Chapter 9

Waste Rock and Rejects

TABLE OF CONTENTS

Tables

Figures

9. WASTE ROCK AND REJECTS

9.1 Introduction

This chapter describes the characterisation of waste rock and coal rejects and is based on the findings of the specialist report Geochemical Assessment of Spoil and Potential Coal Reject Materials provided in **Appendix 12**. This chapter also describes the existing geology at the site, potential mining waste materials which may be generated as part of the project and proposed management / mitigation measures.

9.2 Description of Coal, Waste Rock and Coal Rejects

9.2.1 Coal

The project is located within the Northern Bowen Basin, which contains large reserves of Permian coals. The Bowen Basin is characterised by typical basin fill fluvial (and some marine) sediments, comprising mudstones, siltstones, sandstones and coal seams.

The resource includes coal within the Moranbah and Rangal Coal Measures. The Moranbah Coal Measures (MCM) represent the main stratigraphic unit of interest in the project area, and contain up to seven persistent coal seams. The coal sequence to be mined during the project comprises three main coal seams including the P Rider Seam, Goonyella Middle (GM) and Goonyella Lower (GL) seams from the Moranbah Coal Measures.

The Moranbah Coal Measures are approximately 290 m thick in the project area and strike north-south, dipping to the east at between 4^{o} and 12^{o}. The principal seams of economic interest are the Goonyella Lower (6 to 8 m thick), Goonyella Middle (6 to 10 m thick) and P Rider (2 to 4.5 m thick) seams.

Coal from the Rangal Coal Measures may also be mined during the latter half of the mine life. The main seam of interest in the Rangal Coal Measures is the Leichhardt seam, a correlation of the Upper Newlands seam which is between 4.5 and 6.5 m thick in the surrounding vicinity. **Table 9-1** provides a summary of the stratigraphy in the project area.

Table 9-1 Stratigraphy of the Byerwen Area

Age	Group	Formation	Description	Thickness
Quaternary		Alluvium	Mud, sand, minor gravel (alluvium), residual soil and colluvium	5m - 10m
Tertiary		Suttor Formation	Quartz sandstone, clayey sandstone, mudstone and conglomerate; fluvial and lacustrine sediments and minor interbedded basalt	100m - 150m
Triassic	Rewan Group	Arcadia Formation	Green lithic sandstone, green and red sandstone and mudstone	230m
		Sagittarius Sandstone	Feldspathic and lithic sandstone with mudstone interbeds	280m
Late Permian	Blackwater Group	Rangal Coal Measures (RCM)	Sandstone, siltstone, mudstone, coal, tuff and conglomerate	60m

Age	Group	Formation	Description	Thickness
		Fort Cooper Coal Measures (FCCM)	Medium to coarse-grained, volcano-lithic sandstone, conglomerate, tuff, tuffaceous mudstone, coal and shale	400m
		Moranbah Coal Measures (MCM)	Lithic sandstone, siltstone, shale, coal, mudstone and conglomerate	290m
Early Permian	Back Creek Group	Exmoor Formation	Quartzose to sub-labile sandstone, siltstone and rare limestone	85m
		Gebbie Formation	Quartzose to lithic sandstone, sandy siltstone, siltstone, carbonaceous shale and calcareous sandstone	
		Tiverton Formation	Lithic sandstone, coquinite, calcareous sandstone and siltstone, conglomerate	
		Blenheim Formation	Carbonaceous and micaceous sandstone, siltstone, shale, coquinite and minor conglomerate	

Coal will be extracted from the mine using open cut mining techniques. The mining schedule is based on taking advantage of the area of shallowest depth from surface to top of coal and orienting the mining such that it advances progressively deeper along the coal seam wherever possible. The open cuts will become deeper as mining progresses to the east. The maximum depth below surface level of the open cuts will vary between 140 m in east pit 2 and 350 m in south pit 1.

Extraction of the coal resource will be at a rate of approximately 15 Mtpa Run of Mine (ROM) coal. It is proposed that the mine will produce approximately 10 Mtpa of product coal for the export market over the 46 year operational mine life. Production from the project will primarily be high quality coking coal with some thermal coal.

9.2.2 Waste Rock

The open cut mining process will involve stripping topsoil, weathered and unweathered waste rock and extracting coal quantities to meet coal production requirements. Approximately 5,300 Mbcm (approximately 9,500 Mt at an assumed bulk density of 1.8) of waste rock (overburden and interburden) will be removed over the life of the project. This total quantity equates to approximately 210 Mtpa of waste rock (on average) over the 46 year mining period. Waste rock will be disposed of in out-of-pit and in-pit waste rock dumps.

Waste rock will be comprised of overburden and interburden material. Overburden is rock that is required to be removed to access the uppermost coal seam. Interburden is the rock material between the targeted coal seams.

The waste rock is a mix of Tertiary basalts, sediments and fresh Permian material, with a proportion of weathered material near the surface and will mainly comprise very fine to fine grained sedimentary rock including mudstone, siltstone and sandstone. The depth to weathered material will range from 20 m to approximately 100 m below the natural surface, with an average depth to weathering of 40 m throughout the majority of the project area. Approximately 50% of the waste rock to be mined over the life of the project will be weathered.

Coal seam roof and floor zones (immediately above and below coal) and coal partings (interburden material) will typical comprise similar lithology, including coal laminations.

9.2.3 Coal Reject Materials

The management options for coal rejects are described in **Chapter 7**. Coal reject materials will be derived from the processing of ROM coal at the onsite coal handling and preparation plants (CHPPs). Coal reject materials will mainly comprise coal seam roof and coal seam floor (and some interburden) materials. Each CHPP will comprise a two stage dense medium cyclone and spiral/reflux classifier and froth flotation operation with a co-disposal system for rejects management

It is estimated that the project will produce around 3 to 5 Mtpa of rejects, which is expected to comprise about 2.5% of the average annual mine waste. Coal reject will comprise coarse, mid-size and fine reject, with coarse reject > 12mm, fine reject <1mm and mid-size reject between 1mm and 12mm.

