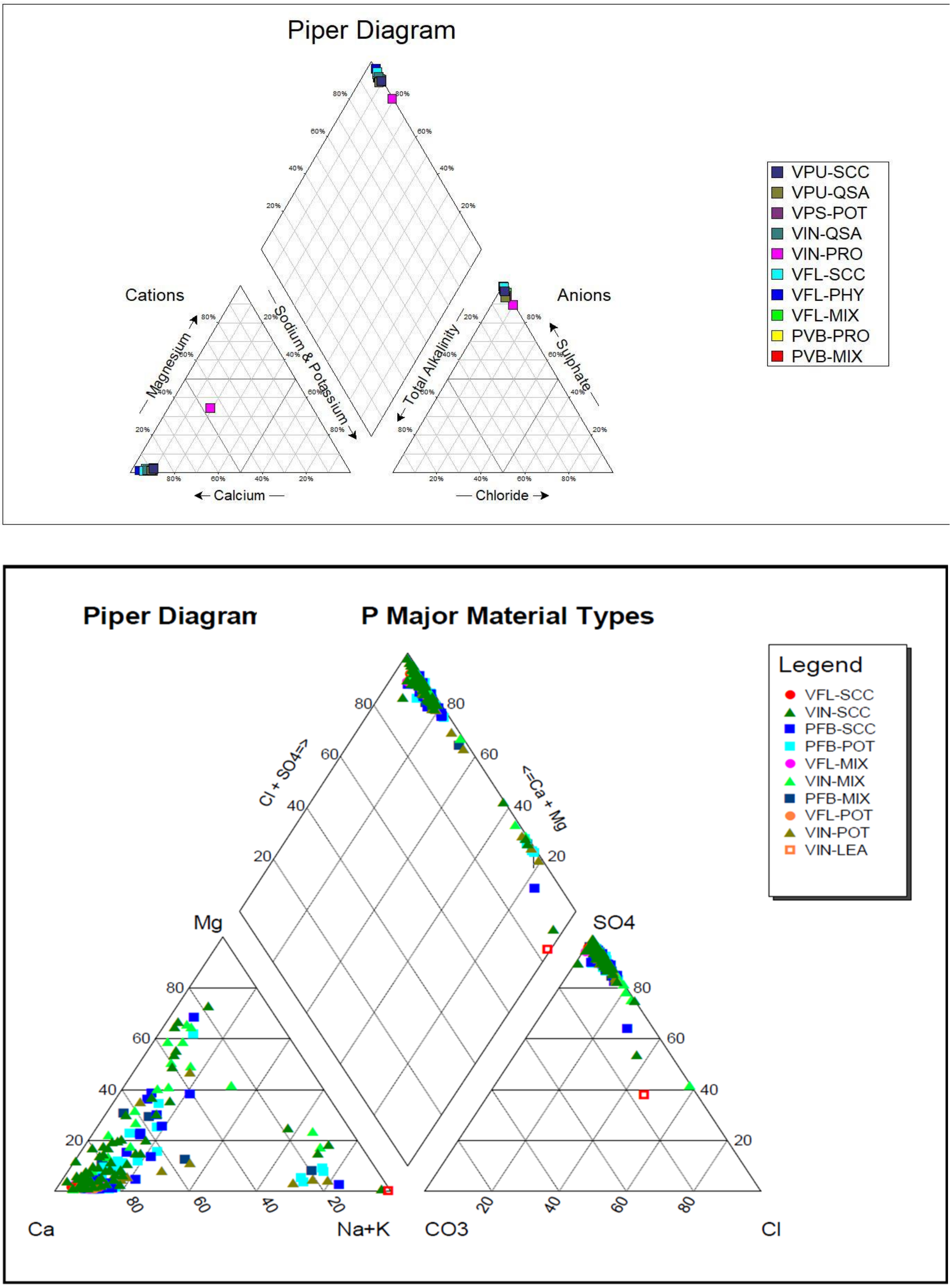

Figure 8-5: Piper diagram for Western Porphyries leachate water quality (a) current project and (b) 2010 SRK results

8.2. Tanjeel

8.2.1. Acid Generation Potential

Table 9-3 summarises the ABA, Sulphur speciation, carbon speciation, and NAG results for the waste rock. A total of 42 samples, including 40 waste rock samples and 2 pit wall samples, were analysed for ABA and NAG.

8.2.1.1. Waste Rock

The acid-generating and neutralising characteristics of the waste rock are as follows:

- The paste pH ranges between mildly acidic to neutral (pH 5.3 – 7.50).
- Total Sulphur ranges from 0.29% to 10%. On average, chromium-reducible Sulphur (or sulphide sulphur) makes up 44% of the total sulphur concentration, HCl-extractable sulphur (or sulphate sulphur) constitutes18%, and the remaining 38% consists of unaccounted sulphur species.
- The MPA ranges from 2.8 kg H_2SO_4/t (VIN LEA) to 419 kg H_2SO_4/t (PQF PHY).
- The ANC ranges from less than the detection limit of <0.5 kg H_2SO_4/t (PQF LEA, VIN LEA and VIN OXI) to 15 kg H_2SO_4/t (VIN OXI).
- The Total Carbon ranges between less than the detection limit (<0.02%) to 0.02% with only 5% of the results that are not below the detection limit and are TIC.
- The ABA plot indicates that 10% are PAN, 3% are uncertain and 86% are PAG (Figure 8-6).
- NAPP is commonly used to indicate if a material has the potential to generate ARD. If the MPA is less than the ANC, then the NAPP is negative it is PAN. Conversely, if the MPA exceeds the ANC then the NAPP is positive meaning it is PAG. The geochemical classification (Figure 8-7) plot indicates that 45% are uncertain and 55% are PAG.
- Based on the Barrick guidelines the classification indicates that 2% is LNAG and 98 is HPAG.

8.2.1.2. Pit Wall

The acid-generating and neutralising characteristics of the waste rock are as follows:

- The paste pH ranges between mildly acidic to alkaline; PFQ LEA (pH 5.60), and PFQ PHY (pH 5.60 – 7.30).
- Sulphur species are the primary source of acid, acidity, and potentially deleterious elemental species in the drainage of materials. Total Sulphur ranges in the pit wall samples are PFQ LEA (0.54%) and PFQ PHY (6.42%). The distribution of Sulphur for chromium-reducible Sulphur (44%), HCl extractable Sulphur (18%) and other Sulphur species (38%) indicates chromium-reducible Sulphur to be dominant.

- The MPA, defined as the capacity of the minerals in the waste rock to produce acidity, ranges from 17 kg H_2SO_4/t (PFQ LEA) to 196 kg H_2SO_4/t (PFQ PHY).
- The ANC, defined as the capacity of the minerals in the waste rock to produce base, ranges from less than the detection limit of 0.1 kg H_2SO_4/t (PFQ LEA) to 0.2 kg H_2SO_4/t (PFQ PHY).
- The Total Carbon is less than the detection limit (<0.02%).
- Assessment of the ANC against Total S referred to as the ABA plot indicates that 10% are PAN, 2% are uncertain and 88% are PAG (Figure 8-1).
- NAPP is commonly used to indicate if a material has the potential to generate ARD. If the MPA is less than the ANC, then the NAPP is negative it is PAN. Conversely, if the MPA exceeds the ANC then the NAPP is positive meaning it is PAG. The geochemical classification (Figure 8-2) plot indicates that 45% are uncertain and 55% are PAG.
- Based on the Barrick guidelines the classification indicates that 2% is LNAG and 98 is HPAG.

In summary, the current pH of Tanjeel waste rock and pit wall samples demonstrate mildly acidic to alkaline with waste rocks indicating 98% of samples HPAG and 2% LNAG. The pit wall samples are 100% HPAG. Like Western Porphyry, the samples demonstrated low Acid Neutralisation Capacity.

Figure 8-8 shows the graph of a plot of Sulphide-S (%) on the y-axis against Total S (%) on the x-axis for various lithologies of Tanjeel waste rock. The diagonal line represents the condition where Total S is equal to Sulphide S. The distribution of sulphide sulphur (chromium reducible sulphur) from the current study compared to previous reports is shown in Figure 8-9. The results indicate the following:

- Most data points lie below the diagonal line, indicating that Total S is greater than Sulphide S for most samples.
- The distribution is consistent across different lithologies and time periods (2010 and 2024).
- The current study shows a lower concentration of Sulphide Sulphur (44%) compared to the previous study (69%). This is because the current study identifies additional Sulphur species (38%) contributing to the total Sulphur concentration.
- Again, the current study shows a lower concentration of Sulphate Sulphur (18% HCl extractable Sulphate) compared to the previous study (31%).
- Both studies indicate high Sulphide Sulphur concentrations in primary lithologies such as PFQ PHY, PWF PHY, and VIN PHY. The consistency in the findings suggests that the primary lithologies are reliable indicators of high Sulphide Sulphur concentrations in both studies.
- Specific lithology comparison indicates the following:

- PFQ PHY, PWF PHY, VIN PHY: Major lithologies with high Sulphide Sulphur concentrations. In the current study (2024), these lithologies show Total S values up to 8% with corresponding Sulphide S values up to 4%, maintaining the trend observed in previous reports.
- VFL PHY 2010 and 2024 (dark blue): These lithologies show a wide range of Total S values with Sulphide S generally below 4%. This indicates that other Sulphur species contribute significantly to the total Sulphur content.
- PFB SCC/MIX (yellow): These samples exhibit higher Total S values, some exceeding 10%, with Sulphide S ranging up to 6%. This suggests high variability and significant contributions from non-Sulphide Sulphur species.
- Minor Lithologies 2010 and 2024 (grey): These show a relatively low range of Total S, generally below 4%, with Sulphide S mostly below 2%, indicating low Sulphur content overall.
- VFL SCC and MIX: These lithologies show lower Total S values with most data points below 4%, and Sulphide S values generally below 2%, indicating less contribution from Sulphide Sulphur.

In summary, the major lithologies consistently show higher sulphide sulphur concentrations, aligning with the detailed textual data provided earlier. The current study indicates that sulphide sulphur constitutes a part of the total sulphur content, but there is a significant contribution from other sulphur species.

