Decommissioning, Rehabilitation and Closure

Draft Environmental Impact Statement
4 Decommissioning, Rehabilitation and Closure

4.1 Introduction

The McArthur River Mine (MRM) Overburden Management Project (the Project) plans to complete ore extraction 19 years after the commencement of the Project, followed by works to decommission and rehabilitate. The risk identification and assessment process adopted as part of the Project’s approach to impact assessment incorporated all relevant Project domains and phases of activity (i.e., a whole-of-project approach). A key feature of this approach was the design and management of each domain in accordance with the Project’s closure objectives. This ensured that managing and mitigating potential long-term environmental risks was incorporated into the design philosophy, rather than being managed solely at the end of the mine’s life. Risk identification, analysis and mitigation were, and will continue to be, an integral part of the life of the Project.

The key principles of successful mine closure include development of:

- a closure framework (including closure goals, objectives and completion criteria and indicators);
- suitable rehabilitation maintenance and decommissioning techniques and plans; and
- a strategy for managing and adapting to unforeseen circumstances such as unplanned mine closure.

A Conceptual Mine Closure Plan (CMCP) has been developed (Appendix S – Conceptual Mine Closure Plan) to assess the optimal and most cost effective methods related to rehabilitation, decommissioning and closure. The CMCP fulfils the terms of reference for the preparation of this environmental impact statement by:

- outlining the key objectives that require management at closure, specifically:
  - minimising impacts to surface and groundwater resources;
  - physical isolation of overburden material from the environment and the prevention of environmental impacts of contaminants arising from the overburden material;
  - compatibility of the final landforms with natural landforms in the surrounding landscape;
  - secure and non-polluting final landforms in the event of unexpected or temporary closure;
  - stabilisation of erosion rates to a level similar to comparable landforms in surrounding undisturbed areas.
- demonstrating that all relevant issues and appropriate management measures have been identified;
- demonstrating the ecologically sustainable mine closure can be achieved; and
- detailing a set of completion criteria and a monitoring program that will investigate the success of the rehabilitation program.
The purpose of this chapter is to provide a summary of the key features of the Project’s closure strategy and to direct readers to other relevant sections of this environmental impact statement (EIS) where important information regarding the potential risks to local environmental values, and proposed mitigation measures to minimize these risks, may be found. As discussed in Chapter 1 – Introduction, this EIS has assessed, where relevant, the various natural systems of the Project for up to a 1,000 year period. Therefore, the closure and long-term management requirements of the site are inherently addressed throughout the EIS.

4.2 Definitions

The term ‘closure’ is used to describe the period of time, and actions taken within this time, following the operational stage of the mine. The closure period is divided into three general stages, the first of which is decommissioning, followed by rehabilitation and monitoring.

- **Decommissioning** is defined as the withdrawal of infrastructure from service and dismantling of this infrastructure.
- **Rehabilitation** is a stage of active management, which may include re-profiling of landforms, soil preparation, planting of vegetation, and control of weeds. Rehabilitation occurs during the adaptive management stage of the Project (rehabilitation is a component of ‘Execution’ in Figure 4-1).
- **Monitoring** is the stage once the land has settled and the site is developing towards its desired final objectives. Some remedial active management may be required within the monitoring stage, but only if monitoring suggests that this is needed to achieve specific completion criteria. The monitoring stage is further divided into proactive monitoring and reactive monitoring (Figure 4-1), reflecting changes in the frequency of monitoring and the decreasing requirement for remediation.

![Figure 4-1 Proposed Staged Approach to Operations and Management](image-url)
4.3 Rehabilitation Management Units

In order to tailor rehabilitation methods to the specific risks and characteristics of each mine component, mine components have been divided into rehabilitation management units. Rehabilitation management units possess similar geophysical characteristics, risks, and rehabilitation objectives and approaches. Appendix S – Conceptual Mine Closure Plan adopts the term ‘domain’ for these rehabilitation management units, in accordance with several Australian mine closure guidelines. However, to avoid confusion with the domains discussed in Chapter 3 – Project Description and Justification, in this EIS the term ‘domain’ is reserved for the three broad operational areas (the North Overburden Emplacement Facility (NOEF), the open cut and the Tailings Storage Facility (TSF)) of MRM.

Appendix S – Conceptual Mine Closure Plan divides the MRM into nine rehabilitation management units:

1. open cut;
2. Overburden Emplacement Facilities;
3. Tailings Storage Facilities;
4. infrastructure areas;
5. borrow pits;
6. water dams;
7. roads;
8. exploration; and
9. Bing Bong infrastructure area.

The locations of these rehabilitation management units are shown in Figure 4-2.

The ninth rehabilitation management unit concerns port facilities that are not affected by the proposed Project and are, therefore, outside the scope of this EIS and will not be considered further in this chapter. The Bing Bong infrastructure area will be decommissioned and rehabilitated in accordance with the rehabilitation strategies proposed in Appendix S – Conceptual Mine Closure Plan.
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This page has been intentionally left blank for consistency between printed and electronic versions of this document.
4.4 Timing

The planned schedule of the Project is described in detail in Chapter 3 – Project Description and Justification. It is summarised as follows, to provide context for the timing of rehabilitation activities:

- the operational phase of the Project will commence in 2018, following EIS approval and authorisation of an associated mine management plan;
- open cut mining operations will cease in 2037, 19 years after the commencement of the Project;
- construction of the NOEF will be completed in 2032, five years prior to the completion of open cut mining operations; and
- tailings will be reprocessed and moved the open cut over ten years (2038-2047) following the cessation of open cut mining.

From 2048 onwards, all rehabilitation management units will be in the process of closure, although some units (e.g., overburden emplacement facilities (OEFs)) will have commenced closure prior to this time. The timing of closure for each rehabilitation management unit is described in Sections 4.10.1 to 4.10.8.

Rehabilitation, which involves active management, will continue throughout the adaptive management phase of the Project. The duration of this phase is informed by on-going monitoring, which demonstrates that rehabilitated areas are self-sustaining with no further need for active management. The duration of this phase will likely vary depending on rehabilitation management unit, but it is anticipated that all rehabilitation management units will have completed this phase by 2100.

Monitoring, with decreasing intensity and regularity, will continue throughout the proactive management and reactive management phases of the Project (see Section 4.2). These are anticipated to last until 3017.

4.5 Closure Objectives

The closure objectives presented below 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. These closure objectives are consistent with those outlined in the opening statement of the Department of Mines and Energy (DME) Northern Territory Draft Guidelines for Mine Closure Plans (the NT Draft MCP Guidelines) (DME 2016).

The overall goal for rehabilitating the McArthur River Mine is to create a site that achieves the following ten closure objectives:

- 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).
- 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.
  o Geochemical stability will be defined, managed and monitored:
    ▪ seepage water quality at toe/base of landforms; and
    ▪ water quality within the mine pit lake.
• 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);
• Rehabilitated areas will provide appropriate habitat for fauna utilization – abundance and
  diversity will be appropriate.
• Metal levels for fauna comparable to background levels.
• Landform will host suitable vegetation for post-mining land use:
  o for traditional land use areas:
    ▪ have similar environmental values as surrounding areas; and
  o for cattle grazing land use areas:
    ▪ grasslands.
• Manage soil to meet post mining land use.
• No infrastructure left on-site unless a beneficial gain is identified and agreed with stakeholders.
• Maintain custodians’ access to areas of cultural significance.
• Foster economic opportunities for custodians and local communities.

