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1 General

1.1 Company and Project Profile

McArthur River Mine (MRM) is a major open cut operation that mines one of the largest known sedimentary stratiform zinc-lead-silver deposits in the world. The orebodies making up the deposit, named *Here’s Your Chance* (HYC), were discovered by Mount Isa Mines (MIM) geologists in 1955, but commercial production did not commence until 1995.

Subsequent developments in fine grinding technology and the emergence of a market for high-grade bulk concentrate for smelters using the Imperial Smelting Process enabled MRM to become a viable project. Construction commenced (as an underground mining operation) in 1994, with the first shipment of bulk concentrate (containing payable zinc, lead and silver) loaded in mid-1995.

In 2003, McArthur River Mining Pty Ltd (McArthur River Mining) announced its intention to convert the underground zinc-lead mine to an open cut operation to enable the mine to continue production. An EIS was lodged as part of a formal assessment process administered by the NT Government based on the Terms of Reference (TOR) issued in 2003. This was followed by the submission of an EIS Supplement (December, 2005) and Public Environmental Report (July, 2006). The NT Government approved the large scale open cut development in October, 2006. Later, during the same month, the Australian Government provided its consent under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). These projects extended the life of mine by an estimated 21 years to 2027.

MRM’s current operations were approved by the Northern Territory (NT) Government in 2013 as the Phase 3 Development Project. This enhanced the project economics and operational life, increasing minable reserves from 53 million tonnes (Mt) to 115 Mt, and extending the life of the mine by a further nine years from 2027 to 2036. This relied upon further technological advances to the processing facilities to produce a new zinc concentrate, opening up a new market for MRM concentrate.

Since the approval of Phase 3, McArthur River Mining has significantly improved its understanding of the overburden geochemistry at MRM. The changes required as a result of this, have necessitated the completion of an additional EIS, referred to as the Overburden Management Project (OMP), which commenced in August 2014. This OMP includes a number of amendments to the Phase 3 Development Project, including:

- refinement of overburden classification and management practices;
- improvements to open cut development and closure aspects;
- revised Tailings Storage Facility (TSF) closure strategy;
- revised water management strategy; and
- revised Project scheduling and phasing.

The proposed open cut mining method, zinc and lead concentrate products produced and transport logistics utilised by MRM will not change from the approved Phase 3 Development Project.

Further details on these proposed changes to future operations are provided in the OMP Draft EIS in Chapter 3 – Project Description and Justification, as well as in the Supplementary EIS Section 5.
1.2 Purpose of this Document

The OMP has originated from an improved understanding of the geochemistry of the overburden and the need to manage it differently from that in the past. As part of this updated management approach, MRM has made a commitment to implement an adaptive management system on the site as part of the Project closure phase. An overview of this proposed system was provided in the Draft EIS, Section 3.3.4, although a number of stakeholder submission comments have requested further detail, including:

- clarity regarding how the adaptive management process will be implemented (i.e. clear objectives, identification of uncertainties, quantitative triggers for implementation, monitoring, options for each rehabilitation goal, action plans in the event that triggers are exceeded); and
- commentary on key decision points for environmental management of a closed site and information required to inform that decision-making.

In addition, regulatory feedback has indicated that a robust framework needs to be developed for action where monitoring indicates that implemented measures and approaches are not effective. Monitoring would need to be designed with adequate sensitivity to detect issues, and include appropriate parameters and locations for detection in the long-term.

In response to these comments, MRM has developed this adaptive management framework document for stakeholder review.

1.3 Scope of Adaptive Management Framework

This document defines the framework that has been established to proactively manage and mitigate the Project’s environmental risks. MRMs adaptive management process will form an integral part of MRM’s site environmental management framework and overarching Health Safety Environment and Community Management System (HSEC MS), the components of which have been described in Section 14.2 of the Draft EIS.

Although there are no specific Australian or international management system standards developed for adaptive management, there are a number of guidelines and other reference documents developed which describe the adaptive management process.

Schreiber et al. (2004) state that the aim of an adaptive management framework is:

“To improve environmental management measures through ‘learning by doing’ and understand the impact of incomplete knowledge...”;

The Australian Government Handbook on Mine Closure – Leading Practice Sustainable Development Program for the Mining Industry defines adaptive management as the systemic process for continually improving management policies and practices by learning from the outcomes of operational programs. The ICMM’s good practice guidance on mining and biodiversity refers to adaptive management as ‘do–monitor–evaluate–revise’;

CEMA (2012) states that adaptive management involves the “careful execution of an iterative, seven-step process” including:

- define the management problem;
- establish governance;
• design the development/infrastructure and its monitoring plan;
• implement the design;
• monitor and observe performance;
• assess and evaluate the performance of the design against the objectives; and
• revise design/operation (cycle back); and

Lee (2014) identified a number of key elements that any adaptive management framework requires for it to be effective, including:

• define the management problem;
• set clear management objectives;
• identify uncertainties and hypothesise;
• identify, select and implement management actions;
• monitor ecosystem response;
• evaluate and report on findings;
• adjust management actions in response to learnings; and
• reiteration of the above elements in an ongoing cycle with evolving management practices in response to learnings and ecosystem changes.

In addition, Lee (2014) states that:

• transparency in the adaptive management process (including as part of up-front design implementation) is critical to enable public oversight and ensuring accountability; and
• good adaptive management requires thorough front end environmental impact assessment in order to determine ecosystem baselines, identify uncertainties and make informed decisions on planning and management.

MRM is developing a two-phased approach to the development of its adaptive management framework as follows:

i. Phase 1 documentation (this report), which:
   o is a strategic level document providing the overarching framework detail and how it will be applied throughout the life of the Project;
   o focusses on the identification, management and monitoring of Project risks as identified in the Draft EIS;
   o includes a framework for how major mine closure related key decision processes will be managed (e.g., mine pit lake closure, North Overburden Emplacement Facility (NOEF) cover system performance and integrity management);
   o incorporates external reporting obligations into MRM’s existing process under the Mining Management Act; and
   o includes a number of commitments including:
     ▪ incorporating proposed annual adaptive management performance monitoring and reporting into the relevant annual audit programs such as the current Independent Monitor’s annual audit program;
     ▪ provision of additional information as it becomes available; e.g.:
       - results of ecotoxicology studies and associated updated performance indicators;
       - updated adaptive management register;
       - updated Environmental Management Plans (EMPs) incorporating results of ecotoxicology studies and any revised performance indicators or site specific trigger values (SSTVs); and
       - more detail on MRM’s closure strategy including an updated mine closure plan incorporating stakeholder consultation details; and
development of Phase 2 adaptive management framework document (refer to point ii below).

ii. Phase 2 documentation, which will:
   o Be an operationally focussed document developed in consultation with the NT EPA;
   o Incorporate the philosophy of the Phase 1 strategic document, but include additional operational details including any additional risks as identified from MRM’s ongoing Broad Brush Risk Assessment process; and
   o Include any available information as committed to in the Phase 1 document.

1.3.1 Alignment with ISO14001 (Environmental Management System) Framework

Based on the abovementioned key elements, MRM’s adaptive management framework is being developed in accordance with the Standards Australia 2014 – ISO 14001 (Environmental Management System) framework, following the “Plan-Do-Check-Act” model. MRM is committed to developing the framework in accordance with the philosophy of ISO14001 including establishing, documenting, implementing, maintaining and continuously improving the system through the establishment of appropriately resourced processes.

The adaptive management framework will be applied:

- during the Operational phase of the Project (nominally 2018-2037); and
- at Project Closure (i.e. throughout MRM’s active closure and proactive monitoring phases) where the process will be used to define and guide key closure decision steps.

Table 1-1 provides a cross-reference between the key ISO14001 elements and MRM’s adaptive management framework.

1.3.2 Key Elements

The key elements of MRM’s adaptive management framework include:

- identification of the Project aspects and associated environmental risks;
- establishment of appropriate performance measures (or objectives) for each Project risk;
- establishment of relevant performance indicators (or targets) for each performance measure (including development of trigger values to provide early warning of potential non-compliances);
- design and implementation of targeted monitoring and management programs for each performance indicator; and
- establishment of a reporting and review process to facilitate continual improvement. This includes both internal (MRM) review of framework performance and external review of annual performance reports by the current Independent Monitor program.

These key elements are discussed in further detail in Sections 3, 4 and 5, with Figure 1-1 providing an overview of their relationship to each other and the ISO14001 elements.
### Table 1-1  ISO14001 Elements verses MRM’s Adaptive Management Framework Elements

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| 4.4.5 - Control of documents | ✓ Section 4.5  
- Provides a summary of MRM’s document filing system. |
| 4.4.6 - Operational Control | ✓ Section 4.6  
- Overview of MRM’s existing management plans, procedures and monitoring programs  
- Description of the environmental management plans purpose and structure. |
| 4.4.7 - Emergency preparedness and response | ✓ Section 4.7  
- Outlines how potential emergencies that can have environmental impact are identified. Includes an outline of MRM’s environmental incident management procedure and emergency response plan. |
| 4.5 - Checking | ✓ Section 5  
- Discusses MRM’s system of checking its performance against set objectives and targets. |
| 4.5.1 - Monitoring and measurement | ✓ Section 5.1  
- Provides operational monitoring measures and the monitoring measures taken post mining and into the closure/decommissioning stages of the Project.  
- This section also describes the key processes to be implemented (including monitoring, mitigations, reporting, and regulatory consultation steps as part of final void, NOEF and TSF closure. |
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**MRM Adaptive Management Framework - Key Elements**

- **Performance Indicator Monitoring and Management Programs**
  - Identify relevant Project Risks (Mr. Draft EIS Risk Assessment and Management Plan)
  - Establish relevant Performance Indicators (can be quantitative and/or qualitative, designed to demonstrate that performance measures are effective and act as an “early warning system”)

**MRM Annual performance reporting (via development of OPR) in accordance with Mining Management Act.**

- Amendments to performance indicators and measures as recommended.

**MRM Annual Broad Brush Risk Assessment**

- MRM to engage independent specialist to assess performance indicator and measure compliance.

**MRM Annual Site Senior Management Review**

- Agency acceptance of independent report findings and recommendations?
1.3.3 Operations verses Project Closure Management

The Draft EIS described the adaptive management stage of the Project as applying at Project closure for a nominal 70 to 80 year period (refer Draft EIS, Section 3.3.3). MRM has further developed this and plans to implement the framework as part of its operations stage as well, during which time MRM will refine the framework’s key elements (including site specific performance indicators) in preparation for site closure. Table 3-2 below provides further site specific details of these key elements, with supporting explanations also included within Section 3.

In addition, given the fact that the mine’s closure process will comprise decommissioning, rehabilitation and monitoring tasks, MRM has developed formal workflow models for the Project Domains key closure steps. Section 5.1.2 provides further detail. These workflows should be considered fluid and may change depending on monitoring, changed conditions and new ideas developed.

1.3.4 Site Management Leadership and Accountability

McArthur River Mining is committed to the highest standards of environmental management and performance. To support this, senior and line management roles include specific environmental responsibilities as summarised below:

- **McArthur River Mining’s General Manager** – has overall responsibility for ensuring that all environmental commitments are met at McArthur River Mine.

- **Environment Safety and People Manager** – Responsible for the preparation and management of work programs and monitoring that are based around commitments documented in the Mining Management Plan, Annual Operating Performance Report, Commonwealth Environmental Monitoring Plan and previous EIS and Public Environment Reports.

- **Site Managers** – responsible for management of their specific department’s performance including ensuring that personnel under their management have the requisite competencies, skills and training in order to carry out their assigned tasks effectively and efficiently.

- **Site Superintendents** – report on the implementation and performance of the various EMPs within their areas of responsibility, and (in the event of non-conformance) undertake appropriate investigation, reporting and implementation of corrective actions in accordance with MRM procedures.

The organisation’s Leadership, Policy and Organisation procedure (MSP-01) outlines how Health, Safety, Environment and Community (HSEC) Management shall demonstrate leadership for, and support of, a HSEC culture that is aligned with the organisation’s Values and Code of Conduct; underpinned by engagement and accountability; and made tangible through the implementation of Corporate HSEC policies and the HSEC Management System.
2 Environmental Policy

MRM’s operational philosophy is reflected in its parent company Glencore Zinc’s Environmental Policy, which can be made available on request of the NT EPA.

In addition, MRM operates in accordance with its “Environment” Procedure (MSP-08), which forms an integral part of the HSEC management system. This procedure sets out MRM’s approach to environmental management, including:

- the establishment of formal environmental accountabilities at all levels of the organisation with senior and line management responsible for performance;
- the maintenance of managed site environmental management systems/programs that include processes to identify, analyse, evaluate and eliminate or otherwise treat all significant potential and actual impacts of their activities, inclusive of product stewardship implications, on the environment, biodiversity and the effective functioning of ecosystems;
- the adoption of compliance, risk management, pollution control, resource efficiency, product stewardship, biodiversity protection, rehabilitation and closure criteria to determine priorities, capability requirements, capital expenditure, and controls;
- improvement plans and target setting at each level of a managed site that considers Glencore and Department designated priorities as directed including pollution prevention, resource efficiency, product stewardship, respecting legally protected areas, protecting biodiversity, rehabilitation and closure planning;
- environmental incident reporting and the application of investigation processes that seek to identify basic causes and prevent reoccurrence;
- the use of assessment, audit, incident and other learning inputs to periodically review the functioning and effectiveness of environmental management processes and practices, and to identify and capture improvement opportunities;
- advancing our understanding of our materials, their impacts, risks, benefits, and opportunities during their lifecycle through the conduct or support of data and knowledge gathering;
- engaging with business partners, industry associations and other relevant stakeholders to develop long-term relationships to support product stewardship, to promote responsible use and to maintain access to markets and act on business opportunities;
- communicating relevant information on our products to our workers and customers to allow safe transport, handling and use;
- aiming to improve the sustainability in the production and application of our products; and
- endorsing the need for the responsible management of mercury which might naturally occur in our products.

3 Planning

MRM’s planning process is centred on the key planning related elements of ISO14001 including:

- identification of significant environmental aspects and key environmental risks (refer to Section 3.1 for details);
- identification of legislative requirements (refer Section 3.2 for details); and
- development of subsequent objectives, targets and management and monitoring programs (refer to Section 3.3).
3.1 Environmental Aspects

MRM operates in accordance with formal management system procedures including its procedure Risk, Hazard and Impact Management (MSP-02), which applies a process to systematically identify, assess, control and communicate HSEC risks associated with MRM’s activities. This requires MRM to:

- identify, rank and communicate the risks posed by its site to people and the environment;
- identify, understand, document and communicate hazards in tasks and jobs before commencing work, and manage these hazards through to the completion of the work; and
- provide the workforce with personal risk management tools to minimise the risk of personal injury and environmental impact arising from day to day activities.

The OMP Draft EIS included the conduct of a detailed Project Risk Assessment (refer Chapter 7 of the Draft EIS for details). This assessment was informed by an extended technical study and stakeholder engagement program, conducted over a multi-year timeframe (refer to Figure 7-1 in the Draft EIS) and included the identification of those environmental aspects of the Project that can have a significant impact on the environment. This list has been complemented with additional aspects as identified through the Draft EIS stakeholder review and submission process.

Each identified environmental aspect has been subject to a qualitative risk analysis based on likelihood and consequences of environmental impact or impact on the organisation from environment-related issues, in the context of existing measures to control the risk. This assessment has been undertaken in accordance with Glencore’s Corporate Risk framework.

Conducting a risk analysis of site environmental aspects resulted in the allocation of risk scores, both inherent and residual, with a subsequent risk profile developed for the Project (refer Chapter 7 of the Draft EIS for further details).

A series of key risks has subsequently been identified from this process (i.e. they were identified as having the potential for significant environmental impact). These key risks were based on a calculated residual risk score of medium or higher, and have been used as the basis for the MRM aspects register, as provided in Table 3-1 below. These risks are given priority for management, and are taken into account in establishing, implementing and maintaining MRM’s adaptive management system.

The Register of Environmental Aspects is reviewed each year to ensure that it is kept up to date. It is also reviewed if there is any change to activities, products or services.

