McArthur River Mine Independent Monitor

Waste Rock Handling Procedures Audit

13 -15 June 2022

Advisian
Worley Group

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Disclaimer

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Acronyms and abbreviations

Acronym/abbreviation	Definition
AEPAR	Annual Environmental Performance Audit Report
AMD	Acid and Metalliferous Drainage
AMP	Adaptive Management Plan
BGM	Bituminous Geomembrane
CCL	Compacted Clay Liner
CCTV	Closed Circuit television
CTP	Constructability Trial Plot (cover system)
DITT	Department of Industry, Tourism and Trade
EDM	Electro-optical Distance Measurement
EIS	Environmental Impact Statement
GPS	Global Positioning System
GSL	Geosynthetic Liner
HDPE	High-Density Polyethylene
ICE	Independent Certifying Engineer
ISO	International Organization for Standarization
MMP	Mining Management Plan
MRM	McArthur River Mine
LiDAR	Light Detection and Ranging
NAF	Non Acid Forming
NATA	National Association of Testing Authorities
NOEF	North Overburden Emplacement Facility
NT EPA	Northern Territory Environment Protection Authority
OEF	Overburden Emplacement Facility
OFI	Opportunities for Improvement
OMP	Overburden Management Project
OMP EIS	Overburden Management Project Environmental Impact Statement
PAF	Potentially Acid Forming

Acronym/abbreviation	Definition
PROD	Perimeter Runoff Dam
QA/QC	Quality Assurance/Quality Control
RFI	Request for Information
SLT	Senior Leadership Team
TSF	Tailings Storage Facility
WDL	Waste Discharge Licence
WMD	Water Management Dam
XRD	X-Ray Diffraction

Executive summary

Advisian was commissioned by the Northern Territory Government Department of Industry, Tourism and Trade (DITT) to provide Independent Monitor services for the McArthur River Mine (the Mine) as required by the Independent Monitoring Assessment Conditions of Authorisation 0059. This report presents the findings of a mine waste rock handling procedures site audit conducted between 13 and 15 June 2022.

This audit considers commitments and safeguards of the McArthur River Mine Pty Ltd's (the Operator's) waste rock handling procedures as relevant to the receiving environment, including the health of the McArthur River. The audit reviewed Operator processes associated with waste rock classification, mining and haulage as well as the North Overburden Emplacement Facility (NOEF) design, construction and operation. Key activities undertaken as part of the audit include:

- Auditing implementation of waste rock handling procedures in accordance with relevant management plans
- Reviewing waste rock handling against stated key objectives for the NOEF's design, construction and operation.

Waste rock (or overburden) produced from open cut mining for zinc and lead requires strict management to prevent potential adverse impacts to the environment. Waste rock can contain metals and sulphates which, when exposed to oxygen or water for an extended period, may react to release hydrogen sulphide to the atmosphere and/or acidic runoff with heavy metals, known as Acid and Metalliferous Drainage (AMD)[1].

A revised waste rock classification system, including refinements from the Overburden Management Project Environmental Impact Statement (OMP EIS) prepared by the Operator in 2018 resulted in an improved understanding of waste rock geochemistry at the Mine. Measures were subsequently developed to provide greater rigour around waste rock classification and handling along with enhancements to the design and construction of the waste rock emplacement facility.

Collective advancements in waste rock handling procedures at the Mine since the OMP EIS provide an elevated level of environmental protection for the receiving environment, including the McArthur River.

Key Findings

The Operator's NOEF Management Plan (the Management Plan) is the overarching document used to manage the design, construction and operation of the NOEF. The NOEF has been designed to encapsulate waste rock and to avoid or minimise oxidation and the potential release of contaminants to the receiving environment. The audit found the Operator to be achieving a 'good' to 'very good' level of implementation of the Management Plan requirements.

[1] AMD is the runoff produced from mining activities when water comes in contact with exposed rocks containing sulphide minerals when exposed to air and water that can impact on air quality and surface water and groundwater.

The Management Plan identifies seven performance objectives based on environmental risk. The Operator's compliance with achieving performance objectives was assessed and rated as 'good' or 'very good'[2].

The audit also identified twelve opportunities for improvement which are outlined in this report.

Key audit observations and findings with respect to waste rock classification, transport, the NOEF and the approach to managing waste rock are summarised below.

Waste Rock Classification

Waste rock is classified into six categories, ranging from benign to non-benign, and is assigned a management level which determines selective placement within the NOEF e.g. depth, compaction, encapsulation and monitoring.

The audit found the Mine places focus on grade control processes to identify and classify waste rock to ensure potentially reactive material is segregated, transported and placed in appropriate zones within the NOEF.

Metallurgical testing on drill hole material is conducted to inform grade control, with data input to the three-dimensional mine model, which defines the location and extent of materials in the pit and provides control over dig activities. Daily pit inspections are conducted by the Mine's Geologist to confirm waste rock classification, with findings entered into a mobile phone app and added to the three-dimensional mine model.

The emphasis and effort placed by the Operator on classification of waste rock is an indication of the importance given to waste rock handling and management.

Transport

Known as 'Modular', the Mine's fleet management system is a sophisticated Global Positioning System (GPS) and digital software system commissioned in 2019 to monitor in real time the haul truck and waste rock movements from the open pit to the NOEF. All production vehicles' (e.g. excavators, haul truck, dozers, water carts) activities are captured and comprehensive data on waste rock movements is recorded. Prior to 2019, the transport tracking system relied on manual entry of information by vehicle operators.

Modular identifies potential incidents (e.g. haul truck misdump or excavator operating outside a defined area of waste rock classification) in real time by triggering an alarm in the control room. Since implementation of this fleet management system misdumps have been almost eliminated and in the event corrective action is required a response can occur immediately.

The Mine's investment in the development and implementation of Modular has enabled improved environmental performance by embedding a very high level of rigor in relation to waste rock handling procedures.

[2] Based upon the audit findings a rating (i.e. 'very good', 'good', 'satisfactory', 'poor', or 'very poor') has been assigned to provide an assessment of the current level of achievement for each individual NOEF performance objectives. A 'very good' rating indicates a very high level of action implementation to support attainment of the objective. A 'very poor' rating indicates negligible or no evidence of action implementation.

North Overburden Emplacement Facility

The NOEF has been designed to manage risks associated with waste rock storage considering construction and operation phases along with the long-term (post-mine closure). An important objective of NOEF design and operation is to minimise ingress and movement of oxygen and water.

Upgrades to NOEF design, construction and operation have facilitated effective management of spontaneous combustion risk, noting there has been no sulphur dioxide emission criteria exceedances recorded at the off-mining lease authorised air quality monitoring station in recent years.

Waste rock lift heights (thickness of emplacement layers) have been reduced compared with previous NOEF designs. A two-metre lift height is used for more reactive material to achieve greater compaction and reduce the ingress and movement of air and water. Fine sized alluvium material is used to construct barriers between lifts in the NOEF; these barriers reduce the advection[3] currents and associated oxidation rate of the placed waste rock. The Inspection and Test Plans (ITPs) are detailed documents utilised to specify the requirements and acceptance criteria (e.g. material characteristics) for the NOEF construction and operational activities (i.e. waste rock placement).

Infiltrating water is contained using a low permeability foundation, which incorporates a basal compacted clay liner (CCL) where required. The foundation directs water to engineered underdrains which transport infiltrated water towards toe seepage recovery points or sumps. Seepage water is recovered for storage and treated in Perimeter Runoff Dams (PRODs). Surface water runoff from non-benign areas is directed to drains, sumps and PRODs.

An extensive system of instrumentation and monitoring has been implemented to monitor the NOEF operational performance. The monitoring systems and testing programs include geotechnical, geochemical, spontaneous combustion (including aerial thermal imagery), gas and temperature, percolation, water quality (seepage, sumps, PRODs), groundwater (hydrogeology model, water quality, pressure) and landform stability. Site Specific Trigger Values (SSTVs), Trigger Action Response Plans (TARPs) and an Adaptive Management Plan (AMP) have been prepared to identify and manage any potential deviation in waste rock handling performance.

The NOEF cover system design includes a geosynthetic liner (GSL) barrier layer to minimise water and oxygen ingress to the interior of the NOEF where non-benign materials will be stored. The barrier layer extends from the top of the facility to below ground level, tying in with another low permeability barrier layer in the foundation. This provides flood protection for the interior of the NOEF, resisting the movement of floodwater into the facility, and movement of infiltrated water out of the facility.

Bituminous Geomembrane (BGM) trials are currently underway to evaluate the suitability of BGM for use as a GSL barrier layer in the cover system over the top of the NOEF. The BGM is impervious and is proposed to be used to eliminate air and water infiltration for the long-term (up to 1,000 years). A 10 ha section of BGM was installed on the southern batter of the NOEF in 2021. Monitoring sensors and telemetry for temperature, moisture and gases, have been embedded under the BGM to evaluate the performance of this cover system.

The NOEF and cover system is planned to have a design life of 1000 years. During construction and operation of the NOEF, the Mine can detect, respond to, and manage potential waste rock issues that

[3] Advection in this situation is the movement of air which may result in the oxidation of reactive waste rock material.

may arise from rainfall infiltration, noting that the cover system needs to prevent infiltration beyond the initial 50 years of mining. Cover system trials are designed to demonstrate the NOEF's long-term performance with respect to effective encapsulation of waste rock.

Approach to Managing Waste Rock

The audit identified that a consistent and conservative approach to management of potentially reactive waste rock is applied across the Mine's departments. Waste rock classification queries from the production team, haul truck operators, excavator operators, and dozer operators are referred to a Mine Geologist, and in cases of uncertainty, the waste rock is classified and treated as higher risk material.

The Mine Engineers, Mine Geologists, Operations Supervisor and Dump Supervisors communicate frequently regarding conformance with waste rock handling procedures. This is good practice and supports implementation of procedures.

A Dispatcher who was interviewed for the audit exhibited pride that no misdump incidents had occurred on their shift over the course of the year. This demonstrates ownership and accountability in provision of oversight to fleet operations and achieving adherence to the waste rock handling procedures.

A new role of Dump Supervisor was recently established at the Mine to provide additional oversight of waste rock handling activities. This provides further indication of the Operator's focus and effort placed on waste rock handling performance.

The workforce attitude and culture observed suggest consistent understanding of the importance of waste rock handling procedures across the Mine's departments.

Conclusion

This audit assessed the Operator to be achieving a "good to very good" level of implementation of the Management Plan requirements. In addition, the Operator has demonstrated effective action to address stated objectives for the design, construction and operation of the NOEF.

The Mine has invested in systems and personnel directly related to the management and handling of waste rock. A significant improvement in waste rock handling has been achieved in recent years with the enhanced waste rock classification system, enhanced design of the NOEF, and implementation of the fleet management system Modular. Of note, Modular has provided a step change advancement in waste rock handling, enabling the use of real time data to support productivity, efficiency and environmental protection. Foreseeable waste rock handling procedure improvements are likely to be in the refinement and optimisation of existing procedures.

1 Introduction

Advisian was commissioned by the Northern Territory Government Department of Industry, Tourism and Trade (DITT) to provide Independent Monitor services for the McArthur River Mine (the Mine) as required by the Independent Monitoring Assessment Conditions of Authorisation 0059. This report presents the findings of a mine waste rock handling procedures site audit conducted between 13 and 15 June 2022.

The Independent Monitor's environmental performance assessment of waste rock handling procedures is intended to provide transparency to the community regarding:

- Actions the McArthur River Mine Pty Ltd (the Operator) has undertaken to maintain continuous improvement in environmental performance of the Mine
- Achievement of the overarching environmental outcome of protecting the health of McArthur River from mine related impacts at all times.

This audit considers commitments and safeguards of the Operator's waste rock handling procedures as relevant to the receiving environment, including the health of the McArthur River. The audit addresses Operator processes associated with waste rock classification, mining and haulage as well as the North Overburden Emplacement Facility (NOEF) design, construction and operation as documented in the NOEF Management Plan (the Management Plan), version 1.0, dated January 2020. The Management Plan is Appendix G of the current Mining Management Plan (MMP), version 1.1, dated 31 January 2020, which was approved under the Variation of Authorisation, dated 13 November 2020.

1.1 Audit Objectives

The review of the environmental performance of the Mine considered in this report involves assessment against the audit objectives, including conducting the following activities:

- Auditing the implementation of waste rock handling procedures in accordance with relevant management plans
- Reviewing waste rock handling against the key objectives for the NOEF's design, construction and operation.

Relevant monitoring programs were considered as part of the audit and opportunities for continuous environmental improvement were identified.

1.2 Scope – the NOEF Management Plan

The scope of this waste rock handling procedures audit is to assess, using a risk-based approach, the Operator's extent of compliance and performance against the main relevant document, the NOEF Management Plan.

There is no single waste rock handling procedure; however, the Management Plan provides an overarching management document for the design, construction and operation of the NOEF based on identified risks and describes the various aspects of waste rock handling procedures.

The NOEF is an engineered permanent encapsulation structure for waste rock derived from open cut mining operations. The NOEF Management Plan sets out:

- Environmental values potentially affected by the NOEF
- Overarching objectives for management
- Design management
- Monitoring programs
- Cultural heritage and socio-economic management
- Corrective actions and adaptive management
- Internal and external auditing
- Reporting and review processes
- Training and awareness programs
- Internal and external communication programs.