McArthur River Mining is committed to closure obligations and conditions contained in any or all of
the following sources:

• Authorisation issued pursuant to the Mining Management Act (NT) including McArthur River
  Mining’s approved Mining Management Plan;
• McArthur River Project Agreement Ratification Act (NT) and the McArthur River Project
  Agreement; mineral lease conditions;
• waste discharge licence conditions issued pursuant to the Water Act (NT);
• Commonwealth’s Environmental Protection and Biodiversity Conservation Act 1999 approval
  conditions;
• Mineral Royalty Act (NT);
• Authority Certificates issued pursuant to the Northern Territory Aboriginal Sacred Sites Act (NT);
• labour and employment agreements;
• service and supply agreements; and
• legally binding and non-legally binding commitments and promises (letters, references,
  records and documents).

These are discussed in detail in Chapter 3 of Appendix S – Conceptual Mine Closure Plan. These
commitments have been incorporated in the development of the CMCP.

4.6 Post-mining Land Uses

The post-mining land uses will be refined through negotiations with stakeholders including
Government, custodians, local communities and future land holders. They will also consider further
environmental information gained as operations progress. The preliminary proposed final land uses
for each rehabilitation management unit are presented in Table 4-1. These land uses are intended to
be applicable from approximately 2100 onwards or once monitoring has determined suitability.
Chapter 3 – Project Description and Justification presents simulated plans of the site including one for the year 2100 with the proposed final landforms and land uses established.

Table 4-1 Preliminary Post-Mining Land Uses for Each Rehabilitation Management Unit

<table>
<thead>
<tr>
<th>Mine Domain</th>
<th>Mine Feature/ Major Landform Name</th>
<th>Preliminary Potential End Land Use( Post-2100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Open cut</td>
<td>Open cut and mine levee wall</td>
<td>Conservation area – McArthur River</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flow-through mine pit lake (with acceptable water quality conditions), which would form a secondary flow path for the McArthur River. The mine pit lake would be a conservation area with the potential for custodian use.</td>
</tr>
<tr>
<td></td>
<td>River channels</td>
<td>Primary drainage paths with (after 100 years) functioning riverine ecosystems comparable to original water courses prior to diversion and potential for custodian use.</td>
</tr>
<tr>
<td>2 Overburden Emplacement Facilities</td>
<td>NOEF and West Overburden Emplacement Facility (WOEF)</td>
<td>Conservation area – cattle grazing excluded.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All infrastructure removed. Safe, stable, non-polluting landform with native vegetation/habitat for fauna utilisation.</td>
</tr>
<tr>
<td>3 Tailings Storage Facility</td>
<td>TSF</td>
<td>Cattle grazing area – with native woodland and pasture species.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tailings reprocessed and rehandled to open cut. All aboveground infrastructure (including TSF walls) removed. Safe, stable, non-polluting area generally consistent with pre-mining topography with native vegetation and/or pastoral grasses. Access for custodians to sacred sites, as co-ordinated with the land manager.</td>
</tr>
<tr>
<td>4 Infrastructure areas</td>
<td>Surface infrastructure excluding Barney Hill</td>
<td>Cattle grazing area – with native woodland and pasture species.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Generally, infrastructure/buildings will be decommissioned and dismantled, although there may be potential opportunities to transfer ownership of some components to third parties, to foster economic opportunities for custodians and local communities. Examples of components which may be transferred include:</td>
</tr>
<tr>
<td></td>
<td>Barney Hill infrastructure</td>
<td>• accommodation camp;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• potable water infrastructure;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• sewerage infrastructure;</td>
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<td></td>
<td></td>
<td>• telecommunications infrastructure; and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• McArthur River Aerodrome.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safe, stable, non-polluting area consistent with pre-mining topography with native vegetation and/or pastoral grasses. Access for custodians to sacred sites, as co-ordinated with the land manager.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conservation area – cattle grazing excluded.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Generally, infrastructure/buildings will be decommissioned and dismantled, although there may be potential opportunities to transfer ownership of some components to third parties, in particular to foster economic opportunities custodians and local communities. Examples of components which may be transferred include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• MRM power station and transmission lines;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• fuel storage;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• sewerage infrastructure;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• telecommunications infrastructure; and</td>
</tr>
</tbody>
</table>
4.7 Infrastructure to be Retained

While the majority of the infrastructure installed for the Project will be decommissioned and removed following the cessation of operations, certain structures will likely be retained, subject to commercial agreements and agreements with post-mining land users, for the purposes of site access, monitoring, maintenance and rehabilitation works. These infrastructure items will likely be retained in the short to medium closure period with long term retention difficult to predict:

- a small caretakers’ accommodation facility will remain;
- the airstrip will remain;
- the MRM power station, although not a McArthur River Mining asset, will remain for the medium term;
- the access road between the mine and the Carpentaria Highway will remain;
- the on-site Barney Creek bridge will remain;
- the diversion drain north of the NOEF will remain, but in a rehabilitated state;
- a stockpile of non-acid forming material (at the Mine Infrastructure Area) will be retained as a source of material for ongoing remedial works;
- the open cut will remain as a mine pit lake;
- gauging telemetry and other monitoring infrastructure will remain;
- the Telstra tower will remain as long as there is power on-site; and
- certain tracks are to remain open, to allow access for monitoring and the final land users.
Further information about the final landforms and retained infrastructure is contained within Chapter 3 – Project Description and Justification.

4.8 Key Risks

Two key risks pertaining to mine closure are specified in the terms of reference (TOR) for the preparation of this environmental impact statement:

1. following closure and rehabilitation, potential may exist for the mine to negatively impact the environment and/or associated communities; and
2. the Project may create an ongoing environmental, social and/or economic legacy if operations are required to cease ahead of schedule due to unforeseen circumstances, prior to the planned closure and rehabilitation of the site.

The potential for the Project to negatively impact the environment and nearby communities is assessed separately for each rehabilitation management unit (Section 4.10), as many of these risks are unit-specific. Likewise, the potential for ongoing environmental, social and/or economic legacy if operations are temporarily suspended or cease prematurely is specific to each rehabilitation management unit. This potential risk is therefore discussed in relation to each unit in Section 4.10. More detailed long-term risks associated with the Project are assessed in Chapter 7 – Project Risk Assessment.

4.9 Progressive Remediation of Mine Landforms

In accordance with the NT Draft MCP Guidelines, rehabilitation of mined and other disturbed landforms will be undertaken progressively, as infrastructure becomes redundant and is decommissioned. Progressive remediation of mine landforms has been a consideration during the planning of the Project and the preparation of Appendix S – Conceptual Mine Closure Plan. This expedites the re-establishment of vegetation at disturbed sites and reduces the duration of habitat loss for certain flora and fauna. Chapter 3 – Project Description and Justification presents progressive mine stage plans which identify areas made available for rehabilitation throughout the mine life.