Environmental aspects associated with a legal requirement, or another requirement to which MRM subscribes are also considered to be significant, independent of the outcome of the risk analysis.
## Appendix R – Adaptive Management Framework

### Table 3-1  Register of Project Environmental Aspects

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</tr>
<tr>
<td>1</td>
<td>Site wide</td>
<td>Site-wide flood</td>
<td>Overload of adaptive management controls (Long-Term)</td>
</tr>
<tr>
<td>2</td>
<td>NOEF</td>
<td>Inappropriate storage and disposal of overburden</td>
<td>Contamination of surface water systems</td>
</tr>
<tr>
<td>3</td>
<td>TSF</td>
<td>Accumulation of surface waters on the TSF</td>
<td>Piping through wall and subsequent contaminant release.</td>
</tr>
<tr>
<td>4</td>
<td>Open cut</td>
<td>Spontaneous combustion in walls of the open cut</td>
<td>Increased geochemical loading on waters in the open cut, leading to deterioration of water quality.</td>
</tr>
<tr>
<td>5</td>
<td>Site wide</td>
<td>Changes to values within the site’s current waste discharge license (WDL)</td>
<td>Mine’s ability to meet any new proposed trigger values</td>
</tr>
<tr>
<td>6</td>
<td>TSF</td>
<td>Increased holding capacity</td>
<td>Creates groundwater mound beneath TSF, with potential impacts on surface water flow regimes, surface water quality and aquatic habitat</td>
</tr>
<tr>
<td>7</td>
<td>Open cut</td>
<td>Geotechnical failure of the open cut wall with the mine pit lake partially filled</td>
<td>Loss of western levee functionality and the resultant water inflows in flood and releases after flood event and failure to meet downstream water quality objectives.</td>
</tr>
<tr>
<td>8</td>
<td>Open cut</td>
<td>Open cut wall failure compromises long term mine pit lake water quality</td>
<td>Loss of functionality of western levee, incorrect location of McArthur River inflow, levee failure and failure to meet downstream water quality objectives</td>
</tr>
<tr>
<td>9</td>
<td>NOEF</td>
<td>Seepage from facility including PAF material</td>
<td>Giving rise to acid and metalliferous drainage, with impacts on surface water quality.</td>
</tr>
<tr>
<td>No.</td>
<td>Project Domain</td>
<td>Aspect</td>
<td>Impact</td>
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</tr>
<tr>
<td>10</td>
<td>NOEF</td>
<td>Failure of surface water management system within/around the NOEF</td>
<td>Impeding ability to achieve acceptable downstream water quality</td>
</tr>
<tr>
<td>11</td>
<td>Open cut</td>
<td>Slow filling of the mine pit lake</td>
<td>Poor water quality (change in water chemistry) and inability to meet water quality criteria</td>
</tr>
<tr>
<td></td>
<td><strong>Groundwater</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>NOEF</td>
<td>Inappropriate storage and disposal of overburden</td>
<td>Contamination of groundwater systems</td>
</tr>
<tr>
<td>13</td>
<td>Open cut</td>
<td>Water treatment plant operations and inability to treat seepage waters (post closure)</td>
<td>Leading to a change in chemistry within the groundwater and inability to meet water quality discharge criteria.</td>
</tr>
<tr>
<td></td>
<td><strong>Biodiversity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Site wide</td>
<td>Clearing of vegetation</td>
<td>Reduction in habitat for certain species of fauna and flora</td>
</tr>
<tr>
<td>15</td>
<td>Open cut</td>
<td>Mining below groundwater level</td>
<td>Potential drawdown in adjacent McArthur River and waterholes, with reduction in habitat availability</td>
</tr>
<tr>
<td>16</td>
<td>Site wide</td>
<td>Lack of appropriate fluvial sediment management</td>
<td>Impacts on aquatic environments and ecology, and potentially health of people consuming fish</td>
</tr>
<tr>
<td>17</td>
<td>NOEF</td>
<td>Seepage from facility including PAF material</td>
<td>Giving rise to acid and metalliferous drainage, with impacts on aquatic habitat.</td>
</tr>
<tr>
<td>18</td>
<td>NOEF and TSF</td>
<td>Generation of acid and metalliferous drainage</td>
<td>Impacts on wildlife through exposure to (and accumulation of) metals and other toxicants</td>
</tr>
<tr>
<td>No.</td>
<td>Project Domain</td>
<td>Aspect</td>
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<tr>
<td>19</td>
<td>NOEF</td>
<td>Placement of non-benign overburden material in the growth medium</td>
<td>Revegetation failure</td>
</tr>
<tr>
<td>20</td>
<td>Open cut</td>
<td>Ingress of Largetooth Sawfish into the mine pit lake</td>
<td>Sawfish kills due to lack of suitable habitat available</td>
</tr>
<tr>
<td>21</td>
<td>Site wide</td>
<td>Changed vegetation due to operations and rehabilitation, including spread of invasive/feral species</td>
<td>Impact on significant species/habitat</td>
</tr>
<tr>
<td></td>
<td><strong>Social and/or Economic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Site wide</td>
<td>EIS rejected by regulator</td>
<td>Inability to continue mining for ore beyond current approval period, and ultimate closure of the mine with resultant loss of jobs and investment in the community</td>
</tr>
<tr>
<td>23</td>
<td>Site wide</td>
<td>Major changes in the design of the NOEF and other final landform features</td>
<td>Community benefits being less than previously expected</td>
</tr>
<tr>
<td>24</td>
<td>NOEF</td>
<td>A change in the block model resulting in a change to the non-acid forming (NAF) and potentially acid forming (PAF) ratio (NAF/PAF ratio) during construction (e.g. insufficient clean layers available)</td>
<td>Triggers the need for a further assessment, with resultant cessation of operations and subsequent loss of jobs and community investment.</td>
</tr>
<tr>
<td>25</td>
<td>NOEF and TSF</td>
<td>Release of contaminated waters above acceptable levels</td>
<td>Negative social and economic impacts to the Roper-Gulf region and the NT associated with environmental degradation</td>
</tr>
<tr>
<td>No.</td>
<td>Project Domain</td>
<td>Aspect</td>
<td>Impact</td>
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<tr>
<td>26</td>
<td>TSF</td>
<td>Tailings re-mining</td>
<td>Mine face or embankment failure leading to injuries to site personnel</td>
</tr>
<tr>
<td>27</td>
<td>TSF</td>
<td>TSF construction activities</td>
<td>Injury to site personnel (e.g. from tailings delivery pipeline movement on crest of embankment)</td>
</tr>
<tr>
<td>28</td>
<td>NOEF and TSF</td>
<td>Generation of acid and metalliferous drainage</td>
<td>Potential impact on public health (e.g. through consumption of contaminated aquatic fauna)</td>
</tr>
<tr>
<td>29</td>
<td>NOEF</td>
<td>Spontaneous combustion of overburden</td>
<td>Release of sulphur dioxide and other products of combustion and affecting nearby receptors</td>
</tr>
<tr>
<td>30</td>
<td>Open cut</td>
<td>Spontaneous combustion during in-pit dumping rehabilitation works</td>
<td>Sulphur dioxide exposure to site personnel</td>
</tr>
<tr>
<td>31</td>
<td>TSF</td>
<td>Exposure of tailings to atmosphere during re-mining</td>
<td>Generation of AMD and/or sulphur dioxide</td>
</tr>
<tr>
<td>32</td>
<td>TSF</td>
<td>Spontaneous combustion of tailings due to improper handling during dam construction</td>
<td>Potential health impacts</td>
</tr>
<tr>
<td>33</td>
<td>Open cut</td>
<td>Poor mine pit lake water chemistry</td>
<td>Inability to relinquish site</td>
</tr>
<tr>
<td>34</td>
<td>TSF</td>
<td>Storage of tailings and process water</td>
<td>Excessive settlement of the embankments and/or overtopping and resultant release of tailings to the environment</td>
</tr>
<tr>
<td>No.</td>
<td>Project Domain</td>
<td>Aspect</td>
<td>Impact</td>
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</tr>
<tr>
<td>35</td>
<td>TSF</td>
<td>TSF high rate of rise</td>
<td>Embankment failure which leads to a release of contaminants</td>
</tr>
<tr>
<td>36</td>
<td>TSF</td>
<td>Earthquake/seismic activity</td>
<td>TSF embankment failure and release of tailings/contaminants</td>
</tr>
<tr>
<td>37</td>
<td>Site wide</td>
<td>Operations are forced to cease prior to originally planned</td>
<td>Premature closure and rehabilitation of structures, potentially creating an ongoing environmental, social and/or economic legacy.</td>
</tr>
<tr>
<td>38</td>
<td>TSF</td>
<td>Water erosion or scouring of TSF embankment toe</td>
<td>Embankment failure and tailings release</td>
</tr>
<tr>
<td>39</td>
<td>TSF</td>
<td>Differential settlement of tailings</td>
<td>Cracking, a reduction in shear resistance, increase in potential for water infiltration and/or embankment piping failure, with potential for unplanned releases.</td>
</tr>
<tr>
<td>40</td>
<td>TSF</td>
<td>Embankment failure</td>
<td>Release of tailings and sediment causing environmental damage, cost from lost production, clean-up and reconstruction costs, regulatory restrictions, community discontent, and a potential fatality or permanent incapacity</td>
</tr>
<tr>
<td>41</td>
<td>NOEF</td>
<td>Geotechnical failure of existing landform</td>
<td>Loss of cover system functionality and resulting in sedimentation and loss of gas and water management functions</td>
</tr>
<tr>
<td>42</td>
<td>NOEF</td>
<td>New NOEF construction around existing NOEF, with potential spontaneous combustion in new NOEF and desiccation of barrier layers</td>
<td>Cracking, ingress of water and high oxidation rates, with release of contaminants.</td>
</tr>
<tr>
<td>43</td>
<td>Site wide</td>
<td>Site-wide flood in the short term (30-100 years) as a result of the McArthur River overtopping the levee</td>
<td>Widespread erosion, overwhelming of water treatment facilities, disruption of operations and lack of access.</td>
</tr>
<tr>
<td>No.</td>
<td>Project Domain</td>
<td>Aspect</td>
<td>Impact</td>
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</tr>
<tr>
<td>44</td>
<td>TSF</td>
<td>Insufficient availability of suitable construction materials</td>
<td>Requirement to expand borrow material sources and associated increase in ground disturbances</td>
</tr>
<tr>
<td>45</td>
<td>Site wide</td>
<td>Fugitive dust emissions and metals introduced into food chain as a result of operations. Resulting in emissions from the TSF, haul roads, run-of-mine pad, concentrate stores and other aspects of operations, and seepage from the TSF, South Perimeter Runoff Dam, run-of-mine sump and NOEF.</td>
<td>Negatively impacts water and fluvial sediment quality in McArthur River and Barney, Little Barney and Surprise Creeks, including reduction in water quality, and associated reduction in diversity and abundance of aquatic fauna. Metals bio-accumulate in aquatic fauna, which are then consumed by humans, causing potential morbidity and/or health effects. Contaminants migrate downstream from the mine site. Contaminated biota move from exposed sites around the MRM to regional reference sites.</td>
</tr>
</tbody>
</table>
3.2 Legal and Other Requirements

Chapter 2 – Legislative Framework of the Draft EIS provides a summary of the Commonwealth, Northern Territory and Local Government legislative requirements applicable to the Project, including whole-of-project approvals, permits, licences, policies, standards and codes of practice.

In addition, the organisation operates in accordance with its Compliance (Legal and Other) and Document Control Procedure (MSP-03). This procedure includes the requirements that the site must meet in identifying and complying with the legal and other HSEC requirements to which it subscribes; and in providing the documentation required for the effective operation of their HSEC Management Systems.

3.3 Objectives, Targets and Programs

The site operates in accordance with its Plans, Resources, Targets and Management Review Procedure (MSP-04), which applies a consistent approach to the development and maintenance of HSEC objectives, targets and plans.

MRM has developed comprehensive objectives (also referred to as performance measures), targets (also referred to as performance indicators) and associated monitoring and management programs. These have been designed and implemented based on the identified site environmental risks (refer to Table 3-1 above). Table 3-2 below provides an overview of these objectives, targets and programs, with further explanation provided in Sections 3.3.1 to 3.3.3.
## Table 3-2  Overview of Project Objectives, Targets and Programs