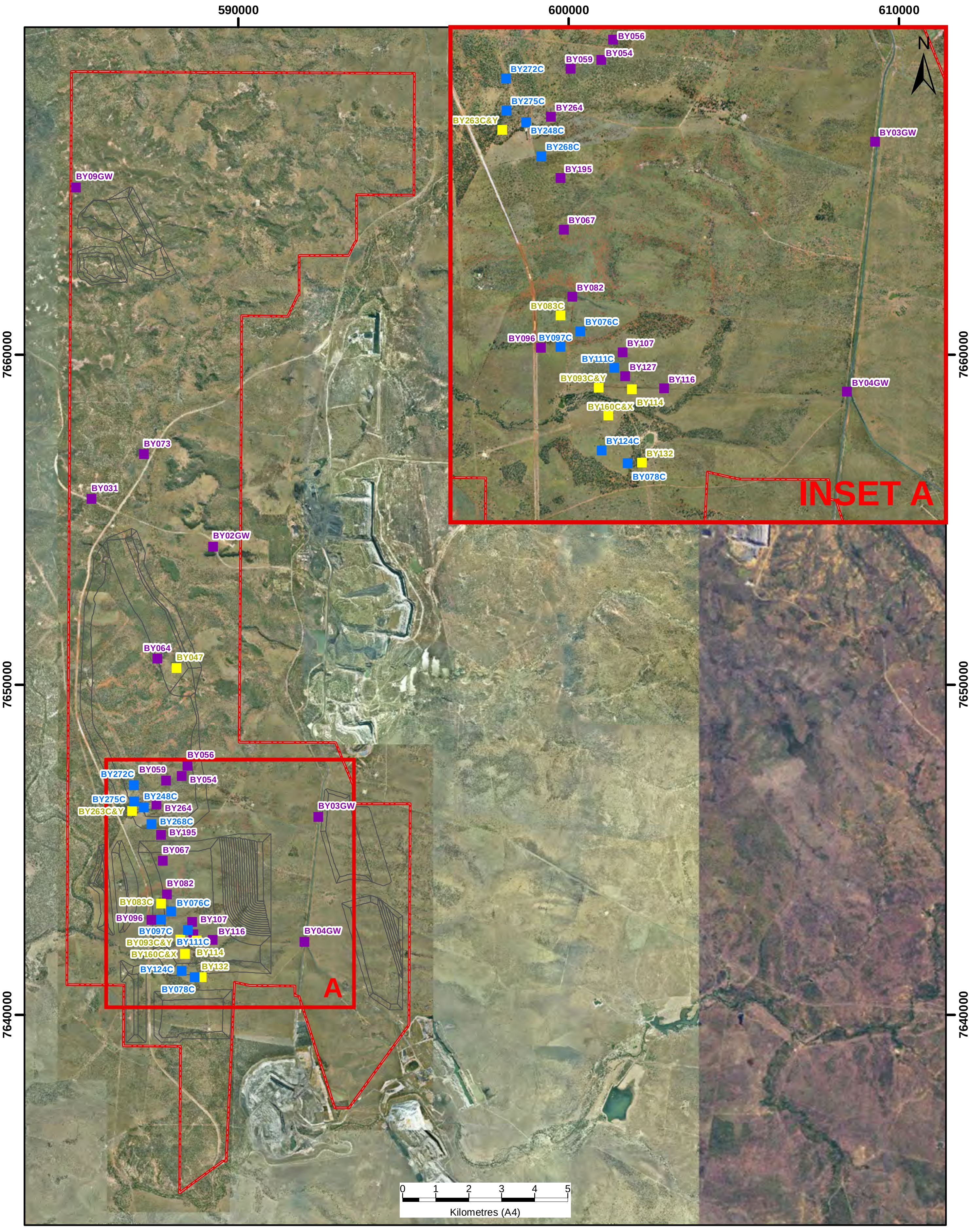
9.3 Waste Rock and Coal Rejects Geochemical Assessment Methodology

A geochemical testing program was undertaken to characterise waste rock and coal reject materials. Samples were collected from drill-core and drill-cuttings from 37 drill holes located across the project area. The location of the drill holes is provided in **Figure 9-1**.

There are currently no specific regulatory requirements regarding the number of samples required to be obtained and tested for coal, waste rock or potential reject materials at mines in Queensland. Whilst historical guidelines do exist in Queensland (DME, 1995a), more recent Australian and international guidelines (DITR, 2007; INAP, 2009) advocate a risk-based approach to sampling, especially for proposed coal mines where the geology is well understood and existing information is available on similar coal and mining waste materials. These guidelines have been referenced in characterising waste rock and potential coal reject samples.

A total of 279 samples were selected for geochemical testing including:

- waste rock samples comprising:
  - 83 samples from the Quaternary and Tertiary materials
  - 15 samples from the Fort Cooper Coal Measures
  - 133 samples from the Moranbah Coal Measures
  - 7 samples from the Exmoor Formation, which lies immediately below the Moranbah Coal Measures.
- potential coal reject samples comprising:
  - 2 roof/floor samples from the P Rider seam
  - 7 roof/parting/floor samples from the P seam
  - 30 roof and floor samples from the Goonyella Middle seam
  - 2 roof samples from the Goonyella Lower seam.



Legend

- Project Area
- Waste Rock Dumps and Pits
- Waste rock samples
- Potential coal reject samples
- Waste rock and potential coal reject samples

Drill Holes Sampled for Geochemical Assessment	
Figure 9-1	**Byerwen Coal Project**
Date: *29/01/2013*	**Author:** Shahram.Nasiri **Map Scale:** 1:150,000
Revision: R1	**Coordinate System:** GDA 1994 MGA Zone 55

G:\CLIENTS\A-TO-D\BYEGEN - Byerwen EIS\GIS\Maps\EIS Chapters\EIS_Chpt_9_WasteRock\BYEGEN_DrillHoles.mxd

The sampling strategy was focused on the GM seam and in the areas to be mined during the first 15 years of the project (West Pit 1 and South Pit 1), with 29 of the 37 drill holes located in these areas. Further assessment of representative samples from the GL and other seams will be undertaken as the project develops.

The geochemical characterisation of coal (ROM and product coal) will also be ongoing as the project develops, with representative coal samples included in future assessments. Additionally, further assessment will be undertaken as required to characterise waste products including surface run-off and seepage from waste rock dumps.

An environmental geochemical assessment of waste rock and potential coal reject material was undertaken based on the characterisation of samples using static geochemical test methods. Samples were tested for a range of parameters considered important for characterising the material for management and re-use purposes, including:

- pH (1:5)
- electrical conductivity (EC) (1:5 w:v)
- total sulfur [Leco method]
- acid neutralising capacity (ANC) [AMIRA, 2002]
- sulfide (chromium reducible sulfur – Scr) [AS 4969.7-2008 method]
- sulfate-sulfur.

