Mining Waste Management Plan

Ensham Coal Mine

Prepared for: Ensham Resources Pty Ltd

RGS

MINE WASTE AND
WATER MANAGEMENT

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Glossary of Terms and Acronyms

Acid	A measure of hydrogen ion (H^+) concentration; generally expressed as pH
Acidity	Acidity accounts for both the actual hydrogen ion (H^+) concentration of the aqueous solution and the potential for acid generation due to mineral or latent acidity
ABA	Acid base account is the evaluation of the balance between acid generation and acid neutralisation processes.
AC	Acid consuming mine waste; typically defined as AC because it is has the potential to neutralise substantial acid loads
AF	Acid forming mine waste; typically defined as AF because it is producing acid drainage
AMD	Acid and Metalliferous Drainage (also known as ARD) from mine waste materials characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity. See also "NMD"
ANC	Acid Neutralising Capacity, expressed as kg H_2SO_4 per tonne of sample. A measure of a sample's maximum potential ability to neutralise acid
ANC: MPA Ratio	The ratio of the acid neutralising capacity to the maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions
CHPP	Coal Handling and Preparation Plant
CRS	Chromium reducible sulfur is a method that measures sulfide sulfur and exclude other S species.
EC	Electrical Conductivity, expressed as µS/cm
eCEC	Effective cation exchange capacity provides a measure of the amount of exchangeable cations (Ca, Mg, Na and K) in a sample
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a materials and propensity to erode
Interburden	Mining waste material located between mined coal seams. See also "Parting"
KLC test	Kinetic leach column tests are procedures used to measure the geochemical/ weathering behaviour of a sample of mine material over time
LoR	Limit of Reporting. Laboratory detection limit for the reporting of results for a particular geochemical test
MAW	means the following types of water: pit water, groundwater or runoff water that is mixed with above waters or not part of Erosion and Sediment Control Plan
MPA	Maximum potential acidity. Calculated by multiplying the total sulfur or sulfide-sulfur (Scr) content of a sample by 30.6 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne
NAF	Non Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions
NAG	Single addition peroxide Net Acid Generation (NAG) test that uses hydrogen peroxide to oxidise sulfide minerals so that the MPA can be measured using NAG

NMD	Neutral mine drainage typically caused by exposure of sulfide minerals in mine waste materials to oxygen and water and then neutralisation by gangue minerals. Typically characterised by neutral pH and elevated concentrations of salts, sulfate and metals/metalloids
NAPP	Net Acid Producing Potential, expressed as kg H_2SO_4 per tonne. Calculated by subtracting the ANC from the MPA
NPR	Neutralisation Potential Ratio a numerical value defined by dividing MPA by ANC; an NPR of < 1 infers material will produce acid and values of 2 to 3 are used to classify material that will not produce acid
Overburden	Overburden material overlying the uppermost mined resource. See also “interburden” and “parting”
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to oxidise and generate acidity.
Parting	Thin band generally less than 0.5m thick of overburden material from between economic coal seam plys
ROM	Run-of-Mine. Coal as it comes from the mine prior to screening or processing
%S	Percent sulfur. A measurement unit for the sulfur content of a sample material
S	Sulfur
SD	Saline drainage typically characterised with neutral pH and elevated salts
SO_4^{2-}	Sulfate
Static test	Procedure for characterising the geochemical nature of a sample at a single point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account
TS	Total sulfur content of a sample generally measured using a ‘LECO’ analyser expressed as %S
TSS	Total suspended solids is a measurement of the suspended solids concentration in a water sample

1 Introduction

Ensham Mine (EM) is an opencut / underground bord and pillar coal mine located approximately 35 km east of Emerald along the Nogoa River in Central Queensland (refer **Figure 1-1**). The mine is operated by Ensham Resources Pty Ltd (Ensham), a wholly owned subsidiary of Idemitsu Australia Resources Pty Ltd (Idemitsu), on behalf of the Ensham Mine joint venture (JV) partners. The JV partners, and holders of the Environmental Authority, are Bligh Coal Limited, Idemitsu and Bowen Investment (Australia) Pty Ltd. EA EPML00732813 (the EA), dated 3 September 2020, is the relevant environmental authority under which Ensham operates the mine (DES, 2020).

EM currently undertakes underground mining using continuous miner operations, while utilising the existing access and supporting infrastructure located within the current Mining Leases. The mine also produces coal from open cut pits using both dragline, and truck and shovel operations. The mine has approval to produce up to 12 million tonnes per annum (Mtpa) of coal product.

RGS Environmental Pty Ltd (RGS) has prepared this Mining Waste Management Plan (MWM Plan) for Ensham to comply with relevant EA conditions and relevant guidelines (DME, 1995, DEHP, 2013 and COA, 2016). RGS has completed a number of projects over the past few years for Ensham Resources regarding the geochemical characteristics and management of mining materials (RGS; 2019, 2020). There have also been a number of other studies completed over the years as reviewed by RGS in 2020.

A list of actions for implementation of the MWM Plan by EM is shown in **Section 10** (**Attachment A**).

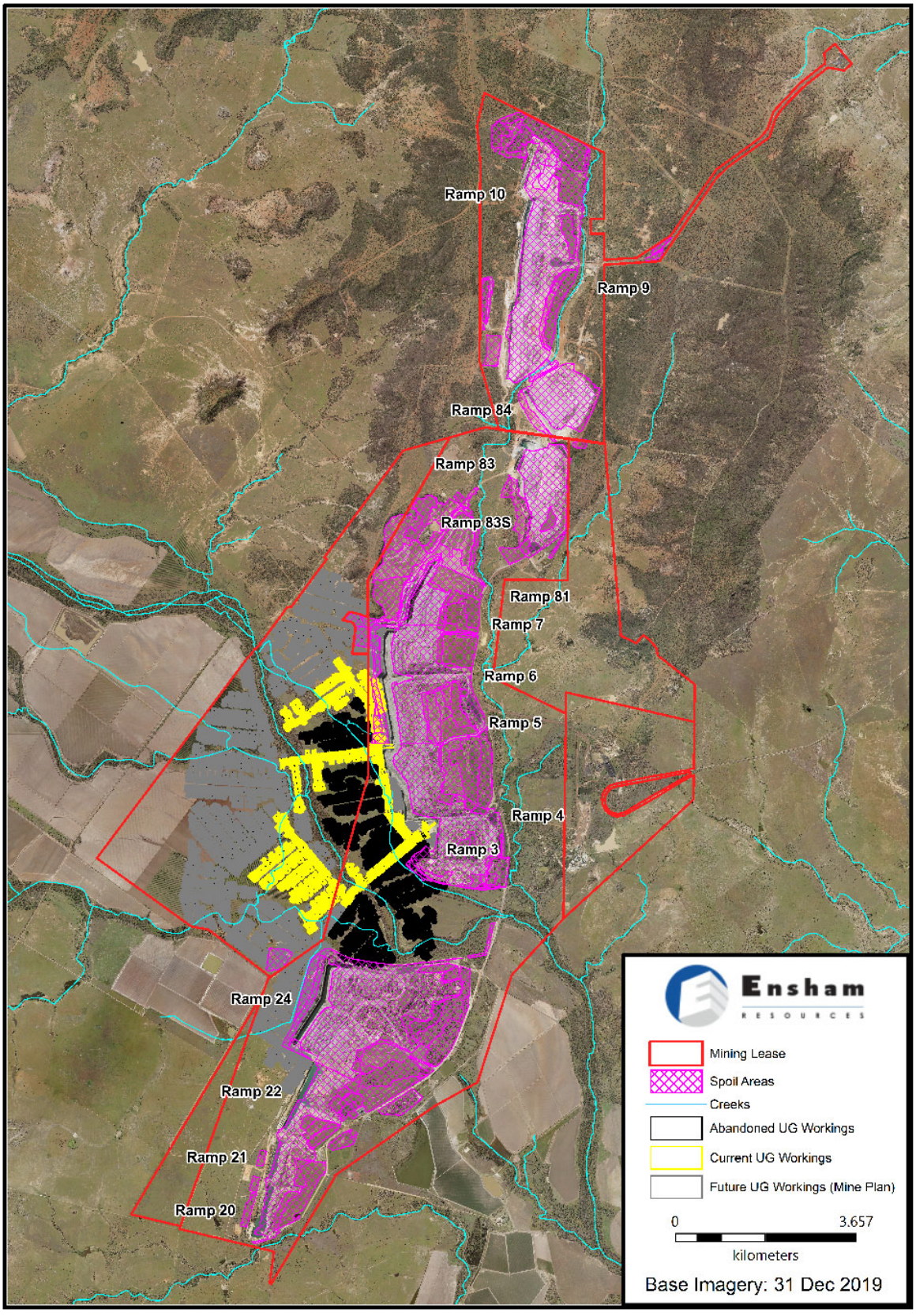

Figure 1-1: Project Location

2 MWM Plan Requirements

This is the first iteration of the MWM Plan. Significant aspects of the MWM Plan that require action by the owners of the plan are documented in **Section 10.1 (Attachment A)**.