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Performance Indicator</th>
<th>Monitoring Program or Initiative</th>
<th>Nominal Contingency Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surface Water</strong></td>
<td></td>
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</tr>
</tbody>
</table>
| Maintain integrity of the mine levee wall to avoid the overwhelming of site management infrastructure | Allocate landform stability indicators; e.g.:  
- long-term static drained Factor of Safety (FoS) of 1.5  
- maximum design earthquake (MDE) – 1 in 1,000 year event;  
- slumping indicator | Stability monitoring of the Project’s domains will include annual monitoring for the first ten years following closure/rehabilitation, with the frequency of further monitoring after this period to be determined by the results of the initial ten years. This monitoring will comprise:  
- aerial laser surveys (ALS) every five years to allow accurate quantification of any geomorphic changes;  
- satellite imagery reviews in the years that ALSs are not conducted; and  
- monthly visual surveys in the early stages of domain closure. | To be developed |
| Levee wall surface erosion | Mine Levee Wall Geotechnical Assessments:  
The mine levee wall is assessed annually by a qualified geotechnical engineer, particularly at the sites identified with surface erosion and the area adjacent to the beginning of the McArthur River Channel (where the old channel directs flood waters into the levee). Any areas of surface erosion are repaired to maintain structural integrity. | To be developed |
| **Maintain integrity of the TSF embankment wall/batters and adequately manage surface water** | Allocate slope stability indicators; e.g.:  
- long-term static drained Factor of Safety (FoS) of 1.5  
- maximum design earthquake (MDE) – 1 in 1,000 year event; and  
- slumping indicator. | Stability monitoring of the Project’s domains will include annual monitoring for the first ten years following closure/rehabilitation, with the frequency of further monitoring after this period to be determined by the results of the initial ten years. This monitoring will comprise:  
- aerial laser surveys (ALS) every five years to allow accurate quantification of any geomorphic changes;  
- satellite imagery reviews in the years that ALSs are not conducted; and  
- monthly visual surveys in the early stages of domain closure. | Should monitoring identify that additional or alternative water management intervention is required, MRM has developed a suite of management contingencies that can be drawn upon. These contingencies have been developed through a number of processes and include:  
- groundwater interception trenches;  
- vertical interception bores;  
- increased water treatment plant capacity;  
- increased water reuse;  
- increased water storages; and  
- decrease controlled water discharges. |
| TSF Embankment – the MRM Operational Management System includes a number of control measures designed to mitigate the potential impacts from any seismic event. These include:  
- regular inspections of the TSF and surrounds;  
- construction standards of TSF walls and foundations; and  
- TSF design considerations including dam safety (seismicity) allowances. | Should additional stability be required, modification to the embankment buttress, tailings handling (mud farming) and water management practices would be investigated. Such contingencies will be further developed. |
<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Performance Indicator</th>
<th>Monitoring Program or Initiative</th>
<th>Nominal Contingency Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation of the TSF as per Australian National Committee on Large Dams (ANCOLD) Guidelines in order to achieve the following:</td>
<td>As defined within MRM’s Operational Maintenance and Surveillance Manual, which defines and describes:</td>
<td>In accordance with ANCOLD guideline requirements:</td>
<td>As defined within MRM’s Operational Maintenance and Surveillance Manual.</td>
</tr>
<tr>
<td>• control the distribution of the tailings in order to achieve the required geometric shape of the deposit, to maintain the water pool within the specified position and to ensure that segregation does not compromise the structural integrity of the deposit;</td>
<td>• key components of the tailings water management systems;</td>
<td>• groundwater monitoring with special emphasis on the environmental impacts of the tailings dam on groundwater (e.g. geochemical impacts);</td>
<td>As defined within MRM’s DSEP.</td>
</tr>
<tr>
<td>• control the deposition cycle in order to ensure that settlement and drying of tailings conforms with the design intent;</td>
<td>• plans for operation of tailings placement and water management;</td>
<td>• visual monitoring and measurement (including chemical analysis of acid drainage generation) of surface drainage and seepage;</td>
<td></td>
</tr>
<tr>
<td>• control the level and position of the water pool in order to maintain a specified water cover or maintain freeboard to prevent the risk of overtopping;</td>
<td>• roles and responsibilities of personnel assigned to the facility;</td>
<td>• capacity monitoring (tailings, process water, water recovery, evaporation);</td>
<td></td>
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<tr>
<td>• control the flow and discharge of storm water which accumulates on the storage in such a way as to prevent damage;</td>
<td>• procedures required to operate and maintain the facility to ensure that it functions in accordance with its design, and meets regulatory and corporate policy obligations;</td>
<td>• tailings monitoring (e.g. beach development, drainage density, desiccation);</td>
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<tr>
<td>• control access so that only those persons authorised to gain access for the purposes of operation and supervisory management can do so;</td>
<td>• dam safety surveillance requirements; and</td>
<td>• monitoring of instrumentation and instrumentation readings;</td>
<td></td>
</tr>
<tr>
<td>• optimise the recycling of water from the storage where appropriate. Discharge of water to the environment should not be permitted unless specifically allowed in the design and subject to water quality requirements;</td>
<td>• An Emergency Response Plan for the TSF.</td>
<td>• monitoring of equipment and pipework;</td>
<td></td>
</tr>
<tr>
<td>• keep uncontaminated water separate from contaminated water; and</td>
<td></td>
<td>• monitoring of dam movements, stresses, cracking and seepage;</td>
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</tr>
<tr>
<td>• control dust during windy conditions by more frequent deposition to create maximum area of wet beaches and by control of traffic in the area.</td>
<td></td>
<td>• inspection reports (i.e. times, dates, observations);</td>
<td></td>
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<tr>
<td>Maintain integrity of the NOEF cover system to provide flood resistance to over the 100 year flood level</td>
<td>To be determined and documented within relevant operating manuals. Will include allocation of relevant indicators (e.g. material geotechnical specifications for texture/grading, permeability, etc.).</td>
<td>• Ongoing monitoring of gas concentrations and temperature. This internal monitoring will also provide validation of the impacts of overburden placement practices, and an understanding of the internal controls of AMD production and release</td>
<td>To be developed</td>
</tr>
<tr>
<td>Maintain compliance with WDL trigger value limits</td>
<td>NOEF design/construction related</td>
<td>NOEF construction manual / QA/QC Processes</td>
<td>Where incorrect placement of material is identified, it will be removed or appropriately managed to reduce its environmental risk to an acceptable level.</td>
</tr>
<tr>
<td>Performance Measure</td>
<td>Performance Indicator</td>
<td>Monitoring Program or Initiative</td>
<td>Nominal Contingency Management Measures</td>
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<tr>
<td>NOEF operations related</td>
<td>• OEF (Overburden Emplacement Facility) monitoring: monthly sampling of all active OEFs is conducted including non-acid forming material (NAF) stockpiles, potentially acid forming material (PAF) cells and low grade ore. This is aimed at controlling the correct placement of material types. • seepage (basal and toe) monitoring and management • NOEF cover system integrity</td>
<td>To be developed</td>
<td>To be developed</td>
</tr>
<tr>
<td>NOEF operational indicators</td>
<td>Additional gathering of information on various components of the water balance such that multiple lines of evidence can be developed to inform cover system performance. • OEF monitoring – monthly sampling of all active OEFs is conducted including non-acid forming material (NAF) stockpiles, potentially acid forming material (PAF) cells and low grade ore. This is aimed at controlling the correct placement of material types. • seepage (basal and toe) monitoring and management • NOEF cover system integrity</td>
<td>To be developed</td>
<td>To be developed</td>
</tr>
<tr>
<td>NOEF maintenance related</td>
<td></td>
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<tr>
<td>SW11 compliance point parameters include:</td>
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<tr>
<td>Field parameters:</td>
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<tr>
<td>• pH – 6.5-8.5 pH units; • electrical conductivity (EC) – 1000 microsiemens per centimetre (µS/cm); and • dissolved oxygen (DO) – 85-120 % saturation.</td>
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<tr>
<td>Metals and metalloids</td>
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<tr>
<td>• aluminium (Al) - 55 micrograms per litre (µg/L); • arsenic III (As) - 24 µg/L; • cadmium (Cd) - 1.73 µg/L; • copper (Cu) – 10.97 µg/L; • iron (Fe) - (II) and (III) – 300 µg/L; • lead (Pb) – 16.6 µg/L; • manganese (Mn) – 1900 µg/L; • mercury (Hg) – 0.6 µg/L; • nickel (Ni) - 11 µg/L; and • zinc (Zn) – 62.68 µg/L.</td>
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<tr>
<td>Total petroleum hydrocarbons (TPHs)</td>
<td></td>
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<tr>
<td>• TPH (C6-C9) – Benzene 950 µg/L and TPH (C10-C14) + (C15-C28) + (C29-C36) - 600 µg/L.</td>
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<tr>
<td>Other:</td>
<td>• sulphate (SO₄) – 341 milligrams per litre (mg/L); and • nitrate (NO₃) – 700 µg/L.</td>
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<tr>
<td>The objectives of the surface water monitoring program are to:</td>
<td>• measure the water quality in the McArthur River, Barney Creek, Surprise Creek, Emu Creek and the Glyde River; • compare the measured water quality in the McArthur River with site specific trigger values specified in WDL 174-9 (and subsequent versions of the WDL); • compare water quality from downstream monitoring sites with upstream control sites to help identify possible contamination of surface water; • identify the potential sources of any contamination measured in the McArthur River or the local tributaries; and • Determine the efficacy of the controls implemented by MRM to prevent contamination of surface waters</td>
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<tr>
<td>Proposed additional monitoring at closure (i.e. after 2047) includes establishment of surface water monitoring sites to enable the estimation of flow and quality into and out of the McArthur River from the mine pit lake. These monitoring sites would be located at both the downstream mine levee wall opening and the upstream mine levee wall opening.</td>
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<tr>
<td>If runoff and/or interflow from the NOEF final cover is found to be inappropriate for passive release, adaptive management measures will be required and/or additional storage volume will be needed to contain it within the Class 4 and/or Class 5 and 6 water management systems. Furthermore, where monitoring identifies runoff from the rehabilitated NOEF is suitable for direct release, the sediment management structures will be decommissioned.</td>
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<tr>
<td>Should monitoring identify that additional or alternative management intervention is required, MRM has developed a suite of management contingencies that can be drawn upon. These contingencies have been developed through a number of processes and include:</td>
<td>• groundwater interception trenches; • vertical interception bores; • increased water treatment plant capacity; • increased water reuse; • increased water storages; and • decrease controlled water discharges.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Measure</td>
<td>Performance Indicator</td>
<td>Monitoring Program or Initiative</td>
<td>Nominal Contingency Management Measures</td>
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<tr>
<td>Groundwater</td>
<td>Maintain groundwater quality such that surface water environmental values and ecosystems are maintained</td>
<td>Establish groundwater quality indicators - ANZECC (2000) Livestock Drinking Water Trigger Guidelines</td>
<td>MRM operates an extensive groundwater monitoring program with 256 groundwater monitoring bores installed across the MRM site including 54 in the mine process area, 90 at the NOEF and 92 at the TSF. The objectives of the groundwater monitoring network are to observe temporal and spatial changes in groundwater quality to allow assessment against the potential that these changes may be a result of mining operations. Corrective actions to be implemented if surface water quality does not meet the relevant standards. Should monitoring identify that additional or alternative management intervention is required, MRM has developed a suite of management contingencies that can be drawn upon. These contingencies have been developed through a number of processes and include:</td>
</tr>
<tr>
<td></td>
<td>Dissolved metals:</td>
<td></td>
<td>• groundwater interception trenches;</td>
</tr>
<tr>
<td></td>
<td>• aluminium (Al) – 5 mg/L;</td>
<td></td>
<td>• vertical interception bores;</td>
</tr>
<tr>
<td></td>
<td>• arsenic (As) – 0.5 mg/L;</td>
<td></td>
<td>• increased water treatment plant capacity;</td>
</tr>
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<td></td>
<td>• cadmium (Cd) – 0.01 mg/L;</td>
<td></td>
<td>• increased water reuse;</td>
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<td></td>
<td>• copper (Cu):</td>
<td></td>
<td>• increased water storages; and</td>
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<td></td>
<td>o 0.4 mg/L (sheep);</td>
<td></td>
<td>• decrease controlled water discharges.</td>
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<tr>
<td></td>
<td>o 1 mg/L (cattle);</td>
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<td></td>
<td>o 5 mg/L (pigs); and</td>
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<tr>
<td></td>
<td>o 5 mg/L (poultry).</td>
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<tr>
<td></td>
<td>• molybdenum – 0.15 mg/L;</td>
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<tr>
<td></td>
<td>• nickel – 1 mg/L;</td>
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<td></td>
<td>• lead – 0.1 mg/L;</td>
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<td></td>
<td>• selenium – 0.12 mg/L;</td>
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<td>• zinc – 20 mg/L.</td>
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<td>Major ions of concern:</td>
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<tr>
<td></td>
<td>• calcium – 1000 mg/L;</td>
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<td></td>
<td>• sulphate – 1000-2000 mg/L;</td>
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<td></td>
<td>• nitrate - &gt;400 mg/L.</td>
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<tr>
<td></td>
<td>Total Dissolved Solids:</td>
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<tr>
<td></td>
<td>• &lt;4000 mg/L (no adverse effects expected);</td>
<td></td>
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<tr>
<td></td>
<td>• 4000-5000 mg/L (animals may have initial reluctance to drink water. Some scouring may occur otherwise no loss of production); and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 5000-10000 (loss of production and decline in animal health).</td>
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<tr>
<td>Design and operation of a fit-for-purpose water treatment plant, that is able to treat anticipated water qualities and quantities in accordance with regulatory requirements</td>
<td>Design parameters in accordance with relevant site constraints</td>
<td>To be developed</td>
<td>To be developed</td>
</tr>
<tr>
<td></td>
<td>No non-compliances with commissioning and operating procedures</td>
<td>To be developed</td>
<td>To be developed</td>
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<tr>
<td></td>
<td>Establish WTP effluent discharge quality indicators</td>
<td>To be developed</td>
<td>To be developed</td>
</tr>
<tr>
<td>Performance Measure</td>
<td>Performance Indicator</td>
<td>Monitoring Program or Initiative</td>
<td>Nominal Contingency Management Measures</td>
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<tr>
<td>Biodiversity</td>
<td></td>
<td></td>
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<tr>
<td>Compliance with site ground disturbance procedure</td>
<td>No unplanned site disturbances</td>
<td>Clearing permit procedure and register of cleared land</td>
<td>To be developed</td>
</tr>
<tr>
<td>Terrestrial fauna and flora abundance and diversity maintained</td>
<td>No disturbance to fauna outside the authorised disturbance area</td>
<td>Clearing permit procedure and register of cleared land</td>
<td>To be developed</td>
</tr>
<tr>
<td>Riparian birds of conservation significance (Purple-crowned Fairy-wren and Buff-sided Robin) and local shorebird populations are not to decline by 15% or more within the MRM leases over any one five-year period.</td>
<td>The existing biannual riparian bird monitoring program will be continued until data suggest that the current scale and/or frequency of survey effort is no longer warranted to provide confidence that no adverse environmental effects are occurring.</td>
<td>In the event that local shorebird populations decline by 15% or more over a five-year period, an investigation will be conducted into the effect of MRM's activities on shorebird populations via analyses of metal concentrations in estuarine sediments and comparisons of migratory shorebird population trends with non-migratory shorebirds that are not exposed to pressures elsewhere in the East Asian-Australasian flyway. If MRM activities are deemed to cause the declines, additional mitigation and remediation measures will be developed.</td>
<td></td>
</tr>
<tr>
<td>Terrestrial fauna and flora abundance and diversity maintained</td>
<td>The percentage ground cover of key food grasses for Gouldian Finches and other threatened fauna (i.e., <em>Tristia</em> spp., <em>Sorghum</em> spp., <em>Chrysocephalum fallax</em>, <em>Alloteropsis semiballata</em>, <em>Heteropogon triticeus</em>), measured at sites across the MRM leases, should not experience a net decline of more than 5% over any five-year period.</td>
<td>The existing annual monitoring program for Gouldian Finches and other woodland birds will be continued until data suggest that the current scale and/or frequency of survey effort is no longer warranted to provide confidence that no adverse environmental effects are occurring. Density of grass species at each monitoring site will be assessed in the mid- to late-wet season.</td>
<td>If a decline in the density of grasses eaten by Gouldian Finches is detected, an investigation into the proximate causes of this decline (e.g., inappropriate grazing intensity, fire regime, weeds and/or drought) will be conducted, and measures developed to reverse this decline.</td>
</tr>
<tr>
<td>No cattle to be detected within the cattle exclusion area</td>
<td>The existing quarterly monitoring program for cattle within the cattle-exclusion zone will be continued</td>
<td>If insufficient densities of grass important for threatened fauna are found to establish within rehabilitated sites, remedial action will take place. Such actions will depend on the cause of failure, but may include supplementary planting, fertilising or weed control.</td>
<td></td>
</tr>
<tr>
<td>No cattle to be detected within the cattle exclusion area</td>
<td>The existing quarterly monitoring program for cattle within the cattle-exclusion zone will be continued</td>
<td>If cattle are detected within the cattle exclusion area, they are to be removed and fences repaired.</td>
<td></td>
</tr>
<tr>
<td>Performance Measure</td>
<td>Performance Indicator</td>
<td>Monitoring Program or Initiative</td>
<td>Nominal Contingency Management Measures</td>
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<tr>
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</tr>
<tr>
<td>Diversity and abundance of aquatic fauna</td>
<td>The objective of the aquatic fauna monitoring program is to establish whether MRM is impacting aquatic fauna within the wider McArthur River catchment area and whether the channels are providing suitable habitat for aquatic fauna, by:</td>
<td>In the event that fish communities within the McArthur River are affected by the Project, an investigation will be conducted into the cause of the decline in diversity or abundance. Such impacts are anticipated to correspond with a failure of surface water quality to meet relevant standards, and corrective actions. Should monitoring identify that additional or alternative management intervention is required, MRM has developed a suite of management contingencies that can be drawn upon. These contingencies have been developed through a number of processes and include:</td>
<td>- groundwater interception trenches; - vertical interception bores; - increased water treatment plant capacity; - increased water reuse; - increased water storages; and - decrease controlled water discharges.</td>
</tr>
<tr>
<td>Habits are classified as downstream complex habitat (DSC), diversion bare bank habitat (DVB), diversion complex habitat (DVC) and upstream complex habitat (USC). Abundance and diversity data for fish collected is analysed using ANOSIM to determine statistical differences in the suite of fish occurring within and between each habitat classification.</td>
<td>- monitoring fish populations in permanent and semi-permanent pools; - monitoring fish diversity in temporary or semi-permanent pools and riffles; - monitoring populations of Freshwater Sawfish (Pristis pristis), listed as Vulnerable under the EPBC Act; - monitoring fish passage success through the McArthur River Channel by:   o implementing a tagging program of key fish species;   o assessing temporal migration patterns of the fish within the river and determining habitat associations and the utilisation of the McArthur River Channel; and   o sampling of key sites within the McArthur River Channel as well as both upstream and downstream; - monitoring the diversity and distribution of species within Surprise and Barney Creeks; and - assessing the effectiveness of adding woody debris to the McArthur River Channel as a key rehabilitation strategy.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diversity and Abundance of Freshwater Macroinvertebrates</td>
<td>Aquatic macroinvertebrate communities within the McArthur River are not to be affected by the Project</td>
<td>In the event that aquatic macroinvertebrate communities within the McArthur River are affected by the Project, an investigation will be conducted into the cause of the decline in diversity or abundance.</td>
<td></td>
</tr>
<tr>
<td>Aquatic macroinvertebrate communities within the McArthur River are not to be affected by the Project</td>
<td>Since 2008, macroinvertebrate monitoring developed in consultation with DPIR-Fisheries has been conducted. Sampling and laboratory processing is conducted in accordance with the NT AusRivAS macroinvertebrate sampling protocols. The objective of the monitoring program is to identify significant changes in macroinvertebrate communities in the vicinity of MRM operations and downstream, as well as to monitor the development of instream habitats within the McArthur River Channel and Barney Creek Channel. Data analysis is based on traditional statistical methods for the assessment of site conditions and comparison of sites.</td>
<td></td>
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</tr>
<tr>
<td>Weeds are not to be more prevalent within the Project area than on adjacent land.</td>
<td>Weed mapping and data collection is an ongoing process and is undertaken annually Reporting will be required at the completion of each seasonal control and weed mapping program and included in the annual Operational Performance Report and/or the Mining Management Plan.</td>
<td>In the event that weed infestations fail to meet performance indicators, additional weed control measures will be implemented in accordance with the Weed Management Plan.</td>
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</tbody>
</table>
Appendix R – Adaptive Management Framework

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Monitoring Program or Initiative</th>
<th>Nominal Contingency Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>No infestations of invasive pasture grasses (including gamba grass (<em>Andropogon gayanus</em>), para grass (<em>Urochloa mutica</em>), olive hymenachne (<em>Hymenachne amplexicaulis</em>) or mission grass (<em>Cenchrus polystachios</em>)), are to exist in the MRM leases.</td>
<td>Weed mapping and data collection is an ongoing process and is undertaken annually Reporting will be required at the completion of each seasonal control and weed mapping programs and included in the annual Operational Performance Report and/or the Mining Management Plan.</td>
<td>Infestations will be removed</td>
</tr>
<tr>
<td>The mean grass cover over a five year period without grazing is to exceed the 10th percentile observed in reference sites.</td>
<td>To be developed</td>
<td>If insufficient densities of grass important for threatened fauna are found to establish within rehabilitated sites, remedial action will take place. Such actions will depend on the cause of failure, but may include supplementary planting, fertilising or weed control.</td>
</tr>
<tr>
<td>The mean tree biomass and species richness is to exceed the 10th percentile observed in reference sites.</td>
<td>To be developed</td>
<td>To be developed</td>
</tr>
<tr>
<td>Canopy cover is to exceed the 10th percentile observed in reference sites.</td>
<td>To be developed</td>
<td>To be developed</td>
</tr>
</tbody>
</table>
| Rehabilitated areas will provide appropriate habitat for fauna utilisation – abundance and diversity will be appropriate. | Monitoring program developed in 2006 which included each of the 32 monitoring sites to include monitoring of:  
- vegetation characteristics:  
  - foliage cover;  
  - ground cover; and  
  - vegetation species composition and structure.  
- disturbance characteristics:  
  - erosion;  
  - weeds;  
  - flooding; and  
  - faunal disturbance.  
- photo monitoring. | In the event that MRM populations of purple-crowned fairy-wrens and/or Buff-sided Robins decline by more than 15% over a five-year period, an investigation will be conducted to determine the proximate causes of this decline and determine the effect of the MRM operations. This investigation would involve comparing population trends at upstream and downstream sites, and at on-lease and off-lease sites. It would also utilise vegetation monitoring data to infer whether a decline in the health of riparian vegetation is a cause of declines. If MRM activities are deemed to cause the declines, additional mitigation and remediation measures will be developed and implemented. |
<p>| Purple-crowned fairy-wrens and buff-sided robins are to recolonise rehabilitated riparian sites along rechannelled sections of the McArthur River and such densities that are at least 25% of the density recorded in reference sites within 20 Years of rehabilitation. | Annual weed surveys will be undertaken in accordance with the existing Weed Management Plan; The existing monitoring program for assessing the development of vegetation in rehabilitated channels of the McArthur River and Barney Creek, as described in the Rechannel Vegetation Monitoring Plan, will be continued; and The Rechannel Vegetation Monitoring Plan will be adapted to extend to non-riparian rehabilitated sites. These sites will be monitored annually for the first three years, then subsequently every three years. | In the event that purple-crowned fairy-wrens and/or Buff-sided Robins fail to recolonise rehabilitated sites at adequate densities, the deficient habitat feature(s) will be identified and actions taken to improve these features. |
| Rehabilitated areas are to contain a diversity of native flora species across a number of strata that is comparable to analogue sites. | | In the event that rehabilitated areas fail to fulfil criteria pertaining to grass cover, biomass, species richness, canopy cover, self-seeding or resilience to disturbances, trials will be undertaken to investigate the most effective remedial actions (e.g., supplementary planting, fire management, fertilising, weed control, etc.). The most appropriate remedial action will then be applied on a large-scale across all areas failing to meet performance indicators. |</p>
<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Performance Indicator</th>
<th>Monitoring Program or Initiative</th>
<th>Nominal Contingency Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitated areas are to possess a self-sustaining vegetation cover that presents features to support self-seeding and resilience to disturbances such as fire, drought and soil erosion.</td>
<td>Annual weed surveys will be undertaken in accordance with the existing Weed Management Plan; The existing monitoring program for assessing the development of vegetation in rehabilitated channels of the McArthur River and Barney Creek, as described in the Rechannel Vegetation Monitoring Plan, will be continued; and The Rechannel Vegetation Monitoring Plan will be adapted to extend to non-riparian rehabilitated sites. These sites will be monitored annually for the first three years, then subsequently every three years.</td>
<td>In the event that weed infestations fail to meet performance indicators, additional weed control measures will be implemented in accordance with the Weed Management Plan.</td>
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</tr>
<tr>
<td>Weed densities within rehabilitated sites are to be compatible with final land use.</td>
<td>Annual weed surveys will be undertaken in accordance with the existing Weed Management Plan</td>
<td>In the event that rehabilitated areas fail to fulfill criteria pertaining to grass cover, biomass, species richness, canopy cover, self-seeding or resilience to disturbances, trials will be undertaken to investigate the most effective remedial actions (e.g., supplementary planting, fire management, fertilising, weed control, etc.). The most appropriate remedial action will then be applied on a large-scale across all areas failing to meet performance indicators.</td>
<td>In the event that weed infestations fail to meet performance indicators, additional weed control measures will be implemented in accordance with the Weed Management Plan.</td>
</tr>
<tr>
<td>The Rechannel Vegetation will be adapted to extend to non-riparian rehabilitated sites.</td>
<td>These sites will be monitored annually for the first three years, then subsequently every three years.</td>
<td>In the event that rehabilitated areas fail to fulfill criteria pertaining to grass cover, biomass, species richness, canopy cover, self-seeding or resilience to disturbances, trials will be undertaken to investigate the most effective remedial actions (e.g., supplementary planting, fire management, fertilising, weed control, etc.). The most appropriate remedial action will then be applied on a large-scale across all areas failing to meet performance indicators.</td>
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<tr>
<td>Revegetation success is in accordance with Rehabilitation Management Plan</td>
<td>As defined within the Rehabilitation Management Plan (refer to Supplementary EIS Appendix T).</td>
<td>As defined within the Rehabilitation Management Plan (refer to Supplementary EIS Appendix T).</td>
<td>In the event that rehabilitated areas fail to fulfill criteria pertaining to grass cover, biomass, species richness, canopy cover, self-seeding or resilience to disturbances, trials will be undertaken to investigate the most effective remedial actions (e.g., supplementary planting, fire management, fertilising, weed control, etc.). The most appropriate remedial action will then be applied on a large-scale across all areas failing to meet performance indicators.</td>
</tr>
<tr>
<td>Landform will host suitable vegetation for post-mining land use.</td>
<td>To be developed - for traditional land use areas, establish indicators in order to achieve similar environmental values as surrounding areas. Cattle grazing land use areas will have established, stable grasslands</td>
<td>To be developed</td>
<td>To be developed</td>
</tr>
<tr>
<td>Drawdown effects to be maintained within agreed parameters/boundaries</td>
<td>To be developed - Groundwater levels – relative to modelled impacts – location specific.</td>
<td>Groundwater monitoring program</td>
<td>In the event of a Largetooth Sawfish fatality as a result of water level drawdown within the Djirrinmini Waterhole, mitigation measures will be developed (including supplementary water provision) and implemented each subsequent dry season to prevent further deaths.</td>
</tr>
<tr>
<td>Performance Measure</td>
<td>Performance Indicator</td>
<td>Monitoring Program or Initiative</td>
<td>Nominal Contingency Management Measures</td>
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<tr>
<td>Maintenance of dry season refugia and wet season connectivity</td>
<td>Fish communities within the McArthur River are not to be affected by the Project; with no decline in fish diversity or density to occur downstream of the Project (relative to reference sites upstream or in neighbouring catchments)</td>
<td>The existing fish monitoring program will be continued until data suggest that the current scale and/or frequency of survey effort is no longer warranted to provide confidence that no adverse environmental effects are occurring.</td>
<td>In the event that fish communities within the McArthur River are affected by the Project, an investigation will be conducted into the cause of the decline in diversity or abundance. Such impacts are anticipated to correspond with a failure of surface water quality to meet relevant standards, and corrective actions will follow those as described in Table 15-2 of the Draft EIS.</td>
</tr>
<tr>
<td>Aquatic macroinvertebrate communities within the McArthur River are not to be affected by the Project.</td>
<td>Aquatic macroinvertebrates will continue to be monitored annually according to the current program in place, until data suggest that the current scale and/or frequency of survey effort is no longer warranted to provide confidence that no adverse environmental effects are occurring.</td>
<td>In the event that aquatic macroinvertebrate communities within the McArthur River are affected by the Project, an investigation will be conducted into the cause of the decline in diversity or abundance.</td>
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</tr>
<tr>
<td>No deaths of largetooth sawfish as a result of water level drawdown within the Djirrimmini Waterhole.</td>
<td>The existing sawfish tagging program will be continued to assess whether connectivity of habitats through the mining leases is being maintained.</td>
<td>In the event of a Largetooth Sawfish fatality as a result of water level drawdown within the Djirrimmini Waterhole, mitigation measures will be developed (including supplementary water provision) and implemented each subsequent dry season to prevent further deaths.</td>
<td></td>
</tr>
<tr>
<td>Movement of Largetooth Sawfish upstream and/or downstream through the MRM leases is to be demonstrated at least once every five years.</td>
<td>The existing sawfish tagging program will be continued to assess whether connectivity of habitats through the mining leases is being maintained.</td>
<td>In the event that no Largetooth Sawfish are recorded migrating upstream and/or downstream through the MRM leases, the potential barriers to movement will be investigated and remediated.</td>
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</tbody>
</table>
| Maintain fluvial sediment quality such that there are no adverse impacts on aquatic ecology. | Establishment of geomorphological indicators (e.g. sediment quality related) including the following sediment quality guideline (SQG) values:  
  - cadmium (Cd):  
    - low = 1.5 mg/kg; and  
    - high = 10 mg/kg  
  - copper (Cu):  
    - low = 65 mg/kg  
    - high = 270 mg/kg  
  - lead (Pb):  
    - low = 50 mg/kg  
    - high = 220 mg/kg  
  - zinc (Zn):  
    - low = 200 mg/kg  
    - high = 410 mg/kg  
  - arsenic (As):  
    - low = 20 mg/kg  
    - high = 70 mg/kg | MRM operates an extensive fluvial sediment monitoring program. The objectives of the monitoring are the following.  
  - Identify potential variations in physio-chemical parameters of sediments collected throughout the survey area.  
  - Identify sediments where contaminant concentrations were likely to result in adverse effects on sediment ecological health.  
  - Identify sediments with the potential for remobilisation of contaminants in the water column and/or into the aquatic food chains.  
  - To establish a measure of background fluvial sediment quality to create appropriate benchmarks for ongoing monitoring criteria.  
  - Identify potential sources of any pollutants detected in contaminated bed sediments. | To be developed |