The maximum potential acidity (MPA) and net acid producing potential (NAPP) was calculated from the total sulfur or Scr and ANC results.

Based on the results of the initial screening tests selected individual samples (and some composite samples of the same lithological type and similar basic geochemical characteristics) were submitted for further testing, including:

- total organic and inorganic carbon [Leco method]
- standard net acid generation (NAG) testing [AMIRA, 2002]
- sequential NAG testing [AMIRA, 2002]
- total metals and metalloids analyses by HCl and HNO3 acid digest followed by FIMS for Hg and ICP-MS / -AES for all other elements
- exchangeable cations (Al, Ca, Mg, Na, K);
- soluble metals and metalloids ICP-AES and FIMS (1:5 w:v water extracts)
- soluble cations and anions ICP-AES (1:5 w:v water extracts)
- soluble cations, anions, metals, metalloids, nitrate and nitrite by tTCLP [buffered to pH 7 with NaOH or acetic acid]
- Emerson Class testing.

Results obtained from the static testing were conclusive and indicated that the materials were expected to pose a low environmental risk. Further detailed characterisation using methods such as kinetic leaching tests was therefore not required as part of the assessment.

A summary of the geochemical testing undertaken is provided in **Table 9-2.**

Table 9-2 Summary of Geochemical Testing

Analytical tests	Waste Rock Material	Potential Coal Reject
pH, EC, total sulfur, ANC, NAPP	All (238) samples	All (41) samples
Scr	89 samples	40 samples
Sulfate, Carbon (total, organic and inorganic), NAG	63 samples	7 samples
Sequential NAG	1 sample	6 samples
Total elements in solids	79 samples 1 composite sample	13 discrete samples 5 composite samples
Exchangeable cations	13 samples	-
Soluble elements and major ions in 1:5 water extracts	15 discrete samples 1 composite sample	6 discrete samples 5 composite sample
Soluble elements, major ions, nitrate and nitrite by TCLP	63 samples	7 samples
Emerson Class	17 samples	-

An evaluation of the levels of metals within the overburden, interburden and coal samples has been undertaken. The aim of this part of the assessment was to assist in the management of the waste rock dumps and evaluation of the metal levels within the potential seepage emanating from the rock dumps.

There are no guidelines and/or regulatory criteria specifically related to total metal concentrations in mining waste materials, such as waste rock, coal and potential coal reject materials. In the absence of specific guidelines, the total concentration of each element reported in mining waste samples (solids) has been compared to National Environment Protection Council (NEPC) 1999a) health-based investigation levels (HIL) category 'E' for parks and recreation (open spaces). The applicability of the NEPC (1999a) guideline for 'open spaces' stems from the potential final land use of the mine following closure (i.e. low-intensity livestock grazing). Soluble element concentrations were compared to livestock drinking water guidelines (NEPC, 1999b and ANZECC, 2000).

These guidelines are considered to be appropriate in the context of the project and applicable to the end use of the mine following closure (i.e. low intensity livestock grazing).