Table 8-3: Acid-Base Accounting, Sulphur Speciation and NAG Test Results for the Tanjeel waste rock

Sample ID	Lithology Code	Paste pH	EC	NAPP	ANC as H_2SO_4	ANC as $CaCO_3$	Total Sulphur	Chromium Reducible Sulphur	HCl Extractable Sulphur	MPA	ANC/MPA	Total Carbon	TOC	TIC	NAG pH	NAG (pH 7.0)	Classification
		-	mS/m	kg H_2SO_4/t	kg H_2SO_4/t	% $CaCO_3$	%	% S	%	kg H_2SO_4/t		%	%	%		kg H_2SO_4/t	
RDDT-176 (172m - 173.5m)	VIN PHY	7.20	113	142	3.40	0.30	4.76	4.35	0.108	146	0.023	<0.02	<0.02	<0.02	2.10	137	HPAG
RDDT-171 (90.5m -92m)	VIN PHY	6.40	122	167	6.10	0.60	5.65	4.97	0.082	173	0.035	<0.02	<0.02	<0.02	2.20	103	HPAG
RDDD-301 (10m-10.5m)	VIN OXI	7.10	588	5	14.80	1.50	0.66	0.019	0.546	20	0.733	<0.02	<0.02	<0.02	5.30	1.50	HPAG
RDDD-151 (56m - 57.5m)	VIN LEA	5.80	160	180	<0.50	<0.10	5.88	4.22	0.214	180	0.003	<0.02	<0.02	<0.02	2.40	63	HPAG
RDDT-191 (56m-57.5m)	VIN LEA	5.60	132	48	1.70	0.20	1.61	0.015	0.194	49	0.035	<0.02	<0.02	<0.02	6.00	1.2	HPAG
RDDT-202 (74.5m-76m)	VIN LEA	7.30	69	-3	5.80	0.60	0.09	0.015	0.049	3	2.11	<0.02	<0.02	<0.02	5.50	1.3	LNAG
RDDT-202 (60m-61.5m)	VIN LEA	6.40	116	11	3.60	0.40	0.46	0.006	0.054	14	0.256	0.03	0.02	<0.02	4.50	1.7	HPAG
RDDD-083 (81m-82.5m)	PQF PHY	6.70	110	122	4.50	0.40	4.12	3.6	0.05	126	0.036	<0.02	<0.02	<0.02	5.90	1.0	HPAG
RDDT-139 (91m-92.5m)	PQF PHY	6.90	74	76	3.80	0.40	2.60	2.3	0.031	80	0.048	0.02	0.02	<0.02	5.20	2.0	HPAG
RDDT-115 (99m-100.5m)	PQF PHY	6.10	68	83	3.20	0.30	2.83	2.43	0.038	87	0.037	<0.02	<0.02	<0.02	6.10	1.0	HPAG
RDDT-133 (150m-151.5m)	PQF PHY	6.00	263	417	1.80	0.20	13.7	10.4	1.09	419	0.004	<0.02	<0.02	<0.02	6.60	0.4	HPAG
RDDD-111 (148.5m-150m)	PFQ SCC	6.80	79	136	4.10	0.40	4.57	4.19	0.071	140	0.029	<0.02	<0.02	<0.02	5.50	4.1	HPAG
RDDD-125 (111m-112m)	PFQ SCC	7.40	83	71	7.90	0.80	2.59	2.47	0.049	79	0.100	<0.02	<0.02	<0.02	5.40	1.9	HPAG
RDDT-134 (95.5m-97m)	PFQ PHY	7.10	238	44	5.80	0.60	1.64	1.33	0.311	50	0.116	<0.02	<0.02	<0.02	6.20	1.9	HPAG
RDDT-136 (120.5m-122m)	PFQ PHY	7.30	73	80	5.80	0.60	2.81	2.58	0.041	86	0.067	<0.02	<0.02	<0.02	5.70	1.3	HPAG
RDDT-145 (134m-135.5m)	PFQ PHY	8.00	154	124	14.40	1.50	4.51	4.1	0.082	138	0.104	<0.02	<0.02	<0.02	2.90	16	HPAG
RDDT-137 (148.5m-150m)	PFQ PHY	6.80	94	97	3.30	0.30	3.28	2.9	0.035	100	0.033	0.05	0.05	<0.02	2.90	21	HPAG
RDDD-296 (14m-14.5m)	PFQ OXI	5.50	110	43	1.30	0.10	1.45	0.026	0.068	44	0.029	0.05	<0.02	0.05	2.30	79	HPAG
RDDT-146 (68m-69.5m)	PFQ LEA	6.70	201	11	1.20	0.10	0.39	0.019	0.122	12	0.101	<0.02	<0.02	<0.02	2.60	36	HPAG
RDDT-189 (59m-57.5m)	PFQ LEA	5.50	126	48	1.30	0.10	1.60	0.008	0.098	49	0.027	<0.02	<0.02	<0.02	2.20	102	HPAG
RDDT-195 (63.5m-65m)	PFQ LEA	6.00	141	31	1.00	<0.1	1.03	0.009	0.623	32	0.032	<0.02	<0.02	<0.02	2.90	21	HPAG
RD-664 (32.5 to 33)	PFQ LEA	5.60	91	27	0.60	<0.1	0.91	0.023	0.054	28	0.022	<0.02	<0.02	<0.02	2.40	47	HPAG
RD-665 (53 to 53.5)	PFQ LEA	5.40	151	14	0.60	<0.1	0.47	0.012	0.115	14	0.042	<0.02	<0.02	<0.02	2.70	37	HPAG
RD-671 (15 to 15.5)	PFQ LEA	5.70	164	13	1.00	<0.1	0.45	0.01	0.228	14	0.073	<0.02	<0.02	<0.02	2.90	18	HPAG
RDDT-134 (57.5 to 59)	PFQ LEA	6.20	102	15	1.40	0.10	0.54	0.008	0.06	17	0.085	<0.02	<0.02	<0.02	2.80	23	HPAG
RDDT-156 (40 to 41)	PFQ LEA	5.40	45	47	0.60	<0.1	1.54	0.012	0.309	47	0.013	<0.02	<0.02	<0.02	4.80	2.0	HPAG
RDDT-155 (40 to 41)	BHY LEA	5.30	87	45	0.60	<0.1	1.48	0.02	0.522	45	0.013	<0.02	<0.02	<0.02	4.30	1.6	HPAG
RDDT-137 (135 to 136)	BTE PHY	6.80	145	162	1.50	0.20	5.35	4.75	0.069	164	0.009	<0.02	<0.02	<0.02	4.60	2.0	HPAG

Sample ID	Lithology Code	Paste pH	EC	NAPP	ANC as H_2SO_4	ANC as $CaCO_3$	Total Sulph ur	Chromiu m Reducible Sulphur	HCl Extractabl e Sulphur	MPA	ANC/MP A	Total Carbon	TOC	TIC	NAG pH	NAG (pH 7.0)	Classificatio n
		-	mS/ m	kg H_2SO_4/t	kg H_2SO_4/t	% $CaCO_3$	%	% S	%	kg H_2SO4/t		%	%	%		kg H_2SO_4/t	
RD-414 (23 to 23.5)	PFQ OXI	6.00	101	6.20	2.70	0.30	0.29	0.01	0.052	8.9	0.304	<0.02	<0.02	<0.02	4.80	3.1	HPAG
RD-663 (7 to 7.5)	PFQ OXI	6.30	137	37	1.70	0.20	1.27	0.013	0.184	39	0.044	<0.02	<0.02	<0.02	2.30	76	HPAG
RDDT-156 (196.5 to 198)	PFQ PHY	5.60	144	194	2.40	0.20	6.42	6.3	0.071	196	0.012	<0.02	<0.02	<0.02	2.70	30	HPAG
RD-664 (133.5 to 134)	PFQ PHY	5.70	72	100	1.00	<0.1	3.29	3.08	0.035	101	0.010	<0.02	<0.02	<0.02	2.80	21	HPAG
RDDT-136 (167.5 to 169)	PFQ PHY	6.30	72	92	2.40	0.20	3.09	3.06	0.033	95	0.025	0.02	<0.02	0.02	2.20	118	HPAG
RD-687 (190 to 190.5)	PFQ SCC	7.50	202	203	6.30	0.60	6.84	1.88	4.54	209	0.030	0.02	0.02	<0.02	5.30	11	HPAG
RD-657 (19 to 19.5)	PQF LEA	5.70	155	40	<0.50	<0.10	1.29	0.012	0.388	39	0.013	<0.02	<0.02	<0.02	2.20	91	HPAG
RD-669 (27.5 to 28)	PQF LEA	5.40	157	42	<0.50	<0.10	1.36	0.008	0.423	42	0.012	<0.02	<0.02	<0.02	5.10	2.8	HPAG
RD-670 (23 to 23.5)	PQF LEA	5.60	120	40	<0.50	<0.10	1.30	0.009	0.335	40	0.013	<0.02	<0.02	<0.02	6.80	0.6	HPAG
RDDD-072 (14 to 15)	PQF LEA	6.00	163	36	1.00	0.10	1.20	0.008	0.677	37	0.027	<0.02	<0.02	<0.02	6.80	0.5	HPAG
RD-662 (47 to 47.5)	PQF PHY	6.20	63	99	<0.50	<0.10	3.23	2.37	0.07	99	0.005	<0.02	<0.02	<0.02	7.70	<0.1	HPAG
RD-662 (10 to 10.5)	VIN OXI	5.50	85	96	<0.50	<0.10	3.13	0.02	1.07	96	0.005	<0.02	<0.02	<0.02	5.00	2.0	HPAG
RDDT-176 (94.5 to 96)	VIN PHY	5.00	126	313	1.80	0.20	10.30	10	0.087	315	0.006	<0.02	<0.02	<0.02	2.50	60	HPAG
RD-381 (155 to 155.5)	VIN PHY	6.70	184	136	14.30	1.50	4.90	4.86	0.087	150	0.095	<0.02	<0.02	<0.02	2.30	97	HPAG