To be developed: establish indicators for dry season abundance and biodiversity.  
To be developed: establish indicators for drawdown effects.  
To be developed: establish indicators for dry season abundance and biodiversity.  
To be developed: establish indicators for drawdown effects.
## Performance Measure
Metals levels in aquatic fauna comparable to background levels

### Performance Indicator
- Maximum metals concentrations in aquatic fauna, including:
  - Inorganic arsenic (As)
    - Crustacea (cherabin) – 2 mg/kg
    - Fish (barramundi, sooty grunter, archer fish, spangled perch, chequered rainbow fish and bony bream) – 2 mg/kg
    - Molluscs (freshwater mussel) – 1 mg/kg
  - Cadmium (Cd)
    - Molluscs – 2 mg/kg
    - Fish – 0.5 mg/kg
    - Molluscs – 2 mg/kg
  - Lead (Pb)
    - Fish – 0.5 mg/kg
    - Molluscs – 2 mg/kg
  - Mercury (Hg)
    - Barramundi
      - If >9 sample units available and Hg concentration in any sample is >1 mg/kg, then maximum mean level = 1 mg/kg, maximum level = 1.5 mg/kg
      - If 5 sample units available then maximum mean level = 1 mg/kg
      - If insufficient samples to analyse in accordance with the Australian and New Zealand Food Standards Code, then maximum level = 1 mg/kg
    - Sooty grunter, archer fish, spangled perch, chequered rainbow fish and bony bream
      - If >9 sample units available and Hg concentration in any sample is >1 mg/kg, then maximum mean level = 0.5 mg/kg, maximum level = 1.5 mg/kg
      - If 5 sample units available then maximum mean level = 0.5 mg/kg
      - If insufficient samples to analyse in accordance with the Code then maximum level = 1 mg/kg

### Monitoring Program or Initiative
IPE has undertaken the monitoring program since 2009, which has been undertaken in consultation with DPIR. Augmentations have also been made to address comments by the IM, DME (now DPIR) and NT Department of Health. Monitoring involves biannual assessments (conducted during the early and late dry seasons) at over 20 sites across the McArthur River and its tributaries. The objective of the monitoring program is to identify whether metals are entering the aquatic food chain as a result of MRM’s mining activities through the collection and analysis of various biota tissues from environmental indicator species (including spangled perch, chequered rainbow fish and bony bream) and commonly consumed species including barramundi, sooty grunter, archer fish, cherabin and freshwater mussel.

The existing monitoring program will be continued until data suggest that the current scale and/or frequency of survey effort is no longer warranted to provide confidence that no adverse environmental effects are occurring.

The mine pit lake will be added to the existing set of sites surveyed for metals in fish.

### Nominal Contingency Management Measures
In the event that fish are detected with metal concentrations exceeding the trigger levels, an investigation will be conducted into the potential sources of contamination, and remediation efforts will be implemented. For example, previous instances of lead deposition due to dust at the Barney Creek bridge triggered a suite of successful management measures that were targeted towards remediating the specific impacts, including:

- Installation of a new sediment trap;
- Installation of new baffles between the haul road and creek; and
- Mechanical excavation and removal of sediment from the creek bed.

### Additional Monitoring
**No ingress of sawfish into the mine pit lake**

Establish barrages to deter sawfish entry

Establish shallow benches along the edges of the mine pit lake

Additional monitoring of aquatic fauna entering and exiting the mine pit lake will be undertaken to understand the effectiveness of fish ways and the role of the mine pit lake as a potential trap

In the event that no largetooth sawfish are recorded migrating upstream and/or downstream through the MRM leases, the potential barriers to movement will be investigated and remediated.
<table>
<thead>
<tr>
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<th>Nominal Contingency Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic and Socio-economic</td>
<td>Maintain social licence to operate</td>
<td>Positive contributions to the community such as sponsorships, employment or delivery of local services. Local and Indigenous employment targets met. Complaints register.</td>
<td>Ongoing coordination of the MRM Open Group Meetings (OGM), which serves as an overarching management tool to enable MRM to monitor impacts on the community and facilitate the provision of Project information and feedback. Undertake ongoing stakeholder engagement throughout the Project life and include Indigenous individuals input into the implementation of the mine’s long-term monitoring program. Continued economic contribution to Borroloola and the Gulf Statistical Local Area (SLA) through direct employment at the mine or via purchase of supply services. Continuation of the Community Benefits Trust (CBT), which will deliver community benefits for the duration of the operation phase (20 years) in the same form as it has since its creation in 2008. Continued support for businesses in Borroloola and Darwin throughout the life of the Project via purchase of supplies. Continued contribution to the Australian and NT economies via payment of payroll taxes and royalty payments as well as employment and services where needed.</td>
</tr>
<tr>
<td>Maintain open stakeholder communication</td>
<td>Feedback provided by stakeholders. Attendance at community meetings.</td>
<td>Continued implementation of the open group meetings held with all stakeholders. Engagement with stakeholders via various modes of communication to be used including: • memoranda; • meetings; • email; and • website. Maintain openness with the community and other stakeholders.</td>
<td>Where feedback from any stakeholders express concern with the Project or matters associated with Project, appropriate investigation will be undertaken to resolve the concern.</td>
</tr>
<tr>
<td>Provide community benefits which are not hindered or reduced as a result of Project changes</td>
<td>The Community Benefits Trust will continue to provide benefits to the community</td>
<td>Contributions from the Community Benefits Trust are presented on the MRM website which is available to the public to monitor.</td>
<td>To be developed</td>
</tr>
<tr>
<td>Performance Measure</td>
<td>Performance Indicator</td>
<td>Monitoring Program or Initiative</td>
<td>Nominal Contingency Management Measures</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------</td>
<td>----------------------------------</td>
<td>----------------------------------------</td>
</tr>
</tbody>
</table>
| Maintain operating protocols during hydraulic re-mining, TSF wall construction and other tailings handling activities including ensuring irrigation of TSF surface to prevent spontaneous combustion | No incidents which affect the health and safety of the staff | As defined within MRM’s Operational Maintenance and Surveillance Manual including:  
- incorporation of sulphur dioxide management procedures and implementation of operating procedures which include:  
  o additional PPE requirements when sulphur dioxide is detected;  
  o re-evaluation of the construction methods (in particular the width and compaction levels of the walls); and  
  o minimise the use of tailings as a wall construction material unless well compacted and sealed from air exposure; and avoid loose dumping of excavated tailings.  
- a dam surveillance program including  
  o routine visual inspections,  
  o intermediate inspections,  
  o comprehensive inspections,  
  o environmental; and  
  o instrumentation monitoring and associated reporting. | MRM will investigate, respond to and take appropriate corrective and preventative actions following a health and safety incident, in accordance with its Dam Safety Emergency Plan (DSEP). |
| Maintain tailings pipelines and embankment conditions, particularly after flood events | No incidents which affect the health and safety of the staff | The risk of embankment failure due to Surprise Creek flooding will be controlled through adoption of the following:  
- flood studies of Surprise Creek and Little Barney Creek undertaken to assess flood levels and flow velocities;  
- design allows for rock armouring of toe of embankment adjacent to waterway;  
- monitoring of toe of the TSF during / following extreme flood events; and  
- relocation of tailings to the final void as part of tailings reprocessing and rehandling. | MRM will investigate, respond to and take appropriate corrective and preventative actions following a health and safety incident. |
<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Performance Indicator</th>
<th>Monitoring Program or Initiative</th>
<th>Nominal Contingency Management Measures</th>
</tr>
</thead>
</table>
| TSF embankment failure, with release of tailings and sediment causing environmental damage | No environmental damage caused as a result of TSF embankment failure | TSF Embankment – the MRM Operational Management System includes a number of control measures designed to mitigate the potential impacts from any seismic event. These include:  
- regular inspections of the TSF and surrounds;  
- construction standards of TSF walls and foundations; and  
- TSF design considerations including dam safety (seismicity) allowances.  
Managing the risk of embankment failure due to excessive rate of tailings rise will include a combination of:  
- design controls which stipulate beach dimensions, water management controls and dam spillway design parameters;  
- operating controls (e.g., water height/freeboard limits);  
- condition monitoring incorporating piezometers, surveillance inspections and on-line alarm systems; and  
- response systems, including a TARP. | To be developed |
| Geotechnical failure of existing NOEF landform, leading to a loss of cover system functionality and resulting in sedimentation and loss of gas and water management functions | No loss of cover system functionality | To be developed | To be developed |
| Spontaneous combustion related measures and management measures established | As detailed within the NOEF TARP:  
- temperature indicator:  
  - Level 1: 70-75 degrees Celsius (°C);  
  - Level 2: 75-85 °C; and  
  - Level 3: >85 °C  
- sulphur dioxide indicator:  
  - Level 1: 0-1.24 parts per million (ppm)  
  - Level 2: 1.24-20 ppm  
  - Level 3: >20 ppm  
- visual indicator:  
  - Level 1: steam visible early in the morning, visually “acidic moist” areas;  
  - Level 2: steam/smoke visible throughout the day, “moist” reactive areas noticeable, green/yellow/orange crystallisation; and  
  - Level 3: large combustion (easily noticeable from highway), green/yellow/orange crystallisation on reactive PAF | MRM has developed an NOEF Trigger Action Response Plan (TARP) for the management of spontaneous combustion risk. This specifies three levels of triggers as follows:  
- Level 1 – low probability of safety and health impacts;  
- Level 2 – moderate probability of safety and health impacts; and  
- Level 3 – high risk of adverse safety and health impacts.  
In addition the following detail is provided for each trigger level:  
- associated actions;  
- monitoring requirements;  
- notification requirements; and  
- criteria for downgrading the alert. | MRM will investigate, respond to and take appropriate corrective and preventative actions following a health and safety incident. |
| Ambient air quality monitoring program implemented:  
- sulphur dioxide 1 hour – 570 micrograms per cubic metre (µg/m³) (National Environmental Protection Council (NEPC), 2016)  
- sulphur dioxide 24 hour – 228 µg/m³ (NEPC, 2016)  
- sulphur dioxide annual – 60 µg/m³ (NEPC, 2016) | As defined within MRM’s Air Quality Management Plan (AQMP) | To be developed |
Ensure appropriate PPE is available and enforce the use for all personnel working on and around the NOEF

No non-compliances with operating procedure

To be developed

MRM will investigate, respond to and take appropriate corrective and preventative actions following a health and safety incident.

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Performance Indicator</th>
<th>Monitoring Program or Initiative</th>
<th>Nominal Contingency Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Quality</td>
<td>Air quality should not exceed:</td>
<td>Multiple methods adopted on site including:</td>
<td>An assessment to validate the monitoring data will be made on a monthly basis or in response to a measured exceedance of criteria (i.e., to confirm whether or not the exceedance is a non-compliance). This will be implemented as per three escalating levels (Level 2 and 3 are applied as necessary):</td>
</tr>
<tr>
<td></td>
<td>PM10 (particulate matter less than or equal to 10 micrometres in size) annual – 25 µg/m³ (NEPC, 2016)</td>
<td>• Airmetric MiniVol Tactical Air Samplers (MiniVols), deployed for 24 hour periods, typically on a monthly basis. Samples from MiniVols are analysed for arsenic and metal concentrations (including lead, zinc, cadmium, copper and manganese).</td>
<td>• Level 1 – this assessment will involve checking that all calibration and maintenance work due for that month has been completed and an examination of the data against the previous months;</td>
</tr>
<tr>
<td></td>
<td>PM10 24 hour – 50 µg/m³ (NEPC, 2016)</td>
<td>• High Volume Air Samplers (HVAS), used to measure TSP concentrations for a 24 hour period, on a one day in six cycle (i.e., measures concentrations every six days). Samples from the HVAS were analysed for metal concentrations.</td>
<td>• Level 2 – where data is assessed as being invalid, detailed examination of the available field records, laboratory notes, calibrations, etc. shall be made and this may include site inspection of monitoring equipment; and</td>
</tr>
<tr>
<td></td>
<td>annual total suspended particulate (TSP) – 90 µg/m³ (NEPC, 2016)</td>
<td>• Tapered Element Oscillating Microbalances (TEOMs), used to continuously measure concentrations of particulates, at approximately 5 minute intervals.</td>
<td>• Level 3 – Where anomalous or potentially invalid data are found and the issue is significant (e.g., may indicate an exceedance or equipment fault) and a level 1 or 2 evaluation cannot determine the cause; engage a professional air quality expert to examine the issue.</td>
</tr>
<tr>
<td></td>
<td>lead (Pb) Annual – 0.5 µg/m³ (NEPC, 2016)</td>
<td>• Ecotech Serinus 50 sulphur dioxide analysers, used to monitor concentrations continuously.</td>
<td>Notes:</td>
</tr>
<tr>
<td></td>
<td>zinc (Zn) 24 hour – 120 µg/m³ (Ministry of the Environment, Ontario (MOE), 2012)</td>
<td></td>
<td>1 The objective to be achieved in order to prevent the risk event from occurring.</td>
</tr>
<tr>
<td></td>
<td>arsenic (As) 24 hour – 0.3 µg/m³ (MOE, 2012)</td>
<td></td>
<td>2 The early warning target established by MRM, designed to demonstrate that established performance measures are effective.</td>
</tr>
<tr>
<td></td>
<td>copper (Cu) 24 hour – 50 µg/m³ (MOE, 2012)</td>
<td></td>
<td>3 The relevant MRM EMP will document these programs/initiatives.</td>
</tr>
<tr>
<td></td>
<td>manganese (Mn) 24 hour – 0.2 µg/m³ in PM10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.3.1 Objectives

A total of 10 closure objectives were originally developed as part of the Project’s planning phase, and subsequently used to inform the development of specific design criteria. The design criteria were used to evaluate and measure construction quality control, as well as in-service performance of elements and components of the designs within the domains. The closure objectives follow the National Strategy for Ecologically Sustainable Development, especially in relation to intergenerational equity, the polluter pays principle, protection of biodiversity and maintenance of essential ecological processes. The closure objectives outlined below are consistent with those outlined in the Department of Mines and Energy (DME) Northern Territory Draft Guidelines for Mine Closure Plans.