9.4 Waste Rock Characterisation

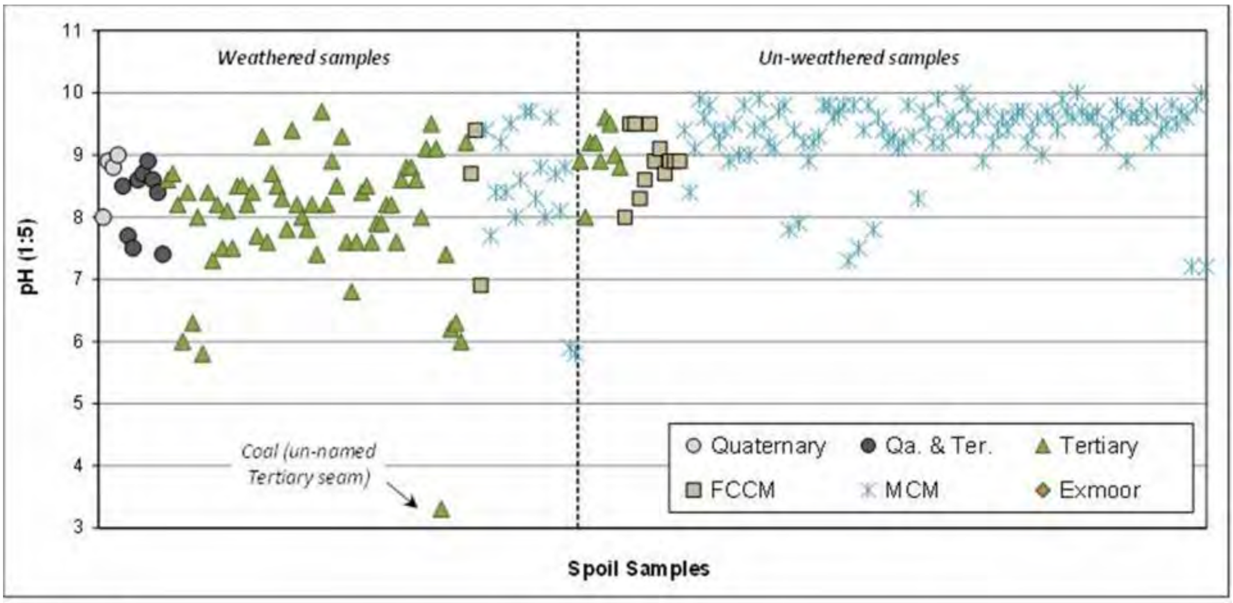
9.4.1 Electrical Conductivity and pH

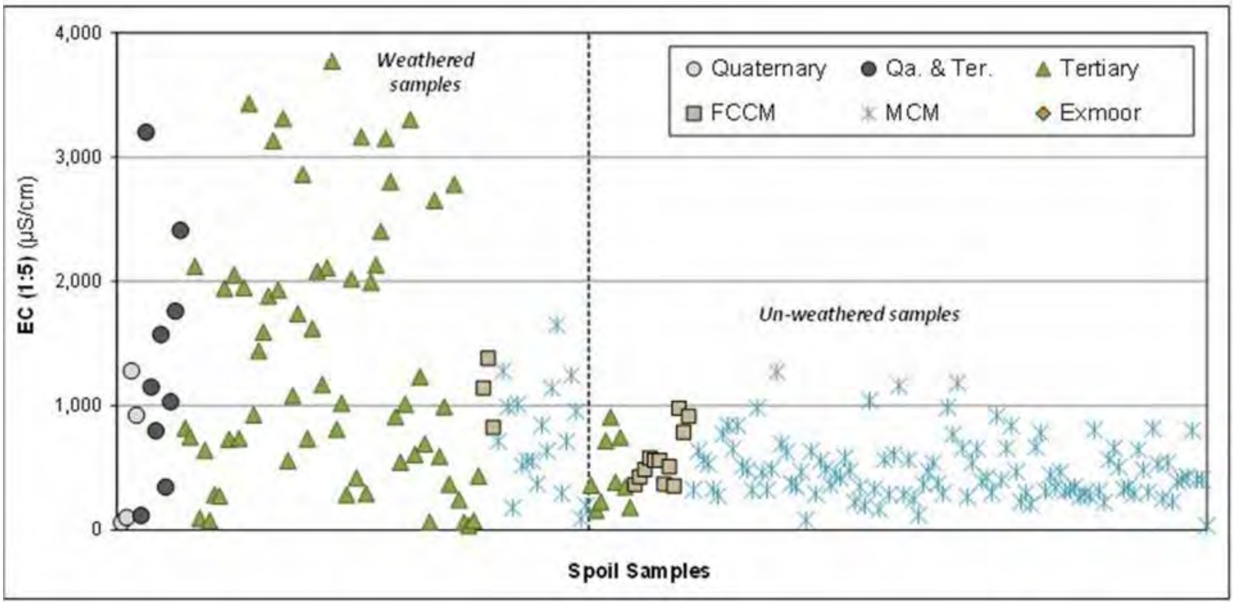
Waste rock samples were generally alkaline (maximum pH 10) with the exception of 11 samples (5% of the 238 samples), which were acidic (minimum pH 3). The weathered Quaternary and Tertiary samples generally had lower pH values than the unweathered samples from the Permian Moranbah Coal Measures (refer **Figure 9-2**).

Electrical conductivity (EC) of samples ranged from low to high (31 to 3,770 µS/cm) with a median EC of 520 µS/cm. The weathered Quaternary and Tertiary samples (median EC of 969 µS/cm) typically produced a higher EC compared to the unweathered samples from the Moranbah Coal Measures (median EC of 423 µS/cm). This is shown in **Figure 9-2**.

The proportions of weathered to unweathered spoil are approximately equal, therefore general waste rock (as a mixed bulk material), is expected to have a generally medium salinity derived from a mixture of low salinity unweathered waste rock and medium to high salinity weathered waste rock. The salinity of the waste rock is considered unlikely to significantly impact local groundwater resources. The groundwater in the local area is naturally highly saline (refer **Chapter 17**).

Figure 9-2 Electrical Conductivity (EC) and pH for Waste Rock (Spoil) Samples

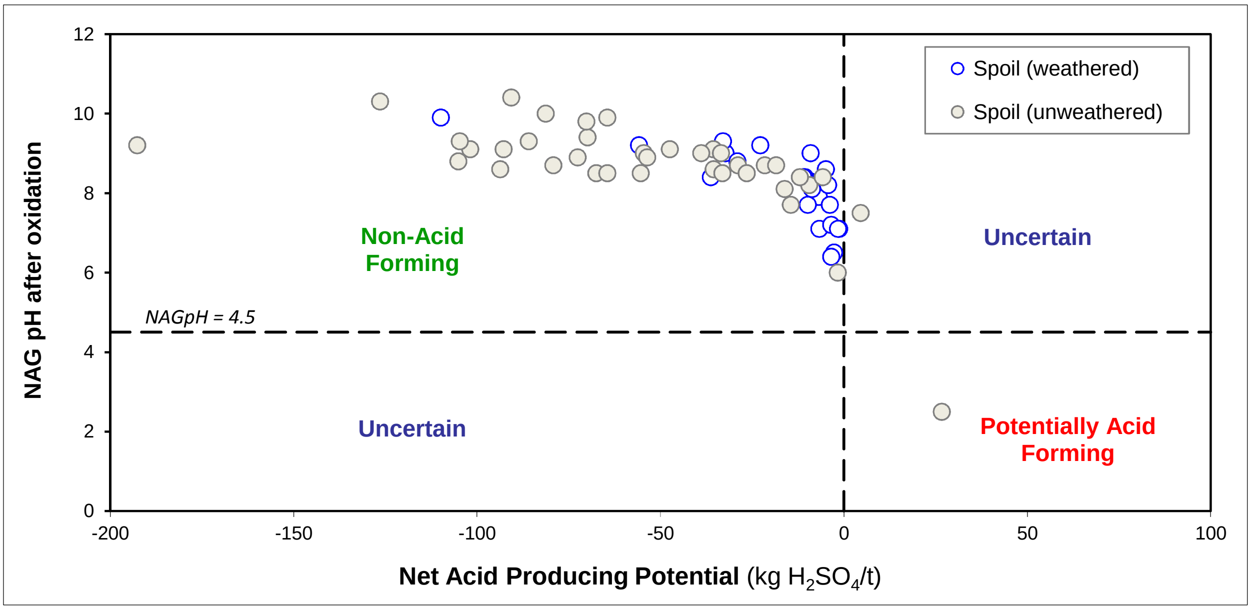




9.4.2 Acidity

The sulfur concentration of the majority (90%) of waste rock samples was low (<0.2%), with sulfur concentrations being more wide ranging in the unweathered samples. The sulphide-sulfur values reported for all but one of the samples were also low (<0.13%). The unweathered samples had greater sulphide concentrations compared to weathered samples. The maximum potential acidity (MPA) values for all the waste rock samples were generally very low (negligible) with a low median MPA of <1 kg H_2SO_4/t. The acid neutralising capacity (ANC) values ranged from low to moderate (<0.5 to 200 kg H_2SO_4/t). Unweathered samples had higher ANC values compared to weathered samples. The majority of calculated net acid producing potential (NAPP) values for samples were negative with the exception of four samples, indicating a significant overall proportion of neutralising capacity (ANC) compared to potential acidity (MPA) within the spoil material. Additionally the majority of samples were classified as non-acid forming (NAF). All samples tested, with the exception of one sample, had Net Acid Generation (NAG) pH values above pH6, indicating that they have a low acid forming potential (refer to **Figure 9-3**).