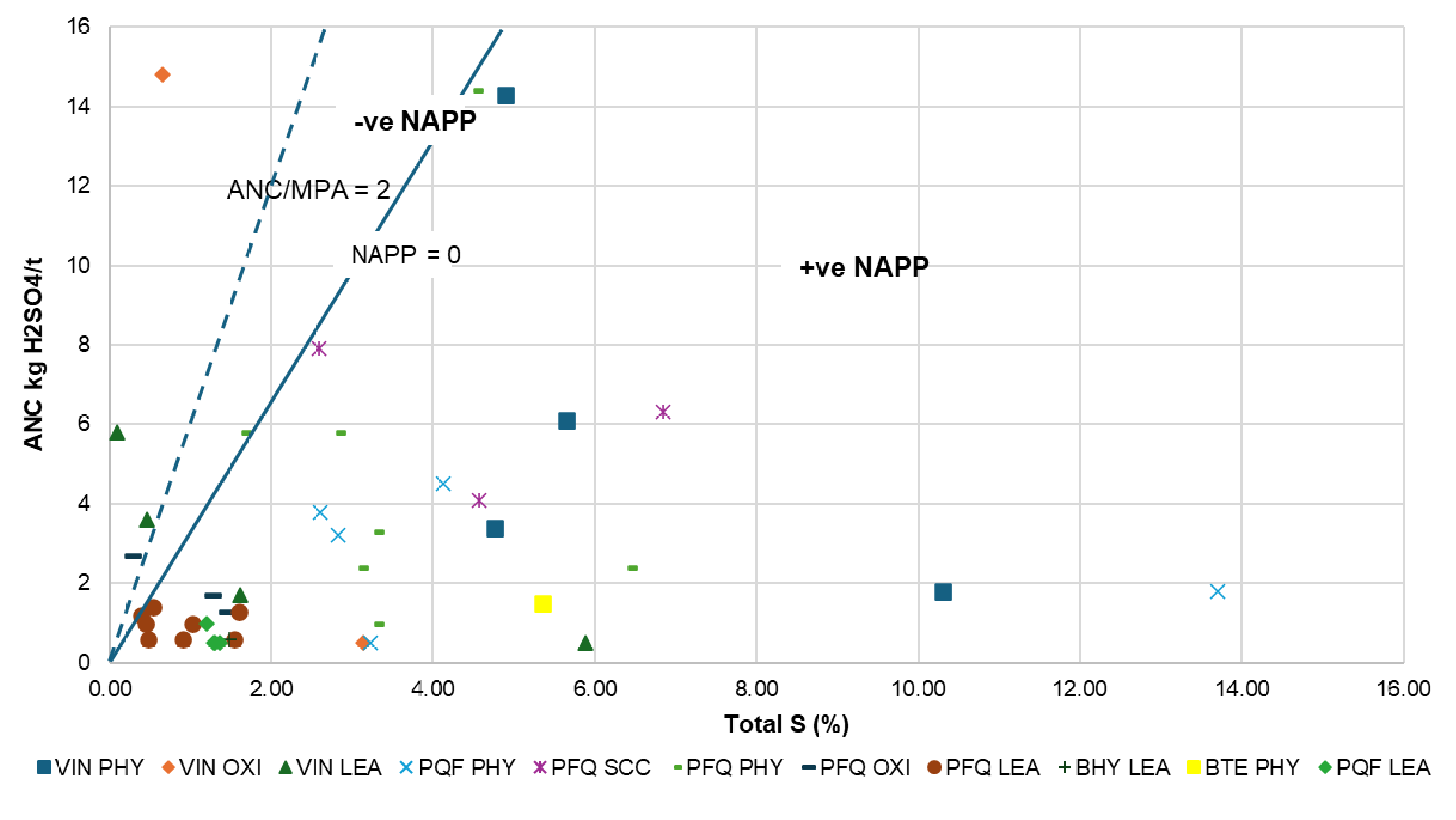

Figure 8-6: Acid-Base Accounting Plot for Tanjeel

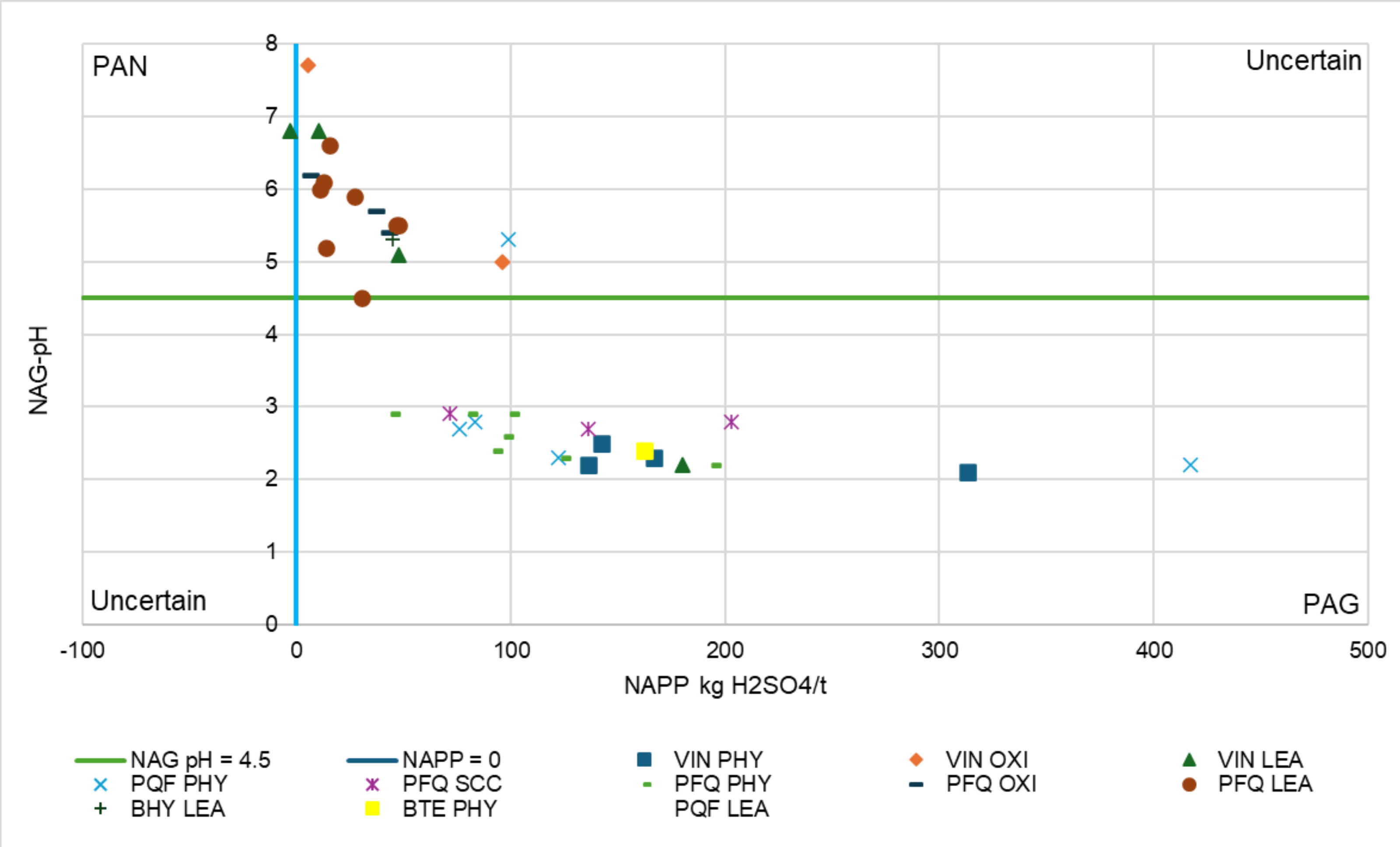

Figure 8-7: Geochemical Classification Plot for Western Porphyry

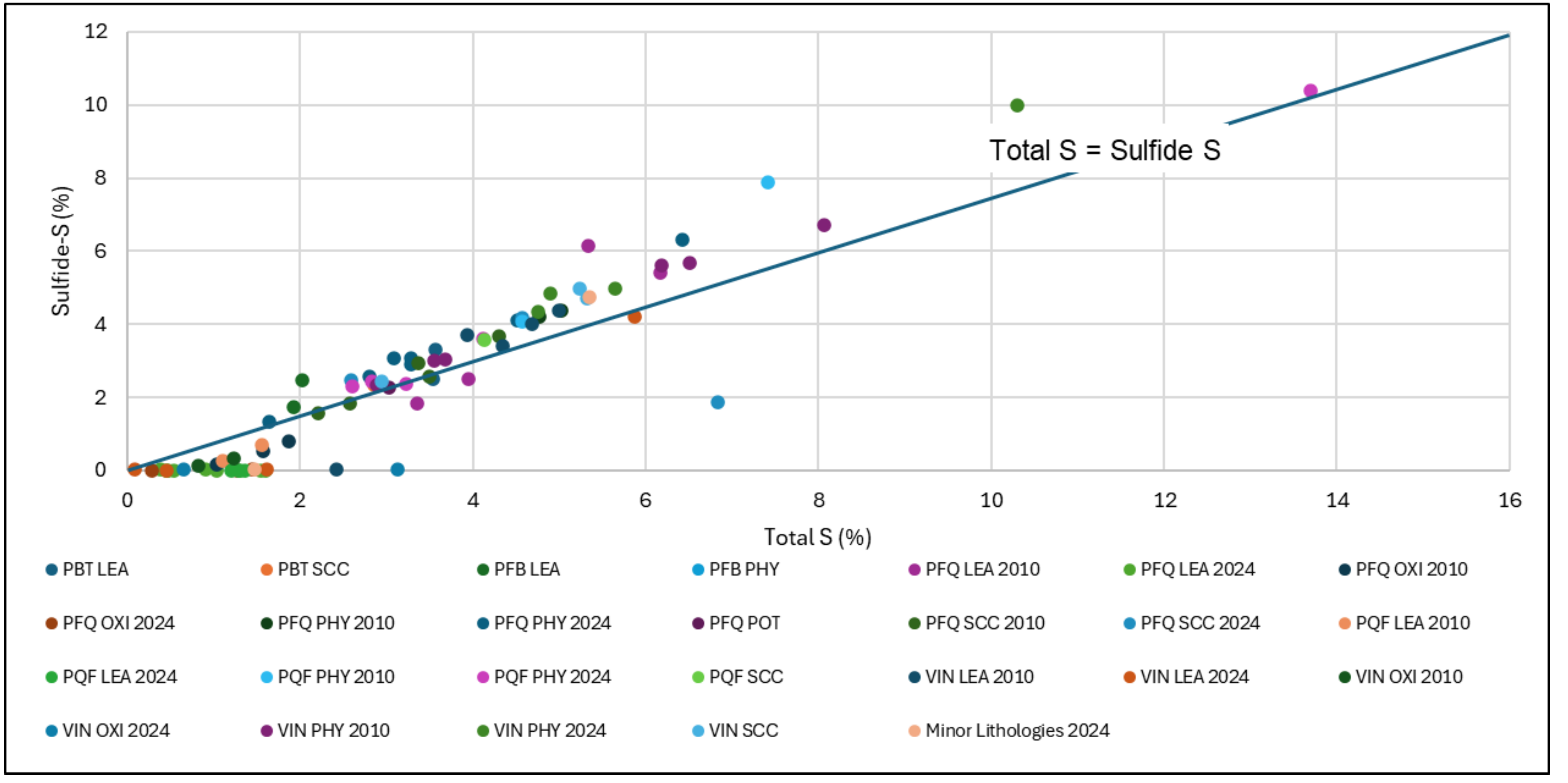

Figure 8-8: Tanjeel waste rock for Sulphide Sulphur versus total Sulphur for previous and current studies