These 10 closure objectives were originally established in order to prevent the occurrence of identified Project environmental risk events. That is, if the objectives were achieved, then the risk events would not be expected to eventuate.

In summary, these 10 closure objectives aim to achieve a site that is:

- safe to humans and wildlife;
- stable;
- non-polluting; and
- able to sustain an agreed post-mining land-use.

Section 3.3.4.1 of the Draft EIS summarised these closure objectives, and they have been reproduced below.

1. Post-mining landscape will be left in a condition safe and secure for humans and animals:
   - safe and secure for short term (0-100 years); and
   - safe for long term (100-1,000 years).

2. Landform stability:
   - geotechnical stability will be maintained at these standards:
     - NOEF: Long-term static drained Factor of Safety (FoS) of 1.5; Maximum Design Earthquake (MDE) – 1 in 1,000 year event;
     - open cut walls: Probability of Failure (Pf) for inter-ramp slopes of <5%; and
   - erosional stability; maintainable for these aspects:
     - cover system and landform to maintain functionality;
     - sediment release from erosion does not adversely impact on water quality;
     - erosion does not affect functionality of the landform; and
     - resulting suspended solids can be mitigated.
   - geochemical stability will be defined, managed and monitored:
     - seepage water quality at toe/base of landforms; and
     - water quality within the mine pit lake.

3. Manage surface water and groundwater such that environmental values and ecosystems are maintained downstream of the lease boundary in the short term (0-100 years), and within the McArthur River in the long term (100-1,000 years).

4. Metal levels for fauna comparable to background levels.

5. Landform will host suitable vegetation for post-mining land use:
   - for traditional land use areas; have similar environmental values as surrounding areas; and
   - for cattle grazing land use areas; grasslands.
6. Rehabilitated areas will provide appropriate habitat for fauna utilisation – abundance and diversity will be appropriate.
7. Manage soil to meet post mining land use.
8. No infrastructure left on-site unless a beneficial gain is identified and agreed with stakeholders.
9. Maintain custodians’ access to areas of cultural significance.
10. Foster economic opportunities for custodians and local communities.

These closure objectives have subsequently been expanded in order to ensure sufficient performance measures have been documented in order to protect the identified key Project risks (refer to Table 3-2 for details).

3.3.2 Targets

MRM has (and will continue to develop) site specific targets, in the form of performance indicators, which are designed to act as trigger values (or an early warning system) and demonstrate that the established objectives (or performance measures) are effective.

Targets can either be qualitative (e.g. to demonstrate compliance with geotechnical related objectives such as slope stability) or quantitative (e.g. to demonstrate compliance with selected water quality related objectives). In either case, MRM will engage suitably qualified technical specialists to design and conduct relevant monitoring programs, and interpret results in order to assess the effectiveness of control programs.

3.3.3 Monitoring and Management Programs

Implementation of targeted monitoring and management programs will be undertaken to assess the site’s compliance with the established targets (or performance indicators). Figure 1-1 details the key features of these programs including a workflow (or logic diagram) which explains MRM’s response in the event that a performance indicator (e.g. trigger value) is exceeded. This includes:

- three levels of response, which are dependent on the findings of investigation programs;
- when MRM’s incident investigation process is activated;
- the role of independent specialists;
- the role of the regulator;
- feedback loops; and
- how MRM’s EMPs are amended and approved for use.

Table 3-2 provides details of MRM’s site monitoring programs. These have been designed to assess compliance with established site targets and objectives to protect key risks; as identified in the Draft EIS Project risk assessment process and included in MRM’s Aspects Register (refer to Table 3-1). These monitoring programs include the following disciplines:

**Water management (surface water), including:**

- surface water - natural flows (also refer Draft EIS Section 8.7.1.2);
- surface water - artificial water storages (also refer Draft EIS Section 8.7.1.2);
- waste discharge;
- fluvial sediment;
- aquatic macroinvertebrates;
- metals in aquatic fauna;
- marine, including:
  - water quality;
nearshore sediments;
- transhipment sediment;
- seagrass; and
- metals in marine biota, water and sediment.

- mosquitoes.

**Water management (groundwater) including:**

- site wide groundwater monitoring program (also refer Draft EIS Section 8.7.1.1).

**Air quality including:**

- dust monitoring (refer Draft EIS Section 13.2.4); and
- sulphur dioxide monitoring.

**OEF materials including:**

- sampling of NAF, PAF and low grade ore stockpiles to control the correct placement of material types.

**Tailings Storage Facility including:**

- tailings monitoring for metals concentration and acid base accounting.

**EPCB related issues including:**

- aquatic fauna; and
- listed migratory shorebirds and other wetlands birds.

**Rehabilitation to assess:**

- plant establishment;
- growth diversity and cover;
- types of disturbances including floods; and
- weeds, erosion and grazing.

**Other miscellaneous including:**

- riparian birds;
- gouldian finch surveys;
- chemicals and dangerous goods;
- soils; and
- geomorphological assessments or McArthur River and Barney Creek diversions.
4 Implementation and Operation

4.1 Resources, Roles and Responsibilities

MRM is responsible for the development, implementation and ongoing review of this adaptive management program. Where required, it will engage appropriately qualified consultants and contractors to carry out required activities in compliance with this program.

MRM will also be responsible for:

- contractually binding the contractors to compliance with this program;
- regularly monitoring contractors’ environmental performance; and
- approval of contractor quality management procedures and systems prepared in accordance with this EMP.

Amongst other obligations, contractors will be responsible for the following:

- Developing systems, procedures and reporting mechanisms to demonstrate, in a tangible way, their compliance with the EMP and the MRM Contractors, Suppliers and Partners Procedure.
- Developing and implementing appropriate training to all staff and sub-contractors on the requirements of this EMP. This shall range from detailed training for supervisors, through to inclusion of environmental matters in project inductions for other workers.
- Participating in audits and reviews and undertaking corrective actions and system improvements when audit and review results deem necessary.

Specific MRM responsibilities include the following:

- Environment team personnel – as outlined within their respective job descriptions. The team comprises a number of key components including monitoring, rehabilitation, projects and sustainable development. Contractors and consultants that conduct work for the environment team are normally managed by the Manager of Environment, Safety and People, although the Environmental Superintendent has input into various projects.
- All employees - responsible for the environmental performance of their activities, complying with the laws of the Northern Territory (NT) and Commonwealth and the day-to-day implementation of the requirements of the EMP.

4.2 Competence, Training and Awareness

The organisation operates in accordance with its Competence, Training and Awareness management system procedure (MSP-06). This procedure outline the processes that the MRM site is required to implement to ensure that all personnel have the appropriate Health, Safety, Environment and Community (HSEC) skills, knowledge, experience, awareness and commitment to undertake their work, and to make operational and business decisions in accordance with the HSEC Management Framework and HSEC Management System.
All Managers are responsible for identifying training and competency requirements for personnel under their management, and for ensuring that personnel have the requisite competencies, skills and training to carry out their assigned tasks. This is established through training needs analysis and the establishment of training matrices indicating what training requirements are required for individual roles. Managers are also responsible for ensuring training records are maintained. Training may include Inductions, Toolbox Meetings and Job Safety Environment Analysis (JSEA).

MRM employees, contractors and visitors receive appropriate environmental awareness training. This is achieved through a variety of methods including induction training, formal presentations, and toolbox meetings. Specifically, MRM 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; and
- site emergency procedures.

Environmental awareness training will be a regular feature of site-wide training, with records maintained of training content and attendance.

The induction process is not designed to train all new MRM 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. Training requirements are identified through the development of a Training Needs Analysis for each section or department. Additional training requirements can also be identified through the performance review process.

4.3 Communication

MRM has implemented the following environmental communication programs that will continue for the life of the Project.

4.3.1 Internal Stakeholder Communication (within McArthur River Mining)

Internal communications are facilitated through the following mechanisms:

- notice boards and television monitors;
- MRM App;
- tool box meetings;
- MRM intranet web page, which includes links to relevant procedures, plans and guidelines;
- General Manager presentations (State of the Nation); and
- a MRM Sustainable Development Committee has been established with Health and Safety Representatives.
4.3.2 External Stakeholder Communication

MRM’s community consultation program, carried out as part of the Project EIS, was well received by all stakeholders and MRM was encouraged to continue this program under a similar format throughout the Project’s life. Accordingly, MRM has committed to maintain productive relationships with external stakeholders through the continuation of a number of existing formal and informal approaches including the following:

- Community access to a mobile phone application which is available for both iPhone and android technology. The application provides regular updates on mine site activities and developments, an emergency call button, important safety information and links to relevant websites.
- Weekly visits to Borroloola by MRM’s Senior Community Relations Advisor, and regular visits to other communities and regions.
- Hosting open community meetings), which provides the opportunity for local residents, businesses and representatives from other organisations to be informed of relevant Project developments. these meetings are held quarterly as a minimum in Borroloola, and are normally attended by MRM’s General Manager, Senior Community Relations Advisor, Manager of Environment, Safety and People, Environmental Projects Manager as well as a representative from the Human Resources department.
- Ongoing consultation with custodians to incorporate appropriate cultural heritage related management measures into its construction and operational programs.
- Continuing MRM representation, where required, on industry and legislative committees and groups.

4.4 Documentation

The organisation operates in accordance with its “Compliance (Legal and Other) and Document Control Procedure” (MSP-03), which outlines the requirements in providing the documentation required for the effective operation of its HSEC management Systems.

A Register of Documents and Records lists policies, manuals, procedures, plans, external documents, registers, forms, templates and records relevant to the management system.

4.5 Control of Documents

All environmental management system documents are filed within McArthur River Mining’s record management system. Each internal document is identified by a unique name and a last updated date and listed in the Register of Documents and Records. Each external document required for the environmental management system is also recorded in this register.

The record management system specifies the frequency for which certain documented information is revised. For example, the environmental policy, environmental aspects, legal and other requirements, and objectives and targets must be revised at least annually, while the Responsibility Matrix requires monthly revision.
McArthur River Mining’s HSEC management system documents are dynamic pieces of information used to guide what people do—they need to be kept up to date and relevant to the organisation’s needs. Changes to the environmental policy, any system manuals, a documented procedure, an environmental management plan, a form, or any register or matrix referenced require approval from the environmental co-ordinator. Corrective and preventive action resulting from identification of actual and potential nonconformities often results in recommendations for changes to documents. Suggestions for improvement to documents can also be made directly on corrective and preventive action records.

4.6 Operational Control

4.6.1 Overview

MRM has been operating on site for over 20 years, and as part of the ongoing development of its management system has established a comprehensive suite of environmental documentation including management plans, procedures and monitoring programs (refer Table 4-1 below).

Table 4-1 Existing Management Plans, Procedures and Monitoring Programs

<table>
<thead>
<tr>
<th>Plan, Procedure or Program</th>
<th>Supporting Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management Plans</strong></td>
<td></td>
</tr>
<tr>
<td>Weed Management Plan</td>
<td>Guides the management of weeds on the MRM mining lease areas.</td>
</tr>
<tr>
<td>Cattle Management Plan</td>
<td>2014-2016 (includes inspection regime of fencing and maintenance requirements).</td>
</tr>
<tr>
<td>Rechannel Rehabilitation Plan</td>
<td>Primarily associated with McArthur River channel and Barney Creek channel.</td>
</tr>
<tr>
<td>Energy Efficiency and Greenhouse</td>
<td>Provides objectives and targets for site.</td>
</tr>
<tr>
<td>Gas Management Plan</td>
<td></td>
</tr>
<tr>
<td>Fire Management Plan</td>
<td>Associated with controlled burns for the purpose of fuel reduction and weed control.</td>
</tr>
<tr>
<td>Dust and Air Quality Management</td>
<td>Covers controls responsibilities and action plans.</td>
</tr>
<tr>
<td>Plan</td>
<td></td>
</tr>
<tr>
<td><strong>Procedures</strong></td>
<td></td>
</tr>
<tr>
<td>Incident and Complaints Management</td>
<td></td>
</tr>
<tr>
<td>Incident Reporting and Investigation Procedure</td>
<td>Defines the process, roles and responsibilities for the reporting and investigation of incidents, including environmental related incidents.</td>
</tr>
<tr>
<td>Complaints Management Procedure</td>
<td>Defines the process, roles and responsibilities for the management of complaints, including environmental related complaints.</td>
</tr>
<tr>
<td>Major Concentrate Spill – Trucking Incident</td>
<td>Includes clean up requirements and responsibilities.</td>
</tr>
<tr>
<td>Lead Concentrate Spill – Trucking Incident</td>
<td>Includes clean up requirements and responsibilities.</td>
</tr>
<tr>
<td><strong>Waste Management</strong></td>
<td></td>
</tr>
<tr>
<td>Management and Disposal of Waste Oils</td>
<td>Includes storage, removal off site and responsibilities.</td>
</tr>
<tr>
<td>Plan, Procedure or Program</td>
<td>Supporting Information</td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Management and Disposal of Waste Cooking Oils</td>
<td>Includes storage, removal off site and responsibilities.</td>
</tr>
<tr>
<td>Disposal of Aluminium Cans</td>
<td>Includes storage, removal off site and responsibilities.</td>
</tr>
<tr>
<td>Management of Contaminated Waste Disposal Area</td>
<td>Includes storage and responsibilities.</td>
</tr>
<tr>
<td>Waste Refuse Facility Management</td>
<td>Includes storage and responsibilities.</td>
</tr>
<tr>
<td>Waste Tyre and Conveyor Belt Management</td>
<td>Includes storage and responsibilities.</td>
</tr>
<tr>
<td>Putrescible Waste Facility Management</td>
<td>Includes storage and responsibilities.</td>
</tr>
<tr>
<td>Management and Disposal of Cardboard and Paper</td>
<td>Includes storage, removal off site and responsibilities.</td>
</tr>
<tr>
<td>Management and Disposal of Lead Acid Batteries</td>
<td>Includes storage, removal off site and responsibilities.</td>
</tr>
<tr>
<td>Management and Disposal of Medical Waste</td>
<td>Includes storage, removal of site and responsibilities.</td>
</tr>
<tr>
<td>Hydrocarbon Management</td>
<td>Includes transport, storage and site responsibilities.</td>
</tr>
<tr>
<td><strong>Biodiversity</strong></td>
<td></td>
</tr>
<tr>
<td>Fauna Management</td>
<td>Includes both feral animal and native animal requirements and responsibilities.</td>
</tr>
<tr>
<td><strong>Water Resources</strong></td>
<td></td>
</tr>
<tr>
<td>Natural Surface Water Monitoring</td>
<td>Objectives and procedures for the collection and chain of custody of surface water samples.</td>
</tr>
<tr>
<td>Groundwater Monitoring</td>
<td>Objectives and procedures for the collection and chain of custody of groundwater samples.</td>
</tr>
<tr>
<td>Artificial Surface Water Monitoring</td>
<td>Objectives and procedures for the collection and chain of custody of artificial water samples.</td>
</tr>
<tr>
<td>Fluvial Sediment Sampling</td>
<td>Objectives and procedures for the collection and chain of custody of fluvial sediment samples.</td>
</tr>
<tr>
<td>DGT Monitoring</td>
<td>Diffusive Gradients in Thin films (DGT). Analysis technique applied to coastal waters around Bing Bong, to determine the concentrations of bioavailable metals.</td>
</tr>
<tr>
<td><strong>Land Disturbance</strong></td>
<td></td>
</tr>
<tr>
<td>Controlled Burning</td>
<td>Objectives and responsibilities.</td>
</tr>
<tr>
<td>Land Clearing and Digging Permit</td>
<td>Covers ground disturbance related procedures of more than 300 millimetres (mm) including clearing or digging. The process requires sign off from various authorised personnel.</td>
</tr>
<tr>
<td><strong>Air Quality</strong></td>
<td></td>
</tr>
<tr>
<td>Dust Monitoring</td>
<td>Objectives and procedures for the collection and chain of custody protocols for dust samples.</td>
</tr>
<tr>
<td><strong>Overburden Management</strong></td>
<td></td>
</tr>
<tr>
<td>Plan, Procedure or Program</td>
<td>Supporting Information</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Grade control</td>
<td>In-pit grade control sampling, analysis &amp; interpretation.</td>
</tr>
<tr>
<td>OEF Sampling</td>
<td>Covers OEF geochemical monitoring sampling and analyses.</td>
</tr>
<tr>
<td>Field Barrel Leaching</td>
<td>Covers sampling and analyses involved in the large scale field barrel leaching experiment.</td>
</tr>
<tr>
<td>Sulphur Dioxide Management</td>
<td>Both personal and large scale monitors.</td>
</tr>
<tr>
<td>NOEF Temperature and Gas Monitoring</td>
<td>Occurring on current NOEF.</td>
</tr>
<tr>
<td>Tailings Storage Facility (TSF)</td>
<td>Covers geochemical monitoring, sampling and analyses.</td>
</tr>
<tr>
<td>Sampling</td>
<td></td>
</tr>
<tr>
<td>Early Flood Warning System</td>
<td>Covers use, maintenance and responsibilities around the early warning flood system and other gauging stations.</td>
</tr>
<tr>
<td>Storage, Handling and Use of Refrigerant Gases</td>
<td>Covers storage, permits/licences and documentation required.</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
</tr>
<tr>
<td>Monitoring Programs</td>
<td></td>
</tr>
<tr>
<td>Water Management (surface water related)</td>
<td></td>
</tr>
<tr>
<td>Surface water (natural flows)</td>
<td>As detailed in Section 8.7.1.2, Chapter 8 – Water Resources, a surface water monitoring network is in place which includes weekly monitoring at 32 locations across the site including upstream control, downstream and on-lease sites. As part of this program continuous water quality monitoring is conducted at SW11.</td>
</tr>
<tr>
<td>Artificial water storages</td>
<td>As detailed in Section 8.7.1.2, Chapter 8 – Water Resources, monthly water quality monitoring of water storage points occurs on site including in all dams, seepage collection points and drains.</td>
</tr>
<tr>
<td>Waste discharge</td>
<td>Flow meters are installed on piping infrastructure to measure discharges from selected site infrastructure including South Eastern Levee 1, WMD &amp; Pete’s Pond 2.</td>
</tr>
<tr>
<td>Fluvial sediment</td>
<td>A program has been implemented to assess potential sediment contaminate fluxes in creeks and rivers within close proximity of the mine. Sites are the same location as for surface water sites.</td>
</tr>
<tr>
<td>Aquatic Macroinvertebrates</td>
<td>Aquatic fauna assessment program, developed in consultation with NT Department of Primary Industry and Resources (DPIR) and based on the NT Australian River Assessment System (AUSRIVAS) protocol.</td>
</tr>
<tr>
<td>Metals in aquatic fauna</td>
<td>Completed on a number of fish species from various locations in the freshwater streams and freshwater bodies around the mine; and To determine whether metals are entering the aquatic food chain as a result of mining activities.</td>
</tr>
<tr>
<td>Marine</td>
<td>Includes annual monitoring of:</td>
</tr>
<tr>
<td></td>
<td>• marine water quality;</td>
</tr>
<tr>
<td></td>
<td>• nearshore sediments;</td>
</tr>
<tr>
<td></td>
<td>• transhipment sediment;</td>
</tr>
<tr>
<td></td>
<td>• seagrass; and</td>
</tr>
<tr>
<td></td>
<td>• metals in marine biota, water and sediment.</td>
</tr>
</tbody>
</table>
## Plan, Procedure or Program | Supporting Information
---|---
**Mosquitoes** | Conducted on a monthly basis at six different sites including two at Bing Bong.