4.10 Proposed Decommissioning and Rehabilitation

Detailed descriptions of the landform design, decommissioning and rehabilitation of each rehabilitation management unit are contained within Chapter 3 – Project Description and Justification and Appendix S – Conceptual Mine Closure Plan. A summary of the proposed management of each rehabilitation management unit during and after closure is provided in the following subsections.

4.10.1 Rehabilitation Management Unit 1: Open Cut

4.10.1.1 Closure Objectives

The following closure objectives pertain to the open cut rehabilitation management unit:

- 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).
- Landform stability:
Geotechnical stability will be maintained at these standards:
- open cut walls: Probability of Failure (Pf) for inter-ramp slopes of <5%.

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.

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).
- Metal levels for fauna comparable to background levels.
- Foster economic opportunities for custodians and local communities.

4.10.1.2 Risks

Chapter 7 – Project Risk Assessment provides a comprehensive assessment of the environmental risks of the open cut across operational and closure timeframes. The key risks identified that are relevant to the open cut rehabilitation management unit include:

- a site-wide flood could overload adaptive management controls of the mine pit lake;
- oxidation of material stored within the mine pit lake could cause the water chemistry to be inadequate to relinquish the site;
- slow filling of the mine pit lake with water could lead to poor water quality and a failure to meet water quality criteria;
- spontaneous combustion in the walls of the open cut prior to filling of the mine pit lake could compromise the water chemistry;
- spontaneous combustion during in-pit dumping rehabilitation works could expose site personnel to sulphur dioxide;
- a failure to achieve long term closure monitoring could result in adequate maintenance and reduced functionality of environmental controls;
- establishment of more stringent water discharge requirements in the short term could lead to an inability to relinquish the site;
- premature closure and rehabilitation of the open cut could create ongoing environmental, social and/or economic legacies;
- geotechnical failure of the open cut wall with the mine pit lake partially filled could lead to a loss of functionality of the western side of the mine levee wall, resulting in inflows from the McArthur River and failure to meet downstream water quality objectives;
- a release of contaminated waters above acceptable levels could have negative social and economic impacts to the region associated with environmental degradation; and
- entry of Largetooth Sawfish into the mine pit lake could result in mortality of this threatened species if the environment present is unsuitable.
4.10.3 Approach

The open cut geometry is dictated by mining operations, influenced by the location of the orebody and material to be extracted from the Woyzbun Quarry. The design of the open cut aims to be sufficiently stable to meet its post-mining land use. The design is compatible with deposition of select overburden and tailings after mining is completed. The rock bench geometry and haul ramps have been designed to be stable for mining operations and subsequent partial backfilling operations. The upper alluvial benches will have batters sloped back to 18 degrees to have suitable stability in a mine pit lake setting. The batters will be top-soiled, revegetated and equipped with habitat structures to suit a lacustrine environment. A mine pit lake will be created with the water level expected to be stable around the lower alluvium/top of weathered rock elevation.

Upon completion of mining in 2037, the open cut will have a surface area of approximately 265 hectares (ha) and a maximum depth of approximately 420 metres (m). The maximum length of the top of the open cut is planned to be approximately 1,950 m and the width is expected to be 1,550 m.

Overburden extracted during operations will be hauled primarily to the NOEF. A small amount of overburden, including non-benign materials, is currently stored in OEFs located within the mine levee wall adjacent to the open cut. Most of the material from these OEFs will be rehandled to an in-pit dump at the base of the final void. Risk assessments determined that the safest way for this material to be stored long term is permanently submerged under water in low oxygen conditions. Over the final approximately six years of mine life, there will be limited overburden material generated by the operations; any that is will remain within the void. The in-pit dump will contain approximately 7.9 million cubic metres of overburden material and will be a “dry structure” for the 6 years of operation, as it will be formed while dewatering of the open cut is maintained and surface water runoff is being actively managed. During this 6 year period of in-pit dumping, controls and actions for managing reactive rock will resemble those at other OEFs. Specifically, clay will be placed over any non-benign rock otherwise exposed to the air.

Any temporary stockpiles of benign material (including clay, alluvium, low salinity non-acid forming (high capacity) (LS-NAF(HC)) material and topsoil) within the open cut rehabilitation management unit will be removed and used for encapsulation, stabilisation and rehabilitation purposes, primarily within the OEFs rehabilitation management unit.

Immediately following the placement of non-benign material into the base of the final void, all tailings (94.5 million tonnes (Mt)) stored at the TSF will be reprocessed and deposited into the void, overlaid onto the non-benign material. This is expected to fill the open cut to approximately 175 m below the crest, over a period of approximately 10 years.

Following the deposition of overburden material and tailings into the base of the open cut, it will be filled with water to limit exposure of the walls and overburden material to oxidation. Water will be actively harvested from the McArthur River during periods of high flow in the first wet seasons following the completion of tailings transfer. A period of approximately 5 years has been allowed to complete the filling process.

Based on detailed, site-specific models of water quality within the mine pit lake over time (Appendix V – Final Void Limnology Report), when the mine pit lake remains as a closed system (no inflow or outflow between the mine pit lake and the McArthur River), water quality is expected to remain reasonably stable in the short term (refer Chapter 8 – Water Resources). The mine pit lake will be maintained as a closed system to surface water for a period of evaluation of hydrodynamics and water quality, to examine how well the observed data match predictive models.

Once water quality within the mine pit lake can be demonstrated to be within acceptable levels, and the models provide a confident representation of observed conditions, a section of the downstream
mine levee wall will be removed to allow for water exchange between the mine pit lake and the McArthur River during periods of seasonal high flow. A further period of assessment will then take place, both of the water within the mine pit lake and in the McArthur River downstream. Upon demonstration of acceptable water quality conditions, a portion of the upstream mine levee wall will be removed to create a second inlet, and hence a flow-through mine pit lake. This will ultimately form a secondary channel of the McArthur River during normal seasonal flood events, with the McArthur River diversion channel maintained as the primary flow path.

The alternative option, to isolate the mine pit lake from nearby catchments, was considered (Chapter 5 – Project Alternatives); however, water quality within such a mine pit lake is expected to deteriorate over time, posing a risk to downstream communities and ecosystems in the event of a flood, or when ex-lake water enters the McArthur River via palaeochannels. The current option, where water quality within the mine pit lake is maintained through annual dilution via contact with the McArthur River, reduces the long-term risks to local environmental and social values.

4.10.1.4 Monitoring

Monitoring will be undertaken throughout decommissioning of the open cut, but will be most intensive after the mine pit lake reaches final water levels.

The following monitoring programs pertain to the open cut rehabilitation management unit:

- **Surface water monitoring** is to be undertaken at the same locations as the operational program. This will involve monthly monitoring of water quality at approximately 30 sites along local creeks and rivers, including five sites along the McArthur River downstream from the open cut. In addition to monitoring natural waterways, water within the mine pit lake will also be sampled on a monthly basis.

- **Groundwater monitoring** will be undertaken at approximately 50 bores located across all rehabilitation management units. The number of bores may be reduced over time, and the bores to be monitored will be selected based on their historical record and the relevance in relation to issues within the open cut rehabilitation management unit. A detailed description about the various groundwater and surface water monitoring programs that will take place are provided in Chapter 8 – Water Resources and Chapter 15 – Environmental Management Plan.