Appendix A of the Management Plan is the Operator's NOEF Design and Construction Guidelines, version 1.0, dated 17 January 2020, which describes:

- Key risks and design objectives
- Key design and construction specifications for NOEF development
- Justification for the design elements and construction practices proposed
- Construction scheduling
- Construction testing and quality control procedures.

Audit methodology including that for audit planning and execution is outlined in Section 2 and Appendix B.

1.3 Limitations

The audit did not consider compliance with regulatory approval conditions or assessment of the following topics:

- Cultural heritage and socio-economics
- Waste characterisation
- NOEF design
- Closure activities
- Operator's discipline-specific related management plans (e.g. air quality, water management)
- Operator's supporting procedures (e.g. laboratory x-ray diffraction testing procedure).

This audit has assessed the Mine's performance at a point in time (13 and 15 June 2022) and has regard to performance over the previous 2 years. The audit findings are based upon samples of information available at the time of the audit, and hence there is an element of uncertainty in the audit findings.

1.4 Regulatory Framework

The Independent Monitoring Assessment Conditions are included in the mining Authorisation 0059 issued to McArthur River Mining Pty Ltd under the *Mining Management Act 2001*.

The purpose of Independent Monitoring Assessment Conditions is to establish and set out the operational requirements for an independent monitoring assessment of the environmental performance of the Mine. This audit assessment undertaken by the Independent Monitor and any findings or opportunities for improvement do not become regulatory requirements. This audit review is additional to the Operator and Department Authorisation obligations and statutory responsibilities in relation to the Mine.

DITT prepared a scope of requirements for the Independent Monitor to review the environmental performance on the Mine, including to conduct an audit of waste rock handling procedures.

1.5 Context

Waste Rock Context

Waste rock (or overburden) produced from open cut mining of zinc and lead requires strict management to prevent potential adverse impacts to the environment. Waste rock can contain metals and sulphates which, when exposed to oxygen or water for an extended period, may react to release hydrogen sulphide to the atmosphere and/or acidic runoff with heavy metals, known as Acid and Metalliferous Drainage (AMD)[4].

Waste rock is classified into six categories, ranging from benign to non-benign, and is assigned varying levels of management which determines selective placement within the NOEF e.g. depth, compaction, encapsulation and monitoring. The location of non-benign material within the NOEF is determined so the most potentially reactive materials are stored deepest in the Core Zone and progressively lower risk materials are placed towards the outer surface. The entire NOEF will eventually be encapsulated with a cover layer.

The primary objective of the NOEF is to prevent or minimise the oxidation of materials placed in the facility and thereby reduce the risk of harm to the environment. Non-benign waste rock that is maintained in a stable non-oxidising environment will behave in a similar way to benign material. The NOEF has been specially designed, and received regulatory approval, to encapsulate waste rock and to avoid or limit the potential transportation of contaminants to the receiving environment.

Background

From 2005 until 2013, waste rock classification criteria applied at the Mine were based on a 2005 report that provided geochemical assessment of overburden and tailings material. The classification used Net Acid Producing Potential and Net Acid Generation pH methodologies to classify overburden material as either Non Acid Forming (NAF) or Potentially Acid Forming (PAF). While conforming to international guidelines, the classification considered the acid generation risk only.

[4] AMD is the runoff produced from mining activities when water comes in contact with exposed rocks containing sulphide minerals when exposed to air and water that can impact on air quality and surface water and groundwater.

A revised waste rock classification system was developed in 2014 by the Mine and considered the results of a comprehensive review of all available characterisation data as well as the results of additional geochemical work undertaken in 2012 and 2013.

The revised overburden classification system, and subsequent outcomes from the Overburden Management Project Environmental Impact Statement (OMP EIS) prepared in 2018 has resulted in an improved understanding of waste rock geochemistry and alteration to Mine operations, waste rock handling and NOEF management.

Waste Rock Classification

There are six waste rock classifications with different management requirements (refer to Table 1-1). Appendix A provides detail of the classification criteria, a description of waste rock type, potential risks (if not managed appropriately), and details of planned management within the NOEF.

Table 1-1: Waste rock classification and potential risks summary

Classification	Description	Management
LS-NAF (HC)	Low Salinity, Non Acid Forming material, High Capacity (high acid consumption capacity), low risk of generating acid mine drainage	Material considered environmentally benign, suitable for placement in NOEF outer cover
MS-NAF (HC)	Metalliferous Salinity, Non Acid Forming material, High Capacity (high acid consumption capacity), low risk of generating acid mine drainage, but higher risk of generating saline metalliferous drainage	Material is considered environmentally non-benign, requires some form of encapsulation
MS-NAF (LC)	Metalliferous Salinity, Non Acid Forming material, High Capacity (low acid consumption capacity), low risk of generating acid mine drainage, but higher risk of generating saline metalliferous drainage	Material is considered environmentally non-benign, requires some form of encapsulation
PAF (HC)	Potential Acid Forming material, High Capacity (high acid consumption capacity), risk of generating acid mine drainage	Material is considered environmentally non-benign, requires some form of encapsulation
PAF (RE)	Potential Acid Forming material, Reactive, high risk of generating acid mine drainage and self-heating which may progress to spontaneous combustion	Material is considered environmentally non-benign, requires encapsulation and specific additional handling strategies to manage self-heating
PAF (HW)	Potential Acid Forming material, Hanging Wall pyrite, most pyritic material at the mine, high risk of generating acid mine drainage and self-heating which may progress to spontaneous combustion	Material is considered environmentally non-benign, requires segregation and encapsulation and specific additional handling strategies to manage self-heating before sub-aqueous disposal at the end of mine life

NOEF Design Concept

Approximately 518 million tonnes (Mt) of waste rock is proposed for placement in the NOEF between 2020 and approximately 2040. The NOEF has been designed to permanently store this material with an acceptable level of risk to the environment.

Management of risk of waste rock storage in the NOEF considers both the long-term scenario (when the NOEF is completed), and during the construction and operational phases. In both phases, minimisation of oxygen ingress and water management, are the key principles influencing design.

In the long-term, an outer cover system is intended to encapsulate the entire NOEF, including the existing NOEF stages, in a protective layer which acts as both a source control and a pathway control. This composite layer will restrict oxygen ingress, store water for plant growth, and shed excess rainfall runoff to purpose-built drains.

The cover system will include a geosynthetic liner (GSL) barrier layer in its composite profile, which will minimise water and oxygen ingress to the interior of the NOEF where non-benign materials will be stored. The barrier layer extends from the top of the facility to below ground level, tying in with another low permeability barrier layer in the foundation. This provides flood protection for the interior of the NOEF, resisting the movement of floodwater into the facility, and movement of infiltrated water out of the facility.

Bituminous Geomembrane (BGM) trials are underway to evaluate the suitability of BGM to be utilised as the GSL barrier layer in the cover system over the top of the NOEF. The BGM is impervious and is intended to eliminate air and water infiltration for the long-term (up to 1,000 years). A 10 ha section of BGM has been installed on the southern section batter of the NOEF in 2021. Monitoring sensors and telemetry for temperature, moisture and gases, have been embedded under the BGM to evaluate the performance of the cover system.

The NOEF and cover system is planned to have a design life of 1000 years. During construction and operation of the NOEF the Mine can detect, respond to, and manage potential waste rock issues that may arise from rainfall infiltration, noting that the cover system needs to prevent infiltration beyond the initial 50 years of mining. Cover system trials are designed to demonstrate the NOEF's long-term performance with respect to effective encapsulation of waste rock.

2 Methodology

2.1 Approach

The approach used to conduct the audit included preparing and undertaking the following:

- Audit framework
- Audit schedule
- Audit plan
- Pre-audit scoping meetings
- Request for Information (RFI)
- Document review
- Site visit opening meetings
- Interviews
- Site inspection
- Site visit closing meeting
- Discussions on matters identified during interviews and document review.
- Audit Report (Draft and Final).

Appendix B provides further detail regarding the audit methodology.

The key document which formed the basis of the audit was the Management Plan including its Appendix A – NOEF Design and Construction Guidelines.

The Management Plan sets out key objectives for design, construction and operation of the NOEF. These key objectives (Table 2-1) were incorporated into an audit interview questionnaire that was utilised to assess the extent to which objectives have been achieved.

Table 2-1: Management Plan objectives

No.	Mangement Plan Key Objectives
1	Manage spontaneous combustion of overburden to control release of sulphur dioxide and associated potential effects on nearby receptors
2	Manage dust to control movement of metals into the terrestrial and aquatic environment
3	Maintain functionality of the surface water management system within/around the NOEF, to achieve acceptable downstream water quality.
4	Control seepage from the NOEF and potential impacts on groundwater and surface water quality.
5	Maintain functionality of the surface water management system within/around the NOEF to achieve acceptable downstream water quality.
6	Control seepage and maintain functionality of the surface water management system within/around the NOEF to achieve acceptable downstream water quality (during operations).

No.	Mangement Plan Key Objectives
7	Control seepage and maintain functionality of the surface water management system within/around the NOEF, to achieve acceptable downstream water quality (during construction).
8	Manage vegetation clearance and re-establishment (rehabilitation) to control weeds and potential impacts on biodiversity on-lease.

Requirements and commitments of the Operator as set out in the Management Plan were collated into an audit checklist. This checklist provided another means to assess the extent of implementation of the Management Plan requirements. The checklist was utilised during an audit interview with the Environment Superintendent.

2.2 Process

The audit was undertaken in alignment with the approach and principles of International Organisation for standardisation (ISO) 19011 (2018) Guidelines for auditing management systems. The key principles underpinning the audit included: integrity; fair presentation; due professional care; confidentiality; independence; and use of an objective evidence-based and risk-based approach.

A qualitative review was undertaken to provide an assessment of the Operator's waste rock handling procedures considering compliance with and extent of implementation of the Management Plan requirements.

The level of implementation of each Management Plan objective (Section 3.4) and requirement (Section 3.3) was assessed and a qualitative rating provided i.e., 'very good', 'good', 'satisfactory', 'poor', or 'very poor', using the rating guidelines presented in Table 2-2. In cases where more than one rating was applicable, the most conservative (lowest) score was applied.

Table 2-2: Guidelines for Implementation rating

Rating	Guidelines
Very Poor	Very low level of implementation based on sample evidence Negligible/no evidence of action Lack of plan to address requirement
Poor	Low level of implementation based on sample evidence Limited evidence of action Limited plan to address requirement
Satisfactory	Adequate level of implementation based on sample evidence Medium level of evidence of action Plan to address requirement, but not fully implemented
Good	High level of implementation based on sample evidence High level of evidence of action Implemented a plan to address requirement
Very Good	Very high level of implementation based on sample evidence Very high level of evidence of action Implemented a plan to address requirement

2.3 Reference Documents

The main reference documents considered during the audit are listed in Table 2-3.

Table 2-3: Key Reference Documents

No.	Reference Document	Document Source
1	NOEF Management Plan, Design Construction Operations, Mining Management Plan - Appendix G, version 1.0, January 2020	Operator
2	NOEF Management Plan, Appendix A - NOEF Design & Construction Guidelines, version 1.0, 17 January 2020	Operator
3	ICE Endorsement of the NOEF Management Plan, Mining Management Plan- Appendix H, 23 January 2020	Operator
4	Waste Characterisation Report, Mining Management Plan – Appendix F, Acid and Metalliferous Drainage Management, version 0, 15 October 2018	Operator
5	Overburden Management Project Supplementary EIS Review, McArthur River Mine Overburden Management Project, Section 2 – Geochemistry, May 2018	ERIAS
6	EIS Review Report, McArthur River Mine Overburden Management Project EIS Review, Section 2 – Geochemistry, May 2017	ERIAS

No.	Reference Document	Document Source
7	McArthur River Mine, Overburden Management Project, Draft Environmental Impact Statement, Chapter 6 - Materials Characterisation, 2017	Operator
8	*Conditions of Authorisation No. 00059-02, Variation of Authorisation, Schedule 2, Independent Monitoring Assessment Conditions,* 13 October 2006	DITT

2.4 Audit Team

The audit team consisted of staff from Advisian with relevant experience and qualifications (Table 2-4).

Table 2-4: Audit Report Team Members

Role	Qualifications	Number of Years' Experience
Lead Environmental Auditor	B. Eng., M.Env.Mgmt Internationally Certified Lead Environmental Auditor	30
Assistant Environmental Auditor	B.Sci., M.Env Biosci	10
Technical Reviewer	B. Eng., M.Env.Eng (Hons)	27

3 Key Findings

3.1 Overview

Findings of the audit are presented as narratives in the sections below:

- Section 3.2 – Audit observations
- Section 3.3 - Management Plan requirements
- Section 3.4 – Management Plan objectives

Opportunities for Improvement (OFIs) and notable successes are also documented in these sections. All OFIs identified are collated in Section 4.

3.2 Audit Observations

This section provides a description and an assessment of the waste rock handling procedure and related potential environmental issues currently experienced at Mine, along with potential opportunities for improvement. Observations were compiled from the following activities:

- Mine documentation review, including the Management Plan and its accompanying Appendix A – NOEF Design and Construction Guidelines, OMP EIS and Waste Characterisation Reports (full list of documents reviewed is provided in Appendix B.4)
- Key site personnel interviews (interview participants list is provided in Appendix B, Table B.3) utilising an interview questionnaire.