## Water management (groundwater related)

<table>
<thead>
<tr>
<th>Groundwater (site wide)</th>
<th>As detailed in <strong>Section 8.7.1.1, Chapter 8 – Water Resources</strong>, an established groundwater monitoring program is in place which:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• monitors potential impacts of drawdown on the local and regional groundwater regime;</td>
</tr>
<tr>
<td></td>
<td>• determines extent of any contaminants in aquifers; and</td>
</tr>
<tr>
<td></td>
<td>• assesses potential impacts on receiving environment from site activities.</td>
</tr>
</tbody>
</table>

## Air quality

<table>
<thead>
<tr>
<th>Dust</th>
<th>As detailed in <strong>Section 13.2.4, Chapter 13 – Air Quality</strong>, MRM has in place an established monitoring program which includes:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• monthly ambient air quality monitoring for particulate matter (dust and lead) at 31 low volume air sampler (LVAS) sites; and</td>
</tr>
<tr>
<td></td>
<td>• monthly analysis for depositional dust at 18 dust gauges across the site.</td>
</tr>
</tbody>
</table>

## Overburden management

<table>
<thead>
<tr>
<th>OEF monitoring</th>
<th>Monthly sampling of all active OEFs including non-acid forming material (NAF) stockpiles, potentially acid forming material (PAF) cells and Low Grade Ore; and</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aims at controlling the correct placement of material types.</td>
</tr>
</tbody>
</table>

| TSF | Monthly sampling of deposited tailings for metal concentrations and Acid Base Accounting. |

## EPBC related

<table>
<thead>
<tr>
<th>Aquatic fauna</th>
<th>Annual monitoring program involving two separate periods. Monitors all fish but mainly around the movement of Freshwater Sawfish (<em>P. pristis</em>) and Barramundi (<em>L. calcarifer</em>) along the McArthur River, using acoustic monitoring and tagging techniques.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listed migratory shore birds and other wetland birds</td>
<td>Conducted in the austral summer and northern migration periods around Bing Bong.</td>
</tr>
</tbody>
</table>

## Rehabilitation

<table>
<thead>
<tr>
<th>Rehabilitation</th>
<th>Annual monitoring of rehabilitation activities including assessment of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• plant establishment;</td>
</tr>
<tr>
<td></td>
<td>• growth, diversity and cover;</td>
</tr>
<tr>
<td></td>
<td>• types of disturbances including flood; and</td>
</tr>
<tr>
<td></td>
<td>• weeds, erosion and grazing.</td>
</tr>
</tbody>
</table>

## Other (Miscellaneous) Monitoring/Assessments

<table>
<thead>
<tr>
<th>Riparian birds</th>
<th>Biannual. Utilises the Buff Sided Robin and the Purple Crowned Fairy Wren as indicator species.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gouldian Finch</td>
<td>Annual surveys</td>
</tr>
<tr>
<td>Chemicals and Dangerous Goods</td>
<td>Inspections of storage tanks and bulk containers; and</td>
</tr>
</tbody>
</table>
### Appendix R – Adaptive Management Framework

#### Supporting Information

<table>
<thead>
<tr>
<th>Plan, Procedure or Program</th>
<th>Supporting Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrity inspections of bunded areas, pavements and associated containment systems.</td>
<td></td>
</tr>
<tr>
<td>Monthly monitoring (conducted in unison with ambient air quality monitoring program).</td>
<td></td>
</tr>
<tr>
<td>Full geomorphic condition assessment and erosion mitigation study, with development of prioritised work program.</td>
<td></td>
</tr>
<tr>
<td>Review of baseline studies to map surface mineralisation to compare with data from the current site soil monitoring program.</td>
<td></td>
</tr>
<tr>
<td>Geotechnical assessment of wall integrity by a qualified geotechnical engineer, focusing on higher risk sites including historically eroded areas and in proximity to the upstream end of the McArthur River</td>
<td></td>
</tr>
</tbody>
</table>

### 4.6.2 Environmental Management Plans

#### 4.6.2.1 Purpose

Chapter 15 (Environmental Management Plan) of the Draft EIS provided a series of draft, strategic level EMPs outlining the framework for the environmental management of the Project’s specific management elements that have changed since the Phase 3 EIS. The details within these EMPs will be incorporated into MRM’s existing operational management plans as summarised in Section 4.6.1 above.

MRM’s operational environmental management plans (EMPs) are the key documents which provide detail on the discipline specific monitoring and management programs on site, including the relevant:

- sampling/monitoring locations;
- sampling/monitoring frequency;
- performance measures;
- performance indicators; and
- response actions in the event that trigger levels exceeded.

These documents are reviewed and updated as required, based on the findings of MRM’s various checking and review processes including (as also summarised in Figure 1-1):

- annual performance reporting;
- annual risk assessments;
- annual Independent Monitor reviews; and
- periodic site senior management reviews.

#### 4.6.2.2 Structure

MRM’s operational EMPs are discipline specific (e.g. air quality, surface water quality) and are generally structured as outlined below:

- introduction;
- objectives (performance measures);
- targets (performance indicators);
- management strategy;
• monitoring programs;
• reporting and review process;
• contingencies/Corrective Actions; and
• responsibilities.

4.6.2.3 Operational versus Project Closure EMPs

It is envisaged that Project closure phase EMPs will be developed on a domain specific basis including those associated with:

• the final void closure;
• NOEF decommissioning, closure and rehabilitation;
• TSF decommissioning, closure and rehabilitation; and
• other related infrastructure such as the process plant.

The final structure, content and other requirements of these EMPs will be developed in consultation with the regulator in accordance with the relevant regulatory requirements.

4.7 Emergency Preparedness and Response

MRM identifies potential emergencies and accidents that can have an environmental impact as a result of its activities. Environmental emergencies and accidents are therefore subject to risk analysis and determination of environmental significance and handled accordingly in the environmental management system. Objectives and targets are set for environmental emergencies and accidents that are regarded as significant environmental aspects and an emergency response plan is established to achieve the objectives and targets.

Environmental emergencies and accidents are regarded as environmental nonconformities. Accordingly, in the event of an occurrence, immediate action is taken to mitigate the environmental impact, followed by corrective action to avoid a recurrence.

MRM has an established environmental incident management procedure and emergency response plan which will be updated as required to incorporate relevant aspects of the Overburden Management Project (the Project). Components of the procedure include systems for:

• reporting all incidents and hazards;
• following up actions and outcomes resulting from incident investigations;
• site inductions and ongoing training of employees and contractors addressing the incident reporting process; and
• communicating incident investigation outcomes and learning experiences with employees and contractors.
5 Checking

MRM’s system of checking its performance against set objectives and targets comprises the use of a number of management tools including:

- monitoring and measurement programs;
- compliance evaluations via:
  - auditing programs (both technical and systems based);
  - incident reporting systems;
  - stakeholder complaints process; and
  - performance reporting processes (both internal and external); and
- management of non-conformances, corrective and preventative actions.

These are described below in Sections 5.1 to 5.3.

5.1 Monitoring and Measurement

5.1.1 Operations

A major feature of MRM’s approach to life of mine and closure management is the consideration of both short-term and long-term management timeframes. This strategy acknowledges that the site will include residual environmental risks that will require ongoing monitoring and management at closure. As a result, MRM proposes to establish a number of closure monitoring and management phases, including short-term adaptive management; long-term proactive monitoring and long-term reactive monitoring programs. A number of contingencies have also been developed in the event that performance monitoring outcomes do not meet MRM’s closure objectives.

Monitoring programs will be implemented to:

- inform the evaluation of mitigation and management effectiveness;
- facilitate determination of compliance with environmental management strategies; and
- identify whether any environmental incidents have occurred.

Monitoring results will feed back into the annual operational performance report.

Effective monitoring requires acquisition of baseline data to compare life of mine (LOM) impacts against pre-mining conditions; and therefore allow an assessment of the significance of any Project related impacts. As such, baseline flora and fauna surveys and background groundwater and surface water monitoring have been conducted throughout the mine life as part of various impact assessment processes.

The environmental monitoring program is designed to achieve the following objectives:

- confirm compliance with statutory regulations;
- evaluate the environmental performance against objectives and targets;
- assist in improving environmental management strategies;
- identify potential environmental impacts; and
- contribute to local knowledge on regional biodiversity.
Site environmental monitoring procedures and plans are maintained, which documents the following information:

- types of monitoring conducted;
- frequency of monitoring;
- monitoring locations;
- analysis conducted on samples;
- laboratories where samples are sent;
- dispatch procedures;
- invoicing procedures;
- data management;
- record keeping requirements; and
- safety issues associated with monitoring activities.

Table 3-2 in Section 3.3 above provides a summary of MRM’s site monitoring programs, which have been developed as part of MRM’s site planning process, and in response to development of the:

- project aspects and resultant risk assessment;
- resulting performance measures (or objectives); and
- performance indicators (targets).

5.1.2 Project Closure

The key elements of the adaptive management framework will continue to be applied at Project closure, including throughout decommissioning and rehabilitation, and subsequently monitoring and maintenance. This will be relevant for scenarios associated with:

- final void closure;
- NOEF cover system performance and management; and
- TSF closure.

5.1.2.1 Final Void Closure

A model of the proposed final void closure process is provided in Figure 5-1 below. This model incorporates a proposed approach to progressing through the various stages of final void closure (i.e. from “open cut” to “final void rapid filling” to “isolated mine pit lake” to “backflow mine pit lake”, to “flowthrough mine pit lake” and into active closure, proactive monitoring, reactive monitoring and relinquishment. It also incorporates:

- the key elements of MRM’s adaptive management process (refer to Figure 1-1);
- key decision points;
- regulatory consultation steps;
- specific action steps;
- mitigation/contingency steps; and
- a strategy for relinquishment.

The overarching philosophy of this approach is that:

- each stage of the process is managed in accordance with MRM’s adaptive management framework approach (the key elements); and
- MRM does not progress to the next stage until it has:
  - formally reviewed the environmental performance of the current stage;
  - developed a proposed adaptive management program for the next stage;
o finalised its proposed design for the next stage of closure (in consultation with the regulator), including contingencies in the event that MRM does not meet the set performance criteria;
o developed an environmental performance report;
o submitted the report to the regulators (and other relevant parties) for review;
o completed consultation with the regulators to progress to the next stage; and
o conducted the necessary engineering works for the next stage’s commissioning.
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Figure 5-1: FINAL VOID CLOSURE - ADAPTIVE MANAGEMENT PROCESS (Page 1 of 3)

<table>
<thead>
<tr>
<th>Operations Phase</th>
<th>Closure Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year</strong></td>
<td><strong>NOEF Development</strong></td>
</tr>
<tr>
<td>2018</td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
</tr>
<tr>
<td>2027</td>
<td></td>
</tr>
<tr>
<td>2032</td>
<td></td>
</tr>
<tr>
<td>2047</td>
<td></td>
</tr>
<tr>
<td>2052</td>
<td></td>
</tr>
<tr>
<td>2057</td>
<td></td>
</tr>
<tr>
<td>2062</td>
<td></td>
</tr>
</tbody>
</table>

**Develop Closure Studies**
- Refer "Adaptive Management Key Elements" flowchart for details

**Performance indicators**
- Refer "Adaptive Management Key Elements" flowchart for details

**Environmental Monitoring Program**
- Refer "Adaptive Management Key Elements" flowchart for details

**Reporting and Review, including:**
- Refer "Adaptive Management Key Elements" flowchart for details

---

**Adaptively managed maintenance and repairs**
- Refer "Adaptive Management Key Elements" flowchart for details

---

**Notes:**
- Green arrow indicates business as usual (BAU) pathway
- Blue arrow indicates alternate pathway
- White arrow indicates an MRM decision step
- Red arrow indicates an MRM mitigation step
- Other arrow indicates completion consultation with regulators
Closure Phase

**Reactive Monitoring**
Environmental monitoring and maintenance conducted in reaction to a large event likely to change site conditions (e.g., exceptional flooding, intense cyclone, widespread and intense fire, etc.).

- Adaptively managed maintenance and repairs
- Routine environmental monitoring continues but:
  - a) at reduced frequency
  - b) potentially less parameters analysed
  - c) reduction in site presence

- Decreased requirement for maintenance/repairs
- Landforms are stable.
- Vegetation well established
- Mine pit lake and surface waters at steady state
- Environmental modelling has ceased
- Routine maintenance needs well understood

**Proactive Monitoring**
Ongoing environmental monitoring based on an agreed fixed schedule and continuous reduced presence on site.

**Action Plan**
- Reactive monitoring
- Relinquishment

**Environmental Performance Report with regulatory consultation to proceed:**
- to Reactive monitoring; or
- directly to Relinquishment

**Mitigation**

- N
- Y

**Acceptable environmental performance?**

<table>
<thead>
<tr>
<th>Maintain environmental performance for nominal period?</th>
<th>Proceed to Reactive monitoring</th>
<th>Proceed to Relinquishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Proceed to Reactive monitoring</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Proceed to Relinquishment</td>
<td></td>
</tr>
</tbody>
</table>

**Implement Relinquishment process**

**Figure 5-1: FINAL VOID CLOSURE - ADAPTIVE MANAGEMENT PROCESS (Page 3 of 3)**
This page has been intentionally left blank for consistency between printed and electronic versions of this document.
The following provides further supporting explanation of the final void closure process. Note that Appendix B of the Supplementary EIS also provides a consolidated discussion of this closure process.

5.1.2.1 Final Void Operations Phase

This phase extends to approximately 2047 and incorporates:

- continued approved mining activities (including NOEF development and in-pit dumping); and
- tailings reprocessing, including placement of reprocessed tailings back into the final void.

During this phase, MRM will continue to develop its closure studies and monitoring programs associated with mine levee wall integrity, McArthur River water quality, aquatic ecology and downstream geomorphology (refer Table 3.2 for details). As per the process described in Figure 1-1:

- monitoring will assess compliance against the established performance indicators; and
- should indicator trigger values be exceeded then the appropriate management response process will be implemented, including:
  - internal and/or external reporting;
  - internal and/or external investigations with developed recommendations;
  - updating of management measures (and relevant EMPs) as required;
  - internal performance reporting and senior management review; and
  - annual external performance reporting in accordance with regulatory requirements.

Prior to completion of tailings reprocessing and placement into the final void, a detailed Closure Plan (including established performance indicators) will be finalised in consultation with the regulator. MRM will not progress to the final void active closure phase until this regulatory consultation has occurred.

5.1.2.1.2 Final Void Closure Phase

This phase will incorporate periods of:

- active closure, comprising a series of sequential steps including:
  - final void rapid filling; followed by development of
  - an isolated mine pit lake; then
  - backflow mine pit; then
  - flowthrough mine pit lake.
- proactive monitoring;
- reactive monitoring; and
- proposed eventual relinquishment.

5.1.2.1.2.1 Final Void Rapid Filling

Upon completion of MRM’s Closure Plan (including associated regulatory consultation), a proposed five year period of final void rapid filling will commence. This will comprise annual harvesting or McArthur River water during the wet season, with conduct of various monitoring programs (and responses to any trigger value exceedances) as described in Section 5.1.2.1.1 above. Specifically, if water quality performance indicators are exceeded then water treatment will be undertaken. Progression of water harvesting in any one year to the following year will not occur until environmental performance indicators are deemed acceptable.
Examples of maintenance and repairs that will be undertaken in the event that one or more performance indicators are exceeded include:

- landform maintenance to manage erosion;
- upgrades or maintenance to sediment or surface water infrastructure;
- potential settlement adjustments;
- river diversion management;
- vegetation and weed management;
- feral animal management; and
- fence and road maintenance.

5.1.2.1.2.2 Isolated Mine Pit Lake

Upon completion of final void rapid filling, the resultant mine pit lake will be managed as an isolated lake until MRM has demonstrated (via its environmental performance monitoring program) that environmental performance is acceptable. This will comprise a number of separate monitoring programs including:

- mine pit lake water quality;
- mine pit lake limnology;
- on-site surface water and groundwater quality;
- downstream surface water quality;
- downstream ecology;
- landform stability;
- fluvial geomorphology;
- revegetation/rehabilitation progress; and
- on-lease ecological monitoring.

As per final void rapid filling, examples of maintenance and repairs that will be undertaken in the event that one or more performance indicators are exceeded include:

- landform maintenance to manage erosion;
- upgrades or maintenance to sediment or surface water infrastructure;
- potential settlement adjustments;
- river diversion management;
- vegetation and weed management;
- feral animal management; and
- fence and road maintenance.

Upon demonstration of acceptable environmental performance over an agreed period of time, MRM shall develop an Environmental Performance Report in consultation with the regulator. MRM will not progress to the proposed backflow mine pit lake until consultation with the regulators has been undertaken. Should the regulator initially reject this report, then MRM will conduct any required additional studies and/or upgrade works. This may include requirements for updated modelling studies, engineering works and/or geochemical, hydrogeological and/or ecological related investigations.