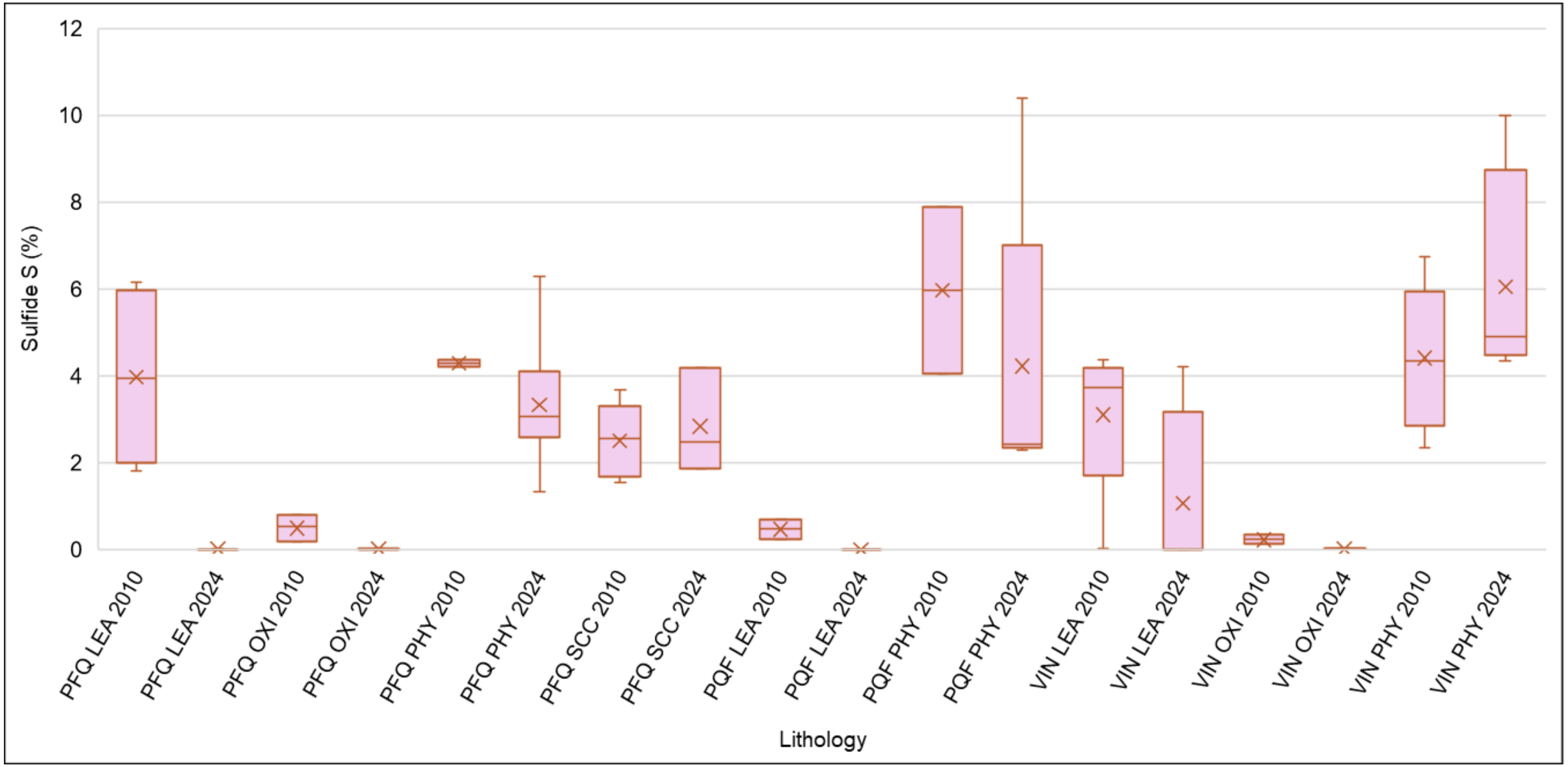

Figure 8-9: Tanjeel waste rock box and whisker plot of Sulphide sulphur content

8.2.2. Leaching Potential

To determine the leaching characteristics, a 3:1 contact leach test using deionized water was conducted on 13 samples representative of the key lithologies. The solutions from these tests were analysed using multi-element ICP for cations and IC for anions. This analysis identified potential mobile chemical phases that are likely to be environmentally available due to their reactivity.

The leachate concentrations were evaluated against the background groundwater quality (BGWQ), there is little precipitation expected but should there be any precipitation groundwater is likely to be affected.

8.2.2.1. Waste Rock

The results for the Tanjeel waste rock samples, summarized in Table 8-4, indicate the following:

- The pH of the leachate varies from acidic to alkaline (pH 4.16 and 8.58). The leachate from PFQ PHY, PQF PHY, and VIN PHY leachate pH values below the minimum limit BGWQ. While VIN OXI lithology demonstrates more alkaline leachate pH. However, the leachate from all other lithologies falls within the acceptable neutral pH range.
- Total Dissolved Solids ranged between 394 to 4,940 mg/L, with sulphate concentrations being the most contributor in total dissolved solids ranging between 6.33 mg/L (PFQ LEA) to 3 060 mg/L (VIN OXI) (480 – 2 450 mg/L. compared to the guideline limit of 3,500 mg/l.
- Additionally, the following parameters exceed the BGWQ standards: low pH, aluminium, antimony, barium, cadmium, cerium, chromium, cobalt, copper, iron, potassium, manganese, scandium, strontium, thorium, thallium, uranium, vanadium, yttrium, and zinc.

In summary, the Tanjeel waste rock sample results reveal that leachate pH ranges from 4.16 to 8.58, with PFQ PHY, PQF PHY, and VIN PHY falling below the minimum BGWQ pH limit. Multiple parameters, such as low pH, aluminium, antimony, barium, cadmium, cerium, chromium, cobalt, copper, iron, potassium, manganese, scandium, strontium, thorium, thallium, uranium, vanadium, yttrium, and zinc, exceed BGWQ levels.

8.2.2.2. Pit Wall

The results for the Tanjeel pit wall waste rock samples, summarized in Table 9-2, show the following:

- Leachate pH: The pH ranges from acidic to neutral, between 5.07 and 6.24. The leachate from PFQ PHY falls below the minimum BGWQ pH limit.
- Total dissolved solids range between 342 – 4 940 mg/L, with sulphate concentrations being the dominant salt in total dissolved solids ranging between 137 – 3 060 mg/L.

However, due to the already elevated salt load in the groundwater, should there be circumstances where seepage occurs groundwater will not be expected to be altered.

- Parameters exceeding BGWQ levels: low pH, antimony, barium, cadmium, cerium, cobalt, copper, potassium, manganese, scandium, thorium, thallium, yttrium, and zinc.

In summary, the Tanjeel pit wall waste rock samples show leachate pH ranging from 5.07 to 6.24, with the leachate from PFQ PHY falling below the minimum BGWQ pH limit. Several parameters, including low pH, antimony, barium, cadmium, cerium, cobalt, copper, potassium, manganese, scandium, thorium, thallium, yttrium, zinc and nitrate , exceed BGWQ levels.

8.2.2.3. Leachate Water Types

The piper diagram of leachate from Tanjeel waste rocks from (a) the current report and (b) 2010 results are presented in Figure 8-10 and indicate the following:

- Both the 2010 and current waste rock leachate water show a dominance of calcium in the cation triangle.
- Sulphate is a significant anion in both leachates.
- Both leachates indicate a mixed water type with calcium and sulphate as dominant ions, Calcium-Magnesium Sulphate water type.
- The current leachates show a few samples with notable sodium + potassium content, whereas the 2010 leachates show significant magnesium content in addition to calcium.

In summary, both sets of water samples are characterised by a dominance of calcium and sulphate, suggesting that these waters might be influenced by gypsum or anhydrite dissolution. The Piper diagrams reveal that while both sets of water samples share similarities in their overall geochemical profiles, there are distinct differences that can be attributed to varying lithologies.

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Table 8-4: ASTM D1987 Leachate Results for Tanjeel Waste Rock in 1:3 Solid to Liquid Ratio

Analytes	Units	BGWQ (2008 - 2009)		RD-671 (15 to 15.5)	RDDT-134 (57.5m-59m)	RD-670 (23m to 23.5m)	RDDD-072 (14m to 15m)	RD-414 (23m to 23.5m)	RD-663 (7m to 7.5m)	RDDD-125 (111m-112m)	RDDT-137 (148.5m-	RDDT-145 (134m-	RDDT-134 (95.5m-97m)	RDDT-136 (167.5m to	RDDT-156 (196.5m to	RD-664 (133.5m to	RDDT-136 (120.5m-	RDDD-083 (81m-82.5m)	RDDT-133 (150m-	RDDT-139 (91m-92.5m)	RDDT-191 (56m-57.5m)	RD-662 (10m to 10.5m)	RDDD-301 (10m-10.5m)	RD-381 (155m to 155.5m)	RDDT-171 (90.5m -92m)	RDDT-176 (172m -	RDDT-176 (94.5m to 96m
		Min	Max	PFQ LEA	PFQ LEA	PFQ LEA	PFQ LEA	PFQ OXI	PFQ OXI	PFQ SCC	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PQF PHY	PQF PHY	PQF PHY	VIN LEA	VIN OXI	VIN OXI	VIN PHY	VIN PHY	VIN PHY	VIN PHY
Physicochemical																											
pH	-	7.20	7.75	5.31	6.24	4.16	6.16	6.01	6.08	6.22	6.16	7.5	6.07	5.60	5.07	5.61	6.35	6.8	4.77	7.77	7.15	7.82	8.39	8.58	5.38	5.78	6.34
Electrical Conductivity	mS/m	1420	1470	129	79.2	1370	1530	864	991	616	737	1390	2640	451	1780	566	578	805	2670	631	983	873	6510	1830	911	793	1040
TDS	mg/l	9450	11488	977	455	1310	862	526	585	399	488	1050	2440	342	1550	362	369	521	2380	427	614	481	4940	1280	623	517	666
Total Alkalinity as $CaCO_3$	mg/l	94	143	2	4	1	5	3	3	4	4	65	3	2	1	4	5	10	1	27	15	15	47	46	2	5	17
Chloride	mg/l	3450	4260	59	132	25	272	125	181	53	93	89	61	26	88	36	44	77	23	66	91	148	562	136	52	68	87
Sulphate	mg/l	2520	3040	633	152	822	318	203	190	195	191	643	1540	137	886	159	166	241	1620	152	318	165	3060	785	326	244	349
Nitrate as N	mg/l	<0.5	29	0.05	0.35	0.01	2.29	0.55	0.59	0.15	0.22	0.22	0.17	0.03	0.05	0.05	0.21	0.09	0.01	0.18	0.06	0.67	4.6	0.42	0.01	0.05	0.05
Nitrite as N	mg/l	<0.5	17	0.01	0.01	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.05	0.05
Fluoride	mg/l	<0.5	3.29	0.1	0.1	0.5	0.1	0.1	0.1	0.7	0.5	0.3	0.2	0.2	0.5	0.3	0.5	0.2	0.6	1.3	0.1	0.1	1	0.5	0.9	0.3	0.5
Ammonia	mg/l			0.23	0.18	0.22	5.75	0.65	0.34	0.14	0.16	0.09	0.03	0.28	0.45	0.32	0.2	0.27	0.25	0.16	4.86	0.29	6.66	0.16	0.76	0.32	2.97
Metals and Metalloids																											
Silver	mg/l	<0.02	<0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Aluminium	mg/l	<0.02	0.44	0.14	0.01	43	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.22	0.01	0.01	0.06	7.9	0.01	0.1	0.01	0.01	0.01	0.96	0.07	0.77
Antimony	mg/l	<0.0001	0.0008	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.002	0.001
Arsenic	mg/l	<0.005	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Boron	mg/l	0.004	5.08	0.27	0.29	0.53	0.3	0.14	0.19	0.16	0.23	0.11	0.1	0.11	0.21	0.18	0.13	0.14	0.15	0.16	0.15	0.2	0.33	0.45	0.27	0.17	0.33
Barium	mg/l	0.036	0.043	0.30	0.37	0.25	0.30	0.28	0.39	0.25	0.29	0.28	0.24	0.30	0.32	0.36	0.33	0.28	0.22	0.39	0.28	0.34	0.15	0.29	0.33	0.39	0.37
Beryllium	mg/l		<0.01	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Bismuth	mg/l	<0.03	<0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Calcium	mg/l	0.69	890	144	6	16	35	14	19	16	15	200	587	9.0	199	6.0	14	15	537	10	24	1.0	461	219	21	38	23
Cadmium	mg/l	<0.0001	0.0003	0.002	0.000	0.002	0.001	0.000	0.000	0.023	0.022	0.001	0.001	0.009	0.012	0.82	0.001	0.53	0.006	0.035	0.001	0.001	0.002	0.21	0.132	0.012	0.066
Cerium	mg/l	<0.00001	0.001	0.004	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.008	0.001	0.001	0.001	0.012	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.003
Cobalt	mg/l	0.00005	0.004	0.037	0.002	0.181	0.002	0.006	0.003	0.13	0.158	0.004	0.071	0.184	0.183	0.095	0.033	0.101	0.341	0.023	0.059	0.001	0.001	0.031	1.51	0.106	0.238