Audit observations are set out in Table 3-1. Some observations are a statement of good practice and provide a record of what the site is currently doing well. In the majority of cases of good or satisfactory practices, there are no required actions and 'nil' has been added to the Table 3-1 Opportunities column.

Table 3-1: Audit observations and opportunities for improvement

Aspect	Item	Observations	Opportunities
Waste Rock Classification	1	A revised waste rock classification system was developed in 2014 by the Mine and considered the results of a comprehensive review of all available waste characterisation data as well as the results of additional geochemical assessments undertaken in 2012 and 2013.	Nil
	2	The revised waste rock classification system, and subsequent outcomes from the OMP EIS, have resulted in an improved understanding of the overburden geochemistry and alterations to Mine operations and management.	Nil
	3	The audit team was advised that waste rock is sampled more than ore. Samples are tested at the Mine's geochemistry laboratory (refer photo 1) to confirm waste rock classification and duplicate samples are independently tested and verified at an offsite National Association of Testing Authorities (NATA) accredited laboratory.  *Photo 1 – The Mine's on-site geochemistry laboratory for ore and waste rock sample testing* Representative samples are taken from drill holes prior to blasting to identify potentially reactive material to inform three-dimensional mine model. Waste rock classification and location information assists with setting boundaries in the mine model and informs the fleet management system (Modular).	Nil

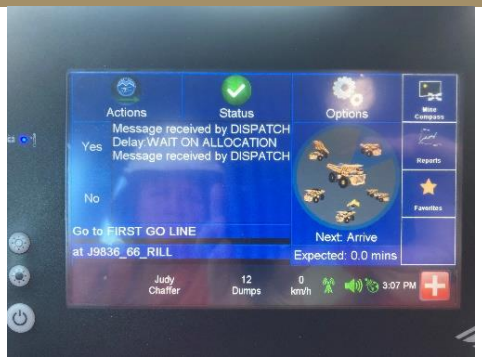
Aspect	Item	Observations	Opportunities
	4	Waste rock handling decisions on placement location are based upon the waste rock classification and are all made within the framework provided in the January 2020 Mining Management Plan Appendix G - NOEF Management Plan and its Appendix A – NOEF Design & Construction Guidelines V01 January 2020.	Nil
	5	The audit team was advised that waste rock types have the same, or very similar, elements but in different proportions which influences the waste rock characteristics and potential reactivity. For this reason, the waste rock is classified into six waste categories and assigned varying levels of management (placement depth, compaction, encapsulation, cover, monitoring, etc.) within the NOEF to prevent potential oxidation issues (refer to Table 1-1).	Note
	6	The audit team was advised that the waste rock classification process has a conservative approach. Where any uncertainty on waste rock classification exists, the material is typically classified as the worst case e.g. PAF (HC) would be treated a PAF (RE)	Future opportunity is to optimise the grade control processes by sampling to greater resolution/accuracy (level of reporting) and achieve greater precision in classification of waste rock. This has the benefit of preserving the capacity of the higher specification PAF (RE) emplacement zone by diverting greater quantities of the less reactive material to other NOEF zone locations.
Grade Control - including ore and waste rock classification	7	The in-field waste class validation implemented at the Mine uses two processes to identify and allocate materials being mined. MRM Technical Work Instruction – Grade Control Sampling describes the process to identify in-situ material prior to blasting. Blast-hole cuttings are sampled at a frequency of one sample per ten blast-holes. A representative sample is taken from each sampled drill-cutting mound or cone that forms around the drilling stem, then dried, ground and homogenised. Once analysed, the samples are classified according to the six waste classes and a map of the blast block is produced by the Mine Geologist for the Mine Engineers and production crews to plan and execute extraction and appropriate placement in the NOEF.	Note

Aspect	Item	Observations	Opportunities
		During the mining process, the PRO-3500022 - Ore Spotting and Grade Control Procedure is used to make any adjustments to boundaries between ore and waste rock (and where possible between waste rock classes) after blasting, and as the area is mined. The waste rock classification process is supported by 'Vulcan' mining software and involves: • Entering drilling result data • Domaining (defining the location and extent) of different ore and waste rock • Implementing the waste rock characterisation procedure • Entering data into Modular tools • Transferring data to GPS enabled equipment e.g. excavators, haul truck, dozers.	
	8	Grade Control refers to the ore grade control process to identify and extract target zinc and lead material in the pit of a suitable quality or 'grade' for processing into a saleable product. In addition to identifying the target ore the grade control process is used to identify and classify the waste rock.	Nil
	9	The audit team was advised that as much effort goes into grade control of ore as classification and management of waste rock. It was noted that the Mine expends great effort in sampling and testing to inform waste rock handling and management to avoid oxidation or AMD.	Nil
	10	Prior to blasting grade control identifies the location and volume of waste rock. This data is entered into the grade control model and the Modular to provide control over mining activities (e.g. location, extent, depth) Metallurgical testing on pit materials is conducted in the Mine's geochemical laboratory to assist waste rock classification. The audit team was advised that the Mine Geologist conducts daily inspections at the pit to check the blasted waste rock pile boundaries, confirm waste rock classification/s, and the inspection findings are entered into a mobile phone app and added to the mine model. Grade control meetings are held daily and waste rock classification issues can be addressed if required.	Nil

Aspect	Item	Observations	Opportunities
		Geology Radar and Light Detection and Ranging (LiDAR) scanner equipment are located overlooking the pit to provide data on pit geometry to inform the grade control and the location of production activities.	
Blasted Waste Rock	11	The audit team was advised that the Mine production team is mindful of not exposing PAF (RE) material to the atmosphere or rainfall for extended lengths of time (i.e. months) after blasting, before transporting to the NOEF. The Mine production team has adopted an 'as required 'approach to blasting to reduce the period blasted waste rock resides in the pit and avoid potential oxidation reactions before being transported and placed in the NOEF.	Note
Waste Rock - Tracking by Global Positioning System (GPS)	12	The placement of waste rock in the NOEF is tracked using the Fleet Management System (Modular) that utilises a GPS tracking system to log haul truck and waste rock movements from the pit to the NOEF. Modular facilitates the following process: • Excavated waste rock is classified and assigned based on the haul trucks loading location within the pit • Waste rock classification information (six classifications raging from benign to non-benign) is transferred to the haul truck transporting the material • An emplacement destination is assigned for the haul truck based on the waste rock classification • Alerts are provided to the haul truck operator if the haul truck is in the wrong emplacement area • Waste rock classification, emplacement information and responses to alerts are logged for further investigation and action, if necessary.	Note
	13	Modular was implemented in 2019 and employs GPS technology on mobile plant (haul trucks, excavators, water carts, dozers) to track and manage the fleet's operations by utilising sophisticated software in the Control Room. The Control Room operates 24/7 to monitor and direct all dispatch activities (haul truck, dozers and excavators) in real time with Closed Circuit Television (CCTV), radio communication and GPS tracking. A minimum of two people are monitoring the fleet management system at all times, refer to photo 2.	Nil

Aspect	Item	Observations	Opportunities
		 *Photo 2: Control room Dispatcher managing fleet operations using the Modular system*	
	14	Modular incorporates failsafe features to avoid mistakes and misdump incidents. The audit team was advised that since the implementation of Modular, only inadvertent human error can result in a misdump (e.g. dumping load in an incorrect location) and this is now extremely rare. The haul route network and emplacement areas are set up in Modular with 'no pass locations' for PAF (RE) material. A haul truck transporting PAF (RE) material cannot travel past a nominated 'no pass location' without triggering alerts in the drivers cab and in the control room. The location and extent of distinct types of waste rock classifications from blasting are mapped in the pit. The boundary of a waste rock classification is entered into Modular. If an excavator slewing movement strays outside the boundary, into an area with different waste rock classification, an alarm will be triggered in the control room. Modular monitors and controls the dig, haul and dump activities and ensure the segregation and correct emplacement locations for different classifications of waste rock.	Nil

Aspect	Item	Observations	Opportunities
	15	Potential incidents, e.g. haul truck misdump or an excavator moving forward into different classification of waste rock, are identified in real time in the control room and therefore corrective action response can occur immediately. Any misdump rehandling response can occur on the same shift, or the next morning in daylight following a night shift. This is an improvement on past practices and ensures that no 'dumping over' different classifications of waste rock occurs. Avoiding 'dumping-over' minimises the volume of waste rock that otherwise may potentially require removing, rehandling and transporting to the correct emplacement location.	Nil
	16	The audit team was advised that GPS units are installed on haul trucks, refer to photo 3, excavators and dozers. GPS sensors are also located on excavator tracks and buckets for increased position accuracy for in pit operations.  *Photo 3: Mine haul trucks are tasked and monitored en route to specific waste rock classification loading or dumping locations by the Modular system* The mobile plant managed by Modular have an in-cabin touch screen display, radio communication and alert system to inform the vehicle operator when and where to load, haul route, dump load and shift performance statics (e.g. loads completed, cycle times, productivity) refer to photo 4 and 5.	Nil

Aspect	Item	Observations	Opportunities
		  *Photos 4 and 5: Mine haul truck in-cabin touch screen display relaying Modular dispatching instructions, tasks and alerts* All production vehicles' (e.g. mine haul trucks, excavators, dozers, water carts etc.) activities and movements are captured and a record is retained (and backed-up) by Modular. Comprehensive records of waste rock movements, locations and vehicle data are able to be interrogated as required and in real time.	
	17	The control room Dispatcher has a step-by-step procedure for managing vehicle activities including call up and switching and activating and checking dumps. Steps for handling PAF (RE) are generated as automatic messages by Modular alerting and prompting the control room Dispatcher's actions in accordance with procedures.	Nil
	18	Prior to 2019 a paper-based records system was utilised to enter data to log waste rock source and placement locations. This relied on manual entry by haul truck drivers and was susceptible to human error. The previous system was known as APS.	Nil
	19	In relation to the upgrade to Modular the audit team noted interview comments including: The Control Room Dispatcher stated he personally "sees a difference and improvement with Modular resulting in less misdump incidents". The Production Manager stated, "without Modular we would have far more issues". The Mining Manager stated, "No question that Modular has reduced the frequency of incidents".	Nil

Aspect	Item	Observations	Opportunities
Modular Culture	20	The audit team observed an organisational cultural attitude to waste rock handling centered around Modular that was demonstrated across all the business units interviewed. This was noted in interview comments including: The Control Room Dispatcher stated, "Nobody misdumps anymore because it is against procedure, and it is bad for the environment." The Dispatcher interviewed exhibited pride that no misdump incidents had occurred on any of his shifts this year. This demonstrates ownership and accountability in overseeing fleet operations and achieving adherence to the waste rock handling procedures. A conservative approach to identifying and handling waste rock was observed and noted in an interview comment: "If in doubt, PAF it out". This reflects a general approach to classify waste rock in the higher reactive classification to ensure material is appropriately identified, handled and placed in the NOEF. This approach avoids unwanted waste rock reactions potentially caused by misclassification or mixing of different waste rock classifications (e.g. blast movement). The Production Manager stated that long-term employees operating mobile plant (e.g. haul truck driver and dozer drivers) "do not want to go back to pre-Modular days" and the associated waste rock issues. The audit team was advised that staff with longer experience at the Mine are conscientious about compliance with the latest waste rock and Modular procedures and they convey the importance of this to new staff.	Nil
Waste Rock Placement	21	The location of waste rock within the overall NOEF has been planned so the potentially most harmful materials are stored in the core of the facility, and progressively lower risk materials placed towards the outer layers (i.e. close to the surface or side). This will minimise oxygen ingress into the more reactive materials. Additionally, if a temporary breach of the outer benign cover system occurred, only materials with lower risk would be likely to be exposed until repairs could be undertaken.	Note
	22	The audit team was advised that the Mine Production Supervisor prepares a daily plan for pit and dump operations, the compliance of these activities with the plans verified by 2 or 3 inspections each day.	Nil
	23	The audit team was advised that each year more material than forecast is placed in the PAF (RE) cell locations due to a conservative approach to classifying some non-benign waste rock as	Consider methods to achieve greater precision in defining boundaries of different waste material classification

Aspect	Item	Observations	Opportunities
		reactive. Potentially some waste rock could be categorised in a less reactive classification, and reduce conservative 'over-reporting' in the volume of PAF (RE) material. The conservatism in assessing variables, such as level data and blast movement, to define the waste rock classification boundaries of distinct types for excavation may result in more waste material being transported and placed in the PAF (RE) cell and the capacity of the higher specification PAF (RE) cell being consumed faster.	in the pit and after blasting to minimise the quantities of non-PAF (RE) material deposited in the PAF (RE) cell.
	24	The audit team was advised that NOEF samples are tested at the Mine's geochemistry laboratory to confirm waste rock classification and duplicate samples are independently tested and verified at an offsite NATA accredited laboratory.	Nil
	25	The audit team was advised that the dozer and haul truck operators take pride in ensuring waste rock is transported and placed in the correct locations as the equipment operators are aware they are contributing to progress and improvement in the management of potentially reactive material.	Nil
Mine Geologist Daily Checks	26	The audit team was advised that the Mine Geologists conduct a daily data check to confirm material classification location in the pit and emplacement locations. Any queries from the Mine production team, haul truck operators, and excavator operators regarding material classification, where the changes in material occur in the pit are discussed at the General Communication Meeting daily with all equipment operators.	Nil
	27	The audit team was advised that visual check of waste rock occurs e.g. a dozer operator may question material classification especially when material appears 'a bit dark' in colour indicating PAF (RE) and possibly the incorrect classification. The Mine Geologist's advice is sought to confirm the classification and correct placement of any suspect material.	Nil
Misdump Procedure	28	In the event of misdump, the Shift Supervisor is advised, and a dozer is mobilised to cordon off the impacted area. The Dispatcher will shut off the affected haul route 'circuit' to avoid dumping further material on top of potentially reactive material. This approach allows the waste rock to be rehandled to correct emplacement location and avoids two, or more, misdumps in a row which would require a greater volume of material to be rehandled.	Nil
Reporting relevant to	29	The audit team was advised that waste rock handling compliance is confirmed and documented by a series of reporting including:	Nil