Figure 9-3 Net Acid Generation pH after Oxidation (NAGpH) versus Net Acid Producing Potential (NAPP) for Waste Rock Samples



The results in **Table 9-3** show that almost all waste rock samples tested (97%) fall in the NAF-Barren or NAF categories, and waste rock materials represented by these samples have very low sulfur values, excess ANC and clearly have little to no capacity to generate acidity. Generally, there was little difference between the classifications of the weathered samples compared to the unweathered samples. Five unweathered waste rock samples were classified as Uncertain due to a low oxidisable sulfur (Scr) content and low NAPP value. Three samples, representing about 1% of samples, were classified as PAF. From an acid generating perspective, waste rock (as a bulk material) is expected to be overwhelmingly NAF with excess ANC.

Table 9-3 Geochemical Classification of Waste Rock Samples

Geochemical Classification	All Spoil Samples (n=238)		Weathered Spoil Samples (n=96)		Unweathered Spoil Samples (n=142)	
	No. of Samples	% of Samples	No. of Samples	% of Samples	No. of Samples	% of Samples
Non-acid forming (barren) (NAF-barren)	197	97 %	91	99 %	106	95 %
Non-acid forming (NAF)	33		4		29	
Uncertain	5	~2 %	-	-	5	~4 %
Potentially acid forming – Low capacity (PAF-LC)	1	~1 %	-	~1 %	1	~1 %

Geochemical Classification	All Spoil Samples (n=238)		Weathered Spoil Samples (n=96)		Unweathered Spoil Samples (n=142)	
	No. of Samples	% of Samples	No. of Samples	% of Samples	No. of Samples	% of Samples
Potentially acid forming (PAF)	2		1		1	

9.4.3 Sodicity

Waste rock samples were found to have moderate to high sodicity levels, with high Effective Cation Exchange Capacity (eCEC) values (median 28.6 meq/100 g) and high Exchangeable Sodium Percentage (ESP) values (median 20%). Strongly sodic materials are likely to have structural stability problems related to potential dispersion. Tests undertaken on the samples indicated that weathered waste rock was more prone to erosion than unweathered rock.

In addition to potential dispersion, sodic soils often have unbalanced nutrient ratios that can lead to macro-nutrient deficiencies. The majority of waste rock samples were indicated to have a exchangeable cation imbalance and would be amendable to amelioration and vegetation growth through the addition of fertiliser (refer **Chapter 10**).

9.4.4 Metals

Total metal and metalloid concentrations in 79 waste samples tested are low. All except two waste rock samples (97% of samples) reported total metals and metalloid concentrations below the applied NEPC (1999a) health-based investigation levels, and in many cases, below the laboratory limit of reporting for metals and metalloids. Slightly elevated levels of arsenic and nickel were reported in two samples above the NEPC guidelines. Refer to **Appendix 12** for the full results.

Soluble multi-element results for 1:5 (solid:water) water extract solutions for 16 waste rock samples indicated that the majority of metal and metalloid concentrations have limited solubility, with the exception of molybdenum, selenium and vanadium which were marginally above the applied NEPC (1999b) and ANZECC (2000) livestock drinking water quality guideline levels for some samples. Soluble metal and metalloid concentrations in TCLP leachates from waste rock samples were also low, with no element concentrations exceeded the adopted guideline values. Refer to **Appendix 12** for the full results.