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Analytes	Units	BGWQ (2008 - 2009)		RD-671 (15 to 15.5)	RDDT-134 (57.5m-59m)	RD-670 (23m to 23.5m)	RDDD-072 (14m to 15m)	RD-414 (23m to 23.5m)	RD-663 (7m to 7.5m)	RDDD-125 (111m-112m)	RDDT-137 (148.5m-	RDDT-145 (134m-	RDDT-134 (95.5m-97m)	RDDT-136 (167.5m to	RDDT-156 (196.5m to	RD-664 (133.5m to	RDDT-136 (120.5m-	RDDD-083 (81m-82.5m)	RDDT-133 (150m-	RDDT-139 (91m-92.5m)	RDDT-191 (56m-57.5m)	RD-662 (10m to 10.5m)	RDDD-301 (10m-10.5m)	RD-381 (155m to 155.5m)	RDDT-171 (90.5m -92m)	RDDT-176 (172m -	RDDT-176 (94.5m to 96m)
		Min	Max	PFQ LEA	PFQ LEA	PFQ LEA	PFQ LEA	PFQ OXI	PFQ OXI	PFQ SCC	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PQF PHY	PQF PHY	PQF PHY	VIN LEA	VIN OXI	VIN OXI	VIN PHY	VIN PHY	VIN PHY	VIN PHY
Chromium	mg/l	<0.05	<0.005	0.001	0.001	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	<0.02	0.041	19	0.068	53	0.076	0.021	0.04	0.079	1.43	0.003	0.078	1.46	16	9.32	0.058	1.18	43	0.38	2.6	0.083	0.046	0.13	11	3.61	31
Iron	mg/l	<0.1	2.8	1.18	0.05	64	0.31	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.44	0.05	0.05	0.07	20	0.05	0.17	0.05	0.05	0.05	1.77	0.1	3.99
Potassium	mg/l	0.01	20	54	25	52	42	40	43	36	43	37	62	46	53	27	32	50	44	35	47	13	15	40	55	55	50
Magnesium	mg/l	0.22	283	19	3.0	39	9.0	17	6.0	19	15	32	22	6.0	21	16	13	10	12	17	22	1	108	20	27	11	18
Manganese	mg/l	0.0009	2.67	1.91	0.15	3.33	0.42	0.75	0.66	1.6	1.58	2.2	2.34	1.03	2.21	1.38	1.54	0.96	3.1	1.16	1.4	0.013	0.14	0.90	1.86	1.28	0.75
Mercury	µg/l	<0.02	<0.000001	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	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	<0.01	0.071	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Neodymium	mg/l			0.002	0.001	0.006	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.008	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Sodium	mg/l	2.59	2620	76	128	40	207	95	140	46	75	27	51	25	61	35	39	86	22	49	93	152	890	121	59	53	83
Nickel	mg/l	<0.03	0.1	0.037	0.001	0.32	0.003	0.012	0.004	0.044	0.031	0.002	0.018	0.036	0.051	0.041	0.015	0.031	0.10	0.005	0.038	0.001	0.009	0.014	0.37	0.047	0.055
Phosphorus	mg/l			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Lanthanum	mg/l			0.002	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
Lead	mg/l	0.0001	0.007	0.002	0.001	0.008	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
Selenium	mg/l	<0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Scandium	mg/l	<0.1	<0.01	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Silicon	mg/l	<20	16	12.6	11.8	12.2	9.23	8.58	8.25	7.1	9.12	3.6	7.53	12.2	13.6	8.26	6.56	10.6	11.6	7.4	10.2	5.88	8.82	7.13	13.3	10.6	13.6
Tin	mg/l	<0.01	0.003	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Strontium	mg/l	0.18	4.78	0.17	0.061	0.066	0.19	0.04	0.097	0.10	0.121	0.32	0.89	0.045	0.76	0.04	0.045	0.096	1.63	0.048	0.12	0.009	0.25	0.58	0.14	0.44	0.21
Thorium	mg/l	<0.0001	0.0006	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Titanium	mg/l	<0.01	0.028	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Thallium	mg/l	<0.0001	0.00002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Uranium	mg/l	0.00075	0.002	0.001	0.001	0.009	0.001	0.001	0.001	0.001	0.001	0.016	0.001	0.001	0.002	0.001	0.001	0.004	0.021	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.007
Vanadium	mg/l	<0.01	0.005	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Yttrium	mg/l	<0.0003	0.0007	0.002	0.001	0.008	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.001	0.018	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002

Analytes	Units	BGWQ (2008 - 2009)		RD-671 (15 to 15.5)	RDDT-134 (57.5m-59m)	RD-670 (23m to 23.5m)	RDDD-072 (14m to 15m)	RD-414 (23m to 23.5m)	RD-663 (7m to 7.5m)	RDDD-125 (111m-112m)	RDDT-137 (148.5m-	RDDT-145 (134m-	RDDT-134 (95.5m-97m)	RDDT-136 (167.5m to	RDDT-156 (196.5m to	RD-664 (133.5m to	RDDT-136 (120.5m-	RDDD-083 (81m-82.5m)	RDDT-133 (150m-	RDDT-139 (91m-92.5m)	RDDT-191 (56m-57.5m)	RD-662 (10m to 10.5m)	RDDD-301 (10m-10.5m)	RD-381 (155m to 155.5m)	RDDT-171 (90.5m -92m)	RDDT-176 (172m -	RDDT-176 (94.5m to 96m
		Min	**Max**	PFQ LEA	PFQ LEA	PFQ LEA	PFQ LEA	PFQ OXI	PFQ OXI	PFQ SCC	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PFQ PHY	PQF PHY	PQF PHY	PQF PHY	VIN LEA	VIN OXI	VIN OXI	VIN PHY	VIN PHY	VIN PHY	VIN PHY
Zinc	mg/l	0.00003	0.09	0.85	0.16	8.16	0.87	0.22	0.17	0.80	1.69	0.16	0.21	1.83	2.37	0.96	0.45	1.18	3.58	0.48	0.52	0.20	0.43	2.31	2.00	4.03	1.22

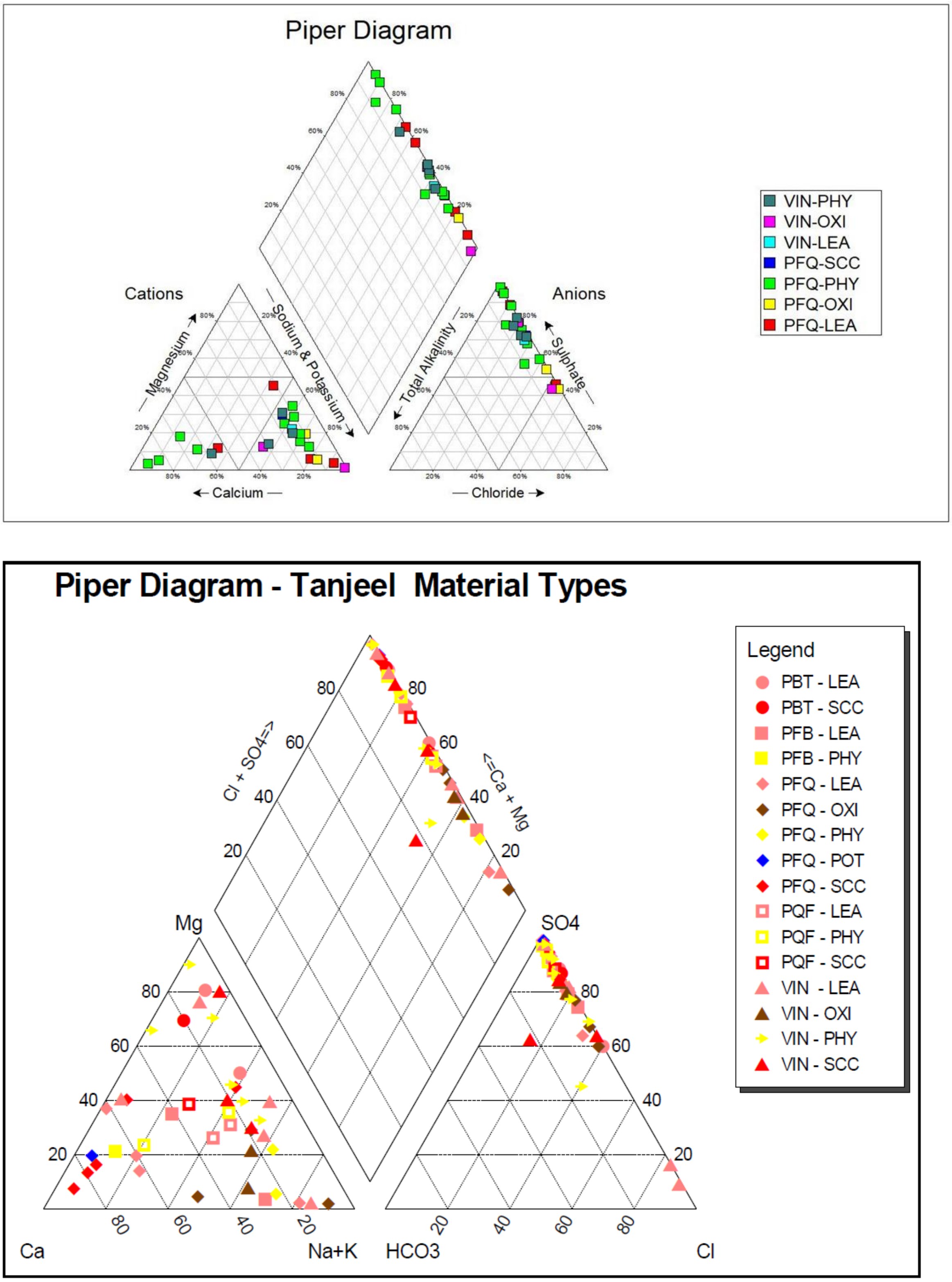


Figure 8-10: Piper diagram for Western Porphyries leachate water quality (a) current project and (b) 2010 SRK results

9. Potential for Environmental Impact

The potential for environmental impacts is identified for the operations and closure phases, specifically associated with the following sources or mining activities:

- Excavation and establishment of the Western Porphyry and Tanjeel open pit;
- Deposition and establishment of the WRD from Western Porphyry and Tanjeel; and
- Deposition of tailings on a TSF.

9.1. Conceptual Models

The conceptual model for the proposed Western Porphyry and Tanjeel pits is indicated in Figure 9-1 and TSF in Figure 9-2.