2.1 Environmental Authority EPML00332013 Condition G29

There are a number of conditions within the EA related to mining waste and limiting the potential for saline drainage and Acid and Metalliferous Drainage (AMD)[1].

- **Condition C33 (Saline and acid rock drainage)**, of the EA states that:

The environmental authority holder must ensure proper and effective measures are taken to avoid, or otherwise minimise, the generation and release of:

(a) saline drainage; and

(b) acid rock drainage.

- **Condition G4 (Mine Waste)** of the EA states that:

A Mining Waste Management Plan together with the certification by an appropriately qualified person must be developed and implemented during the continuation of the environmental authority.

The Mining Waste Management Plan must at a minimum include:

(a) characterisation programs to ensure that all mining waste is progressively characterised during disposal for net acid producing potential, salinity and the following parameters: pH, Electrical Conductivity (EC), Acid Neutralising Capacity (ANC), Net Acid Generation (NAG) (reporting NAG capacity and NAG pH after oxidation), Total Sulphur (S), Chromium Reducible Sulphur (Scr), Boron (B) Cadmium (Cd), Iron (Fe), Aluminium (Al), Copper (Cu), Magnesium (Mg), Manganese (Mn), Calcium (Ca), Sodium (Na), Zinc (Zn) and Sulfate (SO_4);

(b) individual parameters in a) above can be removed following sufficient mine waste characterisation to demonstrate that certain individual parameters are not present in sufficient quantities to warrant further characterisation;

(c) characterisation programs to ensure that the physical properties of the mining waste is progressively characterised during disposal;

(d) the availability or leachability of metals from the mining waste;

(e) quantification of PAF from mining waste present;

(f) review impacts of the PAF mining waste on the rehabilitation;

(g) management actions for mining waste that has been identified as having a high availability or leachability of metals;

(h) management actions for mining waste that has been defined as PAF;

(i) identification of environmental impacts and potential environmental impacts;

(j) control measures for routine operations to minimise likelihood of environmental harm;

(k) contingency plans and emergency procedures for non-routine situations; and

(l) periodic review of environmental performance and continual improvement

2.2 Scope

The scope of the MWM Plan is to manage all mined units including overburden/interburden, coal, and reject coal **associated with the mine at EM**. It is assumed that the majority of the mining waste materials currently stored at surface are associated with previous open cut mining activities and that

[1] AMD is also known as Acid Rock Drainage.

the current underground mine will produce a relatively small amount of additional mining waste materials that will report to surface (i.e., reject coal).

Effective management leading to successful rehabilitation that will attain regulatory relinquishment or be considered as fit-for-purpose by a subsequent landowner will integrate the mining, placement and subsequent rehabilitation of the mining waste materials.

2.3 Aim

The aim of the MWM Plan is to enable mining and rehabilitation to be completed economically with minimal adverse environmental and social impacts on the land and water resources, and to lead to successful post-rehabilitation beneficial reuse. To achieve this aim there must be an integrated planning approach coupling the work programs undertaken by environmental, exploration and operational geology and short, medium and long term mine planning departments.

With an integrated, cross-discipline planning approach at a site, the implementation of the management aims is effective and eliminates any subsequent environmental issues.

The MWM Plan is the central focal point of a broader set of protocol and procedures that are needed to achieve the intent of the Plan. The protocol, procedures and methods for some tasks such as material characterisation would be documented and managed by the custodian of the Plan.

Other tasks such as exploration and operational geological programs, short, medium and long term mine planning (including landform design), water management (including sediment and erosion control), and rehabilitation (ecological) programs are documented in other management plans.

2.4 Objectives

The objectives of the MWM Plan are to document and map out the following.

- Why the Plan is required?
- When the Plan will need to be updated?
- How changes to the Plan will be tracked to enable the reasons for changes to the Plan over the life of mine to be understood?
- How the data are to be used and which other plans the data and the Plan will need to integrate with e.g. the Water Management Plan, Mine Plan, and Progressive Rehabilitation and Closure Plan?
- When the tasks in the MWM Plan are required to be undertaken and what the outputs will be?
- Provide triggers to undertake sampling or investigation based on monitoring results.

2.5 Data management

The material characterisation program will compile geochemical, physical and nutrient data.

All geochemical, and physical data associated with the characterisation of coal, coal roof, coal floor, coal partings, , overburden and interburden is held in the geological database. All data relating to rehabilitation of spoil overburden is held by the Environment Department in the Inviron software.

2.6 Document control and review process

This Plan will be reviewed annually by a suitably qualified person and Environment Department and progressively updated and implemented to align with other key departments such as geology, mine planning and technical services.

Revision 001 of the Plan is dated (27/01/2021) and was approved by Neil Dale, Environmental Superintendent at EM.

The current revision of the Plan (Revision 001) has been certified by RGS.

The information in **Table 2-1** documents the version control and sign off by EM.

Table 2-1: MWM Plan Version Control and Approval

Document Control			
Revision	**Signatory**	**Role**	**Company approval (Signed and dated)**
Revision 001			
Revision 002			
Revision 003			

Table 2-2 allows for future amendments to the MWM Plan to be progressively tracked over the life of the mine, and, if any substantive changes have been made or are proposed to be recorded in the Plan.

It is advisable to document how and why changes are made to the Plan to allow subsequent managers to understand the history of the site and follow the progressive management and operation of the mine areas.

Table 2-2: Management Plan Amendments

Document Control			
Revision	**Signatory**	**Requirement for amendment**	**Reference to amendment**
Revision 001			
Revision 002			
Revision 003			

RGS certifies that this MWM Plan is feasible and would meet the intent of the EA conditions (i.e., the plan will enable EM to progressively characterise, mine and place the mined materials so that their potential to contribute to (or to mitigate) environmental harm can be determined.

In addition to the geochemical and physical characterisation of mined materials, the MWM Plan includes a schedule for a program of work to provide for the management of the future mine materials including plans for the construction of landforms to contain future mine wastes that will limit the extent of any adverse impact on the receiving environment.

3 Geology and Geochemical Analysis

3.1 Geology

EM removed Quaternary, Tertiary and Permian stratigraphic units and then mined the upper coal seam within the A, B, C, D, E, F and Y open pits (**Figure 3-1**).