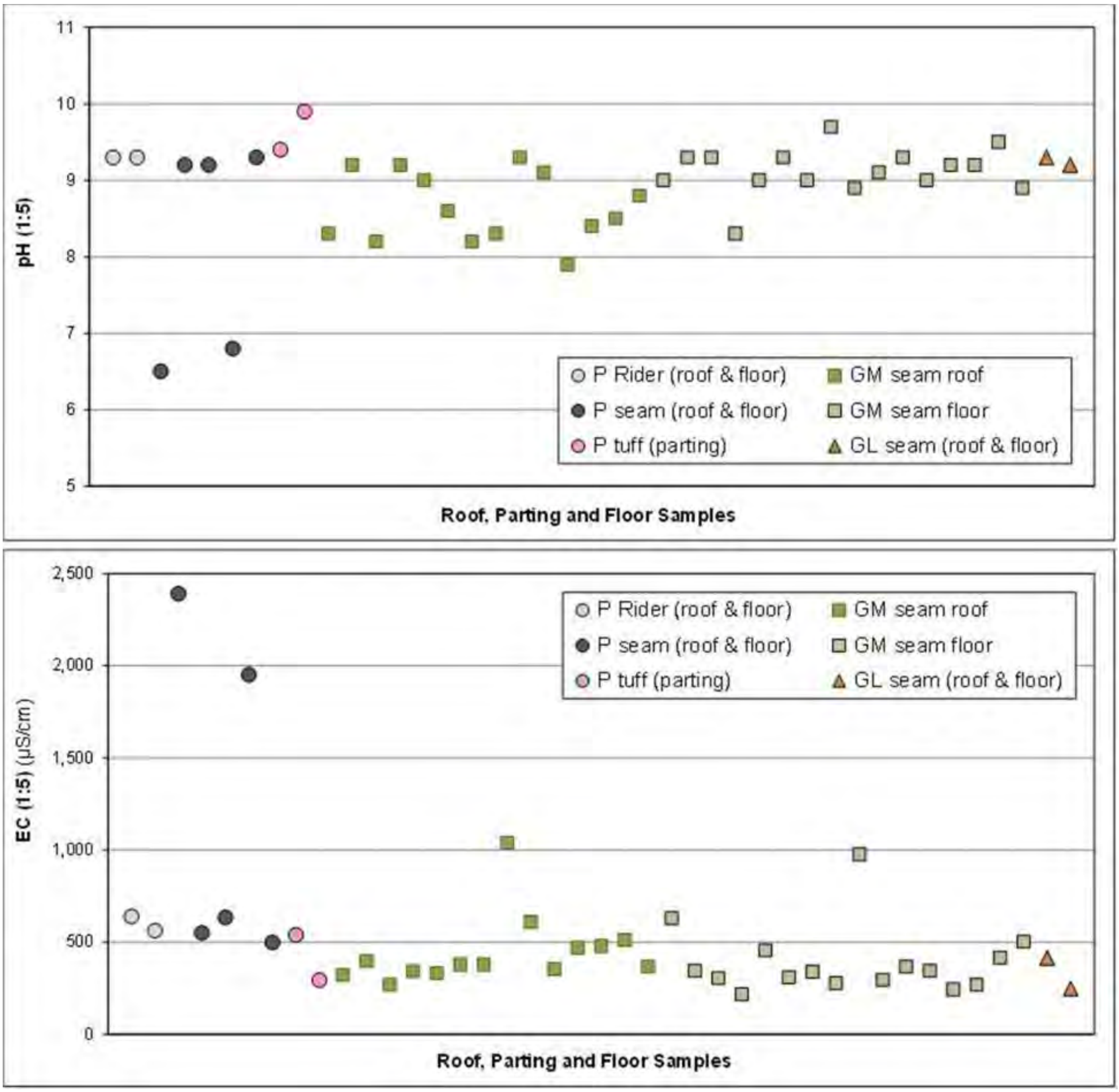
9.5 Coal Rejects Characterisation

9.5.1 Electrical Conductivity and pH

Potential coal reject samples were generally alkaline (maximum pH 9.9) with the exception of two samples (out of 41 samples), which were slightly acidic (minimum pH 6.5). There was no significant difference between the pH values of samples from the various coal seams tested or between roof, parting and floor materials within the same seam. Refer **Figure 9-4**.

The Queensland DME technical guideline (DME, 1995a) defines pH and salinity criteria for mine waste materials. Based on these criteria electrical conductivity of samples ranged from low to high (218 to 2,390 µS/cm), with a median EC of 380 µS/cm, with samples generally being low to moderately saline. There was no significant difference between material types tested. Refer to **Figure 9-4**.

Figure 9-4 Electrical Conductivity (EC) and pH for Potential Coal Reject Samples



9.5.2 Acidity

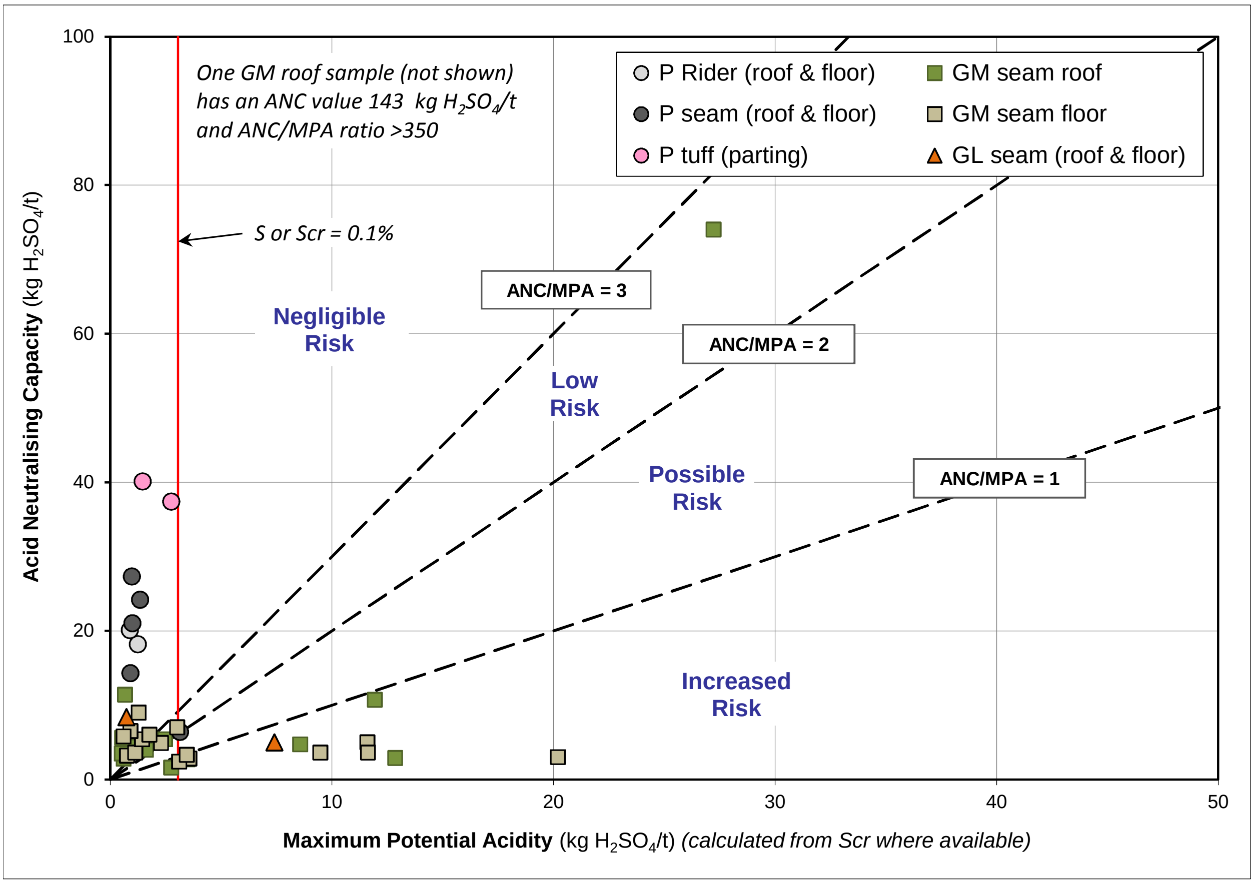
The sulfur concentration of 90% of coal reject samples was low (<0.4%), with sulfur concentrations being more wide ranging in roof and floor samples from the Goonyella Middle seam compared to the P Rider and P Seam samples. The sulfide-sulfur values reported for the majority of samples indicated that the sulfur in the potential coal reject is present as sulfide.

The MPA values for all the coal reject samples were generally very low with a low median MPA of 1.6 kg H_2SO_4/t. Six samples had an MPA value of 10 kg $H_2SO_4/_t$ and two samples had an MPA value above 20 kg H_2SO_4/t. The ANC values ranged from low to moderate (<1.6 to 143 kg H_2SO_4/t).

The calculated NAPP values for samples were generally negative with the exception of 13 samples, indicating a greater overall proportion of ANC compared to MPA.

Over two-thirds (68%) of the potential coal reject samples have an ANC/MPA ratio greater than 2 (and about 39% of samples have an ANC/MPA ratio greater than 5). Therefore, a majority proportion of coal reject samples as a bulk material, are considered to have a low risk of acid generation and a high factor of safety with respect to potential acid generation (refer to **Figure 9-5**).