9.1.1. Pits

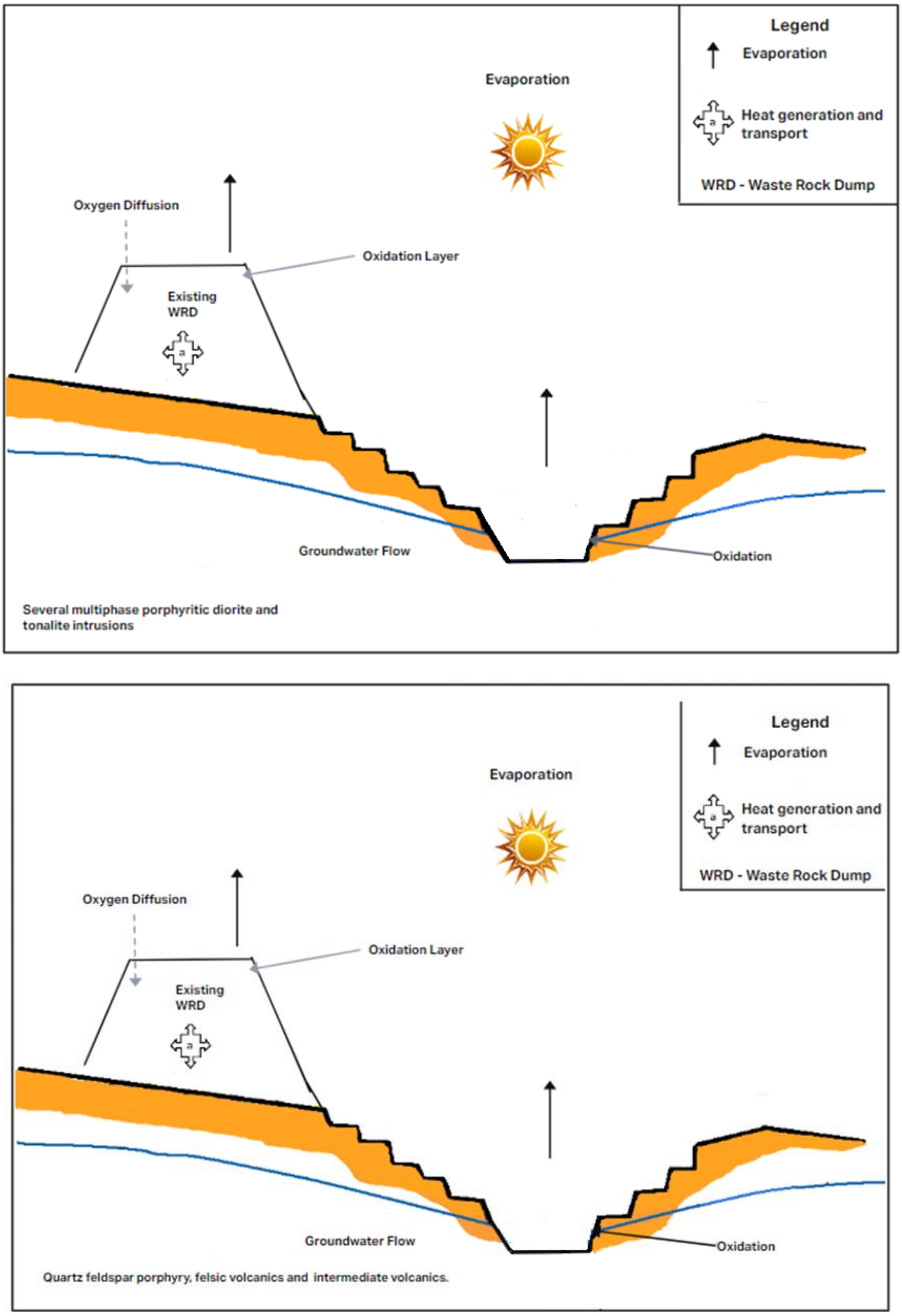
The Project will be a conventional opencast pit mining, using conventional drill, blast, load and haul surface mining methods. Conceptually, open-cast mining will expose both mineralized and non-mineralized rock surfaces on the pit walls and floor to various environmental processes, including oxidation, rainwater infiltration through cracks, and dissolution and mobilization of exposed soluble salts through runoff. The sources of these inputs include groundwater ingress into the pit, runoff from exposed pit walls (containing soluble salts) and rubble (talus) accumulated on benches, as well as infiltration and rare runoff from WRDs situated within the local pit catchment and groundwater drawdown zones.

Although acidic metal drainage will occur within the pit and waste rock dump, the low humidity, high evaporation environment, the depth of groundwater and groundwater chemistry, and low reactivity of the material will limit the potential for AMD/ML to impact this site. Consequently, AMD/ML are not considered to be an environmental issue at the site.

9.1.2. Waste Rock Dump

Conceptually, the waste rock from the open pit expansion areas will be removed and stored in existing Waste Rock Dumps (WRDs) near the pits at Western Porphyry and Tanjeel. Both WRDs are classified as High Potential Acid Generators (HPAG). Natural weathering of the waste rock will release metals which can be mobilised, with runoff when it does occur likely to range from neutral (pH 4.91 – 7.28 for Western Porphyry) to acidic (pH 3.20 – 3.70 for Tanjeel). This drainage will contain parameters of concern, including low pH, total dissolved solids, Sulphate, aluminium, antimony, barium, cadmium, cerium, cobalt, copper, iron, manganese, lead, scandium, strontium, and zinc.

Geochemical testing indicates that over 90% of the extracted rock is PAG. Given sufficient water and oxygen, this rock will eventually produce metal-bearing acidic Sulphate leachate. However, given the low humidity, high evaporation rate, depth to groundwater, and groundwater the potential impact of Acid Rock Drainage and Metal Leaching (ARDML) is likely to be negligible. Additionally, there are no groundwater or surface water receptors in the vicinity.



a.

b.

Figure 9-1: Conceptual Model of the WRD and Pit (not to scale) for (a) Western Porphyry and (b) Tanjeel

9.1.3. Tailings Storage Facility

The tailings will be divided into two streams: cleaner and rougher. Consequently, the TSF will be divided into cells to separate cleaner and rougher tailings with the cleaner tailings cells proposed to be lined. During operation, the tailings are pumped from the plant to the TSFs as a low-density slurry. The settlement of the tailings is uneven, varying with thickness and consolidation characteristics. Settling is generally more effective in the central ponded zone than in the beach or transition zones. The fine tailings have low permeability and can retain water on their surfaces. The tailings will naturally deposit as an alluvial fan.

Seepage from the TSF will occur as water infiltrates through the tailings and percolates downwards. The geochemical composition of seepage water will be influenced by the mineralogy of the tailings, the degree of sulphide oxidation, and the presence of neutralizing agents. Runoff will occur when precipitation exceeds the infiltration capacity of the tailings, leading to surface flow. The geochemical composition of runoff will be influenced by the interaction of rainwater with the tailings surface, resulting in the dissolution of soluble salts and the mobilization of fine particles.

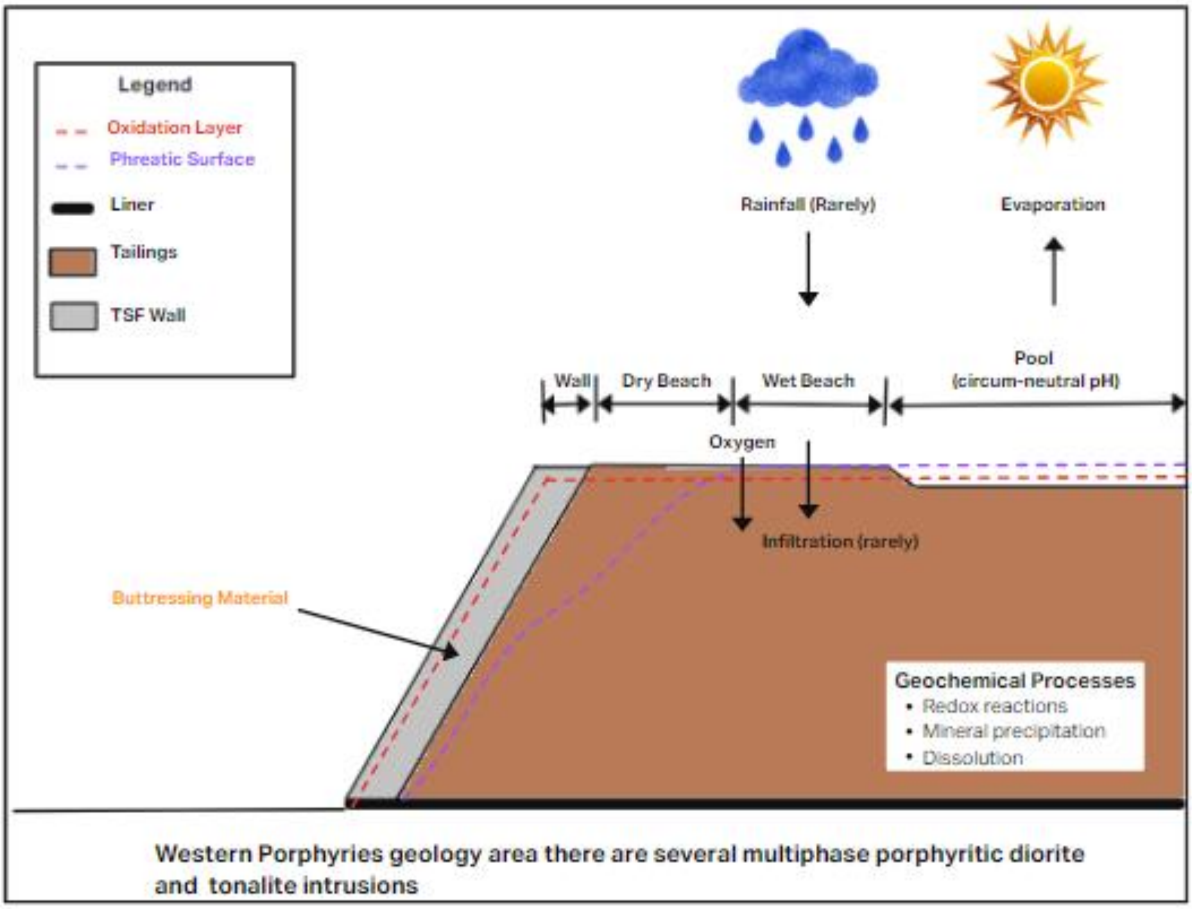


Figure 9-2: Conceptual Model of the TSF Showing Seepage Response Units and Seepage Flow Mechanism

The following seepage response units are conceptualised in the model (Figure 9-2):

- Pool – is the area occupied by supernatant water of a constant hydraulic head to the base of the TSF. The supernatant water seeps through the TSF and represents the operational phase seepage quality for the active TSF. The supernatant water is in near equilibrium with the fine residue.
- Wet Beach – represents the inner beach section (adjacent to the pool) which is wet to moist.
- Dry Beach – represents the outer beach section between the beach and the wall. For active TSFs, the surface is saturated when there has been deposition in the TSF. For non-active TSFs, this area is dry and can experience moist conditions during the rainy season.
- Wall – represents the side-slope section of the TSF comprising mine waste where no hydraulic disposal of fines residue occurs.