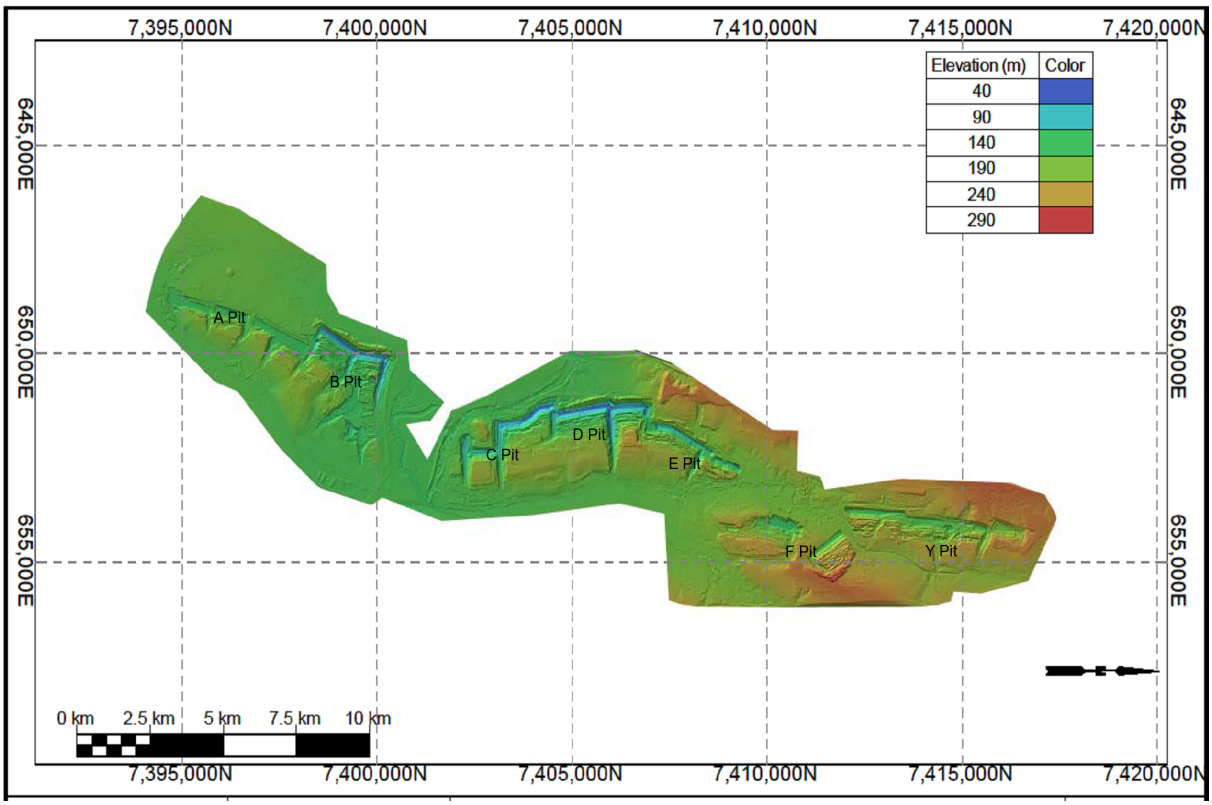

Figure 3-1: EM Open Pits

Ensham Mine is located in the Bowen Basin in Central Queensland. Coal seams in the Bowen Basin exhibit great variations in rank and quality, from low to high-volatile bituminous coking coal in the east, to low-ash thermal coals in the south and west. The coal seams of economic importance are separated by four regressive depositional phases, which are generally filled with non-coal bearing marine sediments (Hutton, 2009).

The seams mined at EM are classified as the relatively young Group IV coals, which includes the diverse, but widely distributed Rangal Coal Measures. Deposited under fluviatile, lacustrine, and paludal conditions, the Rangal Coal Measures are characteristically non-marine and low in sulfur in comparison to the predominately marine-influenced Group III coals.

The Rangal Coal Measures are overlain by unconsolidated Quaternary sediments consisting mainly of quartzose sand and gravels with some bands of sandy silt and clay. The seams to be mined by the Project include the Aries and Castor seams, while the Pollux, Orion, Libra, and Virgo seams are relatively thin and considered uneconomic. Ensham currently produces 5.2 million tonnes of thermal coal per annum; the additional coal to be produced by the Project Area has been estimated to be 23.8 Mt. EM plans extend existing underground mine workings in both a northern and western direction, to access economic deposits of the Aries and Castor seams.

The geology of the area modelled comprises of Cenozoic sediments (alluvium, gravel, sand silt, and clay), and sedimentary rock units including sandstone, siltstone and claystone, and Triassic/Permian sedimentary units, including sandstone, siltstone, carbonaceous mudstone and siltstone and coal. The Cenozoic sediments and sedimentary units have been subdivided into Quaternary sediments and

Tertiary sedimentary units when modelled. The major sedimentary rock units are primarily interbedded siltstone and sandstone with laterally continuous coal seams and some non-coal carbonaceous material, mostly mudstone. Modelled lithology comprises approximately 88.4% Permian, 1.4% Tertiary and 10.2 % Quaternary units. This distribution of ages was modelled using units logged as the Rangal Coal Measures or Rewan Group as the upper boundary of Permian stratigraphy. Sedimentary units shallower than this were designated as Tertiary units and sediments and silcrete overlying Permian or Tertiary stratigraphy were logged as Quaternary sediments.

A and B Pits were combined and are modelled as comprising 79 M m^3 of Permian over/interburden, 0.7M m^3 of Tertiary overburden and 19M m^3 of Quaternary sediments. B Pit is modelled as containing 171 Mm^3 of Permian material, 9,395 m^3 of Tertiary material and 18 Mm^3 of Quaternary material. Cenozoic sediments are approximately 50 m deep in the south of A Pit, becoming shallower to the north. The model of A and B Pit extends to the bottom of the Aries 1 seam, approximately 90 – 100 m below ground level (bgl). The Aries seam dips westward at approximately 3° – 4° and this dip and dip direction is roughly consistent through the rest of the A and B Pit model.

C, D and E Pits combined are modelled to contain 564 M m^3 of Permian material, 137,522 m^3 of Tertiary material and 135 M m^3 of Quaternary material. Cenozoic sediments are approximately 20 m deep and logged as primarily soil in C and southern D Pits and clay in the north of D Pit and E Pit. The model of the C, D and E lithology extends to the base of the Castor seam roughly 125 m bgl. Generally, strata are westward dipping at approximately 2°.

F Pit is modelled to comprise 28 M m^3 of Permian material, 5,448 m^3 of Tertiary material and 6 M m^3 of Quaternary material. Cenozoic sediments in F Pit are very shallow in the south (approximately 2 m bgl), deepening in the north (approximately 16 m bgl). These sediments are primarily clay with a thin soil covering. Marker beds in the model are dipping westward approximately 5 – 6° in the south of F Pit and 2 – 4° in the north. The model is approximately 55 m deep and extends to the base of the Pollux seam.

The Y Pit model contains 137M m^3 of Permian material, 32,824 m^3 of Tertiary material and 33 M m^3 of Quaternary material. The Cenozoic sediments in Y Pit are mostly clay with minor soil in the south and clay in the north. The sediments deepen from approximately 5 m in the south to 20 m in the north. The model extends to the base of the Pollux seam, 60 – 70 m below ground level for most of the model, thickening to 80 – 100 m in the north. There is a vertical offset of 11 m between coal beds logged in drill holes in the central east of the model. Drill hole X5057 is the only hole that shows an offset of this magnitude and coal beds logged in drill holes to the north and south become marginally deeper. This feature is interpreted to be an anticline, shallowly plunging southwest. Marker beds tend towards a western dip, bedding in the northern and southern ends of the model are near-flat (0 - 1°), with steeper angles modelled in the centre around the anticline (up to 12°).

3.2 Existing Geochemical Data

The geochemical characteristics of mining waste materials at EM have previously been reported (URS, 2006, 2015; RGS, 2019, 2020). The 2016 URS study built upon the information contained in the 2006 study and a total of 68 overburden and 32 potential coal reject samples were selected from 12 drill holes and covered the range of lithologies and mining waste materials commonly encountered at the mine.

The URS report found that materials represented by overburden and potential coal reject samples had low sulfide sulfur concentrations (< 0.05 %S) and contained up to two orders of magnitude more acid neutralising capacity compared to acid generating capacity. The overwhelming majority of samples were classified as non-acid forming (NAF or acid Consuming (AC) and the bulk mine waste materials had negligible risk of acid generation and a very high factor of safety in terms of their potential to generate acid.

Total metal/metalloid concentrations in the overburden and potential coal reject materials were low compared to unmineralised soil materials. Leachate from these mining materials was generally pH neutral to slightly alkaline and had low levels of salinity. Dissolved metal/metalloid concentrations were all below applied water quality guideline concentrations apart from molybdenum in a minor proportion of potential coal reject materials.