Should MRM be unable to demonstrate acceptable environmental performance over the agreed period of time, then mitigation options will be investigated, including any required additional investigations. This may include:

- updated mine pit lake modelling;
- remedial water treatment;
- additional earthworks/engineering;
updated maintenance requirements; and
revised revegetation planning.

Should these above options prove that mitigation is not possible, MRM will plan to retain and manage the isolated mine pit lake. This will include subsequent amendments to MRM’s Closure Plan in consultation with the regulator. Required isolated mine pit lake management measures may include ongoing mine pit lake water management (including water treatment as required), mine levee wall maintenance, McArthur River diversion management and groundwater interception. The specifics of these management measures will be identified as part of finalising the amended Closure Plan.

5.1.2.1.2.3 Backflow Mine Pit Lake

Assuming MRM has completed regulatory consultation to construct the backflow mine pit lake, a segment of the downstream levee will be removed (in accordance with agreed requirements) such that the downstream end of the isolated mine pit lake will connect with the McArthur River during periods of high flow. Relevant closure studies will be reviewed and optimised if required, with ongoing environmental monitoring programs conducted (refer Section 5.1.2.1.2.2 for specific monitoring program details).

Maintenance and repairs that will be undertaken in the event that one or more performance indicators are exceeded are detailed within Section 5.1.2.1.2.2.

Upon demonstration of acceptable environmental performance over an agreed period of time, MRM will update its mine pit lake modelling to assess whether a flowthrough mine pit lake scenario is still feasible and/or desirable. If modelling outputs indicate that it is feasible and/or desirable, MRM will then develop an Environmental Performance Report in consultation with the regulator. MRM will not progress to the proposed flowthrough mine pit lake until completion of regulatory consultation. If modelling indicates that progression to a flowthrough mine pit lake is not feasible/desirable, MRM will plan to continue managing the mine pit lake as a backflow. This may require amendment to the existing Mine Closure Plan in consultation with the regulator and development of a revised Environmental Performance Report.

If MRM is unable to demonstrate acceptable environmental performance over the agreed period of time, then an assessment of potential impacts on the downstream environment (including water quality, sediment loads and/or ecology) will be undertaken.

- If it is determined that there is no potential for downstream negative environmental impacts, then appropriate mitigation measures will be adopted. This may include updated mine pit lake and/or fluvial modelling, modifying the mine level opening, and modifying mine pit lake banks and/or vegetation. The environmental monitoring program will then confirm if acceptable environmental performance is achieved, in which case the planning for a potential flowthrough mine pit lake will recommence.
- If there is the potential for downstream negative environmental impacts, then the segment of the mine pit lake downstream levee wall will be reinstated to re-establish an isolated mine pit lake. Remediation options will then be assessed:
  - If remediation is found to be possible then the required mitigation works will be carried out. Ongoing monitoring will be conducted to confirm that environmental performance is acceptable. The downstream levee will only be re-opened again (in order to revert to a backflow mine pit lake) when MRM has developed a revised Environmental Performance Report in consultation with the regulator.
Appendix R – Adaptive Management Framework

5.1.2.1.2.4 Flowthrough Mine Pit Lake

Upon completion of regulatory consultation to construct the Flowthrough mine pit lake, a segment of the upstream mine levee will be removed (in accordance with agreed requirements) such that the upstream (as well as the downstream) ends of the backflow mine pit lake will connect with the McArthur River during periods of high flow. Relevant closure studies will be reviewed and optimised if required, with ongoing environmental monitoring programs conducted (refer Section 5.1.2.1.2.2 for specific monitoring program details).

Maintenance and repairs that will be undertaken in the event that one or more performance indicators are exceeded are detailed within Section 5.1.2.1.2.2.

Upon demonstration of acceptable environmental performance over an agreed period of time, MRM will develop an Environmental Performance Report in consultation with the regulator. This report will also include a proposed revised proactive monitoring phase program. MRM will not progress to its proposed proactive monitoring phase until regulatory consultation has been undertaken.

If MRM is unable to demonstrate acceptable environmental performance over the agreed period of time, then an assessment of potential impacts on the downstream environment (including water quality, sediment loads and/or ecology) will be undertaken.

- If it is determined that there is no potential for downstream negative environmental impacts, then appropriate mitigation measures will be adopted. This may include updated mine pit lake and/or fluvial modelling, modifying the mine level opening, and modifying mine pit lake banks and/or vegetation. The environmental monitoring program will then confirm if acceptable environmental performance is achieved, in which case the planning for progression to a Proactive Monitoring Program will commence, including development of an Environmental Performance Report in consultation with the regulator.

- If there is the potential for downstream negative environmental impacts, then the segments of the mine pit lake downstream and upstream levee walls will be reinstated to re-establish an isolated mine pit lake. Remediation options will then be assessed, and:
  
  o if remediation is found to be possible then the required mitigation works will be carried out. Ongoing monitoring will be conducted to confirm that environmental performance is acceptable. The segments of levee walls will only be re-opened again (in order to revert to a flowthrough mine pit lake) when MRM has developed a revised Environmental Performance Report, and this plan has subsequently been discussed with the regulator.
  
  o If remediation is found to be not possible, then MRM shall amend its Closure Plan to reflect the ongoing management of an isolated mine pit lake, and develop a revised Environmental Performance Report in consultation with the regulator.
5.1.2.1.3 Final Void Proactive Monitoring Program

Proactive monitoring will reflect a more fixed schedule and reduced presence on site, and is planned to come into effect approximately 50 years after the final void has been rapidly filled via pumping from the McArthur River. A substantial amount of environmental monitoring and modelling data will have been collected over this approximate 50 year period and will be assessed in order to inform this modified monitoring phase, which will comprise a revised monitoring scope and frequency. Specific features of this Proactive Monitoring Program include:

- Continuation of the routine environmental monitoring program but:
  - at reduced frequency;
  - with potentially less parameters analysed; and
  - with a planned reduction in site presence.
- Decreased requirement for maintenance/repairs;
- Landforms are stable;
- Vegetation is well established;
- The mine pit lake and surface waters are at a steady state;
- Environmental modelling has ceased;
- Routine maintenance needs are well understood; and
- Repairs are conducted following large events.

5.1.2.1.4 Final Void Reactive Monitoring Program

Reactive monitoring will be established at a point in time as discussed with the regulator and will be designed and conducted in reaction to events that are likely to change site conditions such as exceptional flooding, large/intense cyclones and/or extensive bushfires.

As per the proactive monitoring program, maintenance and repairs will reflect a decreased requirement, which is characterised by:

- a more stable landform;
- well established vegetation communities;
- steady state surface water quality;
- well understood routine maintenance needs; and
- repairs being constructed following large events.

5.1.2.1.5 Relinquishment

The process of relinquishment will be negotiated with the relevant regulatory agencies and other stakeholders in accordance with the regulatory requirements of the time. At this point, MRM has assumed it will sequentially occur following completion of any reactive monitoring program and resultant regulatory consultation on an MRM proposed relinquishment process. However, MRM has also included in its flow chart an option to progress directly from Proactive Monitoring to relinquishment. The feasibility of this will be assessed further into the final void closure adaptive management process, in close consultation with relevant regulatory agencies and stakeholders.

5.1.2.2 NOEF Cover System Performance

A model of how the NOEF Cover System Performance and closure process is proposed to be implemented is provided in Figure 5-2 below. The model incorporates a proposed approach to progressing through NOEF Development and into active closure, proactive monitoring, reactive monitoring and relinquishment. It also incorporates:

- the key elements of MRM’s adaptive management process (refer Figure 1-1);
- key decision points;
• regulatory involvement;
• specific action steps;
• mitigation/contingency steps; and
• a strategy for relinquishment.

The overarching philosophy of this approach is that:

• Each stage of the process is managed in accordance with MRM’s adaptive management framework approach (the key elements); and
• MRM does not progress to the next stage until it has:
  o formally reviewed the environmental performance of the current stage;
  o developed a proposed adaptive management program for the next stage;
  o finalised its proposed design for the next stage of closure (in consultation with the regulator), including contingencies in the event that MRM does not meet the set performance criteria;
  o developed an environmental performance report;
  o submitted the report to the regulators (and other relevant parties); and
  o completed consultation with regulators and other relevant stakeholders.

Other key features of this process include:

• The NOEF cover system construction QA/QC process does not allow progression to the next step until the QA/QC process has passed.
• Due to the staggered/sequential development of the NOEF, construction will be continuing to occur in some sections of the NOEF whilst other sections will be undergoing rehabilitation.
• NOEF rehabilitation does not progress to proactive monitoring and then reactive monitoring phases until performance criteria have been met, and regulatory consultation on progressing to the next phase has been completed.
Figure 5-2: NOEF - ADAPTIVE MANAGEMENT PROCESS (Page 1 of 3)

Operations Phase
Mining Operations and Tailings Reprocessing

NOEF Development

Timeline

Notes

- White coloured box indicates an MRM action step
- MRM decision step
- MRM mitigation step
- Indicates completed consultation with regulators
- Green arrow indicates business as usual (BAU) pathway
- Blue arrow indicates alternate pathway

**Environmental Monitoring Program**
- Update conceptual models
  - NOEF environmental model
  - Geotechnology
  - Hydrogeology
  - Cover system performance
  - Surface waters
  - Ecotoxicology
  - Geochemistry
  - Geotechnical engineering

**Landform Monitoring Program**
- Surface water monitoring
  - Sediment monitoring
  - Rainfall

**Closure studies**
- Quaternary
- Cover system performance
- Slope stability, erosion gullies
- Dust levels, SO2, H2S, CO2

**Construction of NOEF**
- Internal structure
- Updates conceptual models

**Completion of the NOEF**

**Administrative Controls**
- Restrict access to landform
- Establish exclusion zone

**Progressive rehabilitation**
- Prevent discharge to McArthur River via dam and pump from affected local creeks:
  - Barney Creek
  - Surprise Creek
  - Emu Creek

**Acceptable environmental performance?**
- Yes
- No

**Administrative Controls**
- Restrict access to landform
- Establish exclusion zone

**Mitigation**
- Prevent discharge to McArthur River via dam and pump from affected local creeks
  - Barney Creek
  - Surprise Creek
  - Emu Creek

**Acceptable environmental performance?**
- Yes
- No
### Notes
- White coloured box indicates an MRM action step
- MRM decision step
- Blue arrow indicates consultation with regulators
- Green arrow indicates business as usual (BAU) pathway
- Thin arrow indicates alternate pathway

### Closure Phase

#### Proactive Monitoring
- 2100 approx.
- NOE completed

#### Reactive Monitoring
- TBA

#### Relinquishment
- TBA

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**Timeline**

1. **Proactive monitoring phase** and planned maintenance program execution
2. Regulatory consultation completed to proceed?
   - **Acceptable environmental performance for nominal period?**
     - Y
     - N
     - N
     - Y

   - **Environmental Performance Report**
     - Y
     - N

   - **Revert to Active Closure related monitoring program**

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**Environmental Performance Report and consultation with regulator to commence relinquishment process**
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The following provides further supporting explanation of the NOEF cover system management process.

5.1.2.2.1 NOEF Development

This phase extends to 2032, when placement of mined overburden in facilities external to the open cut final void ceases. Specific activities include:

- Development of the internal structure of the NOEF, with the placement of various classes of overburden and barrier materials including reactive PAF(RE) (Potentially-Acid Forming rock (Reactive)) cells, core materials including PAF(HC) (Potentially-Acid Forming rock (High Capacity)) and MS-NAF (Metalliferous Saline Non Acid Forming rock), basal compacted clay layers, the internal NAF halo and low air permeability advection layers. These activities will all be conducted in accordance with specifically developed construction QA/QC processes. Refer to Section 3.4.4.3 (including Figure 3-47) of the Draft EIS for a more detailed description of this process;
- Progressive construction of the NOEF cover system including growth layers, barrier layers, drainage layers and other surface water drainage features (refer to Appendix G and Appendix H of this Supplementary EIS for further details); and
- Progressive rehabilitation of selected sections of the NOEF as overburden and cover system material placement is completed. This includes any additional stabilisation of cover material through installation of surface water management controls and establishment of a vegetative cover.

During this phase MRM will continue to conduct its various NOEF monitoring programs associated with air quality, landform performance, and surface and groundwater quality (refer to Table 3.2 for details). The results of this monitoring will be used to calibrate/update the various conceptual models associated with NOEF unsaturated flow, geochemistry, hydrogeology, surface water and geotechnical performance.

As per the process described in Figure 1-1:

- monitoring will assess compliance against the established performance indicators; and
- should indicator trigger values be exceeded then the appropriate management response process will be implemented, including:
  - internal and/or external reporting;
  - internal and/or external investigations with developed recommendations;
  - updating of management measures (and relevant EMPs) as required;
  - internal performance reporting and senior management review; and
  - annual external performance reporting in accordance with regulatory requirements.

5.1.2.2.2 NOEF Active Closure

Upon completion of NOEF Development in 2032 (when placement of all overburden material has been completed) a period of active closure will commence. This will include the continuation of MRM’s closure studies, conceptual model updates and environmental performance monitoring programs as described above until nominally 2100. This date will obviously be subject to the successful demonstration of required environmental performance.

The following sections provide further details on MRM’s specific monitoring programs and how they influence MRM’s decision steps and management responses (including adoption of controls and mitigation options).
5.1.2.2.2.1 Air quality monitoring program

Upon demonstration of acceptable air quality related performance over an agreed period of time, MRM will develop an Environmental Performance Report in consultation with the regulator.

MRM will not progress to its proposed proactive monitoring program until this report has been reviewed by the regulator.

If MRM is unable to demonstrate acceptable air quality related performance, then an assessment of the potential health and safety risks (H&S) will be undertaken, including risks associated with dust, sulphur dioxide, hydrogen sulphide and/or carbon dioxide (note that MRM has developed an air quality related TARP for the NOEF which details trigger values and response mechanisms).

- Should an immediate H&S risk be determined, appropriate administrative controls will be applied including implementing access restrictions. The appropriate incident reporting process will also be followed, including notifying stakeholders and the regulator if required (refer to Figure 5-2 for further details).
- If no immediate H&S risk is determined then mitigation/remediation works will be implemented which may include a combination of the following:
  - upgrading vegetative cover;
  - repairs to the cover system;
  - partial replacement of barrier layers; and/or
  - changes to the cover system including increasing thickness, replacement of barrier layer and/or placement of additional barrier layer material.

As a result of these non-conformances with performance requirements MRM will subsequently update its maintenance and/or monitoring programs and conceptual models and provide updated details to the regulator via an updated EMP and/or Environmental Performance Report.

5.1.2.2.2 Landform monitoring program

Upon demonstration of acceptable landform related performance over an agreed period of time, (e.g. associated with erosion, cover system, surface and groundwater, and vegetation performance) MRM will develop an Environmental Performance Report in consultation with the regulator. MRM will not progress to its proposed proactive (then reactive) monitoring programs until regulatory consultation has been completed.

If MRM is unable to demonstrate acceptable landform related performance, then an assessment of the potential health and safety (H&S) risks will be undertaken, including risks associated with slope stability and erosion.

- Should an immediate H&S risk be determined, appropriate administrative controls will be applied including implementing access restrictions. The appropriate incident reporting process will also be followed, including notifying stakeholders and the regulator if required (refer Figure 5-2 for further details).
- If no immediate H&S risk is determined then mitigation/remediation works will be implemented which may include a combination of the following:
  - upgrading vegetative cover;
  - repairs to the cover system;
  - partial replacement of barrier layers; and/or
  - changes to the cover system including increasing thickness, replacement of barrier layer and/or placement of additional barrier layer material.
As a result of these non-conformances with performance requirements MRM will subsequently update its maintenance and/or monitoring programs and conceptual models and provide updated details to the regulator via an updated EMP and/or Environmental Performance Report.

5.1.2.2.3 Surface and groundwater monitoring programs

Upon demonstration of acceptable groundwater and surface water quality related performance over an agreed period of time, MRM will develop an Environmental Performance Report in consultation with the regulator. Examples of acceptable performance include seepage waters conforming to modelled results and surface and groundwater quality parameters reporting concentrations below trigger levels. MRM will not progress to its proposed proactive (then reactive) monitoring programs until regulatory consultation has been completed.

If MRM is unable to demonstrate acceptable surface and/or groundwater related performance, then an assessment of the potential to negatively impact on downstream environmental values will be undertaken (including potential impacts on water quality, aquatic fauna, sediment quality and bioaccumulation).

- Should potential negative downstream impacts be determined then MRM will prevent further discharge to the McArthur River via the damming and pumping of impacted local watercourses (e.g. Barney Creek, Surprise Creek or Emu Creek).
- MRM will then assess its remediation options, and:
  - if remediation is deemed to be possible then remedial works will commence including a combination (as required) of cover system repairs, partial or total replacement of barrier layers, cover system changes (e.g. increasing thickness), installation of interception trenches and/or bores.
  - If remediation is not deemed to be possible (e.g. if seepage waters have become acidified and/or impacted with excessive metals or sulphate loads) then seepage collection will continue with associated treatment of collected seepage water prior to discharge.

As a result of these non-conformances with performance requirements MRM will subsequently update its maintenance and/or monitoring programs and conceptual models and provide updated details to the regulator via an updated EMP and/or Environmental Performance Report.

5.1.2.2.3 NOEF Proactive Monitoring Program

Proactive monitoring will reflect a more fixed schedule and reduced presence on site, and is planned to come into effect nominally around the year 2100. This timing is over 50 years after NOEF development has ceased. A substantial amount of environmental monitoring and modelling data will have been collected over this 50+ year period and will be assessed in order to inform this modified monitoring phase, which will comprise a revised monitoring scope and frequency. Specific features of this Proactive Monitoring Program include:

- continuation of the routine environmental monitoring program but:
  - at reduced frequency;
  - with potentially less parameters analysed; and
  - with a planned reduction in site presence.
- decreased requirement for maintenance/repairs;
- landforms are stable;
- vegetation is well established;
- surface and groundwater qualities are at a steady state;
- environmental modelling has ceased;
- routine maintenance needs are well understood; and
5.1.2.2.4 NOEF Reactive Monitoring Program

Reactive monitoring will be established at a point in time as agreed with the regulator and will be designed and conducted in reaction to events that are likely to change site conditions such as exceptional flooding, large/intense cyclones and/or extensive bushfires.