Aspect	Item	Observations	Opportunities
waste rock handling		• Stage reporting • Weekly/monthly report of the Compacted Clay Liner (CCL) ITP approval and progress • Monthly excavation plans which are incorporated into the Mine Plan • Internal audits against the Authorisation conditions with actions entered into risk manager for address, close out and accountability • Procedure reviews.	
Lift Height	30	Lift heights have been reduced with lower lifts used for more reactive waste rock. The Mine plans to construct barriers using finer materials to reduce advection currents and control oxidation rates of the placed waste rock. Advection barriers comprising fine-grained alluvial materials (clay-silts-sands) with appropriate compaction and moisture content are proposed to seal off airflow through the coarser waste rock. Geochemically higher risk materials will have more advection barriers than lower-risk materials. Active PAF(RE) cells will also receive additional wet-season protection through thicker barrier caps installed at the end of the dry season.	Note
	31	The audit team was advised that the Core Zone and Halo construction occur in 7.5m high lifts (not as previously 15m lifts) to create a shallow tip head which reduces the exposure of waste rock to air and water and allows compaction by haul trucks and dozers to reduce air voids and air pathways that may allow oxidation. The audit team was advised that the PAF (RE) zone construction occurs in 2 m high lifts to minimise the exposure of waste rock to air and water and allow high compaction by haul truck and dozer to reduce air voids. The audit team was advised that the 2 m high lifts reduce the exposure time on the plateau (the top of the NOEF) to only one or two months, prior to covering and capping with alluvium material to reduce water infiltration. The audit team was advised that wet season cap of a 1.2 m layer of alluvium is placed on exposed areas of the NOEF to prevent air ingress when the area is unable to be utilised due to wet weather.	Nil
Landform stability	32	Landform stability monitoring includes a combination of: • Geotechnical stability monitoring • Erosion monitoring	Note

Aspect	Item	Observations	Opportunities
		• Pore-water pressure monitoring. Landform stability related objectives for the NOEF include: • Long-term static drained Factor of Safety of 1.5 • Cover system and landform to maintain functionality • Sediment release from erosion does not adversely impact water quality • Erosion does not affect functionality of the landform.	
Geotechnical stability	33	Geotechnical stability monitoring is to be undertaken in accordance with the latest version of MRM's Ground Control Management Plan. This includes a combination of geotechnical inspections, including Operational inspections, conducted daily by the Shift Supervisor to look for signs of: • Changes in groundwater flows • Dribbling of material from spoil dump faces • Cracking of surfaces adjacent to the overburden encasement facility (OEF) crests – this may extend some distance back behind the crest of a wall • Cracking on OEF faces • Cracking on and slumping of OEF surfaces • Signs of depression or sink hole • Floor heave near the toe of a dumped face. Weekly geotechnical inspections (or as requested in response to adverse monitoring data) by a Mine Geotechnical Engineer are used to visually assess areas being inspected to identify signs of potential geotechnical instability that may pose a hazard to mining operations. Any potential instability identified is communicated in a timely manner to relevant stakeholders. Potential instabilities identified are added to the geotechnical hazard map. Inspections are to be undertaken in accordance with the PRO-3500020 Geotechnical Inspection procedure, and includes (but not limited to): • Visual monitoring • Photographic records of slope performance • Electro-optical distance measurement (EDM prism monitoring)	Note

Aspect	Item	Observations	Opportunities
		• Radar scanning • Piezometers (groundwater monitoring).	
NOEF Design and Concept	34	**Foundation/Basel CCL** A low permeability foundation is designed to underlie the new portions of the NOEF. The existing in-situ foundation materials will be retained where testing demonstrates it meets the design requirements, as much of the new footprint has low permeability materials naturally. Where geotechnical strength concerns or, possible preferential pathways to groundwater exist, unsuitable foundations will be removed and replaced with a 0.5 m thick Basal CCL to the satisfaction of the Independent Certifying Engineer (ICE). The geometry and materials of the foundations will promote percolation water to be captured as toe seepage rather than basal seepage, and confine any possible rising groundwater to under the NOEF.	Note
	35	**Base** An MS-NAF Base, approximately 5 m thick, will be constructed in at least one lift above the foundation (including CCL) to reduce the risk of interaction of PAF materials with any possible mounding or toe seepage flows, and to enhance geotechnical stability.	Note
	36	**Core Zone PAF HC and MS NAF** PAF (HC) material, along with excess MS-NAF materials, will be placed in a dedicated Core Zone with construction methods used to restrict the formation of advection currents. This could range from paddock dumping in 2 m lifts, to up to 7.5 m tip heads (nominally placed as a 2 m thick base and then 5.5 m tip head). Advection barriers comprising alluvial materials (clays-silts-sands) with appropriate compaction and moisture content will act to seal off airflow through the coarser waste rock caused by higher tip heads. The lift height and/or use of fine-grained materials to construct barriers to advection currents will be varied to control oxidation rates of the placed materials. Advections barriers will be placed: • On and around every lift in the Core Zone that is tipped in lifts greater than 2 m high. These layers will consist of approximately 0.1 m of alluvium on the level surfaces. • Over the internal inter-stage batters of the Core Zone.	Note

Aspect	Item	Observations	Opportunities
	37	**Core Zone PAF (RE) cell** PAF (RE) materials with a higher risk of spontaneous combustion will be exclusively placed in dedicated PAF (RE) cells within the Core Zone. The PAF (RE) Cells will have the maximum controls against oxidation and water ingress applied including: • Dumping of all materials in maximum 2 m lifts • Application of advection barriers on every 2 m lift (0.1 m of alluvium on top, 0.5 m on the batters) • Application of a wet season cap overactive cells comprising 1.2 m of alluvium with a 1.5 m MS-NAF protection layer to prevent erosion.	Note
	38	**Internal NAF Halo** The Halo, constructed from MS-NAF materials (or better), will ultimately provide a buffer between the Core Zone and the cover system. The lower reactivity of the MS-NAF materials will provide a durable platform for the cover construction, insulate the cover GSL from any heat generated in the Core Zone, and consume any diffusive oxygen entering through the cover system. The Halo will be constructed in lift heights of 7.5 m or less, with the lift height varied to suit the applicable cover construction method or adjacent lifts of the Core.	Note
	39	**Temporary Halo Cap** As the development of the NOEF is subject to an Aboriginal Area Protection Authority height limit, sections of the NOEF will receive a Temporary Halo Cap (temporary plateau) to protect the advection barrier on the top of the NOEF from erosion and desiccation. The Temporary Halo Cap comprising an approximately 5 m to 10 m thick MS-NAF protection layer over the alluvium advection barrier, sloped to be free-draining.	Note
	40	**NOEF Cover Zone System** A Cover Zone of at least 1.5 m thick of benign material with a GSL barrier layer will encapsulate the entire NOEF. This acts as a protection layer by isolating the reactive waste rock from water and air pathways. The plateau also has a minimum 0.2 m thick drainage layer in the Cover Zone, to aid in the removal of excess water from large rainfall events to a network of drains. This is then overlain by	Note

Aspect	Item	Observations	Opportunities
		alluvium and topsoil to act as a growth medium for vegetation. The sides of the NOEF only use rock in the growth layer, to better resist erosion. The bottom of the cover zone comprises a barrier layer to minimise water infiltration and oxygen entry into the NOEF. This includes a GSL design with a 0.2 m thick alluvial or Heavy Media Rejects crushed aggregate bedding layer beneath it and a 0.2 m to 0.3 m overlying alluvial protection layer.	
	41	The role of the ICE includes the preparation of reports, documentation and quality assurance records to verify the NOEF design and construction specifications have been met e.g. ITPs, hold point sign-offs, as build, non-conformance reports. Refer item 121 below audit finding related to ICE tasks.	Nil
Alluvium advection layers	42	The audit team was advised that greater quantities of alluvium are being used in the construction of the advection barriers than in the design. This indicates that the alluvium advection layers are thicker than required by the design and will provide greater protection against oxygen and water ingress and potential reactions in the stored waste material.	Nil
CCL Basal layer construction	43	The Basal CCL, as part of the foundation, is at the bottom of the NOEF and is the base barrier for encapsulated waste rock. Construction of the Basal CCL requires sign off from the ICE to verify it has been built in accordance with the design and specifications. The audit team was advised that the Mine production team will not tip waste rock in an area unit they have received confirmation that the CCL has been 'signed off'. Refer to photos 6 and 7.  	Nil

Aspect	Item	Observations	Opportunities
		Photos 6 and 7: NOEF northern extension major earthworks for compacted clay base layer and underdrains under construction	
	44	The audit team was advised that significant effort goes into the construction of the Basal CCL and it is a major civil engineering operation, refer to photos 5 and 6.	Nil
Air Quality – Spontaneous Combustion	45	The identification and classification of waste rock types are the fundamental steps in the strategy to manage spontaneous combustion.	Nil
	46	The potential for spontaneous combustion in the pit is reduced by limiting the exposure time between blasting and transporting waste rock to emplacement. An 'as required ' approach to blasting developed in the last twelve month makes sure the duration waste rock remains in the pit is limited to weeks rather than months. Typically, blasted waste rock oxidation issues occur after several months of exposure	Nil
	47	The NOEF is constructed in engineered layers to control and prevent SO_2. creation. PAF(RE) material is placed in 2 m high lifts and compacted by mine haul trucks and dozers to minimise air voids and then covered with 0.1 m alluvium advection barrier layer to exclude oxygen and water ingress and avoid oxidization which could otherwise create SO_2 air emissions.	Nil
	48	Numerous advection barriers have been constructed using alluvium in between NOEF lift layers to minimise oxygen and water ingress into the NOEF internal zones and thereby reduce SO_2.	Nil
	49	A permanent SO_2 continuous monitoring station is located near the Carpentaria Highway. The audit team was advised that in recent years monitoring results has only ever recorded low level SO_2 data and not exceeded any trigger levels.	Nil
	50	Realtime SO_2 monitoring data and monthly reports are publicly available via an online portal.	Nil
	51	The audit team was advised there have been no recent instances of spontaneous combustion resulting in off-lease SO_2 emissions. On rare occasions, blasting of reactive material in the pit may result in a smoking reaction. In this situation the reactive material in the pit is contained and managed to prevent oxidation.	Nil
	52	BGM trials are underway to evaluate the suitability of BGM to be utilised as a liner in the cover system over the top of the NOEF. The BGM is impervious and aims to eliminate air and water	Nil

Aspect	Item	Observations	Opportunities
		infiltration for the long-term (up to 1,000 years). A 10 ha section of BGM has been installed on the southern section batter of the NOEF in 2021, refer item 80 below.	
Air Quality - Dust	53	Mine haul truck water carts are utilised for dust suppression in operational areas of the Mine, especially along haul road routes. The Mine operates two large mine haul truck water carts and a third smaller mine haul truck water cart along with smaller back up options of Moxy and other truck water carts. The water carts are typically operated on a continuous 'hot seat' basis, whereby another driver will continue dust suppression activities whenever the first driver is on a break. Typically, during the dry season two large mine haul truck water carts are utilised continuously for dust suppression on haul roads. There are times during the wet season when some or all water carts are not required.	Nil
	54	If dust emissions on the pit are unmanageable, e.g. water cart breakdown, then the pit operation will be shut down temporarily. The audit team was advised that this situation arises occasionally, about once every other month.	Nil
	55	The audit team was advised that the Mine is planning on-site trials to assess the effectiveness of 'binder' additives to water in water carts to assist dust suppression.	Conduct an on-site dust suppression binder trial to assess the effectiveness of additives to minimise dust generation and to further control this potential pathway for the movement of metals into the environment.
	56	Blasting activities in the pit are at depth, greater than 200m below surface level. Blast design results in blasting dust plumes typically being contained within the pit. The audit team was advised that high dust plumes in the pit as a result of blasting are rare. Potential dust from drill patterns areas is controlled by water cannons attached to the water carts.	Nil
	57	Sediment traps and perimeter runoff dams (PRODs) capture/treat sediment laden runoff, including deposited dust. The audit team was advised that the sediment trap at the inlet of Seepage PROD is routinely dredged to remove sediment for appropriate disposal.	Nil