RGS (2019, 2020) provided a review of local groundwater quality from monitoring data over the 11-year time period 2006 – 2017. The results indicated that the local groundwater is circumneutral (pH 6-8), saline and dominated by NaCl. There was no evidence of acid in the groundwater. The water pumped from the existing underground workings was slightly more alkaline and had a pH 8 – 9. The EC of the natural groundwater was markedly higher in the Quaternary stratigraphic units (up to 48,000 µS/cm), compared to Permian (up to 12,000 µS/cm) where the coal seams are located. The water pumped from the underground workings had an EC of 5,000 – 10,000 µS/cm and a median value of 8,200 µS/cm. This indicates that the salinity of the pumped water was most likely generated through the mixing of naturally saline groundwater and dust suppression raw water.

Dissolved Na present in local groundwater was found at up to 7,500 mg/L in Quaternary stratigraphic units and up to 2,000 mg/L in Permian units. The dissolved Na in the water pumped from underground workings ranged from 950 – 1,720 mg/L and had a median of 1,460 mg/L. Similarly, the Cl concentration was up to 13,800 mg/L in Quaternary units, 4,000 mg/L in Permian units and ranged from 1,330 – 3,140 mg/L (median 2,850 mg/L) in the underground mine workings. These data confirm that the disturbance of the coal seams has had negligible impact on NaCl concentrations.

Surface water quality monitoring data at EM collected over the past decade (2010 – 2021) is well aligned with the groundwater data described above and overall statistics show that at surface water quality is typically pH neutral with low concentrations of dissolved parameters such as metals/metalloids. Salinity in surface runoff collected from rehabilitated areas is also low and generally reflects predicted levels in pits and dams containing unrehabilitated spoil runoff and water pumped from underground.

3.3 Coal and sulfur

Sulfur in coal and in mining waste materials is important as it can be present in a reactive sulfide form (such as pyrite or marcasite) and is typically the main contributor to the generation of AMD at mining operations. In general, sulfur concentrations can be elevated in coal and coal reject materials due to the genesis of these materials but can also be present in other stratigraphic units (typically close to coal seams, e.g., coal seam roof and floor materials).

Sulfur in coal is derived from two sources that include the original plant materials and ambient fluids in the coal forming environment. Abundance of sulfur in coal is controlled by depositional environments and the genesis of the coal seams and overlying strata. Typically, low-sulfur coal seams are formed by deposition in an alluvial environment not influenced by seawater. The sulfur in these low-sulfur coals is derived mostly from its parent plant materials. In contrast, high sulfur coal seams are generally associated with marine strata where sulfate in the seawater diffuses into the initial peat and is reduced by microorganisms to form hydrogen sulfide, elemental sulfur and polysulfides. During early genesis in a reducing environment, ferric iron is reduced to ferrous iron, which reacts with hydrogen sulfide to form iron monosulfide. Iron monosulfide is later transformed by reaction with elemental sulfur into minerals such as pyrite or marcasite, which upon exposure to oxidising conditions are typically reactive and generate AMD.

Organic sulfur is formed by reaction of reduced sulfur species with the humic substances formed by bacterial decomposition of the initial peat. Organic sulfur species in coals are mainly thiols, sulfides, di-sulfides, and thiophene and its derivatives. The thiophenic fraction of organic sulfur increases with the carbon content of coals. Organic sulfur compounds formed in peat are mostly thiols and sulfides, which gradually convert to thiophenes with increasing coal maturation. Thus, the organic sulfur species in coal evolve during the history of coal formation and, upon exposure to oxidising conditions, are typically not a source of AMD.

The depositional environment of the coal in the Ensham stratigraphic sequence was an alluvial environment with negligible marine influences at a regional level, therefore the magnitude of any potential for AMD generation is expected to be limited, compared to coal formed in marine influenced strata, and this was verified by RGS through plotting sulfur data (RGS; 2019, 2020). The location of total sulfur assay results from coal within the pits are provided in **Figure 3-2**.

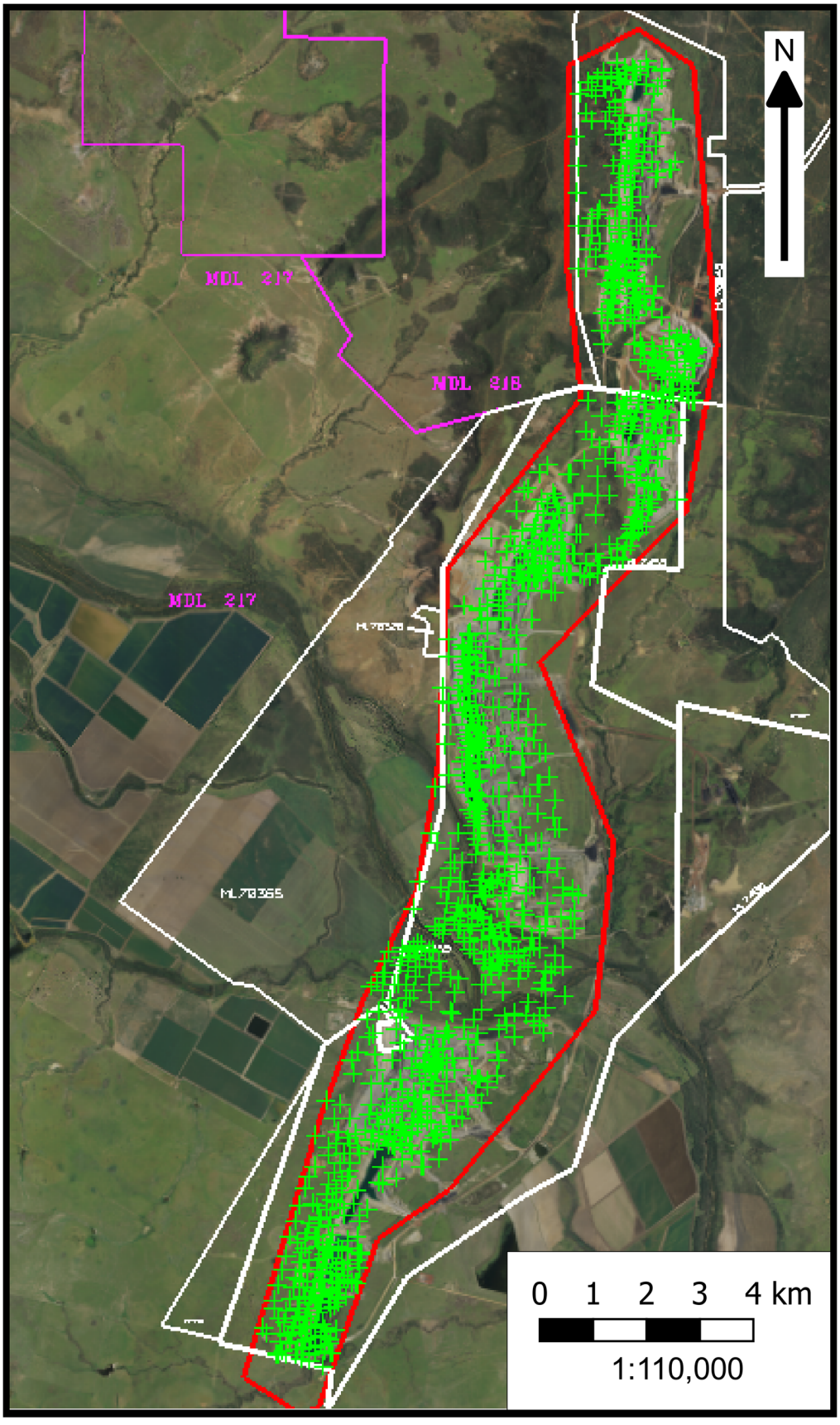

Figure 3-2: Coal assay locations

The coal sulfur data (n = 5,625) were used to produce a sulfur histogram to quantify the range and distribution of the sulfur in the coal (**Figure 3-3**): Approximately half of the coal total sulfur assay results are less than 0.5 % total sulfur, and 91% are less than 1% total sulfur. The results verify the coal is a low sulfur coal. Additionally, as a good proportion of sulfur is known to be organic sulfur, the maximum potential acidity (MPA) is also inferred to be low. The range and distribution of sulfur in roof and floor samples indicates over/interburden is low in sulfur as 84 % of assay results are less than 0.5 % total sulfur and 95 % are less than 1 % total sulfur. The risk profile is further reduced as there is excess Acid Neutralising Capacity (ANC) compared to MPA in the overwhelming majority of mining waste materials (including coal).