As per the proactive monitoring program, maintenance and repairs will reflect a decreased requirement, which is characterised by:

- a more stable landform;
- well established vegetation communities;
- steady state surface water quality;
- well understood routine maintenance needs; and
- repairs being constructed following large events.

5.1.2.2.5 Relinquishment

The process of relinquishment will be negotiated with the relevant regulatory agencies and other stakeholders in accordance with the regulatory requirements of the time. At this point, MRM has assumed it will sequentially occur following completion of any reactive monitoring program and resultant regulatory review of a MRM proposed relinquishment process.

5.1.2.3 TSF Closure

A model of how the TSF closure process is proposed to be implemented is provided in Figure 5-3 below. The model incorporates a proposed approach to progressing through the construction and operation of the TSF, tailings reprocessing, then into active closure, proactive monitoring, eactive monitoring and relinquishment. It also incorporates:

- the key elements of MRM’s adaptive management process (refer Figure 1-1);
- key decision points;
- regulatory involvement;
- specific action steps;
- mitigation/contingency steps; and
- a strategy for relinquishment.

The overarching philosophy of this approach is that:

- each stage of the process is managed in accordance with MRM’s adaptive management framework approach (the key elements); and
- MRM does not progress to the next stage until it has:
  - formally reviewed the environmental performance of the current stage;
  - developed a proposed adaptive management program for the next stage;
  - finalised its proposed design for the next stage of closure (in consultation with the regulator), including contingencies in the event that MRM does not meet the set performance criteria;
  - developed an environmental performance report; and
  - submitted the report to the regulators (and other relevant parties) for review.

Other key features of this process include:

- the TSF construction QA/QC process does not allow progression to the next step until the QA/QC process has passed; and
• TSF rehabilitation doesn’t progress to proactive monitoring and then reactive monitoring phases until performance criteria have been met, and regulatory consultation has been completed.
Figure 5-3: TSF - ADAPTIVE MANAGEMENT PROCESS (Page 1 of 2)

Operations Phase

TSF Construction and Operations, and Tailings Reprocessing

Notes:
- White outlined box indicates an MRM action step
- Red outlined box indicates a decision step
- Green outlined box indicates completed consultation with regulators
- Orange outlined box indicates business as usual (BAU) pathway
- Blue outlined box indicates alternate pathway

Timeline:
- 2018
- 2019
- 2020
- 2021
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- 2099
- 2100
The following provides further supporting explanation of the TSF closure process.

5.1.2.3.1 TSF Construction, Operations and Tailings Reprocessing

Construction and operation of the TSF extends to 2037, with a proposed 10 year tailings reprocessing phase to then occur. Reprocessing will comprise the hydraulic mining of tailings and pumping to the processing facility for reprocessing. Recovered ore will be transported to Bing Bong for export, and spent tailings placed into the open cut final void.

During this phase MRM will continue to conduct its various TSF monitoring programs associated with air quality, landform performance and surface and groundwater quality (refer to Table 3-2 for details). The results of this monitoring will be used to calibrate/update the various conceptual models associated with geochemistry, hydrogeology, surface water and geotechnical performance.

As per the process described in Figure 1-1:

- monitoring will assess compliance against the established performance indicators; and
- should indicator trigger values be exceeded then the appropriate management response process will be implemented, including:
  - internal and/or external reporting;
  - internal and/or external investigations with developed recommendations;
  - updating of management measures (and relevant EMPs) as required;
  - internal performance reporting and senior management review; and
  - annual external performance reporting in accordance with regulatory requirements.

The following sections provide further details on MRM’s specific monitoring programs and how they influence MRM’s decision steps and management responses (including adoption of controls and mitigation options).

5.1.2.3.1.1 Air quality monitoring program

At the completion of TSF operations, and upon demonstration of acceptable air quality related performance over an agreed period of time, MRM will assess whether the TSF is to be decommissioned and tailings either to be reprocessed (the proposed/preferred alternative) or remain insitu. MRM will then develop an Environmental Performance Report for the TSF operations phase in consultation with the regulator. MRM will not commence any TSF decommissioning works (including hydraulic mining and tailings reprocessing) until regulatory consultation on this report has been completed.

If MRM is unable to demonstrate acceptable air quality related performance, then an assessment of the potential health and safety (H&S) risks will be undertaken, including risks associated with dust, sulphur dioxide and/or hydrogen sulphide.

- Should an immediate H&S risk be determined, appropriate administrative controls will be applied including implementing access restrictions. The appropriate incident reporting process will also be followed, including notifying stakeholders and the regulator if required (refer to Figure 5-3 for further details).
- If no immediate H&S risk is determined then mitigation/remediation works will be implemented which may include a combination of increasing the spigoting cycle and/or incorporation of sprinklers or other irrigation techniques.
As a result of these non-conformances with performance requirements MRM will subsequently update its maintenance and/or monitoring programs and conceptual models and provide updated details to the regulator via an updated EMP and/or Environmental Performance Report. Environmental performance monitoring will continue in order to confirm that adopted mitigation measures are achieving acceptable environmental performance over the agreed nominal period.

5.1.2.3.1.2 Landform monitoring program

At the completion of TSF operations, and upon demonstration of acceptable landform related performance over an agreed period of time, (e.g., associated with erosion, surface drainage and/or landform stability) MRM will assess whether the TSF is to be decommissioned and tailings either to be reprocessed (the proposed/preferred alternative) or remain in situ. MRM will then develop an Environmental Performance Report for the TSF Operations phase in consultation with the regulator. MRM will not commence any TSF decommissioning works (including hydraulic mining and tailings reprocessing) until regulatory consultation has been completed.

If MRM is unable to demonstrate acceptable landform related performance, then an assessment of the potential health and safety (H&S) risks will be undertaken, including risks associated with slope stability and erosion.

- Should an immediate H&S risk be determined, appropriate administrative controls will be applied including implementing access restrictions. The appropriate incident reporting process will also be followed, including notifying stakeholders and the regulator if required (refer to Figure 5-3 for further details).
- If no immediate H&S risk is determined then mitigation/remediation works will be implemented which may include a combination of measures including strengthening buttresses and/or dewatering the TSF to the water management dams.

As a result of these non-conformances with performance requirements MRM will subsequently update its maintenance and/or monitoring programs and conceptual models and provide updated details to the regulator via an updated EMP and/or Environmental Performance Report. Environmental performance monitoring will continue in order to confirm that adopted mitigation measures are achieving acceptable environmental performance over the agreed nominal period.

5.1.2.3.1.3 Surface and groundwater monitoring programs

At the completion of TSF operations, and upon demonstration of acceptable groundwater and surface water quality related performance over an agreed period of time, MRM will assess whether the TSF is to be decommissioned and tailings either to be reprocessed (the proposed/preferred alternative) or remain in situ. Examples of acceptable performance include seepage waters conforming to modelled results and surface and groundwater quality parameters reporting concentrations below trigger levels. MRM will then develop an Environmental Performance Report for the TSF operations phase in consultation with the regulator. MRM will not commence any TSF decommissioning works (including hydraulic mining and tailings reprocessing) until regulatory consultation of this report has been completed.

If MRM is unable to demonstrate acceptable surface and/or groundwater related performance, then an assessment of the potential to negatively impact on downstream environmental values will be undertaken (including potential impacts on water quality, aquatic fauna, sediment quality and bioaccumulation).

- Should potential negative downstream impacts be determined then MRM will prevent further discharge to the McArthur River via the damming and pumping of impacted local watercourses (e.g. Barney Creek or Surprise Creek).
MRM will then assess its remediation options:

- If remediation is deemed to be possible then remedial works will commence including a combination of TSF water management changes, installation of interception trenches and/or interception bores.
- If remediation is not deemed to be possible (e.g., if seepage waters have become acidified and/or impacted with excessive metals or sulphate loads) then seepage collection will continue with associated treatment of collected seepage water prior to discharge.

As a result of these non-conformances with performance requirements MRM will subsequently update its maintenance and/or monitoring programs and conceptual models and provide updated details to the regulator via an updated EMP and/or Environmental Performance Report. Environmental performance monitoring will continue in order to confirm that adopted mitigation measures are achieving acceptable environmental performance over the agreed nominal period.

### 5.1.2.3.2 TSF Rehabilitation and Active Closure Management

Upon completion of tailings hydraulic mining in approximately 2047 (when removal of all tailings from the TSF to the open cut final void has been completed) a period of active closure will commence which will include rehabilitation of the TSF footprint. This has been described in more detail in Draft EIS Section 3.4.6.4.

This will include the continuation of MRM’s closure studies, conceptual model updates and environmental performance monitoring programs as described above until nominally 2100. This date will obviously be subject to the successful demonstration of required environmental performance.

Upon demonstration of acceptable environmental performance over an agreed period of time, MRM will develop an environmental performance report in consultation with the regulator. This report will also outline MRM’s proposed Proactive Monitoring Program for the rehabilitated TSF footprint.

### 5.1.2.3.3 TSF Proactive Monitoring Program

Proactive monitoring will reflect a more fixed schedule and reduced presence on site, and is planned to come into effect nominally around the year 2100. This timing is approximately 50 years after TSF rehabilitation has been completed. A substantial amount of environmental monitoring and modelling data will have been collected over this period and will be assessed in order to inform this modified monitoring phase, which will comprise a revised monitoring scope and frequency. Specific features of this proactive monitoring program include:

- continuation of the routine environmental monitoring program but:
  - at reduced frequency;
  - with potentially less parameters analysed; and
  - with a planned reduction in site presence.
- decreased requirement for maintenance/repairs;
- landforms are stable;
- vegetation is well established;
- surface and groundwater qualities are at a steady state;
- environmental modelling has ceased;
- routine maintenance needs are well understood; and
- repairs are conducted following large events.
5.1.2.3.4 TSF Reactive Monitoring Program

Reactive monitoring will be established at a point in time as agreed with the regulator and will be designed and conducted in reaction to events that are likely to change site conditions such as exceptional flooding, large/intense cyclones and/or extensive bushfires.

As per the Proactive monitoring program, maintenance and repairs will reflect a decreased requirement, which is characterised by:

- a more stable landform;
- well established vegetation communities;
- steady state surface water quality;
- well understood routine maintenance needs; and
- repairs being constructed following large events.

5.1.2.3.5 Relinquishment

The process of relinquishment will be negotiated with the relevant regulatory agencies and other stakeholders in accordance with the regulatory requirements of the time. At this point, MRM has assumed it will sequentially occur following completion of any reactive monitoring program and resultant regulatory review of a MRM proposed relinquishment process.

5.2 Evaluation of Compliance

MRM has an established auditing process in place to evaluate its performance and demonstrate its degree of success. Monitoring and audit reports are produced and maintained on site. Relevant information is made available to the appropriate Managers and, when relevant, the regulatory authorities. Internal and external audit results are used to review management practices and update procedures and plans when required.

5.2.1 Audits

The MRM site is subject to both independent external audits and internal corporate audits, with auditing of the EMP compliance conducted and reported as part of the MMP review and renewal process.

5.2.1.1 External Audits

An annual independent environmental audit is undertaken as part of the Independent Monitors’ Annual Environmental Audit program, with audit reports publicly available at www.mrmindependentmonitor.com.au. The annual environmental audits are usually conducted during, or shortly after the wet season (access permitting) in order to best assess the effectiveness of erosion and sediment control measures.

Any reasonable improvements or upgrades to environmental practices, procedures or standards recommended after an environmental audit or assessment are implemented at the first available opportunity.

MRM understands the importance of maintaining high environmental standards and is committed to achieving the closure objectives through sound environmental practice.
5.2.1.2 Internal audits

Monthly environmental data is reported to the Glencore head office for assessment of environmental performance in line with Glencore HSEC procedures. MRM has a compliance management system that identifies the environmental monitoring, sampling and reporting requirements for the operation. Regular reviews are undertaken to assess site compliance and identify any areas of improvement. Corrective actions are recorded in a corrective actions register (Site Safe) and reviewed on a regular basis to track progress and completion.

5.2.2 Incident Reporting and Non-conformance

Incident reporting is recorded and tracked in McArthur River Mine’s onsite safety system (Site Safe) and reviewed daily. Details of the initial incident, follow-up investigation details and corrective actions are recorded and registered in the site safety system. Corrective actions are reviewed on a monthly basis to track progress and completion.

Incident severity and potential severity rating are determined using the MRM risk assessment matrix to determine actual and potential environmental harm. Notification of incidents, both internally and (if required) to external regulatory agencies is undertaken in accordance with the MRM Incident Reporting and Investigation Procedure.

5.2.3 Complaints Register

Any complaints from the public or specific Project stakeholders will be reported in the existing Complaints Register in accordance with the Complaints Management Procedure. Each complaint will be reviewed upon receipt by the appropriate manager, and all valid complaints addressed. Corrective actions and other recommendations including, where applicable, modifications to practices and procedures shall be documented and communicated under the direction of relevant personnel.

5.2.4 Environmental Performance Reporting

Both internal and external performance reporting and review processes have been established to facilitate continual improvement of site performance. Figure 1-1 outlines the linkages between these reporting processes and the monitoring and management programs, whereby the results of any internal or external reviews are used to update and improve the system elements including management and monitoring systems, which are formally documented within the relevant site EMPs. Note that resultant amendments/uploads to these EMPs will be undertaken in consultation with the regulator via the existing Mine Management Plan and Operational Performance Report process under the Mining Management Act.

5.2.4.1 Internal (Corporate) Performance Reporting

MRM has established site environmental performance measures that align with Glencore’s overarching Statement of Values. MRM undertakes reporting against the site environmental performance measures to corporate management on a monthly basis. A review of the data is undertaken regularly to assess site performance, identify opportunities for improvement and establish corrective actions.

5.2.4.2 External (Regulatory) Performance Reporting

MRM develops annual Operational Performance Reports (OPRs) which are submitted to the DPIR on an annual basis in accordance with the Mining Management Act.
It is proposed that these reports to be used to document MRM’s adaptive management performance, including assessing MRM’s performance against its nominated performance measures and indicators, as well as documenting any recommendations for improvement and subsequent progress against these recommendations.

5.3 Nonconformity, Corrective and Preventive Actions

Corrective actions are adopted when monitoring indicates that current management measures are not adequately effective in mitigating impacts, or where a non-conformance with the management plan is identified. Contingency arrangements are triggered when management measures are ineffective due to unforeseen events such as human induced events (e.g., fire or spills) or naturally occurring extreme events (e.g., cyclones or floods).
6 Management Review

Senior site management including the General Manager and Manager Environment Safety and People shall review the site’s adaptive management system on an annual basis for its continuing suitability, adequacy and effectiveness. Each management review shall make decisions on changes to policy, the risk identification and assessment process, environmental aspects, objectives and targets, environmental programs/plans, resourcing and budgeting and other elements of the site’s management system.
7 Commitments

In accordance with the philosophy of continuous improvement, MRM proposes to further develop and refine this framework into the future. This will include the following.

a). incorporation of proposed adaptive management framework reporting and review mechanisms into the existing regulatory framework; e.g.:
   o external reporting of performance against set measures and indicators via the Operational Performance Reporting (OPR) process under the Mining Management Act; and
   o annual review of performance reporting by the Independent Monitor.

b). development of a more operationally focussed document, which will incorporate additional details including revised aspects register (taking into consideration any additional risks as identified through MRMs annual broad brush risk assessment), updated management plans as work programs are completed and performance indicator assessments refined further (e.g. results of the 2017/2018 site specific ecotoxicology studies are finalised); and

c). specific deliverable commitments for 2018, e.g:
   o revised Mine Closure Plan, including:
     ▪ cost estimates and details for regulatory body;
     ▪ which stakeholders will be consulted with and how;
     ▪ details of adaptive management and reactive management phases; and
     ▪ review process via early warning and feedback mechanisms in order to continually review and update closure costs and reduce the risk of unforeseen major costs.

   o further development of additional performance indicators, monitoring programs and contingencies as identified in Table 3-2; and

   o updated or additional EMPs which include details on the risks/Measures/Indicators (including trigger values)/monitoring programs as highlighted in Table 3-2.
8 Summary and Conclusions

This Adaptive Management Framework has been developed to provide further clarity on how MRM’s adaptive management process will be implemented throughout the Project’s Operations and Closure stages. It includes details on framework:

- structure, and particularly its alignment with ISO14001 (Environmental Management System); and
- key elements including:
  - identification of the Project aspects and associated environmental risks;
  - establishment of appropriate performance measures (or objectives) for each Project risk;
  - establishment of relevant performance indicators (or targets) for each performance measure (including development of trigger values to provide early warning of potential non-compliances);
  - design and implementation of targeted monitoring and management programs for each performance indicator in order to provide early warning triggers to inform decision making;
  - contingency management measures in the event that monitoring indicates exceedance of established performance indicators; and
  - establishment of a reporting and review process to facilitate continual improvement, including both internal (MRM) review of framework performance and external review of annual performance reports by third parties.

In addition, models for the closure of the Project domains, including the final void, NOEF and TSF, have been provided including details on key closure decision points, defined and planned contingency management measures and the role of regulators and other relevant stakeholders. These models have been developed to build regulatory confidence through the establishment of well-defined decision making processes and the ongoing collection and analysis of data to improve knowledge and reduce uncertainty.

MRM’s adaptive management process comprises a two-phased approach as follows:

- Phase 1 (this document) – a strategic level document that has been developed by MRM for submission as part of this Supplementary EIS. This Phase 1 document provides a point of reference for a number of MRM responses to Draft EIS stakeholder submission comments, incorporates outputs from the Draft EIS, and sets the overall framework for document development into the future including a list of key commitments.
- Phase 2 – to be developed post EIS approval, to be operationally focussed and build on the Phase 1 document. This document will expand on the Project risks to include additional operationally focussed risks as identified in MRM’s annual broad brush risk assessments. It is not proposed to become a public document, but will be developed in consultation with the regulator and as an MRM internal management system document (part of Glencore’s HSEC MS).
9 References


Commonwealth Department of Foreign Affairs and Trade, 2016; Mine Closure *Leading Practice Sustainable Development Program for the Mining Industry.*


Ministry of the Environment, 2012; *Ontario’s Ambient Air Quality Criteria.* Standards Development Branch Ontario Ministry of the Environment, Ontario, Canada