9.2. Potential Geochemical Risks

The typical Environmental Impact Assessment (EIA) methodology does not directly apply to geochemical studies. The distinction arises because the geochemical assessment is primarily concerned with characterising the source of potential contaminants, rather than the pathway or receptor involved in the environmental impact.

The data gathered from the geochemical risk assessment related to the source terms are integrated into the surface and groundwater impact assessment to understand the potential effects of the identified contaminants on the environment.

Despite this differentiation in approach, geochemical studies identify potential geochemical risks and recommend mitigation and management measures. The recommendations are important in informing the development of the environmental management plan and monitoring program ensuring the protection and preservation of the environment.

9.2.1. Pit and Waste Rock Dump

Acidic metal drainage will occur within the Western Porphyry pit and waste rock dump. However, due to the encapsulated nature of sulphides at Western Porphyry, this process will take decades, especially in the low humidity and high evaporation environment. Although acidic metal drainage will occur within the Western Porphyry pit, the low humidity, high evaporation environment, the depth to groundwater and groundwater chemistry, and low reactivity of the material will limit the potential for ARD/ML to impact this site.

At Tanjeel, the more oxidized nature of the material and greater exposure of Sulphides in the pit wall result in a higher potential for acid generation. Additionally, groundwater flows through the same fractures as the mineralization, leading to partial in-situ oxidation. This makes the material more reactive, even though it has a lower overall potential for acid generation compared to the Western Porphyry material types. Again, due to the extremely low infiltration rates predicted from hydrogeological modelling, the depth of groundwater across the site and the highly mineralised, saline nature of groundwater, there is little potential for ARD/ML impact to groundwater. Additionally, there are no groundwater receptors at risk at this site.

However, the levels of acidity, total dissolved solids, sulphate, aluminium, antimony, barium, cadmium, cerium, cobalt, copper, iron, manganese, lead, scandium, strontium and zinc, identified as potential constituents of concern, should be monitored in the surface water (when it occurs) and groundwater at the sites.

9.2.2. Tailings Storage Facility

The geochemical characteristics of the tailings are variable depending on the fraction of the tailings.

9.2.2.1. *Rougher Tailings*

The rougher tailings typically contain less than 0.5% Sulphide, resulting in negligible acid-generating potential. Although they have minimal buffering capacity and appear potentially acid forming in Net Neutralization Potential (NNP), they are more accurately classified as inert. Leachable metal concentrations are generally below comparative water quality and risk assessment guideline values. Sulphate values are typically below 500 mg/L, and the pH ranges from mildly acidic to circumneutral (around pH 6).

The potential for environmental impacts to groundwater from rougher tailings is low due to extremely low infiltration rates predicted by hydrogeological modelling, the depth of groundwater across the site, and the highly mineralized, saline nature of the groundwater. Additionally, there are no groundwater receptors at risk at this site. Therefore, a liner is not necessary for the deposition of these tailings, and no specific Acid Rock Drainage and Metal Leaching (ARDML) management measures are required.

9.2.2.2. *Cleaner tailings*

Cleaner tailings, which contain between 6% and 23% Sulphide, have a high potential for acid generation. They are characterised by leachable metal concentrations that exceed comparative water quality and risk assessment guidelines. Additionally, these tailings exhibit very high Sulphate concentrations (over 2 g/L) and a low leachate pH (around pH 2).

Natural weathering of these tailings will produce acidic drainage, with concerning constituents including low pH, high electrical conductivity, sulphate, copper, lead, manganese, molybdenum, strontium, and uranium. These substances may be mobilized during operations and could impact groundwater quality. Therefore, installing an impermeable HDPE liner (as currently planned) is recommended to control and manage seepage from the TSF.

9.2.3. Climate Change

The projected climate changes for the Project as a whole include increased risk of flooding, extreme heat, drought, storm intensity, sea level rise, and wildfire risks (Digby Wells Environmental, August 2024). Among these, extreme heat, storm intensity (precipitation) and extreme weather events may impact the mine geochemistry. These changes can alter the chemical and physical processes in mine environments, potentially leading to increased environmental and safety risks.

Aside from extreme weather events, these effects are anticipated to unfold gradually over an extended period. By 2070, the mean annual temperature is projected to increase by at least 1.59°C to 2.09°C. Extreme heat days are projected to increase by approximately 25 to 34 days by 2059. Precipitation is projected to increase in the order of 23% to 30% by 2070, primarily during July, August, and September.

9.2.3.1. Impacts on Mine Geochemistry

The impacts of climate change to the mine geochemistry may include the following:

- Acid Mine Drainage (AMD):
  - Increase in average temperatures: Temperature directly affects the sulphide oxidation process that leads to AMD:
    - Higher temperatures increase the reaction rate of chemical reactions, including the oxidation of sulphide minerals and the subsequent release of acidic components.
    - Warmer temperatures typically enhance the metabolic rates of acidophilic bacteria such as *Thiobacillus ferrooxidans* and *Leptospirillum ferrooxidans*, increasing the overall rate of sulphide oxidation.
    - Increased temperatures can lead to higher evaporation rates, concentrating dissolved substances and potentially exacerbating the acidic conditions created by AMD.
    - In summary, higher temperatures generally accelerate the sulphide oxidation process through increased chemical reaction rates and enhanced microbial activity, leading to more rapid development of AMD.
  - Increased Rainfall: More frequent and intense rainfall can increase the flow of water through mine waste, enhancing the mobilisation of acidic material and metals.
  - Flooding: Extreme weather events and flooding can lead to the overflow of containment systems if not properly designed, releasing AMD into the environment.
- Increased Weathering Rates:
  - Higher Temperatures: Elevated temperatures can accelerate chemical reactions, increasing the rate of mineral weathering and the release of heavy metals and other contaminants.
  - Increased Precipitation: Higher rainfall can enhance the leaching of contaminants from mine waste and tailings, potentially leading to the contamination of groundwater and surface water.

These climate change risks, and management measures have been incorporated into the Environmental Management Plan in the following section of this report.

10. Environmental Management Plan

This Chapter presents the EMP for the Project along with additional supporting plans considered necessary for the management of environmental impacts.

10.1. Approach to the EMP

The EMP has been compiled considering the following principles:

- **The precautionary principle** holds that, wherever there is doubt about the impacts an activity may have on the environment, precautionary measures should be taken, even if cause-and-effect relationships have not been established scientifically. Mitigation measures have been prescribed based on the scientific quantification of the identified potential impacts, as well as unplanned and low-risk events.
- **The mitigation hierarchy** is listed as the primary objective in IFC PS 1 which stipulates "To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimise, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities, and the environment." (Figure 10-1). The mitigation measures included in the EMP aim to prevent the occurrence of identified potential impacts. Where impacts cannot be prevented, mitigation measures are prescribed with the intention of minimise/ reducing the significance of these impacts.

Figure 10-1: The Mitigation Hierarchy as defined by the IFC

Table 10-1: The Different Levels of the Mitigation Hierarchy Defined

Avoidance (or Prevention)	If impacts on the natural environment can be avoided, this is the best possible way of reducing impacts. Avoidance involves considering other options in the project location, siting, scale, layout, technology and phasing to avoid impacts on biodiversity, associated ecosystem services and people. This is the best option but is not always possible. Where environmental and social factors give rise to unacceptable negative impacts, mining should not take place. In such cases, it is unlikely to be possible or appropriate to rely on the latter steps in the mitigation.
Minimization	If impacts cannot be avoided, it is important that these are minimized. Minimization refers to optimising project location, siting, scale, layout, technology and phasing to reduce the footprint of the development on biodiversity, associated ecosystem services and people as far as possible.
Restoration (or Rehabilitation)	If there are still residual impacts, restoration or rehabilitation may be employed to increase the biodiversity value and/ or return impacted areas to near natural state (or an agreed post-development land use after development activities). Rehabilitation may, however, fall short of replicating the diversity and complexity of natural systems
Offset (or Compensation)	If residual impacts remain after all efforts to avoid, minimize and restore have been taken into consideration, offsets may be needed. These include the setting aside of areas as corridors and conservation areas, either within the mining lease area or in other areas for conservation. Offsets are difficult to determine and manage, and a separate study is often needed to identify the best options and those which compensate identical (or as close as possible) biodiversity to that which was impacted by the development.

10.2. The Management Plan

The environmental management measures for geochemistry required for the Project are outlined in Table 10-2 and summarized broadly as follows:

- Lining Systems: Install impermeable HDPE liner in the cleaner tailings TSF to minimize seepage.
- Cover Systems: Apply waste rock covers to the TSFs as part of closure and decommissioning.
- Water Management: Control seepage and runoff water during operations and during rainfall events.

Table 10-2: Environmental Management Plan

Activities	Affected Environmental Aspect	Potential Impact	Size and scale of disturbance	Mitigation/Management Measures	Recommended Action Plans
OPERATIONAL PHASE					
• Excavation and establishment of the Western Porphyry pit	Surface and Groundwater Quality	The generation of acidic, metal-laden pit water can pose significant risks to surface water and groundwater quality. The potential constituents of concern include low pH, Sulphate, aluminium, antimony, barium, cadmium, cerium, cobalt, chromium, copper, iron, manganese, lead, scandium, thorium, thallium, zinc and nitrates.	Limited: The contaminated pit water will be confined within the drawdown area, restricted to the boundaries of the development site.	The goal is to minimize the volume of mine contact water generated during operations. However, due to low precipitation, the volume of mine water will primarily depend on groundwater ingress. To effectively manage water during open pit mining operations, the following measures should be implemented: • Segregate Mine Contact Water and Clean Water: Separate mine contact water from clean surface water. Given the expected low precipitation, use channels and bunds to divert clean surface water away from the pit during the occasional rainfall events, minimizing the volume of water entering the pit. • Control Seepage and Runoff from Existing WRDs: Install surface drains to redirect runoff from the Waste Rock Dumps (WRDs) away from the pit during rainfall events. • Regular Water Quality Monitoring: Continuously monitor pit water quality to assess its suitability for various purposes. The monitoring program should include the identified potential constituents of concern.	• Construct channels and bunds directing seepage from the surface facilities and surface runoff away from the pit. • Monitor the quality of pit water, surface and groundwater.
• Establishment and operation of the Tanjeel pit	Surface and Groundwater Quality	The generation of acidic, metal-laden pit water can pose significant risks to surface water and groundwater quality The CoCs include low pH, sulphate, aluminium, antimony, barium, cadmium, cerium, cobalt, chromium, copper, iron, manganese, lead, scandium, thorium, thallium, zinc and nitrates.	Limited: The contaminated pit water will be confined within the drawdown area, restricted to the boundaries of the development site.	The goal is to minimize the volume of mine contact water generated during operations. However, due to low precipitation, the volume of mine water will primarily depend on groundwater ingress. To effectively manage water during open pit mining operations, the following measures should be implemented: • Segregate Mine Contact Water and Clean Water: Separate mine contact water from clean surface water. Given the expected low precipitation, use channels and bunds to divert clean surface water away from the pit during the occasional rainfall events, minimizing the volume of water entering the pit. • Control Seepage and Runoff from Existing WRDs: Install surface drains to redirect runoff from the Waste Rock Dumps (WRDs) away from the pit. • Regular Water Quality Monitoring: Continuously monitor pit water quality to assess its suitability for various purposes. The monitoring program should include the identified potential constituents of concern.	• Construct channels and bunds directing seepage from the surface facilities and surface runoff away from the pit. • Monitor the quality of pit water, surface and groundwater.
• Establishment and operation of the WRDs.	Surface and Groundwater Quality	The release of acidic, metal-laden seepage and runoff from the WRD can pose significant risks to surface water and groundwater quality. The CoCs include low pH, Sulphate, aluminium, antimony, barium, cadmium, cerium,	Limited: The contaminated seepage and runoff will be contained within the waste rock footprint areas extending only as far as the development site area. Limited to the site and its immediate surroundings.	It is noted that three will be minimal infiltration into the dumps due to the high evaporation rates and any flow through the dumps will be minimal and slow to day light. The goal is to minimize the potential generation of contaminated water from the waste rock dumps during rainfall events. To achieve this, the following measures should be implemented: • Continuous Monitoring: Maintain ongoing monitoring of toe seepage, surface water, and groundwater, focusing on the constituents of concern as outlined in the monitoring and management plan in Section 14.	• Construct channels and bunds directing seepage from the WRD and surface runoff into a water storage facility