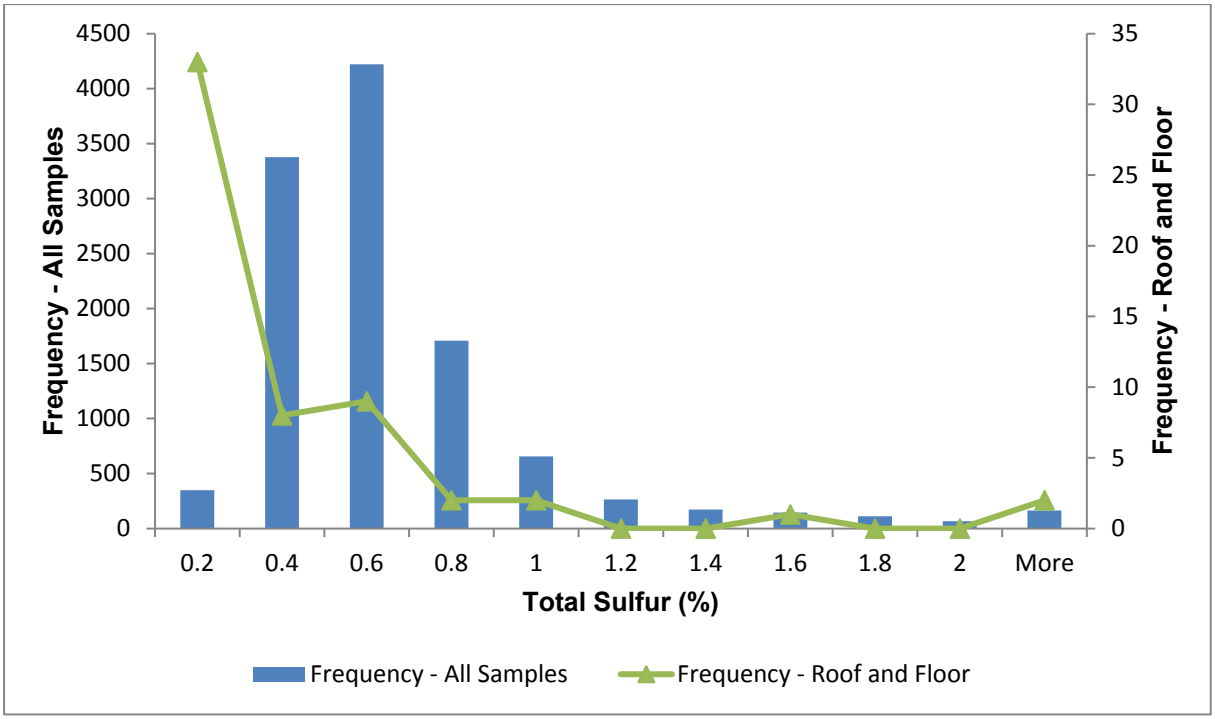

Figure 3-3: Coal total sulfur histogram

3.4 Geochemical assessment

The most reliable method to characterise the acid producing potential of a sample would be to undertake a range of analyses that include total sulfur (TS), sulfide sulfur (SS) measured using the chromium reducible sulfur method (CRS), sulfate (that can be measured in a range of fractions and species using various methods), the hydrogen ion concentration, (pH), Electrical Conductivity (EC), Acid Neutralising Capacity (ANC), reactive ANC using the Acid Buffering Characteristic Curve (ABCC) method, mineralogy, and the standard net acid generation (NAG) method (AMIRA, 2002; MEND, 2009). However, it is often cost prohibitive and unnecessary to undertake all these analyses on every sample and the standard NAG test has been shown to be unreliable (and can produce false positive results) for coal mine wastes with elevated total organic carbon content (ACARP, 2008).

It is typical to complete pH, EC, TS and ANC on all samples to screen them and undertake supplementary analyses on specific samples to understand anomalies or to verify assumptions. This approach results in a balance between sample coverage and cost and is an effective strategy for geochemical assessment.

3.4.1 Terminology

The mining and processing of coal and the mining and management of mine water has the potential to result in environmental harm associated with a loss of land use and potential adverse effects to surface water and groundwater resources.

General industry terms that can be used to **describe water quality** at mines that are, or have the potential to be, adversely affected by mineralised rock include the following.

- Acid Rock Drainage (is used extensively in North and South America) (ARD)
- Acid and Metalliferous Drainage (AMD)
- Neutral and Metalliferous Drainage (NMD)
- Saline Drainage (SD)
- Mine Impacted Water (MIW)

In Australia, **Acid and Metalliferous Drainage (AMD)** is a broad term defined as incorporating *acid metalliferous drainage*, *neutral metalliferous drainage (NMD)* and *saline drainage (SD)* (COA, 2016).

The use of consistent terminology relating to AMD is required so the potential for misunderstanding is reduced when a MWM Plan is being implemented at EM and utilised by different departments.

3.4.2 Mine material types

The mining waste materials at EM include coal that is:

- Mined and conveyed by underground mining methods to surface
- Reject coal that is placed by Eimco loader within the former open pit mining areas adjacent to the portal entry.

The broader **EM mining waste material types** that are present in mining waste landforms associated with the former open pit mining areas include the following.

- **Cover material** - Cover material includes topsoil and subsoil that is stripped before mining and is selectively placed within the upper profile of the rehabilitated landform in a soil cover system.
  - Topsoil (nominally the top 10 to 30 cm of the soil profile)
  - Subsoil (nominally the top 30 to 150 cm of the soil profile)
- **Rehabilitation material** - Material may be utilised for things such as use in cover systems for rehabilitation. These materials may be present within the top 10 m of the surface and are mined by truck and shovel mining methods and could include:
  - laterite material
  - Silcrete
- **Mine waste -** The mine spoil at EM includes the sedimentary strata that is mostly fresh rock but can also occur as transition and oxide units..
- **Reject coal –** Reject coal from the underground mine is placed into the open pit area.
- **Tailings** – There are no tailings at EM.

3.4.3 AMD classification

Standard industry terms used to **classify mined materials** include the following.

- **AF** (Acid Forming) – the material is already producing acid (e.g. < pH 5), contains no residual ANC and has additional sulfide content that will continue to oxidise and produce additional acid. At EM AF waste routinely produces MIW with a pH of 2 to 3.
- **PAF** (Potentially Acid Forming) – typically has a pH > 5 and has the potential to produce acid when all ANC is consumed.
- **PAF-LC** (Low Capacity – Potentially Acid Forming) - has the potential to produce minor acidity.

- **NAF-Barren** (Non-Acid Forming - Barren) - is geochemically inert in respect to total sulfur and will produce circum-neutral drainage in the range of 7 to 9 with low sulfate concentrations.
- **NAF** (Non-Acid Forming) - will not produce acid but may leach salts and some metals/metalloids due to the presence of low sulfide bearing material.
- **AC** (Acid Consuming) - has some ANC that will contribute to ongoing acid neutralisation e.g., calcite.

Other terminology used to classify geological materials include the following.

- **Saline** - material may leach salts dominated by NaCl and/or sulfate.
- **Sodic** – this material has a proportionally high concentration of exchangeable Na and has the potential to disperse and tunnel.

Mine affected water (MAW) is a general term to describe groundwater or water affected by the mining process and can be classified as having:

- acid, neutral or alkaline pH.
- variable concentrations of major ions (salts e.g., calcium, magnesium, potassium, sodium, chloride, sulfate, boron or fluoride, or phosphate).
- variable concentrations of metals (e.g., Al, Fe, Mn and Zn) or metalloids (e.g., Be, Mo, Se and V) with the concentrations often linked to pH.