- **Monitoring of the stability of the open cut rehabilitation management unit** will be undertaken annually over the initial ten years following the filling of the mine pit lake, and at longer intervals (pending results) afterwards. Monitoring will involve aerial laser surveys (ALS) at five-yearly intervals during the adaptive management monitoring period. This will allow accurate quantification of geomorphologic changes by detecting differences in the digital terrain model (DTM) over time. Satellite images will be acquired in years when an ALS is not undertaken.

- **The existing aquatic and terrestrial fauna monitoring programs** (see Chapter 9 – Biodiversity and Chapter 15 – Environmental Management Plan) 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. This includes an ongoing assessment of the levels of metals in the tissues of aquatic fauna.

- **The revegetated areas around the edge of the mine pit lake** will be monitored annually for the first three years, then every three years subsequently, until the flora-related completion criteria are achieved.

- **Soil qualities pertaining to plant growth and establishment** will be monitored every five years, until vegetation has adequately established and further monitoring is not necessary.
4.10.1.5 Timing

Placement of non-benign material into the open cut will commence in 2031 and will continue until 2037. The re-location of tailings to the open cut will occur between 2037 and 2047. Active filling of the final void with water will occur from 2047 to 2052. The area between the void and the mine levee wall will be re-profiled, top-soiled and re-vegetated in 2037-2047. Supplementary planting of riparian species along accessible areas of the mine pit lake will occur once equilibrium water levels are reached.

4.10.2 Rehabilitation Management Unit 2: Overburden Emplacement Facilities

4.10.2.1 Closure Objectives

Closure objectives pertaining to the Overburden Emplacement Facilities rehabilitation management unit are:

- 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).
- 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.
  - 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.
- 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).
- Rehabilitated areas will provide appropriate habitat for fauna utilization – abundance and diversity will be appropriate.
- Metal levels for fauna comparable to background levels.
- Landform will host suitable vegetation for post-mining land use.

4.10.2.2 Risks

The following risks pertain to closure of the Overburden Emplacement Facilities rehabilitation management unit:

- a site-wide flood could overload adaptive management controls at the NOEF;
- inappropriate storage and disposal of overburden material could lead to contamination of surface water and groundwater systems;
- a failure to achieve long-term closure monitoring could result in inadequate maintenance and reduced functionality of environmental controls;
- changes to water discharge requirements may have an impact on the mine’s ability to meet any new proposed trigger values;
premature closure and rehabilitation of the open cut could create ongoing environmental, social and/or economic legacies;

inappropriate fluvial sediment management could elevate metal concentrations in local waterways and lead to sedimentation;

geotechnical failure of the NOEF could lead to loss of functionality of the cover system and lead to potential water quality impacts on local waterways;

acid and metalliferous drainage could expose wildlife to metals that bio-accumulate and become a public health hazard;

acid and metalliferous drainage could lead to seepage of metals, sulphates and/or acids that result in direct toxicity to aquatic fauna and adversely impact aquatic ecosystems within Barney Creek and the McArthur River;

spontaneous combustion of overburden could release sulphur dioxide that is a health hazard to nearby wildlife and people;

major changes to the design of the NOEF could increase the costs of the Project and reduce the community benefits that are delivered;

a release of contaminated waters above acceptable levels could have negative social and economic impacts to the region associated with environmental degradation;

accidental placement of non-benign overburden within the growth medium added to rehabilitation sites could lead to revegetation failure;

a failure of the surface water management system within and/or around the NOEF could impede the achievement of acceptable downstream water quality;

a failure of vegetation establishing on the rehabilitated NOEF to resemble local habitats (e.g., excessive weeds) could impact recolonisation by significant species; and

fugitive dust emissions during the construction of the NOEF could introduce metals into local food chains, leading to potential health hazards for wildlife and people.

4.10.2.3 Approach

The planning and design of the NOEF is heavily based on the management of long-term risks following closure, in addition to short-term requirements during operations. It is designed for the viable storage of non-benign overburden material, with periodic maintenance, for over 1,000 years. The design considerations, geometry, geotechnical stability, geochemical stability, and resilience to floods and earthquakes are described and assessed in Chapter 3 – Project Description and Justification.

The design of the NOEF is informed by an extensive suite of studies, including:

- overburden drilling and testing within the open cut footprint and revisions of the overburden block model;
- kinetic and static geochemical characterisation of overburden;
- geotechnical and hydrogeological characterisation of overburden;
- geotechnical, geochemical and hydrogeological characterisation of cover materials;
- groundwater and geological investigations, and modelling based on these data;
- clay resource drilling, mapping and characterisation;
- in situ runoff coefficients across a variety of OEF surfaces;
- erosion modelling of cover system materials and slope options;
- surface water modelling of seepage and runoff from the NOEF;
- long-term erosion trials;
- implementation of a drilling investigation into the existing NOEF to improve understanding of its current characteristics;
- aquatic ecology baseline assessments, primarily focussing on the Emu Creek catchment;
• terrestrial ecology baseline assessments, primarily focussing on the area to the north of the NOEF; and
• a range of on-going environmental monitoring programs (surface water, groundwater, air quality, soil and ecology).

Details about each of these studies and key findings influencing the design of the NOEF are contained in:

• Appendix H – NOEF Historical Construction and Drilling Report;
• Appendix I – 7.5 Advection Cover Lift Height Assessment;
• Appendix J – NOEF Cover System and Landform Design;
• Appendix K – Erosion Assessment for OEF Landform Configurations;
• Appendix L – Kinetic Geochemistry Report;
• Appendix M – Static Geochemistry Report;
• Appendix N – Geotechnical Report;
• Appendix T – Groundwater Report;
• Appendix X – Terrestrial Ecology Report;
• Appendix W – Aquatic Ecology Report;
• Appendix AE – Borrow Pit and NOEF Subsoil Drainage Designs;
• Appendix AF – Spontaneous Combustion Technical Report; and
• Appendix AD – NOEF Surface Water management Sediment Dams and Stilling Basins.

In addition to the above studies, the final design of the NOEF was also influenced by indigenous cultural values, footprint constraints, visual amenity impacts, and material transport and placement economics (refer to Chapter 3 – Project Description and Justification).

At the cessation of mining operations, the final NOEF will have a maximum height of 140 m above the pre-mining landscape (approximately 175 m Australian Height Datum (AHD)), occupy a footprint of 525 ha, and possess trilinear, concave batter slopes that gradually diminish in slope from the crest to the toe, progressing downward from 2.5 horizontal to 1 vertical (2.5H:1V) to 3.5H:1V and then 4.5H:1V. The functionality and stability of this landform as a store for potentially reactive overburden is discussed in detail within Chapter 3 – Project Description and Justification. This section focuses on the management of the NOEF following the placement of the upper-most cover system over the final benign material halo added to the overburden emplacement facility.