Aspect	Item	Observations	Opportunities
Water – Seepage PRODs	58	The audit team was advised that the NOEF ultimate design is to control seepages. Staged construction of basal CCLs directs seepages via sumps to PRODs. Seepage PRODs are designed to contain sediment at edges to enable dredging and removal of accumulated sediments. At the time of the audit, the PROD inlet sediment trap was being dosed with lime to treat incoming seepage water to assist to remove metals, refer to photo 8.  *Photo 8: South PROD dam captures NOEF seepage and surface runoff waters, lime added at inlet.*	Nil
	59	All dams (e.g. PRODs and sumps) containing potential AMD are lined with High-Density Polyethylene (HDPE) to assist eliminate seepage. Refer to photo 8 of North East Sump under construction with HDPE line installed.	
	60	The Mine operates an extensive network of groundwater monitoring bores to test for and identify any potential migration of contamination associated with seepage from the PRODs.	
Water – Seepage NOEF	61	An underdrain beneath the newer northern areas of the NOEF is designed to capture seepage, potentially containing metals and sulphates, at sumps and in turn to the PRODs for water treatment. Refer to photo 9 – sump under construction.	Nil
	62	Initially the underdrain seepage water from new areas of the NOEF will discharge to the sumps but in the long-term, as the NOEF cover system is installed to prevent water infiltration, the seepage water volumes are expected to reduce over time.	Nil

Aspect	Item	Observations	Opportunities
	63	The Mine operates an extensive network of groundwater monitoring bores to test for and identify any potential migration of contamination associated with seepage from the NOEF.	Nil
	64	The audit team was advised that piezometers (measuring water pressure) have been installed in selected groundwater monitoring bores around the NOEF to identify any 'mounding' of seepage flow in case underdrain pathways or toe seepage are silted up.	Nil
	65	The audit team was advised that in 2020/2021 a study was conducted to consider the need and timing for a proposed NOEF Seepage PROD interception trench. The groundwater modelling found the need for the interception trench was not immediate. The Adaptive Management Plan (AMP) provides a recommendation for installing groundwater interception trenches should conditions arise that warrant additional measures.	Regularly assess the need to install, and benefits of, an interception trench around sections of the perimeter of the NOEF, especially older southern areas of the NOEF.
	66	Seepage (including AMD) from waste rock may express at the toe of the NOEF and could cause surface water contamination. The audit team was advised (and observed) that the low permeability foundation incorporating a Basal CCL included engineered underdrains to promote the transport of infiltration towards specific toe seepage recovery points around the toe of the NOEF. The toe seepage is recovered and stored in the PRODs, refer to photos 9, 10 and 11.  *Photo 9: North East Sump inlet collecting seepage from NOEF underdrain system*	Nil

Aspect	Item	Observations	Opportunities
		  *Photos 10 and 11: North East Sump under construction with liner installed and awaiting extraction tower construction*	
	67	At the time of the audit an NOEF underdrain flow was discharging near the North East Sump. The audit team was advised that underdrain water quality monitoring, sampled adjacent to North East Sump is undertaken by the Mine Environment team, refer to photo 8. The quantity and quality of seepage in monitored and recorded.	Provide the underdrain water quality monitoring result data to the Mine Principal Engineer for assessment and interpretation to assist in greater understanding of the quality of seepage collected from the NOEF.
Water - Sumps	68	A network of sumps collect seepage water from the NOEF underdrainage system. Seepage generally drains from west to east and water quality is monitored. Water is removed from the sump through extraction towers and transported to a PROD for treatment and storage The North East Sump is a new permanent internal sump collecting seepage from the NOEF underdrain system. The sump is currently under construction and has been BGM lined (refer to photos 9 and 10) and will ultimately have a 1.2 m diameter, 15 m high polyethylene riser seepage extraction tower from where water will be drawn and pumped to EPROD (Eastern Perimeter Runoff Dam) for treatment. The sump has been designed to provide access to service and change out pumps.	Nil

Aspect	Item	Observations	Opportunities
	69	Aerial drone surveillance is conducted to inspect sumps to check if water is pooling or running especially early in the wet seasons to confirm roadways and drainage system are maintained and functioning.	Nil
Water - Sediment	70	Sediment is prevented from leaving the Mine and from entering the downstream receiving environment. Sediment is captured in surface drainage sediment traps, sediment ponds and PRODs. Water releases from Mine are regulated by Department of Environment, Parks and Water Security (DEPaWS) Waste Discharge Licence and only occur at one of three authorised discharge point locations and are subject to strict water quality criteria.	Nil
Water - Surface Water	71	Surface water runoff from the NOEF cover system is redirected through sediment management infrastructure (drains, sediment traps and PRODs) before controlled release to receiving waters.	Nil
	72	The Mine has been designed and constructed to ensure rainwater runoff for all operational areas, i.e. water potentially contaminated, is directed to a PROD or a sump so it is contained and treated. Clean rainwater runoff is diverted around the Mine's operational areas by a network of clean water diversion drains.	Nil
	73	The Mine has a pipeline network to transfer water between dams (PRODs, Process Water Dams and the Water Management Dam) to manage water storage levels and any need for off-site release within approval conditions. The pipeline network has in-built redundancy with twin pipelines permitting water transfer in either direction.	Nil
	74	A wet weather plan to manage runoff in operational and disturbed areas is prepared and implemented prior to the wet season and forecast rain events.	Nil
	75	Water in the PRODs will typically be evaporated or managed in the site-wide contaminated water management system.	Nil
	76	Lime is added to surface runoff water entering some PRODs to separate metals and sulphates in sediment traps which can then be removed by dredging sediment., refer to photo 8. Following treatment and testing, the water is able to be stored in the main area of the PROD and be reused for various Mine processes or discharged under strict regulatory criteria.	Nil

Aspect	Item	Observations	Opportunities
Water - Flood	77	The BGM is tied into toe of the NOEF batter slope with a 14 m wide 'dish' section to create a low permeability barrier to prevent erosion and scouring damage from flood waters to the interior of the NOEF. The barrier resists the movement of floodwater into the facility, and of infiltrated water out of the facility, refer to photo 12.  *Photo 12 - NOEF toe batter with BGM liner and rock armouring to provide flood barrier protection*	Nil
	78	The audit team was advised that exposed surfaces of the NOEF (lower batter slopes) are design for a 1 in 100 year flood event with rock material providing armouring against flood water flows, refer to photo 12.	Nil
NOEF Cover System	79	A Cover Zone system of at least 1.5 m thick of benign material with a BGM barrier layer will encapsulate the entire NOEF. This acts as a protection barrier layer by isolating the reactive waste rock from water and air pathways A GSL will be the protection of water and oxygen ingress into the interior of the NOEF and the key element of the cover system. The barrier layer extends from the top of the facility to below ground level, tying in with another low permeability barrier (CCL) in the foundation, refer photo 12.	Nil
Cover Trials	80	A 10 ha area BGM trial is underway on the southern section of the NOEF, refer to photo 13. The full scale trial installed in late 2021 also assessed construction techniques for laying and jointing	Consider developing and conducting further cover liner trials to test the

Aspect	Item	Observations	Opportunities
		the BGM. The BGM is the principal component of the cover system to provide a long lasting airtight and waterproof cover to encapsulate the NOEF.  *Photo 13: NOEF southern batter installed BGM liner cover system 10ha trial* The 10 ha trial area has been embedded with sensors (fibre optics and wireless) and monitoring equipment (e.g. temperature, moisture, strain, slippage, oxygen, carbon dioxide etc.) to evaluate the performance of cover system., refer to photos 13 and 14.	BGM in extreme conditions to demonstrate infiltration barrier integrity and long-term durability performance properties.

Aspect	Item	Observations	Opportunities
		 *Photo 14: NOEF BGM cover system monitoring (e.g. temperature, moisture, gases) system network locations embedded under the impervious liner.*	
	81	A cover system constructability trial plot (CTP) was constructed on top of BGM placed on the western batter face of the NOEF. Seven small plots using different grades and layer thickness of materials (e.g. crushed rock, NAF rock 1.5 m deep, alluvium) and construction equipment (e.g. different size dozers and types of trucks) were trialed to examine the constructability and performance of BGM with assorted designs and construction techniques. The CTP objective was to determine the optimum rock layer depth, rock diameter, weight of dozer to construct over the BGM and avoid creating a 'bow' or 'wave' in the BGM or damaging or puncturing the membrane, refer to photos 15 and 16.	Nil

Aspect	Item	Observations	Opportunities
		  *Photos15 and 16: Cover system constructability trial plot on NOEF western batter*	
	82	The trial found the optimum solution to be placing over the BGM a 300 mm layer of <20 mm diameter crushed rock, 1200mm layer NAF rock (growing medium)) and about 200 mm layer of topsoil placed using a D6 dozer. The dozer constructing the cover system was GPS equipped and was able to place layers of material to ±20 mm accuracy. These results informed the full scale 10 ha BGM trial, refer item 80 above.	Nil
	83	The CTP trial identified that the BGM supplied by the manufacturer had a plastic membrane on one side which reduced the friction when placed on a slope resulting in the BGM potentially able to slide down the batter of the NOEF. The membrane has been removed to create a higher friction angle on the underside and each section of the BGM was tied into an anchor trench every 55 m length to prevent unwanted slippage.	Nil
	84	Prior to the 10 ha trial a smaller scale PAF (RE) cell cover trial was conducted in the south eastern area of the NOEF with BGM laid over PAF (RE) layers to deliberately feed oxygen to encourage reactions within the cell. Embedded sensors and instrumentation within the cell layers monitored parameters to measure in-situ practical performance results to prove the concept and provide confidence in the BGM ultimately selected.	Nil
	85	The audit team was advised that the BGM trial and the constructability trial plots were conducted over and above regulatory requirement. This was a practical approach to optimise the performance of the proposed cover systems and provide long-term confidence.	Nil

Aspect	Item	Observations	Opportunities
	86	The audit team was advised that the current NOEF cover system provides a low risk solution but has a high cost. Future refinement of the cover system may reduce construction cost but will need to maintain a low risk cover solution to ensure environmental protection.	Future opportunity is to examine ways to refine the NOEF cover system and reduce the construction cost but keep high level of performance to ensure environmental protection.
Revegetation	87	Currently revegetation has not been established on the NOEF. Revegetation trials are proposed to determine suitable species and the design of cover materials layers (e.g. alluvium, rock and topsoil) to enable vegetation to establish without damaging or affecting the performance of the BGM, e.g. roots penetrating BGM.	Conduct NOEF revegetation trials with proposed species and cover materials (alluvium, rock and topsoil) to ensure revegetation does not affect the performance of the BGM and cover system.
Compliance regulatory	88	There are 116 conditions and sub conditions in the Authorisation specifically related to NOEF requirements. The Mine has achieved a high level of compliance with these condition as assessed in the Annual Environmental Performance Audit Report 2020, 2021 and 2022, prepared by the Independent Monitor.	Nil
	89	The Mine has established and maintains an obligation register where Authorisation conditions and internal environmental commitments have been entered. The system is called 'risk manager' and it allows actions to be assigned and is used as a compliance tracking tool.	Nil
Compliance with MRM processes	90	The ICE administers hold points in NOEF construction to ensure certain requirements are met and supporting evidence reported prior to proceeding. The audit team was advised that Mine has developed and implemented numerous procedures which are audited and reviewed internally to ensure compliance and support performance to achieve NOEF objectives.	Nil
Monitoring - NOEF	91	The audit team was advised that NOEF performance monitoring has been established to monitor NOEF compliance against design specifications. The Mine's stated monitoring approach is to place priority on early preventative action and comprehensive monitoring of the defined sources and pathways to identify adverse or unexpected trends prior to the receptor becoming impacted. Monitoring of the receiving environment and receptors is also undertaken.	Nil

Aspect	Item	Observations	Opportunities
		Key monitoring programs that the audit team observed evidence of implementation or are aware of include the following: • Grade control • GPS material tracking • Geochemical sampling • Spontaneous combustion • Gas and temperature • Cover system performance • Air quality monitoring • Revegetation • Artificial surface water • Natural surface water quality • Groundwater • Fluvial sediment • Macroinvertebrates • Aquatic fauna abundance/diversity • Large tooth Sawfish • Metals in aquatic fauna.	
Monitoring – confirm performance	92	The audit team was advised that monitoring programs confirm the Mine's activities are performing as expected and any departures or Site Specific Trigger Values (SSTVs) would be investigated.	Nil
Monitoring - Daily Inspection	93	The Dump Supervisor conducts daily morning inspections to check and confirm compliance with waste rock handling processes. The Dump Supervisor is a new role, recently created to provide additional oversight of waste rock handling activities. It was advised that the Dump Supervisor role is particular to this Mine which is an indication of the focus and effort placed on waste rock handling management.	Nil

Aspect	Item	Observations	Opportunities
ITPs	94	ITPs are detailed documents to specify the requirements and acceptance criteria for the construction activities for NOEF. ITPs are used extensively and define the: • Project, activity (location or cell number) • Specification requirement • Responsible person • Hold point • Activity checklist • Inspection (MRM and ICE signatures and date) • Acceptance criteria • Relevant procedure • Test frequency. The audit team was advised that waste rock handling compliance is achieved by following ITPs e.g. grab sample checks, daily reconciliation and design conformance. The audit team was advised by Mine Operations staff state that the ITPs are easy to audit and understand.	Nil
Communication	95	The audit Team was advised that the staff, Mine Engineers, Mine Geologists and Operations Supervisor and Dump Supervisors are 'talking all the time' checking conformance with waste rock handling processes across business units. This is good practice and supports implementation of procedures with the benefit of experience and oversight.	Nil
Monitoring – Geochemical	96	The Operator uses information from the following extensive sampling, testing, and monitoring programs to classify and manage waste rock: • Acid-base accounting - a static geochemical analysis to determine acid-base balance and metal content of the waste material • Mineralogy - X-ray diffraction (XRD) • Minerology - scanning electron microscopy (detects 42 elements) • Leachate extractions, shake flask extraction and liquor analysis	Nil