Figure 9-5 Acid Neutralising Capacity (ANC) versus Maximum Potential Acidity (MPA) for Potential Coal Reject Samples



The results **Table 9-4** show that about 73% of potential coal reject samples tested (30 out of 41 samples) fall in the NAF-Barren or NAF categories, and coal reject materials represented by these samples have very low sulfur values, excess ANC and clearly have little capacity to generate acidity. Eight samples were classified as PAF-Low Capacity and one sample was classified as PAF. These nine samples represent about 22% of the samples – indicating that about one-quarter of coal reject samples have some capacity to generate acid. With respect to ANC/MPA ratios, and evident in the lower left corner of **Figure 9-5**, some samples classified as PAF-LC or Uncertain have very low sulfur values, therefore these samples are unlikely to generate significant acidity even in the absence of modest neutralising capacity.

Overall, from an acid generating perspective, coal reject as a bulk material, from the areas expected to be mined within the first 10 to 15 years, is expected to be NAF.

Table 9-4 Geochemical Classification of Potential Coal Reject Samples

All coal reject samples (n =41)	Non-acid forming – barren (NAF-barren)	Non-acid forming (NAF)	Uncertain	Potentially acid forming – low capacity (PAF-LC)	Potentially acid forming (PAF)
Number of samples	24	6	2	8	1
% of samples	73 %		5 %	22 %	

9.5.3 Metals

Total metal and metalloid concentrations in 18 coal reject samples tested were low and below the applied NEPC (1999a) health-based investigation levels.

Soluble multi-element results for 1:5 (solid:water) water extract solutions for 11 potential coal reject samples indicated that the majority of metal and metalloid concentrations have limited solubility, with the exception of molybdenum, selenium and vanadium which were marginally above the applied NEPC (1999b) and ANZECC (2000) livestock drinking water quality guideline levels for some samples. Soluble metal and metalloid concentrations in TCLP leachates from waste rock samples were also low, with no element concentrations exceeded the adopted guideline values. Refer to **Appendix 12** for the full results.

9.6 Waste Materials Handling and Management

9.6.1 Waste Rock Dumps

Initial out-of-pit dumping is required as the boxcuts are developed. Out of pit waste rock dumps will be created adjacent to the coal mining areas within the project area. Once there is sufficient space for in-pit dumping, pits will be progressively backfilled with waste rock. The pit depths along the subcrop are very shallow allowing coal to be mined and in-pit dumping to commence early in the operation. The in-pit dumps will merge with out of pit dumps and contain all of the subsequent waste material at elevation height of up to 60m above the initial topography.

Waste rock is scheduled to be placed back into each pit from approximately year three of the commencement of operations of that pit. Waste rock will be dumped in-pit once the initial mining strips are established, however out of pit dumping will continue sporadically over the life of mine.

9.6.2 Mine Waste Management Plan

A Mine Waste Management Plan (MWMP) will be developed prior to project operations at each of the eight open pits. Waste rock throughout the entire project area is expected to be benign with a negligible risk of acid generation (and low metals concentrations). Never-the-less the MWMP will address the following:

- Effective characterisation of the mining waste to predict, under the proposed placement and disposal strategy, the quality of run-off and seepage generated including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances.
- Classifying waste rock zones (on the basis of acid forming potential, salinity and sodicity), placement and use of waste rock materials and appropriate disposal of PAF waste or waste designated as not suitable for use on final surfaces.
- Uneconomic coal seams mined as waste rock will not report to final surfaces, as these ‘carbonaceous’ zones can be associated with sulfide minerals.
- Coal reject disposed directly into waste rock will be covered by waste rock (taking into account re-shaping of waste rock areas during rehabilitation activities), such that coal reject does not report to final surfaces.
- A program of progressive sampling and characterisation to identify dispersive and non-dispersive waste rock and the salinity, acid and alkali producing potential and metal concentrations of mining waste. Such further assessment will also include the collection, characterisation, assessment and management evaluation of actual waste rock and actual coal reject from the CHPPs and the coal

reject disposal area(s) to confirm the expected geochemical properties of these materials described above.

- A materials balance and disposal plan demonstrating how PAF and acid forming mining waste (if any) will be selectively placed and/or encapsulated to minimise the potential generation of AMD.
- A sampling program to verify encapsulation and/or placement of PAF and acid-forming (if any) mining waste.
- Regular review of the MWMP and criteria to assesses the performance of plan implementation.
- Monitoring and rehabilitation in accordance with the Rehabilitation Management Plan (refer **Chapter 9**).

The waste rock characterisation described in **Section 9.4** focused on waste rock in the first 10 to 15 years of mining. The MWMP will detail activities associated with the collection, characterisation and assessment of waste rock from areas of operations beyond Year 10 to confirm the expected geochemical properties of these materials.

Revegetation and rehabilitation field trials for waste rock materials will commence when bulk materials become available.

9.6.3 Waste Rock Disposal Method and Dump Design

The waste rock materials will be largely NAF producing pH neutral to alkaline leachate with moderate to high salinity and low soluble metals concentrations. The waste rock has a negligible risk of developing acid conditions.

Weathered materials (primarily Quaternary and Tertiary) are expected to have a greater potential for dispersion (erosion) than unweathered materials, which are mostly Permian. Weathered materials comprise about half of all waste rock. Waste rock used for final landform covering will primarily comprise unweathered material, which has a relatively low salinity and low potential for dispersion.

In an open pit mining operation, the weathered waste rock will typically be placed at the base of the waste rock dumps, beneath the unweathered materials. The weathered rock is therefore not considered to pose significant management issues to the project.

Where waste rock is proposed to be used for construction activities, particularly where engineering or geotechnical stability is required, testing will be undertaken by the proponent to determine the propensity of such materials to erode given the potential sodicity of the material. More sodic and dispersive materials will be identified, selectively handled and placed within the centre of waste rock piles or returned to voids away from the final surface.

Permian materials (Moranbah, Fort Cooper and Rangal Coal Measures) are generally more amenable to amelioration for sodicity and vegetation growth, through the addition of fertilizer, than Tertiary materials. Slopes should be well stabilised against erosion to reduce the risk of significant erosion of potentially dispersive sodic Permian materials.

It is proposed that Permian materials are used for the outer slopes of waste rock dumps to limit dispersion and erosion, with Tertiary materials disposed of within the central (inner) zones of waste rock dumps. Surface run-off and seepage from waste rock dumps and any rehabilitated areas will be monitored for a standard suite of water monitoring parameters including pH, electrical conductivity, sulfate (and other major ions) and a broad suite of soluble metals. This is further described in **Chapter 14**.

Expected landforms and locations of waste rock dumps at various stages of mine life are shown in **Figure 7-3** to **Figure 7-12** in **Chapter 7**.