Overlying all material within the NOEF will be a 0.5 m thick compacted clay layer (CCL), designed to limit infiltration into the underlying material. Above this will be a 2.1 m thick layer of growth media. Growth media will vary in composition depending on location upon the NOEF and associated erosion risk. On the plateau, growth media will comprise 0.1 m of topsoil, 1.5 m of alluvium and 0.5 m of breccia. On the batter slopes, growth media will comprise 0.1 m of topsoil and 2.0 m of breccia. This growth media acts as a cover system that utilises both the ‘moisture store-and-release’ and ‘barrier’ concepts; the highly permeable breccia layer overlying the compacted clay drains water laterally, while the topsoil/alluvium layers support the growth of vegetation that limits erosion, increases slope stability and is necessary to achieve the final land use goals.

The growth media layer not only supports vegetation, but also protects the integrity of the barrier layer from potential damage due to various site-specific physical, chemical, and biological processes (e.g. wet-dry cycling). Most rainfall is stored within the cover system and gradually released back to the atmosphere through evaporation and evapotranspiration. During periods of high (and more intense) rainfall, the moisture store-and-release capacity is typically exceeded and the cover system and landform are designed to be ‘water shedding’, with water draining laterally through the growth media.
Models indicate that a high cover of vegetation growing on the growth media will act to reduce net percolation (Appendix J – NOEF Cover System and Landform Design). However, less than 8% of rainfall is predicted to percolate through the compacted clay layer, even in the absence of vegetation (during early rehabilitation stages or immediately following fire). Consequently, rather than being necessary for managing water percolation, the main benefit of vegetation establishment is to reduce erosion.

The types of vegetation to be planted on the NOEF following the placement of the growth media will be informed by the vegetation communities growing in analogous environments in the surrounding natural environment. Local analogue sites (with similar slope, aspect and substrate) will be assessed to produce a list of flora species that are suitable for planting on rehabilitated landforms. The eventual seed mixes to be applied will also consider the functional role of vegetation within and on the cover system, as well as the opportunity to improve habitat for fauna of conservation significance (e.g., by planting native grasses eaten by Gouldian Finches, *Erythrura gouldiae*). Rehabilitated areas with fine-grain alluvium growth media will likely support woodland communities typical of lowland plains (e.g., vegetation mapping units 5 and 6 described in Chapter 9 – Biodiversity), while areas with porous breccia will support species that grow naturally in well-drained sandstone escarpments and scree slopes (e.g., vegetation mapping units 1, 2 and 4 described in Chapter 9 – Biodiversity). Limited vegetation establishment is expected to occur on the upper rocky slopes. As fine-textured materials are washed onto the lower slopes over time, some vegetation is expected to establish there, with a resultant appearance consistent with the rocky escarpments in the surrounding area. The final seed mixes and application rates will be subject to trials that investigate establishment success and functionality of the cover system.

Protection of surface and ground water was an important design consideration for the NOEF. The resultant plateau is to be separated into sub-catchments, with surface water runoff to be conveyed down purposely built drains, formed by coarse, durable, benign (LS-NAF(HC)) rock. These drains are designed to manage a 1:100 year critical storm duration events, as well as an allowance for increases due to climate change. Once rehabilitation of the NOEF is complete and there is no further risk of runoff from non-benign materials, the drains will be routed through sediment dams for control of suspended solids until suitable vegetation cover is established, and run-off waters will no longer be captured by the Perimeter Runoff Dams (PRODs). The purpose of the PRODs will change from collecting contaminated run-off to supporting the general site water balance. Decommissioning will commence when the site water balance permits. Contaminants captured by the dams will be moved to the open cut for final storage, and the dam walls will be used to fill the resulting voids. The dam sites will then have topsoil added and be revegetated.

Seepage management systems, in place to collect and treat water affected by leaching of oxidation products from the base of the NOEF, will remain throughout the closure period until such a time that monitoring confirms it is no longer required. These systems will remain in place at least throughout the adaptive monitoring phase following cessation of operations.

The South OEF (SOEF) and East OEF (EOEF) are planned to temporarily store non-benign overburden at various times throughout the mine’s life. Upon cessation of mining activity, material within these OEFs will be rehandled to stable long term facilities. Most of the material will be placed in the open cut in-pit dump for permanent sub-aqueous storage, with the lake water acting as a cover system. The former footprints occupied by these facilities will have alluvial materials added to reshape the land to drain positively into the open cut through rock armoured drains. Outside the drains, the areas will be top-soiled and revegetated to form suitable riparian habitat suited to the post-mine land use of the open cut domain.
4.10.2.4 Monitoring

The following monitoring programs will address environmental risks posed by closure of the OEF rehabilitation management unit:

- Surface water monitoring is to be undertaken at the same locations as the operational program. This will involve monthly monitoring of water quality at approximately 30 sites along local creeks and rivers. In addition to monitoring natural waterways, water entering the PRODs and the seepage management drains will be sampled on a monthly basis.

- Groundwater monitoring will be undertaken at approximately 50 bores located across all rehabilitation management units. The number of bores may be reduced over time, and the bores to be monitored will be selected based on their historical record and the relevance in relation to issues within the NOEF rehabilitation management unit. A detailed description about the various groundwater and surface water monitoring programs that will take place are provided in Chapter 8 – Water Resources and Chapter 15 – Environmental Management Plan.

- Monitoring of the stability of the OEFs will be undertaken annually over the initial ten years following the installation of the cover system, and at longer intervals (pending results) afterwards. Monitoring will involve aerial laser surveys at five-yearly intervals during the adaptive management monitoring period. Satellite images will be acquired in years when aerial lasers surveys are not undertaken. These will be supplemented with monthly visual surveys in the early stages of closure.

- Performance of the cover systems will be monitored by lysimeters, and gas and temperature sensors, which measure infiltration of air and water (for more detail, refer to Appendix O – NOEF Closure Monitoring System Report). These instruments will allow the assessment of the specific completion criteria relating to water and oxygen ingress, which heavily influence acid and metalliferous drainage.

- The existing aquatic and terrestrial fauna monitoring programs (see Chapter 9 – Biodiversity and Chapter 15 – Environmental Management Plan) 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. This includes an ongoing assessment of the levels of metals in the tissues of aquatic fauna.

- The revegetated plateau and slopes of the NOEF will be monitored annually for the first three years; then, every three years until the flora-related completion criteria are achieved.

- Soil qualities pertaining to plant growth and establishment will be monitored every five years, until vegetation has adequately established and further monitoring is not necessary.

- Gas detectors will be installed around the base of the NOEF and along the Carpentaria Highway. Sulphur dioxide levels will be assessed monthly with regards to safety to humans and livestock.

4.10.2.5 Timing

Placement of the final (closure) cover system will occur during operations, as soon as possible following completion of areas within the NOEF to final grades. The last non-benign material to be added to the NOEF will be in 2031, and any remaining rehabilitation will occur within four years of the cessation of its operation (i.e., by 2035). The timing of the decommissioning of the PRODs and seepage management systems will be contingent on the results of on-going monitoring.
4.10.3 Rehabilitation Management Unit 3: Tailings Storage Facility

4.10.3.1 Closure Objectives

Closure objectives that pertain to the Tailings Storage Facility rehabilitation management unit include:

- 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).

- Landform stability:
  - Geotechnical stability will be maintained at these standards:

- 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).

- Rehabilitated areas will provide appropriate habitat for fauna utilization – abundance and diversity will be appropriate.