Aspect	Item	Observations	Opportunities
		• Geochemical reactivity - standard humidity cells; leach column testing; oxygen consumption rate and large scale field barrel leaching. Geochemical sampling of placed waste rock is undertaken monthly at the NOEF as part of the broader program using PRO-3500008 - OEF Sampling Procedure Update. This monitoring program's aim is to characterise the placed waste rock and provide final verification that materials are placed in the designated locations within the NOEF. The audit team was advised that the Quality Assurance/Quality Control (QA/QC) program samples NAF, PAF and mineralised waste rock on the NOEF, with an average of 250 samples collected each year. Rock samples (10 to 26 samples of approximately 3 kg) are collected each month from randomly selected locations within the active placement areas. Sampling density is proportional to the amount of material movement and is based on international guideline recommendations.	
	97	The audit team was advised that in addition to the laboratory XRD, a field handheld XRD unit is now utilised to assist material classification refer to photo 17.  *Photo 17: Geochemistry laboratory XRD unit provides elemental analysis for a wide range of metals in waste rock samples*	Nil
Monitoring - Spontaneous Combustion	98	The Mine's spontaneous combustion monitoring program aims to identify areas on the NOEF showing early signs of increased reactivity (abnormal surface moisture, elevated temperatures, cracks, heaving, or efflorescent salts) prior to the onset of spontaneous combustion, so that early remediation can be undertaken. Monitoring undertaken includes:	Nil

Aspect	Item	Observations	Opportunities
		• In-pit thermal monitoring prior to and during drill and blast operations • Daily NOEF inspections: daily visual and thermal inspections • Daily gas measurements including SO_2 levels on the NOEFs • Thermal imaging of the NOEFs using a survey drone equipped with a thermal camera.	
	99	The audit team was advised there have been no instances of 'steam pockets' on the NOEF, an indicator of heating and potential spontaneous combustion, in the past several years. The audit team was advised the next spontaneous combustion testing is planned to occur in the next 12 months. An objective of the testing is to determine changes from previous spontaneous combustion testing conducted 5 years ago.	Nil
Monitoring - Gas and Temperature	100	19 monitoring bores have been drilled into the NOEF, and monitor temperature and gas. The bores extend through the full thickness of the PAF cells and are equipped with thermocouples and gas ports at varying depths to enable gas sampling and the ongoing monitoring of internal temperatures within the NOEF. Monitoring is undertaken quarterly, The internal temperature and gas monitoring program forms part of the broader NOEF environmental management strategy, which aims to eliminate spontaneous combustion, minimise SO_2 production and control AMD generation. The audit team was advised that temperatures in the NOEF are slowly reducing and are below the historic peak temperatures. Attention will remain on areas where higher temperatures are reported, principally the north eastern batter of the NOEF where monitoring will continue and bores replaced as required.	Nil
Monitoring - Cover System Performance	101	The NOEF cover system performance is assessed through monitoring programs including: • Net percolation and gases • Lysimeter – monitors change in in-situ volumetric water content, matric suction, temperature and oxygen • Watershed water balance monitoring • Meteorological - automated meteorological station on NOEF plateau to capture climate parameters required for the water balance. e.g. net radiation, air temperature, relative humidity and wind speed, rainfall and barometric pressure	Nil

Aspect	Item	Observations	Opportunities
		• Soil profile monitoring sensors are installed within the NOEF cover system to automatically record in-situ water content and temperature conditions near the surface • Soil oxygen automatic sensors to evaluate the cover system in limiting oxygen ingress • Runoff and interflow monitoring – flow depths and velocities • Pore-gas sampling and gas pressure.	
Data interpretation	102	The NOEF monitoring systems collect an enormous amount of data to satisfy internal procedures and regulatory requirements. The individual monitoring programs appear to be conducted separately for independent but related purposes.	Collate the various monitoring program records to aggregate the data for analysis to potentially gain even greater learnings and understanding of the processes and behaviour of the waste rock and the NOEF.
AMP	103	The AMP aims to provide a framework for sound management and decision-making under uncertainty. It is a planned and structured, iterative approach that facilitates continuous incremental improvement in environmental management and decision making in response to evolving knowledge and changing circumstances. The AMP process steps are: 1. Define the management problem 2. Establish clear environmental objectives 3. Identify uncertainties and hypotheses 4. Establish performance triggers 5. Identify and implement management actions 6. Monitor ecosystem response 7. Evaluate effectiveness 8. Adjust management actions. The audit team is aware that the Mine has prepared and updated a comprehensive AMP (current version D October 2021) which provides a framework for environmental management, monitoring, mitigation and reporting relevant to achieving waste rock handling procedures objectives.	Nil

Aspect	Item	Observations	Opportunities
TARP	104	TARPs are developed by the Mine to manage potential environmental harm through mitigating environmental impacts, and to assess performance against overarching environmental objectives. TARPs have three trigger levels, namely: Trigger Level 1 – when a performance indicator is above the Level 1 trigger value this indicates that potentially adverse behaviour is occurring; however, the environmental objectives continue to be met. (When a performance indicator is below the Level 1 trigger value this suggests performance is achieving the overarching environmental objectives). Trigger Level 2 - when a performance indicator is above the Level 2 trigger value and below Level 3 trigger value. This indicates that potentially adverse behavior is occurring however, the environmental objectives continue to be met., Trigger Level 3 – when a performance indicator is greater than the Level 3 trigger value, adverse environmental harm may be occurring. The audit team is aware that the Mine has prepared a detailed TARP, incorporated into the AMP, which clearly sets out objectives, performance indicators, monitoring (sites, parameter, frequency, sample site, analysis, methodology), trigger levels 1, 2 and 3 and Action responses. The TARP objectives all relate to protecting the McArthur River and air quality from mining impacts and support the achievement of waste rock handling procedure objectives.	Nil
Site Specific Trigger value (SSTV)	105	The SSTV's utilised by the Mine are often based upon the Waste Discharge Licence criteria (e.g. water quality parameters), or where insufficient baseline monitoring data exists, the adoption of default guideline trigger values. The audit team is aware that SSTV are incorporated into the TARPs as trigger levels, where appropriate, to support environmental performance related to waste rock handling processes.	Nil
Incident - Response and Reporting	106	Incidents are recorded in the Mine's on-line BSafe system. Incidents are classified and assigned depending on their severity. All risks and corresponding actions are tracked for accountability and close out. Actions which are not closed out by their due date are automatically escalated by the system to next level of senior mine management or corporate management for close out. High potential risk incidents are escalated to the Risk Manager System for greater senior management scrutiny. The audit team was advised that a standing agenda item on the Mine's Daily Senior Leadership Team (SLT) meeting is incidents and every incident is reviewed by the SLT.	Nil

Aspect	Item	Observations	Opportunities
	107	Incident reporting is recorded and tracked in MRM's online safety system (BSafe) and is reviewed daily. Information recorded, when an incident is identified, includes the following: • Incident number (used for tracking purposes) • Incident date • Person who detected the incident • A brief description of the findings of the investigation following incident identification • Assessment of the risk of environmental harm • Actions considered to mitigate environmental harm that may have occurred • Corrective actions to prevent re-occurrence of the incident • Actions completed.	Nil
	108	The audit team was advised that the reclassification of waste rock would constitute an incident and would need to involve a Mine Geologist to investigate e.g. waste rock blast movement, edge margin change, level control or operator query. This type of incident would be raised in BSafe for action and close out.	Nil
	109	The audit team was advised that in the rare instance that a load of waste rock was misdumped (e.g. transported to incorrect location) and not corrected within the same shift, the incident would be entered into BSafe and escalated to Superintendent level for priority action and close out.	Nil
	110	The Management Plan states that corrective actions will be developed, assessed and implemented as required to manage the NOEF when construction and design objectives are not being met. Where a potential issue is identified (through monitoring and inspection programs) a process to determine the cause and required corrective actions will be implemented. No specific examples of corrective actions were identified during the audit.	Nil
Tailings Storage Facility (TSF)	111	The TSF is currently carrying out construction of Lift 6 (2 m tailings height in cell 2) and planning for Lift 7 a combined lift of both cell 1 and cell 2 in 2026, refer to photo 18.	Nil

Aspect	Item	Observations	Opportunities
		 *Photo 18: TSF Cell 2 receiving mineral processing tailings ultimately planned to be reprocessed and returned to the main pit*	
TSF - Interception Trench	112	An interception trench, commissioned in 2020, is operational between the northern batter toe of the TSF and Surprise Creek. The audit team was advised that typically the seepage interception flows at around 9L/s with higher flow rates in the wet season. Intercepted water is captured in a series of sumps interconnected by dual pipelines and water is pumped out to PRODs for treatment, refer to photo 19.	Nil

Aspect	Item	Observations	Opportunities
		 *Photo 19: TSF interception trench sump and pump equipment adjacent to Surprise Creek* The audit team was advised that the interception trench is having a beneficial impact on groundwater quality monitoring results in the area showing improvement over time with reduced level of sulphates and electrical conductivity since the interceptions trench's installation.	
Water Management Dam (WMD)	113	The WMD, located next to the TSF, is currently near empty during dam wall rectification works, refer to photo 20. The WMD is connected to the PRODs and when back in service will provide greater control over the Mine water inventory which is sensitive to variability in annual rainfall. This increased ability to store, treat and manage the different qualities of water (e.g. NOEF runoff and seepage) and optimise a water balance will provide increased protection to the receiving environment from potential waste rock impacts.	Nil

Aspect	Item	Observations	Opportunities
		 *Photo 20: WMD at a low level while dry season upgrade to dam wall occurs* An approval request for an exemption has been submitted to allow water releases from the WMD (refer to photo 21) at times other than when the downstream Little Barney Creek is flowing to provide greater control over Mine water inventory. Currently the majority of Mine water releases are at the Mine Levee authorised release point.	

Aspect	Item	Observations	Opportunities
		 *Photo 21: WMD release point, subject of approval request to allow release to Little Barney Creek in dry flow conditions*	
Revegetation - McArthur River Diversion	114	The audit team was advised that revegetation of the upstream section of the McArthur River diversion banks is the oldest revegetation area at the Mine with 800,000 trees planted which meets the completion criteria, refer to photos 22 and 23.   *Photos 22 and 23: Mature revegetation of the banks of the upstream section of McArthur River Diversion including an example of placed woody debris*	Nil

Aspect	Item	Observations	Opportunities
		Woody debris (i.e. cleared trees) are placed in the McArthur River Diversion to create back pools and resting places for fish habitat. The Mine's tree nursery produces around 120,000 trees per year for revegetation projects, comprised of 30 tree species and 4 grass species. Around 30% of trees planted each year survive with losses due to the cycle of erosion from severe flooding (10 -15 m river level rises) and the harsh dry seasons experienced on the waterway banks where they are planted.	
Auditing	115	MRM's internal audit program including compliance and performance inspections are undertaken by both mining and environmental management personnel. Monthly reports on the NOEF by geology, geotechnical and engineering staff effectively audit the design and construction of the facility. This includes geochemical and geotechnical testing checks. An Environmental Management Report is developed annually (31 August) after each review of operational and environmental performance against environmental objectives. Periodic environmental inspections are also completed by the Mine Environment Department. The Independent Monitor prepares an Annual Environmental Performance Audit Report (AEPAR) for the Minister. The AEPAR is made publicly available and is presented to the local community through an engagement program.	Note
Reporting and Review	116	This Management Plan includes a commitment for it to be reviewed on an annual basis for its continuing suitability, adequacy and effectiveness. However, the Management Plan originally issued in January 2020 remains the current version.	Review the NOEF Management Plan (suggest every other year) and, where necessary, update the NOEF Management Plan.
NOEF Design and As-built Reporting	117	The Management Plan states each stage of the NOEF will have a detailed design report completed prior to construction commencing. This will contain information on the design, specifications and construction management plan. This is reviewed by the ICE, and amended as required until it has been endorsed. As part of the construction phase, a Quality Management Plan will be produced that contains ITPs and QA/QC processes for use in the detailed management of the physical works. These are also reviewed and approved by the ICE.	Nil