Activities	Affected Environmental Aspect	Potential Impact	Size and scale of disturbance	Mitigation/Management Measures	Recommended Action Plans
		cobalt, chromium, copper, iron, manganese, lead, scandium, thorium, thallium, zinc and nitrates.		• Regular Inspection and Maintenance: Regularly inspect the WRDs and monitoring systems to identify issues or areas of concern. Ensure proper maintenance and timely repairs to maintain the effectiveness of the measures. • Rehabilitate WRDs: Rehabilitate the waste rock dumps from operation to closure by shaping, levelling, and compacting. • Long-Term Site Closure Plans: Integrate waste rock management into long-term site closure plans to ensure the stability and safety of the WRDs after mining activities have ended. By implementing these measures, the project aims to proactively manage potential environmental impacts and ensure responsible and sustainable management of waste rock and its associated water concerns throughout its operational and closure phases.	(leachate ponds) for monitoring and treatment before they are discharged. • Monitor the quality of surface and groundwater as detailed in the groundwater report.
• Establishment and operation of the cleaner tailings TSF	Surface and Groundwater Quality	The release of acidic, metal-laden seepage and runoff from the TSF can pose significant risks to surface water and groundwater quality. Cleaner tailings exhibit very high sulphate concentrations, surpassing 2 g/L, and have a low leachate pH, typically around pH 2	Limited: The contaminated seepage and runoff will be contained within the waste rock footprint areas extending only as far as the development site area. Limited to the site and its immediate surroundings.	The goal is to minimize the potential generation of contaminated water from the TSF. To achieve this, the following measures should be implemented: • Liner: Install an impermeable HDPE liner in the TSF to reduce seepage. • Capture seepage where possible for reuse at the plant. • Divert Clean Surface Water: Use runoff control channels to divert clean surface water away from the TSF during rainfall events. • Continuous Monitoring: Maintain ongoing monitoring of toe seepage, surface water, and groundwater, focusing on the constituents of concern as outlined in the monitoring and management plan in Section 12. • Rehabilitate TSF: Progressively close the TSF by covering the cells with waste rock from Western Porphyry to reduce dust emissions and improve stability. • Regular Inspection and Maintenance: Conduct routine inspections of the TSF and its monitoring systems to identify any issues or areas of concern. Perform necessary maintenance and timely repairs to ensure the continued effectiveness of the measures. • Long-Term Site Closure Plans: Incorporate tailings management strategies into the long-term site closure plans to ensure the stability and safety of the TSF after mining activities have ceased. By implementing these measures, the project aims to proactively address potential environmental impacts and ensure responsible and sustainable management of cleaner tailings and related water concerns throughout both the operational and closure phases.	• Capture seepage where possible for reuse at the plant.Monitor the quality of surface and groundwater as detailed in the groundwater report.
DECOMMISSIONING, CLOSURE AND REHABILITATION PHASE					
• Refiling of the open pit with groundwater on cessation of	Surface and Groundwater Quality	Refilling the open pit with water on cessation of dewatering activities will result in the formation of a pit lake. The water quality in the pit lake could potentially	Local: The influence of the pit lakes will be limited to the local mine development area, as indicated by the hydrogeological numerical	The objective is to minimize the potential generation of contaminated water from surface water runoff and pit walls, preventing it from entering the pit lake.	

Activities	Affected Environmental Aspect	Potential Impact	Size and scale of disturbance	Mitigation/Management Measures	Recommended Action Plans
dewatering activities		affect the quality of surface and groundwater.	results (please refer to the Groundwater Impact Assessment Report). The cone of depression is limited to the site and its immediate surroundings- as the groundwater levels recover the zone of influence will reduce in size. Moderate: The pit water quality is expected to improve as there will be ingress from groundwater	To minimize the potential generation of contaminated water from surface water runoff and pit walls, preventing it from entering the pit, the following measures should be implemented: • Retention Berms: Retain the berms around the open pit to minimize the entry of surface water runoff into the pit at post-closure. • Post-Closure Monitoring: Conduct post-closure monitoring of the pit lake water and surrounding monitoring boreholes. This monitoring will assess the predicted water quality and effectiveness of associated management measures. • Monitoring of Decant Points: Continuously monitor potential decant points established for the project post-closure to assess water quality. • The rehabilitation and closure of the open pits should align with the prescribed rehabilitation and closure plan. By implementing these measures, the project aims to proactively address potential environmental impacts, safeguard the pit lake's water quality, and maintain responsible environmental management throughout its operational and closure phases.	
• Refinement and final rehabilitation of WRDs	Surface and Groundwater Quality	The established WRDs will undergo occasional infiltration, weathering, and erosion, resulting in acidic to neutral to mildly acidic runoff and seepage during rainfall events. This has the potential to impact the quality of both surface and groundwater.	Limited: The contaminated seepage and runoff will be confined within the footprint areas, limited to the development site area based on the hydrogeological numerical results (please refer to the Groundwater Impact Assessment Report).	The primary objective is to minimize the potential generation and volumes of contaminated water from the WRD. To ensure proper management and rehabilitation of the WRDs, the following measures should be taken: • Berm Maintenance: Maintain the berms around the WRDs, designed to divert clean water away from the facilities, even after closure. This will help prevent clean water from entering the WRDs and potentially becoming contaminated. • Progressive Rehabilitation: Implement progressive rehabilitation of the WRDs through activities such as shaping, levelling, and compacting. • Ongoing Water Quality Monitoring: Continue regular monitoring of water quality emanating from the WRDs after the final rehabilitation. This monitoring will detect any changes in water quality and assess the effectiveness of rehabilitation efforts. • The rehabilitation and closure of the WRD should align with the prescribed rehabilitation and closure plan. By implementing these measures, the project aims to ensure responsible waste rock management, protect the surrounding environment, and promote long-term ecological balance during and after the closure of the WRDs.	
Final Rehabilitation of the TSF	Surface and Groundwater Quality	The established Tailings Storage Facility (TSF) will be lined. Once deposition stops, the pool water is expected to recede, with minimal seepage and runoff anticipated after closure.	Limited: The contaminated seepage and runoff will be contained within the TSF footprint areas extending only as far as the development site	To ensure proper management and rehabilitation of the TSFs, the following measures should be implemented: • Natural Deposition: The tailings will naturally deposit as an alluvial fan, and no reshaping is proposed after closure. • Covering with Waste Rock: Cover the tailings with waste rock from Western Porphyry.	

Activities	Affected Environmental Aspect	Potential Impact	Size and scale of disturbance	Mitigation/Management Measures	Recommended Action Plans
			area. Limited to the site and its immediate surroundings.	• . • Ongoing Water Quality Monitoring: Continue regular monitoring of water quality from the TSF after final rehabilitation. This monitoring will help detect any changes in water quality and evaluate the effectiveness of rehabilitation efforts. • The rehabilitation and closure of the TSF should align with the prescribed rehabilitation and closure plan. By implementing these measures, the project aims to ensure responsible tailings management, protect the surrounding environment, and support long-term ecological balance during and after the closure of the TSFs.	

11. Monitoring Plan

The monitoring plan is detailed in Table 11-1. The main purpose of the monitoring program is to gather information essential for assessing the project's operational and environmental performance in and around the proposed mining area. Regular monitoring helps evaluate the effectiveness of mitigation and management measures and ensures compliance with applicable standards, guidelines, and permit conditions.

A comprehensive on-site geochemical characterization and monitoring program is essential throughout all phases of the project, from operations to rehabilitation and closure. The monitoring program has been designed with the following objectives:

- Verify the Performance of the Waste Facilities: Assess the performance of waste facilities and management practices to ensure they meet environmental standards.
- Proactively Identify Potential Failures: Identify any potential failures in the implemented mitigation measures from the beginning of the project, allowing for timely corrections and improvements.

By fulfilling these objectives, the monitoring programme will play a vital role in promoting responsible environmental management, ensuring sustainable practices, and safeguarding the surrounding ecosystem throughout the project's lifecycle.

Table 11-1: Monitoring and Management of Environmental Impacts

Source Activity	Impacts requiring monitoring programmes	Functional requirements for monitoring	Frequency of monitoring
Pit	Pit Wall and Waste Rock	Geochemical characterization of pit wall materials for each pit (laboratory static)	As required
	Pit Water	Parameters should include but not limited to pH; Electrical Conductivity; Sulphate; major cations (K, Ca, Mg & Na); trace metals (Ag, Al, As, B, Ba, Be, Bi, Cd, Co, Cr, Cr (VI), Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Si, Sn, Sr, Th, Ti, Tl, U, V & Zn); Anions (NO_3, NO_2, NH_4, Cl, F, PO_4) and Total Dissolved Solids (TDS).	Initially monthly monitoring, which could become less frequent over time depending on results. .

Source Activity	Impacts requiring monitoring programmes	Functional requirements for monitoring	Frequency of monitoring
Waste Rock Dump and Tailings Storage Facility	Waste Rock Dump/ Tailings Storage Facility	Mass/volumes of waste rock/Tailings	Daily records
		Inspection of the WRDs, its surroundings, and the drainage/seepage[5]	During rainfall events
	Toe Seepage from the Waste Rock Dump/Tailings Storage Facility	Parameters should include but not limited to pH; Electrical Conductivity; Sulphate; major cations (K, Ca, Mg & Na); trace metals (Ag, Al, As, B, Ba, Be, Bi, Cd, Co, Cr, Cr (VI), Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Si, Sn, Sr, Th, Ti, Tl, U, V & Zn); Anions (NO_3, NO_2, NH_4, Cl, F, PO_4) and TDS.	During rainfall events

12. Conclusion

The proactive management measures outlined in the report collectively contribute to mitigating geochemical risks associated with waste rock and tailings. They foster environmentally responsible practices and ensure the protection of surrounding ecosystems. The report's findings and recommendations demonstrate a commitment to environmental stewardship and regulatory compliance, ensuring that potential geochemical impacts are appropriately managed and mitigated in accordance with relevant standards, guidelines, and laws set forth by competent authorities.

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