- No infrastructure left on-site unless a beneficial gain is identified and agreed with stakeholders.

- Manage soil to meet post mining land use.

- Maintain custodians’ access to areas of cultural significance.

- Foster economic opportunities for custodians and local communities.

4.10.3.2 Risks

By removing non-benign materials from the TSF and consolidating these within the open cut during decommissioning (see Section 4.10.3.3), minimal risks will be posed by the TSF rehabilitation management unit, once rehabilitated. Nevertheless, the following risks require management during the decommissioning and rehabilitation of the TSF:

- Embankment failures could lead to erosion, sedimentation of waterways and/or safety risks during tailings re-mining;

- Premature closure and rehabilitation of the TSF could create ongoing environmental, social and/or economic legacy;

- Inappropriate fluvial sediment management prior to vegetation establishment could lead to sedimentation of local waterways;

- Accidental placement of non-benign overburden within the growth medium added to rehabilitation sites could lead to revegetation failure;

- Exposure of tailings to oxygen during re-mining could lead to acid and metalliferous drainage and/or the production of sulphur dioxide;

- A failure of vegetation establishing on the rehabilitated TSF to resemble local habitats (e.g., excessive weeds) could impact recolonisation by significant species; and

- Fugitive dust emissions during the construction of the NOEF could introduce metals into local food chains, leading to potential health hazards for wildlife and people.

4.10.3.3 Approach

Rather than capping the TSF and confining non-benign material within it, the proposed approach for decommissioning the TSF is for tailings to be transferred to the final void of the open cut rehabilitation management unit, where it will be permanently stored in the mine pit lake. Prior to this, tailings will be extracted using hydraulic mining methods and reprocessed to recover residual economic value (refer to Chapter 3 – Project Description and Justification). Submerging tailings in a water-filled pit is a known management approach. Other advantages include:
• there will be reduced interaction with oxygen when stored in the mine pit lake, decreasing potential reactivity of the tailings and potential seepage from the TSF, lowering potential risk to Surprise Creek;
• dust generation will be greatly reduced, as well as the potential for tailings oxidation, as the tailings are to be placed subaqueously;
• supernatant water will be recycled from the open cut for hydraulic mining use;
• additional borrow areas will not be disturbed as there will be no requirement for additional cover materials; and
• tailings will be placed in the final void at closure, in accordance with industry best practice.

Hydraulic mining utilises high-pressure water monitors to break up and slurry the tailings. The slurry then flows to a sump, from where the slurry is pumped to the reprocessing plant. The depth of the tailings deposit will be approximately 35 m and the tailings will be mined in ±10 m high benches, requiring three mining benches and possibly a fourth to remove any contaminated basement alluvium/soils. Safety zones are maintained near the TSF edges to maintain a wall around the mining areas, with the walls being deconstructed progressively by conventional earthmoving equipment as the mining progresses. Clean, salvaged wall construction materials will be stockpiled and/or used directly to re-shape the cleaned TSF area footprint.

The use of hydraulic mining ensures that tailings materials are thoroughly mixed with water throughout the mining and transport operations. Maintaining high moisture content of the tailings reduces the reactivity of the material (Section 6.10.3.2 of Chapter 6 – Materials Characterisation). Weathered tailings can also contain significantly elevated concentrations of a number of metals, including arsenic, copper, lead, cadmium, cobalt and zinc, which are prone to leaching under neutral conditions. Section 6.10 of Chapter 6 – Materials Characterisation contains a detailed description of the tailings’ properties. The properties of MRM tailings, and the requirement for continual active management to mitigate environmental impacts of tailings stored above ground, were reasons for finding an alternative to storing tailings within the TSF in perpetuity.

The final height of the ground surface within the rehabilitated TSF area will resemble the pre-existing surface and drainage where practicable. All structures and earthworks above the natural surface level will be removed. After the tailings have been removed and the landform re-shaped using remnant materials from the embankment and stockpiles, a topsoil layer will be added from stockpiles formed during the construction of the TSF. The rehabilitation management unit will be subsequently revegetated using a combination of trees and shrubs native to the area and pasture grasses.

The reshaped surface of the TSF footprint would be free-draining, shedding water to Surprise and Little Barney Creeks. During vegetation establishment, waters will be directed through sediment control structures to settle out excess sediments, before being discharged to the receiving environment.

4.10.3.4 Monitoring

The following monitoring programs pertain to the Tailings Storage Facility rehabilitation management unit:

• Surface water monitoring is to be undertaken at the same locations as the operational program. This will involve monthly monitoring of water quality at approximately 30 sites along local creeks and rivers. Water entering the seepage management drains will be sampled on a monthly basis.
• Groundwater monitoring will be undertaken at approximately 50 bores located across all rehabilitation management units. The number of bores may be reduced over time, and the bores to be monitored will be selected based on their historical record and the relevance in relation to issues within the TSF rehabilitation management unit. A detailed description about the various groundwater and surface water monitoring programs that will take place are provided in Chapter 8 – Water Resources and Chapter 15 – Environmental Management Plan.

• Monitoring of the stability of the TSF final landform, with respect to erosion of non-vegetated surfaces, will be undertaken annually over the initial ten years following rehabilitation of the site, and at longer intervals (pending results) afterwards. Monitoring will involve aerial laser surveys at five-yearly intervals during the adaptive management monitoring period. Satellite images will be acquired in years when aerial lasers surveys are not undertaken. These will be supplemented with monthly visual surveys in the early stages of closure.

• The existing aquatic and terrestrial fauna monitoring programs (see Chapter 9 – Biodiversity and Chapter 15 – Environmental Management Plan) 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. This includes an ongoing assessment of the levels of metals in the tissues of aquatic fauna.

• The revegetated TSF will be monitored annually for the first three years; then, every three years until the flora-related completion criteria are achieved.

• Soil qualities pertaining to plant growth and establishment will be monitored every five years, until vegetation has adequately established and further monitoring is not necessary.

4.10.3.5 Timing

Decommissioning of the TSF, involving the removal and reprocessing of tailings, will commence in 2037 and continue until 2047. This will be followed by five years of earth-works and revegetation of the rehabilitation management unit.

4.10.4 Rehabilitation Management Unit 4: Infrastructure Areas

4.10.4.1 Closure Objectives

The following closure objectives pertain to the infrastructure areas rehabilitation management unit:

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

• Rehabilitated areas will provide appropriate habitat for fauna utilization – abundance and diversity will be appropriate.

• No infrastructure left on-site unless a beneficial gain is identified and agreed with stakeholders.

• Landform will host suitable vegetation for post-mining land use:
  o for traditional land use areas:
    ▪ have similar environmental values as surrounding areas; and
  o for cattle grazing land use areas:
    ▪ grasslands.

• Manage soil to meet post mining land use.

• Foster economic opportunities for custodians and local communities.
4.10.4.2 Risks

The key risks pertaining to the infrastructure areas rehabilitation management unit are:

- inadequate decommissioning of infrastructure could pose a safety risk to people and animals;
- a failure to identify and manage areas of contaminated land could lead to contamination of surface waters and groundwater;
- inappropriate fluvial sediment management prior to vegetation establishment could lead to sedimentation of local waterways; and
- a failure of vegetation establishing on previous areas of infrastructure to resemble local habitats (e.g., excessive weeds) could impact recolonisation by significant species.