Aspect	Item	Observations	Opportunities
		The audit team is aware of completed ITPs, ICE reviews and approvals of the construction of the NOEF.	
	118	The Management Plan states that at the completion of the works, an 'as-built' report will be produced that compiles all the relevant proof that the construction was as per design, or where differences were present, how they were managed and why the design objectives will still be met by the final works. The 'as-built' reports are also required by the Authorisation. The audit team is aware that the 'as built' report/s are not yet complete as NOEF and associated infrastructure (e.g. PRODs) construction is ongoing; however, progress reports should be provided to address the intent of the requirement to provide progressive verification and record that the stages of the NOEF are being built in accordance with approved design.	Prepare an 'as built' reporting schedule to identify for which component or stage/s of the works an 'as built' report is to be prepared and when.
Roles and responsibilities	119	The main roles and responsibilities associated with the design, construction and operation of the NOEF are outlined in the NOEF Design and Construction Guidelines. These include the: • ICE • Project Manager • Project Engineer • Project Supervisor. The audit team noted that other than the ICE, the specific role titles do not exist and the responsibilities are undertaken by other senior Mine staff including e.g. Mining Manager, Production Manager, Principal Mining Engineer, Dump Supervisor. In addition, there are other personnel and departments with relevant responsibilities including: • Mining Manager and Mining Department: implementation of the NOEF Management Plan, so that the NOEF construction and performance monitoring are conducted in accordance with the Management Plan. • Manager – Health, Safety, Environment and Community Department: implementation of the NOEF Management Plan, so that associated environmental (receiving environment) monitoring is conducted in accordance with the Management Plan.	Update the NOEF Management Plan to reflect current position titles and ensure clear assignment of waste rock handling procedure responsibilities.
Role - Dump Supervisor	120	The Dump Supervisor is a recent role created in 2022 with the primary purpose to oversee waste rock handling. The Dump Supervisor (day shift) role has the responsibility to manage and inspect the placement of waste rock in accordance with the approved NOEF design and MRM's	Nil

Aspect	Item	Observations	Opportunities
		procedures. This Dump Supervisor role is a dedicated role over and above typical practice on other mine sites and is a valuable initiative to ensure vigilant management of waste rock.	
Role - ICE	121	ICE's role is to provide external supervision and review of the NOEF construction. The ICE is required to: • Undertake audits of the Mine's quality systems and documentation. • Provide weekly/monthly progress reports outlining compliance with specifications, including justification for the acceptance of any items which did not meet the specification requirements and/or any material changes. • Audit and verify the NOEF construction reports.	Nil
Training and Awareness - Environment	122	The Mine requires all employees, contractors and visitors to be provided awareness and procedural training in: • Their roles and responsibilities (including reporting environmental incidents) • The environmental impacts (potential or actual) of their activities on site • The potential consequences of poor environmental performance • Site emergency procedures. The induction process is not designed to train all new Mine employees and contractors in all aspects of environmental management. It provides a basic understanding of environmental risks, responsibilities and management requirements, and is supplemented as required by job-specific training.	Nil
Culture - Waste Rock	123	The audit team was advised that there is increased waste rock procedure awareness and consciousness with the production staff (excavator, haul truck and dozers operators) than in past years since they now have a better understanding of why they do things and what things are done to manage waste rock risks. • The audit team observed that there is a pride among the excavator, haul truck and dozer operator workforce to avoid past issues associated with waste rock handling and this culture is handed down to new starters. • The audit team noted that the production workforce has a mantra "If in doubt PAF it out" reflecting a "better to be safe than sorry" approach.	Nil

Aspect	Item	Observations	Opportunities
		These audit examples of workforce attitude and culture are indicators of a consistent understanding across business units recognising the importance of observing waste rock handling procedure requirements for individuals to collectively contribute to high standards of environmental performance in the management of a potentially reactive material.	

3.3 Management Plan Requirements

The Management Plan is the overarching management document for the design, construction and operation of the NOEF and was developed in accordance with the NT EPA requirements. The document contains a large number of NOEF design and management commitments to be adopted as requirements. For the purpose of conducting this audit, the requirements have been extracted by identifying terms such as “shall”, “should”, “must”, “will”, “could” and “may” in order to create a checklist. These requirements were collated into a checklist to inform audit discussions that were conducted and to identify and assess the level of implementation and compliance. An implementation rating was given to each of the requirements i.e., ‘very good’, ‘good’, ‘satisfactory’, ‘poor’ or ‘very poor’.

Applying the checklist of NOEF requirements provided an indication as to the extent of implementation and compliance with the NOEF Management Plan. Any Opportunities for Improvement were captured as part of the audit process and are noted in Section 4.

3.4 NOEF Key Objectives

The Management Plan (Table 3-2) provides performance objectives for the design, construction and operation of the NOEF based upon the risks identified. The extent to which the NOEF performance objectives are met is related to the adequacy of implementation of the waste rock handling procedures. Based upon the audit findings a rating (i.e. 'very good', 'good', 'satisfactory', 'poor', or 'very poor') has been assigned to provide an assessment of the current level of achievement of each of the individual NOEF objectives. Table 3-2 lists the NOEF key objectives, the key project risks and the assigned performance rating based upon the audit findings.

Table 3-2: Environmental performance criteria ratings

Ref	Key Objectives	Key Project Risks	Audit Rating	Audit findings
1.	Manage spontaneous combustion of overburden to control release of Sulphur dioxide and associated potential effects on nearby receptors.	Spontaneous combustion of reactive material (release of SO_2 plume off-lease).	Very Good	Air quality monitoring network continuous records has not detected any SO_2 emission criteria exceedances at the off-lease monitoring station in recent years (2018 onwards data). No spontaneous combustion incidents have been recorded (e.g. community complaints) or identified resulting in SO_2 releases or potential effects on nearby receptors (2018 onwards data). NOEF design and construction activities have been implemented with the aim to minimise the air and water ingress to emplaced waste rock. NOEF gas, temperature and thermal aerial drone monitoring program provides early indication of any potential spontaneous combustion issues. Waste rock classification, segregation and transport procedures, sighted during the audit, assist in managing high risk waste rock emplaced in designated NOEF location for encapsulation to avoid potential spontaneous combustion and consequent SO_2 release.
2.	Manage dust to control movement of metals into the terrestrial and aquatic environments.	Waste rock dust release to receiving environment.	Good	Dust suppression on haul routes has been conducted by water carts 24 hours a day in the dry periods and as required in wet season.

Ref	Key Objectives	Key Project Risks	Audit Rating	Audit findings
				'Hot seat' operation of water carts so dust suppression occurs continuously even during crib breaks. The audit team was advised that pit operations are halted during extremely windy/dusty conditions to reduce or avoid dust releases. Metal levels in sediment at the Haul Road bridge at Barney Creek have been monitored and managed. Sediment traps and perimeter runoff dams have been installed to capture and treat sediment laden runoff. NOEF design and construction has a cover system (layers of NAF rock, BGM, alluvium) to encapsulate waste rock and avoid dust release. Air quality management and associated environmental monitoring (i.e. dust, surface water, sediment and biota) has been implemented. Binding agent additive trials are planned for late 2022 to examine potential enhancements for dust suppression.
3.	Maintain functionality of the surface water management system within/around the NOEF, to achieve acceptable downstream water quality.	Seepage (including AMD) from perimeter runoff dams and process water dams causing groundwater then surface water contamination.	Very Good	The audit team was advised that all PRODs and process water dams are lined with impervious geotextile (e.g. HDPE) and/or CCL to prevent seepage (observed HDPE liner in-situ exposed at freeboard above water levels in the Southern PROD). The water levels and water quality of surface water storages have been monitored and managed to minimise uncontrolled water releases. Planned releases have been in accordance with Waste Discharge Licence conditions. A network of interconnecting pipelines has been implemented to allow water to be transferred between PRODs, Water Management Dam and process water dams to maintain a balance of water storage capacity and avoid overtopping.

Ref	Key Objectives	Key Project Risks	Audit Rating	Audit findings
				Groundwater monitoring bores have been installed down gradient of the PRODs to regularly test water quality samples. The AMP has TARPs and measures to react to any issues identified by groundwater monitoring results.
4.	Control seepage from the NOEF, and potential impacts on groundwater and surface water quality.	Seepage (including AMD) from waste rock causing groundwater then surface water contamination.	Good	NOEF construction has seepage interception systems including, underdrain and sumps. North East Sump underdrain discharge was flowing at time of audit inspection (dry season). NOEF has a foundation, including Basal CCL. Clay material for CCL construction is specified as low permeability to minimise seepage to groundwater. CCL material properties are part of an inspection and testing program which are tested at the Mine's NATA accredited geotechnical laboratory and verified by the ICE. NOEF design and construction activities (including BGM trials and cover zone) have been implemented with the aim to minimise the air and water ingress into potential high risk waste rock. Groundwater monitoring bores have been installed below the Basal CCL and down gradient of the NOEF to regularly test groundwater samples. Sump water is transferred to surface water and is stored and treated in the network of PRODs, process water dams and Water Management Dam. No uncontrolled releases of surface water are permitted, refer to item 3 above.
5.	Maintain functionality of the surface water management system within/around the NOEF, to achieve acceptable downstream water quality.	Sediment release from the mine site leads to contaminant bioaccumulation in downstream aquatic/estuarine fauna impacting human health.	Very Good	The Mine has an extensive network of surface water drainage to direct surface water runoff from the Mine affected catchment to PRODs and, where necessary, treatment. Sediment traps have been installed at the inlet of PRODs to capture sediment contained in runoff. Lime dosing of runoff water occurs at some PROD inlets to treat and capture metals to be removed by dredging the sediments.

Ref	Key Objectives	Key Project Risks	Audit Rating	Audit findings
				Water releases from the Mine (PRODs, Water Management Dam) only occurs at authorised discharge point and in accordance with the Authorisation conditions and water quality limits. The comprehensive and long-term aquatic ecosystem monitoring programs have not identified any downstream McArthur River contaminant bioaccumulation in aquatic fauna.
6.	Control seepage and maintain functionality of the surface water management system within/around the NOEF, to achieve acceptable downstream water quality	Seepage (incl. AMD) from waste rock expressing at toe and causing surface water contamination during operations.	Good	NOEF construction has seepage interception systems including, underdrain and sumps, layer separation barriers (alluvium), toe drains and flood protection. All of these seepage interception measures were observed in-situ or under construction in the NOEF northern extension. Vibrating wire piezometers have been installed in groundwater monitoring bores in the NOEF toe to detect pressure changes which may indicate an accumulation of seepage water so that it can be managed before it may express at the toe. NOEF design and construction activities have been implemented with the aim to minimise the air and water ingress into potential risk waste rock and avoid seepage issues. Refer items 3 and 4 above.
7.	Control seepage and maintain functionality of the surface water management system within/around the NOEF, to achieve acceptable downstream water quality.	Seepage (incl. AMD) from waste rock expressing at toe and causing surface water contamination post operations.	Good	Refer to item 6 above. Noting that post operation is a future requirement.

Note: The Management Plans key objectives for weed control were not examined as part of this audit.

4 Opportunities for Improvement

The OFIs identified by the audit have been presented as clear and succinct practical actions. OFI actions and their implementation aim to assist the Mine in managing environmental risks and improve performance. It is important to note that the OFIs identified by the Independent Monitor are suggestions and are not regulatory requirements.

The OFIs have been prepared at a point in time and may remain valid until changes in the Mine's circumstances and/or processes make them redundant or require their amendment. It is recommended that they are included, where possible, as control measures in the Mine's compliance and risk registers in order to become part of the actions taken to address waste rock handling procedures. This will assist to ensure that they remain current and are amended where necessary to remain appropriate for any changes in circumstances.

Opportunities for improvement actions are listed in Table 4-1.

Table 4-1: Opportunities for improvement

Ref	Aspect	Description of Opportunity
OFI-WR22-01	Waste Rock - sampling	Consider methods to optimise the grade control processes by sampling to greater resolution/accuracy (level of reporting) and achieve greater precision in the classification of waste rock. The aim is to divert greater quantities of the less reactive material to other NOEF zone locations and thereby conserve the capacity of the higher specification PAF (RE) emplacement zone.
OFI-WR22-02	Waste Rock - quantities	Consider methods to achieve greater precision in defining boundaries of different waste rock classification in the pit and after blasting to minimise the quantities of non-PAF (RE) material deposited in the PAF (RE) cell.
OFI-WR22-03	Dust – binder trials	Conduct an on-site dust suppression binder trial to assess the effectiveness of additives to minimise dust generation and to further control this potential pathway for the movement of metals into the environment.
OFI-WR22-04	Water – seepage	Assess the need to install an interception trench around sections of the perimeter of the NOEF, especially the older southern areas of the NOEF, on a regular basis.
OFI-WR22-05	Water – seepage	Provide the NOEF underdrain water quality monitoring results data to the Mine Principal Engineer for assessment and interpretation to assist in greater understanding of the water quality of seepage collected from the NOEF.
OFI-WR22-06	Cover trials	Consider methods to refine the cover system design and reduce the construction effort but retain the high level of cover performance to ensure environmental protection.
OFI-WR22-07	Cover trials	Consider developing and conducting further cover liner trials to test the BGM in extreme conditions to demonstrate its infiltration barrier integrity and long-term durability performance properties.
OFI-WR22-08	Revegetation	Conduct NOEF revegetation trials with proposed species and cover materials to ensure revegetation does not affect the performance of the BGM and cover system.
OFI-WR22-09	Monitoring Data	Collate the various monitoring program records to aggregate the data for analysis to potentially gain even greater learnings and understanding of the processes and behaviour of the waste rock and the NOEF.
OFI-WR22-10	Review – the Management Plan	Review the Management Plan regularly (suggest every other year) and, where necessary, update the Plan.
OFI-WR22-11	Reporting - As Built	Prepare an 'as built' reporting schedule to identify for which component, stage/s or project of the works require an 'as built' report is to be prepared.
OFI-WR22-12	Roles and Responsibilities	Update the Management Plan to reflect current position/role titles and ensure clear assignment of waste rock handling procedure responsibilities.