The main source of acidity in MAW at mine sites is generally from oxidation of sulfide minerals such as pyrite/marcasite that can produce sulfuric acid (COA, 2016; INAP, 2009)

The main sources of salts in MAW at mine sites can include:

- the coal seams are the major groundwater aquifers and contain moderate to high salt levels.
- oxidation of sulfide minerals, the production of sulfuric acid and subsequent neutralisation reactions that mobilise major ions such as sulfate and calcium.
- the mobilisation of sodium chloride or sodium bi-carbonate from mined geological units.

Potential sources of metals (e.g., Al, Fe, Mn and Zn) and oxyanions (e.g., Mo, Se and V) in water at mine sites that can include elements present:

- as ancillary minerals within primary sulfide minerals.
- in the solid phase of mined geological units.
- in pore water.

3.5 Geochemical analytical methods

3.5.1 Maximum potential acidity (MPA)

MPA includes actual acidity (that is present at the time of the analysis) and potential acidity (that may be generated in the future).

3.5.1.1 Actual acidity

Actual acidity can be divided into soluble acidity and retained acidity. Soluble acidity is defined here as acidity measured using a 1:5 (soil:water) extract whereas retained acidity is defined as the acidity that is not recorded in such an extraction. However, there is no clear-cut distinction between soluble acidity and retained acidity because part of the retained forms of acidity can be released during successive extractions with water. Soluble acidity can be subdivided into active soluble acidity and buffered acidity. Active soluble acidity accounts for the activity of hydrogen ion (H^+) whereas buffered soluble acidity

accounts for other soluble acidic cations (mainly Fe^{2+}, $AlSO_4^+$ and Al^{3+}) that can produce hydrogen ion when they hydrolyse (Lin et al, 2002).

Retained acidity can be sub-divided into:

(a) exchangeable acidity,

(b) acidity carried by protonated variably charged particles, such as clays, and

(c) acidity carried by basic sulfate minerals.

These retained forms of acidity are temporarily immobilised by soils and are subject to re-mobilisation if geochemical conditions change, such as occur in liming or re-flooding with brackish tidal water. Exchangeable acidity is acidity that is retained through cation exchange reactions (Lin et al, 2002). Jarosite is the most common basic sulfate mineral in acid mine spoil.

One mole of jarosite carries three moles of acidity that can be released by hydrolysis: $KFe_3(OH)_6(SO_4)_2 + 3OH^- \rightarrow 3Fe(OH)_3 + 2SO_4^{2-} + K^+$. Acidity that is buffered through protonation of variably charged particles can be released through their de-protonation e.g. $[Al(OH)]^{2+}\text{-}SO_4^{2-} + 2OH^- \rightarrow Al(OH)_3 + SO_4^{2-}$.

3.5.1.2 Potential acidity

Potential acidity is the component of the acid base account that has the potential (but has not currently) oxidised and weathered to produce acid. Potential acidity is derived from sulfide (S) minerals such as pyrite.

TS is measured by combustion of the sample in a furnace at 1,350 ºC in the presence of strong oxidants/catalysts. The TS method measures the total concentration of sulfur, including elemental sulfur, sulfur present in sulfide and sulfate minerals as well as organic sulfur. The most environmentally conservative approach to calculate MPA is to assume that all sulfur in a sample is potentially reactive sulfide and therefore capable of generating acid.

By convention in Acid Base Accounting studies, it is assumed that the sulfide sulfur is present as pyrite (FeS_2). Therefore, the stoichiometry of pyrite oxidation is used to calculate a theoretical maximum amount of sulfuric acid that could be generated. However, this ignores the fact that not all sulfur will contribute to the generation of acidity (e.g., organic sulfur or sulfate sulfur in gypsum and barite). As a result, the TS concentration may overestimate the acid generation potential of a sample which is expressed in kg H_2SO_4 / tonne.

Sulfur can be present within acid producing primary minerals such as pyrite (FeS_2), chalcopyrite ($CuFeS_2$) and bornite (Cu_5FeS_4) and non-acid producing primary minerals such as galena (PbS) and sphalerite (ZnS). TS can also be also present as a large number of non-acid producing secondary minerals such as alunite ($KAl_3(SO_4)2(OH)_6$), gypsum ($CaSO_4 \bullet 2H_2O$) through to minerals such as jarosite ($KFe^{3+}3(OH)_6(SO4)_2$) that can store and release acid and trace, minor and major elements. Jarosite is an important mineral in EM acid spoil.

To differentiate between total sulfur and sulfide sulfur the CRS method was used to measure the sulfide sulfur. The CRS method provides a direct measure of reduced inorganic sulfur over the wide range of values encountered in acid sulfate soils and mineral waste in geological materials. The selectivity of the CRS test in samples containing residual organic sulfur makes it an ideal choice analytically to measure sulfide within primary sulfide minerals. While this method excludes sulfur present as sulfate, or organic sulfur it does not differentiate between acid producing (e.g., pyrite) and non-acid producing (e.g., sphalerite) minerals.

Acid generation is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum acid that could be generated by the sample by either directly determining the pyritic sulfur content or assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction: $4FeS_2 + 15O_2 + 14H_2O \rightarrow 4Fe(OH)_3 + 8H_2SO_4$.

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

3.5.2 Acid Neutralising Capacity (ANC)

The ANC can be measured by the peroxide siderite correction for the Sobek method that utilises digestion of a pulp sample with 0.5 M hydrochloric acid (HCl), boiling and addition of 5 mL of 30 % hydrogen peroxide (H_2O_2). The sample is then back titrated with sodium hydroxide (NaOH) to measure the amount of acid consumed by reaction with the sample and provides the ANC in units of kg H_2SO_4/t. By convention, ANC is also expressed in kg H_2SO_4/t of material representing the capacity of the solids to neutralise acid but not necessarily implying that calcite ($CaCO_3$) is present.

The primary minerals in geological materials that are readily able to neutralise acidity are calcium and magnesium carbonates. Secondary neutralising minerals accounted for in the measurement of total acid neutralising capacity include basic silicates such as calcic feldspars, olivine, amphiboles, and biotite. However, due to their slower dissolution rates, their contribution to the overall ANC is generally considered to be small under ambient conditions. Felsic silicates such as sodic and potassic feldspars, muscovite, most clay minerals, and quartz do not contribute significantly to the ANC. In addition, carbonate minerals that contain iron and/or manganese do not report to the ANC measurement. The relative reactivity of acid consuming minerals at pH 5 is provided in **Table 3-1**.

Table 3-1: Relative Mineral Reactivity

Mineral Group	Typical Minerals	Relative Reactivity at pH 5
Dissolving	Calcite, aragonite, dolomite, magnesite, brucite	1.0
Fast weathering	Anorthite, nepheline, olivine, jadeite, leucite, spodumene, diopside, wollastonite	0.6
Intermediate weathering	Epidote, zoisite, enstatite, hypersthene, augite, hedenbergite, hornblende, glaucophane, tremolite, actinolite, anthophyllite, serpentine, chrysotile, talc, chlorite, biotite	0.4
Slow weathering	Albite, oligoclase, labradorite, montmorillonite, vermiculite, gibbsite, kaolinite	0.02
Very slow weathering	K-feldspars, muscovite	0.01
Inert	Quartz, rutile, zircon	0.004

(Source http://technology.infomine.com/enviromine/ard/acid-base%20accounting/ABAdiscussion.htm)

3.5.3 Available ANC

The available ANC is determined using the Acid Buffering Characteristic Curve (ABCC) method (AMIRA, 2002) method. The measurements of available ANC involves slow titration of a sample with the addition of hydrochloric or sulfuric acid over set time intervals while continuously measuring the pH. The method is used to estimate the ANC of the material and the buffering capacity available at a pre-determined pH value. When acid is added to finely ground particles or aggregates the material will react with the acid neutralising components and reduce the pH of the solution. The amount of acid required to reach each pH interval is dependent on the amount of neutralisation present. 'Buffering' occurs where a significant amount of acid is added before the pH drops, thereby producing a 'step-like' curve in a plot of pH versus volume of acid added.