4.10.4.3 Approach

The infrastructure areas rehabilitation management unit comprises a diverse range of structures, which will be managed differently according to their potential future use by local communities and future land owners. The decommissioning of key infrastructure is described below.

Most of the accommodation village, stores and concentrate haulage depot will be decommissioned:

- Transportable buildings and equipment will be sold and removed, unless otherwise agreed with stakeholders. Services such as power and sewerage will first be disconnected and any remaining structures such as footings, electrical cables and pipes will be dismantled and buried.
- Larger buildings such as the manager residences, wet and dry messes, warehouses, workshops and camp support buildings will be demolished once all valuable material has been salvaged and services disconnected.
- Any large excavations such as the swimming pool and haulage depot work pit will be filled.
- The Metalliferous saline non-acid forming (MS-NAF) fill that covers the stores area will be excavated and removed to the pit. This is estimated at 830,000 m$^3$ of material and covers an area of approximately 5.0 ha. The disturbed area will then be covered with topsoil, ripped and seeded and allowed to revegetate naturally.
- All buildings associated with the haulage depot will be dismantled and removed. The service pit will be filled.
- Any areas with signs of significant hydrocarbon contamination will be excavated and removed to the open cut.

After decommissioning, land formerly containing the accommodation village, stores and concentrate haulage depot will be covered with topsoil (where required), ripped and seeded. Topsoil required for revegetation will be sourced from the stockpile to the west of stores. No major land surface re-profiling works will be undertaken in proximity to existing drainage systems.

The airstrip will remain on-site rather than be decommissioned. Being the second-largest airstrip in the Northern Territory (NT), it is of potential value to the local community for freight, general transport and for emergencies, as well as providing a facility that has been used by the Australian military. The fence will be maintained for regulatory reasons. The fuel storage area and small building associated with the airport will be decommissioned and removed, and the area rehabilitated. The fuel storage tank will be decommissioned by the relevant fuel supply company. Any areas with significant hydrocarbon contamination will be excavated and removed to the open cut and buried.

Infrastructure associated with the water management system including pump stations and pipes as well as power distribution infrastructure will be salvaged and removed from site when no longer required.
After decommissioning infrastructure, earthworks will be undertaken to create a natural landform consistent with surrounding landscapes. Then, topsoil will be added and the ground will be ripped and seeded. Locally native trees and shrubs will be planted, along with pasture grasses. The final land use is to be open woodland that supports native flora and fauna, and is also suitable for grazing.

4.10.4.4 Monitoring

The following monitoring programs pertain to the infrastructure areas rehabilitation management unit:

- Surface water monitoring is to be undertaken at the same locations as the operational program. This will involve monthly monitoring of water quality at approximately 30 sites along local creeks and rivers. A detailed description of the surface water monitoring programs that will take place is provided in Chapter 8 – Water Resources and Chapter 15 – Environmental Management Plan.
- Monitoring of the stability of the final landform will be undertaken annually over the initial ten years, and at longer intervals (pending results) afterwards. Monitoring will involve aerial laser surveys at five-yearly intervals during the adaptive management monitoring period. Satellite images will be acquired in years when aerial lasers surveys are not undertaken. These will be supplemented with monthly visual surveys in the early stages of closure.
- The existing aquatic and terrestrial fauna monitoring programs (see Chapter 9 – Biodiversity and Chapter 15 – Environmental Management Plan) 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 revegetated infrastructure areas will be monitored annually for the first three years; then, every three years until the flora-related completion criteria are achieved.
- Soil qualities pertaining to plant growth and establishment will be monitored every five years, until vegetation has adequately established and further monitoring is not necessary.

4.10.4.5 Timing

Decommissioning and rehabilitation of infrastructure will be a gradual process, which takes place as infrastructure becomes redundant. Decommissioning of some structures will likely commence in 2037, following the cessation of mining. The final structures to be decommissioned (e.g., power, potable water, sewerage and telecommunications structures) will be retained until permanent staff presence on-site is no longer required (between 2052 and 2118, depending on results of monitoring).

For any particular piece of infrastructure, rehabilitation will commence immediately following decommissioning, to reduce the risk of erosion from disturbed, non-vegetated surfaces.

4.10.5 Rehabilitation Management Unit 5: Borrow Pits

4.10.5.1 Closure Objectives

The following closure objectives pertain to the borrow pits rehabilitation management unit:

- 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).
- 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.
• Landform stability.
• Rehabilitated areas will provide appropriate habitat for fauna utilization – abundance and diversity will be appropriate.
• Manage soil to meet post mining land use.
• Foster economic opportunities for custodians and local communities.

4.10.5.2 Risks
The chief risks pertaining to the borrow pits rehabilitation management unit are:

• inappropriate fluvial sediment management prior to vegetation establishment could lead to sedimentation of local waterways;
• a failure of vegetation establishing on the rehabilitated TSF to resemble local habitats (e.g., excessive weeds) could impact recolonisation by significant species; and
• the depth of borrow pits could result in a surface expression of groundwater and/or salts, leading to soil qualities inappropriate for vegetation establishment.

4.10.5.3 Approach
Extraction of clay and other benign materials for lining the TSF and capping OEFs will lead to localised surface lowering in borrow pit rehabilitation management units. Shallow borrow pits will be re-contoured and revegetated to achieve a stable cover of vegetation consisting of species local to the area as well as pasture grasses.

In some places, the borrow pits are or will be deep enough to allow surface pooling of water during the wet season. The site of the proposed TSF Cell 4 was a borrow pit for clay materials during construction. This has resulted in surface exposure of groundwater during the wet season. The closure concept involves the construction of a sediment basin and wetland system in this borrow area. The wetland will receive drainage from the rehabilitated TSF (see Section 4.10.3) before discharging to the adjacent Surprise Creek via an open channel. Re-contouring and revegetation would be implemented in this area to maximise integration of the wetland with the wider environment in a way that is compatible with natural features of the surrounding region. The closure of the TSF will minimise groundwater expression in this area.

Borrow pits within and adjacent to the water management dam (WMD) and near the TSF will be contoured to allow drainage to the reinstated Little Barney Creek.

The borrow pit to the east of Cell 1 will be infilled and revegetated to limit the surface expression of groundwater and salts.

All borrow areas will be seeded as necessary to promote a stable cover of vegetation.

4.10.5.4 Monitoring
The following monitoring programs pertain to the borrow pits rehabilitation management unit:

• Surface water monitoring is to be undertaken at the same locations as the operational program. This will involve monthly monitoring of water quality at approximately 30 sites along local creeks and rivers. A detailed description of the surface water monitoring programs that will take place is provided in Chapter 8 – Water Resources and Chapter 15 – Environmental Management Plan.
• Monitoring of the stability of the final landform will be undertaken annually over the initial ten years, and at longer intervals (pending results) afterwards. Monitoring will involve aerial laser surveys at five-yearly intervals during the adaptive management monitoring period.
Satellite images will be acquired in years when aerial lasers surveys are not undertaken. These will be supplemented with monthly visual surveys in the early stages of closure.