The management of seepage from waste rock dumps is included in the mine affected water management system described in **Chapter 8**. This system will be designed to limit release of seepage from waste rock dumps to the environment, other than in accordance with the release criteria described in **Chapter 8**. Potential impacts from discharge of seepage from waste rocks on groundwater are described in **Chapter 17**.

9.7 Rejects Disposal Method and Containment Design

The production and management of rejects is described in **Chapter 7**. Rejects management principles in the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (DME 1995b) were considered in developing the management options for rejects. Rejects management will:

- produce stable rejects (either buried in-pit or contained within a co-disposal dam that will be decommissioned and rehabilitated)
- minimise disturbance to the environment by placing coarse rejects in-pit in the initial years of operation and all rejects in-pit in later years of operation
- minimise risks to the environment through appropriate design and construction of rejects management facilities, encapsulation of rejects in-pit and decommissioning and rehabilitation of co-disposal facilities and waste rock dumps.

The large majority of potential coal reject materials will not pose a risk of developing acid conditions. Based on sample numbers, about 20% of potential coal reject materials may have a low capacity to generate acidity. However, when managed as a bulk material at the reject co-disposal facility this small proportion of PAF waste would be expected to pose a low environmental risk when mixed/disposed amongst the broader NAF coal reject bulk material. Furthermore, bulk coal reject is expected to be alkaline, which assists with neutralising any acid generated.

Coal reject disposed into a pit, whether as coarse reject or as co-disposed reject, will be progressively covered (buried) with waste rock. Coarse reject may be disposed initially into out of pit waste rock dumps. The management of coarse reject disposed under this scenario is essentially the same as for in-pit disposal (i.e. progressive burial by a thick layer of waste rock).

Co-disposed reject managed under an in-pit disposal strategy will likely be disposed into cells in a nominated area of the pit (below the natural lip of the pit). As the cells are filled, they will be progressively buried by backfilled waste rock.

Coal reject, whether disposed in-pit or amongst out-of-pit waste rock, will not report to final landform surfaces.

9.7.1 Co-disposal Dams

Co-disposal dams at the southern and northern CHPPs are described in **Chapter 7**. A dam hazard assessment was conducted for both co-disposal dams (as described in **Chapter 8**) and both dams are considered to be high hazard dams and therefore regulated dams. Design of regulated dams will be in accordance the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (DERM, 2012) (the Manual) and any other relevant codes and guidelines. This will include determining the design storage allowance (DSA) of the dams.

The following general principles will be adopted to minimise potential environmental impacts from co-disposal dams:

- The co-disposal dams will be constructed on a prepared low-permeability base to minimise seepage from the base and basal edges of the facility.
- The co-disposal dams will be operated to minimise the level (volume) of decant water in the facility and maintain a safe water depth (low hydrostatic pressure) at dam walls.
- Decant water will be reused, as much as practical, in the CHPPs.
- Design and operation will include inspection and monitoring of integrity and seepage loss.
- Surface run-off and seepage from co-disposal dams will be monitored for 'standard' water quality parameters, including pH, EC, sulfate (and other major ions) and a broad suite of soluble.

In-pit rejects disposal facilities are described in **Chapter 7**.

Decommissioning and rehabilitation of co-disposal dams is described in **Chapter 10**.

9.8 Conclusion

A total of 238 waste rock and 41 potential coal reject samples were tested as part of the geochemical assessment. Weathered waste rock, particularly Quaternary and Tertiary material, is likely to generate alkaline, medium to high salinity run-off and seepage. Unweathered rock, primarily from the Moranbah Coal Measures is expected to generate alkaline and low salinity run-off and seepage. Weathered materials comprise about half of all waste rock expected to be mined. The salinity of the waste rock is considered unlikely to significantly impact local groundwater resources. The groundwater in the local area is naturally highly saline.

The total sulfur and sulphide-sulfur concentrations of the majority of waste rock samples were low (almost negligible). The majority (97%) of waste rock samples were classified as non-acid forming (NAF).

Total metal and metalloid concentrations were generally low and below the adopted health based guideline levels for soil. Some waste rock material may produce leachate containing slightly elevated concentrations of some soluble elements including molybdenum, selenium and vanadium. However, these concentrations are common for rock material in the Bowen Basin.

Weathered materials (primarily Quaternary and Tertiary) are expected to have a greater potential for dispersion (erosion) than unweathered materials, which are mostly Permian. Waste rock used for final landform covering will primarily comprise unweathered material, which has a relatively low salinity and low potential for dispersion.

It is estimated that the two CHPPs will produce around 3 to 5 Mtpa of coal reject, which is expected to comprise about 2.5% of the average annual mine waste. Potential coal reject is likely to generate alkaline, low to medium salinity surface runoff and seepage, following surface exposure.

The total sulfur concentration of the samples was generally low, however some coal reject materials contained sulphide concentrations, which may be sufficient to generate acid (in the absence of any neutralising materials).

Approximately 22% of potential coal reject samples have been classified as PAF, 73% of samples as NAF and 5% as Uncertain. However, the PAF and Uncertain samples have low sulfur concentrations and therefore a low capacity to generate acid.

Total metal and metalloid concentrations in coal reject samples were low and below adopted health based guidelines for soil. Some potential coal reject materials may have the potential to produce leachate containing slightly elevated concentrations of soluble elements, including molybdenum, selenium and vanadium. However, these concentrations are common for coal reject material in the Bowen Basin.

A Mine Waste Management Plan will be developed to characterise and classify waste rock and guide the placement of waste rock within each waste rock dump with the objective of placing the most benign waste rock near the surface of the waste rock dump. The Rehabilitation Management Plan will guide any amelioration required of surface waste rock, covering of waste rock with stripped soils and re-vegetation of waste rock dumps.

Coal rejects comprises approximately 2.5% of total mine waste. The rejects management system includes co-disposal dams for fine and mid-size reject in the initial years of operation, disposal of coarse reject in the waste rock dumps (encapsulated within waste rock) and in-pit co-disposal in later years of operation (which will be progressively encapsulated beneath waste rock). Co-disposal dams will be regulated dams and designed in accordance with relevant guidelines and codes.

In summation:

- there is a low risk of acidity forming for waste rock or coal rejects
- there is moderate to high risk of salinity and dispersion from the weathered material if left exposed in final landform, if covered by unweathered material the risk is low
- there are low concentrations of metals and metalloids.