3.5.4 Net Acid Producing Potential and Neutralisation Potential Ratio

Geochemical classification is achieved using the net acid producing potential (NAPP) of a sample, which is calculated from Acid Base Accounting (ABA) procedures (COA, 2016). The NAPP value is derived as the difference between the MPA and ANC of a sample.

The ANC/MPA ratio (or Neutralising Potential Ratio (NPR)) is also used as a means of assessing the risk of acid generation from mining waste materials. The purpose of the ANC/MPA ratio is to provide an indication of the relative margin of safety within a material. As a general rule, an ANC/MPA ratio of 2 or more signifies that there is a high probability that the material will remain circum-neutral in pH (AMIRA, 2002; INAP, 2009).

3.5.5 Net Acid Generation (NAG)

The standard NAG test involves a single addition of 250 ml of 15 % H_2O_2 to a 2.5 g of pulverised (< 75 µm) sample. The sample is then allowed to react overnight. The entire sample is heated until gently bubbling for approximately 1-2 hours to remove excess H_2O_2 and encourage release of inherent ANC. Once the sample has cooled to room temperature, the pH and titrated acidity to pH 4.5 and 7.0 (in kg H_2SO_4/t of sample) of the solution are measured. A NAG_{pH} less than 4.5 generally indicates the sample is acid producing.

A NAG_{pH} value can be used in combination with NAPP values to classify the geochemical nature of samples. The Australian Government Leading Practice Handbook on Acid and Metalliferous Drainage (COA, 2016) states that “the risks of misclassifying Non-Acid Forming (NAF) material as Potentially Acid Forming (PAF) and PAF material as NAF, are substantially reduced by conducting both NAPP and NAG tests.”

RGS recommends that the NAG method be relegated in preference to ABA methods because the NAG method has limitations at coal mines that should be considered in the interpretation of data (ACARP, 2009, MEND, 2009) when the materials have elevated total organic carbon content.

3.5.6 Metalliferous drainage potential

The potential of a geological material to leach trace, minor or major elements (salts, metals and metalloids) is a function of the fractionation and speciation of the elements and the way the mine waste materials will be managed. The static methods used in this assessment have measured the “total” and “water soluble” fractions of these elements.

The geochemical abundance index (GAI) quantifies a “total” assay result for a particular element in terms of the median crustal abundance for that element. The index, based on a log (2) scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times median crustal abundance, as shown in **Table 3-2**.

Table 3-2 Geochemical Abundance Index values and Enrichment Factors

GAI	Enrichment factor	GAI	Enrichment factor
0	Less than 3-fold enrichment	4	24 – 48 fold enrichment
1	3 – 6 fold enrichment	5	48 – 96 fold enrichment
2	6 – 12 fold enrichment	6	Greater than 96 fold enrichment
3	12 – 24 fold enrichment		

As a general rule, a GAI greater than or equal to three indicates element enrichment to a level that may warrant further investigation (INAP, 2009; Bowen, 1979). This is the case with some environmentally important ‘trace’ elements, such as, Cd, Cu and Zn, rather than with major rock-forming elements, such as Ca, Mg, K and Na. Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality or public health, but their significance should still be evaluated. Similarly, because an element is not enriched does not mean it will never be a concern, because under

some conditions (e.g. low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

A 1:3 or 1:5 (solid:deionised water) leach can be used to measure the pH, EC, and the concentration of major ions and trace metals/metalloids in water extracts. It should be recognised that direct comparison of geochemical data from water extracts with guideline values can be misleading.

The potential solubility of metals/metalloids and major ions from mining waste materials over time can be achieved using kinetic leach column (KLC) testing that provides the rate of weathering and associated concentration of elements in the leachate.

3.5.7 Saline and sodic potential

Typical EA conditions require material characterisation to identify dispersive and non-dispersive spoil and saline drainage potential. The primary source of salts that can leach from soil, sub-soil, regolith units, transition material and fresh rock can be sodium chloride (brought inland from the ocean in rain and leached through the geological profile over geological timescales) or primary and secondary minerals.

Saline drainage associated with sodium chloride (NaCl), sodium bi-carbonate ($NaHCO_3$) or sulfate (SO_4^{2-}) can result in non-compliance with water quality targets and the ability to release water from site.

Soil and spoil dominated by NaCl or $NaHCO_3$ can be sodic (the clay minerals disperse making them erodible when the clays settle, and they can have very low permeability) and this can reduce the ability to use the soil or spoil for rehabilitation.

The EM Environment Department will ensure that samples as required will be collected of soil and overburden to undertake rehabilitation as specified by the Rehabilitation Management Plan .

4 Sampling and Monitoring

4.1 Assumptions

1. EM open pit mining has almost ceased and mining waste from these activities is stored in surface landforms which are being progressively rehabilitated moving towards mine closure.
2. Underground bord and pillar mining is the source of all new mining waste, that is limited to coal reject.
3. The mined open pit voids area either being backfilled or contain water (pit lakes).
4. Monitoring and rehabilitation of the open pits and spoil dumps is managed through the EM Rehabilitation Plan.

To comply with the EA, Ensham will review annually the performance of monitoring results against the trigger levels in the EA to determine potential environmental impacts.

4.1.1 Mining waste

Mining waste units at EM are currently limited to coal roof, floor and partings (reject coal) from bord and pillar mining.

The potential geochemical properties of the mining waste at EM are well defined from the coal quality analyses and are low risk (**Section 3.3)** (URS, 2006, 2015; and RGS, 2019, 2020).

4.1.1.1 Mining waste sampling program

The sampling program utilised by exploration and resource geologists for coal quality analysis of the underground mine are referenced in this MWM Plan. The data from the coal quality analysis will be monitored and tracked over time to ensure the sulfur analyses remain within historic (low risk) trends.

4.1.1.2 Geochemical analysis of mining waste

Previous geochemical analysis of overburden included key analytes that address the major issues related to (i) acid, neutral and alkaline pH (ii) saline drainage and (iii) metalliferous drainage e.g. (i) paste and 1:5 pH and EC, TS, ANC, CRS and sulfate (SO_4); (ii) 1:3 water soluble salts, cation exchange capacity (CEC), exchangeable sodium percentage (ESP) and (iii) total elemental content, exchangeable metal content and water soluble metal content. Trace metals metals/metalloids have included Boron (B) Cadmium (Cd), Iron (Fe), Aluminium (Al), Copper (Cu), Magnesium (Mg), Manganese (Mn), Calcium (Ca), Sodium (Na), Zinc (Zn).

As discussed in **Section 3.4.5**, the NAG test method cited in the EA has significant limitations at coal mines (ACARP, 2009, MEND, 2009) and would only be used if the geochemical nature of the mining waste materials was not identified using the Acid Base Account methodology described above.

4.2 Water management

Runoff from any reject coal is collected from sumps near the portals and pumped into the Water Management System. Sampling is undertaken monthly according to the Water Management Plan and analysed for parameters as outlined in the EA.

Sampling of rehabilitation runoff is carried out when conditions are suitable to ensure completion criteria are being achieved.

4.3 Data management

The Inviron database is used by EM to store monitoring data.

5 Scheduling and material balances

The overall intent of the information in **Section 4** and **Section 5** of this MWM Plan is to quantify the geochemical properties of the mining waste materials at EM.

In this section of the MWM Plan the intent is for the mine planners to utilise the information obtained in **Section 4** of this MWM Plan to reduce geochemical risk, environmental harm and water treatments costs and continually improve rehabilitation outcomes.

5.1.1 Deepest mined and final landform surface

The deepest mined surface in each pit will be retained as an electronic file (surface) by the Mine Planning Department. The deepest surface combined with the final mined surface and final rehabilitated surface will be used to calculate the volume of backfilled spoil and or rejects in each pit and based on known or inferred geochemical data the AMD risk will be quantified.

The file locations of the datafiles stored by the mine planning department will be documented so that they can be made available in the future should there be a need for evaluation of the data.

5.1.2 Underground mining

Bord and pillar mining will retain underground voids that will seep water during mining and that will fill with water when mine dewatering ceases.