5 Conclusion

This audit considers commitments and safeguards of the McArthur River Mine Operator's waste rock handling procedures as relevant to the receiving environment, including the health of the McArthur River. The audit addresses Operator processes associated with waste rock classification, mining and haulage as well as the NOEF design, construction and operation.

This audit assessed the Operator to be achieving a "good to very good" level of implementation of the Management Plan requirements. In addition, the Operator has demonstrated effective action to address stated objectives for the design, construction and operation of the NOEF. These findings were based upon document reviews, audit interviews and site visit audit evidence obtained that demonstrated a high level of action to address requirements. Important observations that support these findings include:

- The revised waste rock classification system has resulted in an improved understanding of the waste rock geochemistry prior to transport to the NOEF and subsequent enhancements to the Mine's waste rock handling operations and NOEF design and construction.
- The Operator places particular focus on grade control processes to identify and classify the ore and waste rock to ensure potentially reactive waste rock is segregated, transported and placed in appropriate zones within the NOEF based on the waste rock classification identified risk.
- The Mine's high level of investment in the development of the Modular GPS waste rock tracking system has supported environmental performance improvements by embedding a very high level of rigour in relation to waste rock handling procedures.
- The latest NOEF design has proven successful in recent years with no spontaneous combustion incidents resulting in any off-site sulphur dioxide emissions criteria exceedances.
- Recent and extensive NOEF-related monitoring programs demonstrate that no exceedance of contaminant levels in water quality, sediment or biota has occurred in receiving environments downstream of the mining lease.
- The workforce across business units consistently displayed a recognition of the importance of observing waste rock handling procedure requirements to enable them to individually contribute to high standards of environmental performance in the management of potentially reactive waste rock.

The audit report highlights some medium and some longer-term opportunities for improvement in relation to greater resolution in waste rock classification, monitoring NOEF seepage, cover trials, NOEF revegetation trials and collating existing monitoring data for further analysis.

Overall, the collective advancements in waste rock handling procedures since the OMP EIS provide an elevated level of environmental protection for the receiving environment including the McArthur River.

Appendix A
Waste Rock (Overburden) Classification

Waste Rock Classification System

The table below is an extract from the Management Plan, Section 1.4.2 Overburden Geochemistry and Fundamental Management Requirements.

The table provides the classification criteria for waste rock types and corresponding classes with infomation on the managment of each classification.

Criteria	Class	Description	Management
NPR ≥ 2 and S < 1% and Zn < 0.12 % and Pb < 0.04% and As < 40 ppm and Cd < 10 ppm	LS-NAF (HC)	Low Salinity High Capacity NAF. Material considered at low risk of generating AMD. Generally characterised by a high acid consumption capacity.	This material is considered environmentally benign and suitable for placement in environmentally sensitive areas such as the overburden emplacement facility (OEF) outer cover. Only sediment controls are required. Control of dilution from surrounding non-benign materials will be required during mining.
NPR ≥ 2 and S ≥ 1% or Zn ≥ 0.12 % or Pb ≥ 0.04% or As ≥ 40 ppm or Cd ≥ 10 ppm	MS-NAF (HC)	Metalliferous Saline High Capacity NAF. Material considered at low risk of generating AD but higher risk of generating Saline Metalliferous drainage. Generally characterised by a high acid consumption capacity.	This material is not considered environmentally benign and requires some form of encapsulation and water management strategy. Suited to encapsulating higher-risk materials within the internal zones of the OEFs.
1 ≤ NPR < 2	MS-NAF (LC)	Metalliferous Saline Low Capacity NAF. Material considered at risk of generating Saline Metalliferous drainage. While non-acid forming, this material is likely to provide limited acid consumption capacity.	This material is not considered environmentally benign and requires some form of encapsulation and water management strategy. Suited to encapsulating higher-risk materials within the internal zones of the OEFs.
NPR < 1	PAF (HC)	High Capacity PAF. Material considered at risk of generating AD, though high acid-consumption capacity results in a considerable lag period. Will generate SD and NMD in the short- to medium-term. Samples classed as undefined according to the DITR 2007 classification are included in the PAF (HC) category at MRM.	This material is not considered environmentally benign and requires some form of an encapsulation and water management strategy. To be placed in the inner core of OEFs with moderate oxidation-reduction strategies.
NPR < 1 and S ≥ 10% and BbH	PAF (RE)	Reactive PAF Material considered at high risk of generating AD, and at high risk of self-heating which may progress into spontaneous combustion. High acid-consumption capacity will result in considerable lag times to acid generation if combustion is avoided.	This material is not considered environmentally benign. It requires encapsulation and water management. Additionally, intense oxidation-reduction strategies will be required to manage self-heating. To be placed further inside the inner core of selected OEFs, in dedicated cells.
S ≥ 20%	PAF (HW)	Hanging wall pyrite, which is the most pyritic material at MRM. PAF Material considered at high risk of generating AD, and at high risk of self-heating which may progress into spontaneous combustion.	This material is not considered environmentally benign. It has been segregated for management as per PAF (RE) before sub-aqueous disposal at the end of mine life.

NPR = neutralisation potential ratio; S = sulphur; Zn = zinc; Pb = lead; As = arsenic; Cd = cadmium; BbH = Black Bituminous Shale

Appendix B
Detailed Audit Methodology

B1 Audit framework

An Audit Framework was prepared that outlines the Audit Plan and procedures. The core elements of the Audit Framework were tailored by the McArthur River Mine Independent Monitor and are provided in the following Sections B2 to B8.

B2 Audit plan / schedule

Table B-1 McArthur River Mine, waste rock handling procedures, audit plan and schedule

Day / Time		Activity	Notes / Comments
Monday 13 June 2022 MRM site	0700h-0815h	Flight TL812 DWN to MRM dep 0700h arr 0815h	Booking flights 2 passengers Booking accommodation 2 nights, 2 persons, arr Mon 13 June 22 (am flight), dep Wed 15 June 22 (pm flight)
	0900h -1700h	Waste Rock handling audit early work	Opportunity to hold audit interview/s or visit/s on Monday, earlier if MRM staff unavailable on Tuesday or Wednesday
Waste Rock Handling Audit Day 1 Tuesday 14 June 2022	0800h-0915h	Interview	With the Superintendent Environment
	0930h-1600h	Interviews	Audit will utilise pre-prepared interview questionnaires as appropriate: 1. Waste rock handling procedure – environmental risk and audit interview questionnaire (Enviro) 2. Waste rock handling procedures – compliance audit interview questionnaire (NOEF Superintendent, Project Manager, Project Engineer, Quality Assurance Representative, Survey, Mine Planning, Mining, others) Interviewee participant/ availability /venue • NOEF Superintendent • Project Manager or Project Engineer • Survey • Quality Assurance Representative • Other relevant MRM staff – NOEF Manager
	1000h-1100h	Interview #1	Interviewee
	1100h-1200h	Interview #2	Interviewee

Day / Time		Activity	Notes / Comments
	1300h-1400h	Interview #3	Interviewee
	1400h-1500h	Interview #4	Interviewee
	1500h-1600h	Interview #5	Interviewee
Waste Rock Handling Audit Day 2 Wed 15 June 2022	0800h-1200h	Site visit (Refer proposed locations below)	The key documents to verify compliance with for the Waste Rock Handling Procedures audit are the approved: 1. MMP Appendix F – Waste Characterisation Report 2. MMP Appendix G – NOEF Management Plan It is expected that the audit site visit will also include viewing documentation/records in the office to further inform discussions (e.g. waste rock handling procedures/Management Plans/Reports/Monitoring and Identification/Testing/ Verification, waste transfer and tracking process and procedures, Air Quality Plan, ICE monitoring reporting e.g. as constructed reports, QA/QC, Position Descriptions with waste rock handling responsibilities and accountabilities). In addition to the Environment team members, if necessary, the audit team may wish to meet and discuss specific aspects with the Mine's Senior Management Team members or their delegates, as needed (this could be done in the second half of Day 2 once the audit team has compiled questions during the site visit): During the site visit the audit team may seek to engage with shift supervisors/operators, as relevant, to ask some questions. Waste rock handling procedures focus areas will include: • Main pit and waste rock haul routes • NOEF West (Alpha, Bravo, Charlie), CW (Alpha, Bravo and Charlie), CE (Alpha and Bravo) SE, NW, N • NOEF groundwater seepage interception and recovery system • Water dams and runoff management infrastructure (incl PRODS, segregation of Mine affected water and contaminated runoff) • NOEF geosynthetic cover systems trial • Air Quality monitoring stations • Other relevant water rock handling Mine site locations/facilities
	1300h-1500h	Interviews or complete site visit inspections	Complete interview/s unable to be conducted on Day 1 Site inspection of any key areas unable to be visited pre lunch

Day / Time		Activity	Notes / Comments
			Review key procedures/plans Preparation of presentation for closing meeting
	1530h-1600h	Closing meeting	Closing Meeting with Senior Management Team members, key audit findings
	1905h-2025h	Flight TL817 MRM to DWN Overnight Accom. Darwin	Flight Booking TBC 2 passengers Accommodation overnight, Darwin

B3 Pre-audit meeting

A pre-audit meeting (scoping meeting and discovery meeting via conference call) was held with MRM Environment Superintendent and Advisian Auditors to identify site-specific environmental performance risks and areas of focus for the audit.

B4 Request for information

As part of the pre-audit planning an RFI was prepared to support the MRM Independent Monitor Waste Rock Handling Procedure Audit. The RFI is presented in table B-2.

Table B-2 Pre-Audit request for information

Item No.	Item
1	Mining Management Plan Appendix F – Waste Characterisation Report
2	Mining Management Plan Appendix G – NOEF Management Plan
3	Mining Management Plan Appendix H – ICE Endorsement of the NOEF Management Plan

B5 Document review

In preparation for the site visit and the interviews, Advisian conducted a review of the waste rock handling procedures, environmental management plans and other relevant documents to:

- Become familiarised with the site operations
- Gain an understanding of the environmental and monitoring framework at the site
- Gain understanding of the key environmental and community aspects and issues of the site
- Identify environmental risks
- Become familiar with the key documents against which environmental performance would be evaluated.

The document review assisted in identifying site-specific environmental risks. It also assisted with the site visit and interviews as it allowed the Advisian audit team to have informed discussions with MRM personnel regarding audit focus areas, without needing an extensive 'discovery' phase.

B6 Interviews

The purpose of the interviews was to identify and assess site-specific environmental performance that key site personnel considered important along with examining potential opportunities to improve performance. The interviews included:

- Developing and utilising an interview questionnaire with some pre-prepared questions and a checklist to promote consistency between and comprehensiveness of interviews
- Nominating key site management personnel to participate in interviews based on the respective areas of accountability e.g. Mining Manager, Environmental Superintendent, Operations Manager, Mining Operations Superintendent, Principal Mining Engineer, Production Supervisor, Mining Inspector and Relevant technicians

- Conducting an interview with the Environment Superintendent and key site personnel
- Environmental risks and performance in addition to examining the site's environmental managements system standards and procedures.

An interview questionnaire was prepared to facilitate interview sessions with key personnel to adequately understand how environmental performance is managed at the site. The questions were designed to examine and assess the MRM management team's understanding of the site's environmental performance.

Interviews were conducted with the following key site management personnel as listed in Table B-3.

Table B-3 Interview participants

Role
Environment Superintendent
Mining Manager
Principal Mining Engineer
Mining Operations Superintendent
Production Supervisor
Dispatcher

B7 Site visit - opening and closing meetings

Audit opening and closing meetings were held at site with the Mine's management team representatives and the audit team.

The Waste Rock Handling Audit opening meeting agenda included:

- A Safety moment
- Project team
- Objectives
- Approach
- Audit plan
- Deliverables
- Questions.

The Waste Rock Handling Audit closing meeting was a recap of:

- Identified risks
- Identified good practices
- Next steps
- Deliverables.

B8 Site visit inspection

The purpose of the site inspection is to focus on high risk areas/activities and conduct a visual assessment and on-site discussions with relevant site personnel at the respective site assets particularly areas identified as having environmental risks. Site inspection tasks include:

- Prior to the inspection, identifying higher risk site assets/activities and areas to inspect prior to site visit, and develop an inspection list
- Updating the inspection list, as required, based upon interview outcomes
- Facilitating discussion of potential environmental issues/risks and solution options at time of inspection with relevant site staff
- Where possible, meeting with operators to gain an understanding of their knowledge/training of standards and procedures and gain feedback on these standards and procedures
- Determining compliance against relevant corporate and site documents and legislative/approval requirements.

The Audit team was escorted by the MRM Environment Superintendent

The team visited the following areas:

- Main pit and waste rock haul routes
- NOEF West (Alpha, Bravo, Charlie), CW (Alpha, Bravo and Charlie), CE (Alpha and Bravo) SE, NW, N
- NOEF geosynthetic cover systems trial
- TSF Interception trench
- TSF Cells 1 & 2
- NOEF groundwater seepage interception trench and recovery system
- Mine levee release point
- Water dams and runoff management infrastructure (incl PRODS, segregation of Mine affected water and contaminated runoff)
- Dispatch control room
- Vegetation nursery
- Geochemistry laboratory
- Soils and materials laboratory
- Haul truck depot (including Modular).