The quality of the water pumped from underground sumps is collected and analysed monthly for pH, EC, major cations and anions and metal(loids), as referenced in the EA.

5.1.3 Life of mine material balances and schedules

Reject is end tipped into mined spoil dump(s) within a mined open pit. Given the low risk of AMD from the EM coal this management practice is fit for purpose from a geochemical perspective.

The measured historical material balances and scheduling information for the MR_{UNITS} and MW_{UNITS} that have been mined to date and stored in surface and open pit landforms are documented. This information will be used to evaluate current and future geochemical risk.

5.2 Verification of the landform design

The constructed landform designs and proposed landform designs to be constructed in the future are defined in the Rehabilitation Management Plan.

6 Risks and opportunities

The holder of environmental authority EPML00732813 must develop and implement a risk management system for mining activities which mirrors the content requirement of the Standard for Risk Management (18031000:2009), or the latest edition of an Australian standard for risk management, to the extent relevant to environmental management, within three months from grant of Mining Leases 70505, 70506 and 70441.

Risks and opportunities for the board and pillar mine and mined open pits have been quantified by EM as a component of the 2020 EIS.

6.1 Potential Environmental Issues, Impacts and Controls

The potential environmental issues, impacts and controls associated with storage of rejects from current and future underground mining operations in selected open pit areas and rehabilitation of historical landforms (containing spoil) from former open pit operations are described in **Table 6-1**.

There is negligible potential for AMD and metal leaching from former open cut operations and no selective handling and treatment measures are proposed and low permeability capping is not required. There is the potential for saline drainage from spoil materials and dispersion due to elevated sodicity.

There is low potential for AMD and metal leaching from rejects generated from current and future planned underground operations and disposal in selected mined out pit areas is appropriate.

The following hierarchy of control strategies in order of priority can be categorised as:

- prevention of impact;
- minimisation of impact and/or likelihood through rehabilitation; and
- interception and control of impact.

The control measures were developed based on topography, mining method, material type, soil/rock types, and available amelioration resources, if required (e.g., gypsum, fertilizer and rock mulch). Control measures are documented in **Table 6-1**.

Table 6-1: Potential Environmental Issues, Impacts and Controls

Potential Issue	Potential Impact	Control Measures
AMD	• Contamination of surface water and seepage from spoil dumps and contained reject coal.	• Spoil and reject coal have been characterised as NAF and mainly NAF and the risk of AMD from these materials is negligible and low, respectively.
Salinity	• Contamination of surface water and seepage from spoil and reject coal.	• Low to moderate salinity levels and low to moderate concentrations of dissolved solids are expected to be generated in surface water and seepage from the spoil and reject coal and will be managed within the site water management system.
Metals/metalloids leachate	• Leaching of metals/metalloids into surface runoff and groundwater.	• Metals/metalloids are sparingly soluble from spoil and reject coal materials and therefore low concentrations of dissolved metals/metalloids are expected to be generated from these materials.

7 CONTINGENCY AND ENVIRONMENTAL INCIDENT PLANS

7.1 Operational Contingencies

EM has developed operational contingencies for scenarios that may occur throughout the life of the mine associated with mining waste materials. Each scenario may have more than one contingency of which a portion of the contingencies may be enacted in that event based on the site conditions at the time. The scenarios and contingencies are presented in **Table 7-1**.

Table 7-1: Operational Contingencies

Scenario	Possible Contingencies
Abnormal monitoring results	• Investigation into cause of results and potential mitigation measures required. • Implement mitigation measures.

7.2 Environmental Incident Response

Where an incident occurs that results in an emergency or incident which results in, or may result in, environmental harm or the release of contaminants not in accordance with the EA, the administering authority will be notified in writing within 24 hours.

Written advice will be provided to the administering authority, no more than 10 business days following the initial notification of an emergency, incident or information about circumstances which result or may result in environmental harm or the release of contaminants, including the following:

- Results and interpretation of any samples taken and analysed;
- Outcomes of actions taken at the time to prevent or minimise environmental harm; and
- Proposed actions to prevent a recurrence of the emergency or incident.

8 References

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URS (2015). Geochemical Characterisation of Overburden and Potential Rejects. Report # 42627460/R001/A prepared by URS Australia Pty Ltd for Ensham Resources Pty Ltd. 19 March.

9 Certification

RGS certifies that this MWM Plan is feasible and would meet the intent of the relevant EA conditions (i.e., the MWM Plan will enable EM to continue to mine and place the mining waste material so that their potential to contribute to (or to mitigate) environmental harm can be determined. The Qualifications of the RGS personnel suitably qualified to certify this WRDP are provided below.

9.1 Suitably Qualified Persons – RGS Company Details

The core business of RGS is to undertake static and kinetic chemical and physical material characterisation studies and produce certified mine material, mine rehabilitation and mine closure plans that include sampling, analytical and monitoring programs.

RGS is an owner-operated leading environmental consulting company that has been operating successfully for the past twelve years. We provide timely and cost-effective solutions to complex environmental management issues from exploration through the planning, operational and closure phases of small to large scale mining projects. RGS has gained an international reputation as a leading provider of environmental management services to the mining and mineral processing industry and takes pride in being flexible, practical and innovative. RGS is committed to delivering on time and within budget; technical excellence; consistent quality; and continual improvement of our service delivery and skills.

RGS personnel have provided services to more than 400 mining and mineral processing projects in Algeria, Argentina, Australia, Bangladesh, Brazil, China, Ghana, India, Indonesia, Laos, Malaysia, Mozambique, New Caledonia, New Zealand, Papua New Guinea, Philippines, Romania, Thailand, Turkey and Vietnam. RGS has worked on more than 50 coal mine projects in Queensland, New South Wales, Western Australia, Africa, New Zealand, Indonesia, Laos and Bangladesh. Our clients range from small to large mining companies including Anglo American, BHP Billiton, CS Energy, Evolution Mining, MMG, Rio Tinto, Stanwell Corporation, Vale and Glencore.

9.2 Suitably Qualified Persons – Relevant Experience

RGS Personnel

Alan Robertson has a PhD in Pure and Applied Chemistry and has over 27 years' experience completing geochemical studies for the mining and mineral processing industry. He has worked on projects for major mining companies (*e.g.* Anglo American, BHP Billiton, Glencore and Vale) in Australia, Asia, Africa, Europe and South America for both coal and hard rock mines. Alan has expertise in mine waste characterisation, development of AMD management plans, and design of mine waste storage facilities from conception through to closure. Alan has previously been engaged directly by Regulators and mining clients to provide independent environmental advice to legal experts for mine closure and rehabilitation aspects of mining operations.

Greg Maddocks has a PhD in Geochemical Engineering, over 17 years' mining sector experience and has worked on various open pit and underground mining projects in Australia and South-East Asia. Greg has developed Mine Waste and Rehabilitation Management Plans compliant with the requirements of Australian industry guidelines and standards. Mine closure work ranges from evaluating and selecting optimal water and waste management strategies to developing management plans for tailings and waste rock storage facilities and open pits.

10 Attachments

10.1 Attachment A: MWM Plan Actions

Table 10-1: MWM Plan action list

MWM Plan Reference	Single department action or multi-department action (Examples to be finalised in Revision 001)	Comment, commitment or requirement
	The Environment Department will complete the sampling and analytical requirements detailed in this MWM Plan.	
	The MWM Plan will be updated, as required, to ensure there is compliance with any future EA requirements.	
	The geochemical data collected under this MWM Plan will be stored in Inviron and reviewed by the Environment Department.	
	The deepest mined surface in each pit will be retained as an electronic file (surface) by the Mine Planning Department. The deepest surface combined with the final mined surface and final rehabilitated surface can be used to calculate the volume of backfilled spoil and reject coal in each pit and based on known or inferred geochemical data the AMD risk can be quantified, if required.	
	The constructed landform designs and proposed landform designs to be constructed in the future should be retained and documented by the Mine Planning Department so they can be used to evaluate the potential for geochemical risk, if required.	

MINE WASTE AND
WATER MANAGEMENT