- The existing aquatic and terrestrial fauna monitoring programs (see Chapter 9 – Biodiversity and Chapter 15 – Environmental Management Plan) 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 revegetated borrow pits will be monitored annually for the first three years; then, every three years until the flora-related completion criteria are achieved.
- Soil qualities pertaining to plant growth and establishment will be monitored every five years, until vegetation has adequately established and further monitoring is not necessary.

### 4.10.5.5 Timing

Decommissioning and rehabilitation of borrow pits will proceed sequentially as each is no longer required for operations. The borrow pit east of the TSF will be the first to commence rehabilitation, in 2032. The remaining borrow pits will commence rehabilitation in 2037. All borrow pits are expected to be in an advanced stage of rehabilitation by 2047. Chapter 3 – Project Description and Justification presents progressive mine stage plans which identify areas made available for rehabilitation throughout the mine life.

### 4.10.6 Rehabilitation Management Unit 6: Water Dams

#### 4.10.6.1 Closure Objectives

The principal closure objectives relevant to the water dams rehabilitation management unit are:

- 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).
- Landform stability.
- Manage soil to meet post mining land use.
- No infrastructure left on-site unless a beneficial gain is identified and agreed with stakeholders.

#### 4.10.6.2 Risks

Key risks associated with the water dams rehabilitation management unit include:

- inadequate removal of contaminated material within certain storage ponds could pose a potential safety risk to humans and wildlife;
- inadequate removal of contaminated material within certain storage ponds has the potential to affect water quality in the nearby Barney Creek, Surprise Creek and McArthur River during periods of flooding;
- inappropriate fluvial sediment management prior to vegetation establishment could lead to sedimentation of local waterways; and
- dams that are decommissioned and rehabilitated may not provide an appropriate growing medium for vegetation if soil conditions (e.g., compaction) are inadequate.

#### 4.10.6.3 Approach

Whether water dams are to be decommissioned or retained depends on whether they have been used to store contaminated material as well as the desires of the final land holder.

In storage ponds such as the anti-pollution pond (APP), concentrator runoff pond (CRP), Pete’s Pond and Van Duncan’s Dam (for locations of these dams, refer to Chapter 8 – Water Resources),
contaminated material will be removed and placed in the open cut final void. The ponds will then be back-filled or pushed over and rehabilitated.

Other dams constructed for the storage of bore water, such as Emu Dam, Donkey Dam and the Turkey’s Nest Dam (see Chapter 8 – Water Resources) will be retained for pastoral use. The removal of pipe work will be negotiated with the final landholder.

The WMD within Cell 3 of the TSF will be decommissioned unless required by the landholder.

All of the dams at the OEF will remain in place until approximately the end of mine life and tailings reprocessing, at which point they will be removed.

4.10.6.4 Monitoring

Three monitoring programs pertain to decommissioned and rehabilitated water dams:

- Surface water monitoring is to be undertaken at the same locations as the operational program. This will involve monthly monitoring of water quality at approximately 30 sites along local creeks and rivers. A detailed description of the surface water monitoring programs that will take place is provided in Chapter 8 – Water Resources and Chapter 15 – Environmental Management Plan.

- The revegetated dams will be monitored annually for the first three years; then, every three years until the flora-related completion criteria are achieved.

- Soil qualities pertaining to plant growth and establishment will be monitored every five years, until vegetation has adequately established and further monitoring is not necessary.

4.10.6.5 Timing

Storage dams that contain contaminated material (APP, CRP, Pete’s Pond and Van Duncan’s Dam) will be decommissioned during in-pit dumping within the open cut (2031-2037). The timing of decommissioning of the WMD will depend on negotiations with stakeholders.

4.10.7 Rehabilitation Management Unit 7: Roads

4.10.7.1 Closure Objectives

The closure objectives relating to the roads rehabilitation management unit include:

- Manage soil to meet post mining land use.
- No infrastructure left on-site unless a beneficial gain is identified and agreed with stakeholders.
- Maintain custodians’ access to areas of cultural significance.
- Foster economic opportunities for custodians and local communities.

The number and location of roads retained on site after closure will be a compromise between the desires to replace unnecessary infrastructure with pasture and to maintain access for custodians, monitoring and maintenance, and other stakeholders.

4.10.7.2 Risks

The environmental risks posed by the closure of roads are relatively benign. The principal risk is that soil compaction may prevent the establishment of vegetation consistent with post-mining land use.
4.10.7.3  Approach

There will be approximately 5 km of sealed roads and approximately 25 km of unsealed access roads on the mine site. Once they are deemed to be of relatively little use (for monitoring purposes, custodians or future land holders, or as firebreaks), roads will be ripped and covered with topsoil. Roads around the TSF, NOEF and mine site hardstand areas will be compacted to provide a permanent firebreak around rehabilitation areas. Bitumen removed will be placed in the open cut final void.

4.10.7.4  Monitoring

Two monitoring programs pertain to rehabilitated roads:

- revegetated roads will be monitored annually for the first three years; then, every three years until the flora-related completion criteria are achieved; and
- soil qualities pertaining to plant growth and establishment will be monitored every five years, until vegetation has adequately established and further monitoring is not necessary.

4.10.7.5  Timing

The timing of road closure will depend on when these are no longer required for operational or monitoring purposes. Consistent with recommendations in the NT Draft MCP Guidelines, decommissioning and rehabilitation of roads will be undertaken progressively as roads become redundant, rather than waiting until operations cease completely.

4.10.8  Rehabilitation Management Unit 8: Exploration

Exploration activities are not currently proposed as part of the Project; however, there is potential for further investigations in the future and, for completeness, this section has been included to maintain accordance with the NT Draft MCP Guidelines. This section also addresses the rehabilitation of any exploration holes identified during mine closure that have not yet been rehabilitated. Should rehabilitation of exploration activities be required, the associated disturbance will be managed in compliance with the following sections.

4.10.8.1  Closure Objectives

The following closure objectives pertain to the exploration rehabilitation management unit:

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

4.10.8.2  Risks

The chief risks pertaining to the exploration rehabilitation management unit are:

- unplugged exploration holes could create an unsafe environment for humans and animals;
- rehabilitated exploration holes may not provide an appropriate growing medium for vegetation if soil conditions (e.g., compaction) are inadequate; and
- a failure of vegetation establishing on rehabilitated exploration areas to resemble local habitats (e.g., excessive weeds) could impact recolonisation by significant species.
4.10.8.3 Approach

Exploration areas will be rehabilitated in accordance with NT guidelines.

Exploration holes on the outer leases will be plugged with concrete plugs once their collars have been removed. Aggregate and topsoil will be placed back over the plug to ensure that no access can be gained or erosion does not occur at the surface. Exploration holes near the pit will be temporarily capped with the use of concrete plugs and not buried as they will be consumed by the expansion of the Project.

Sumps will be partly filled so that they will be no bigger than 3 x 4 m with a maximum depth of 2 m. Pads will be ripped in order to promote vegetation growth. Pads will be allowed to rehabilitate naturally.

4.10.8.4 Monitoring

In the event that exploration is undertaken, or that pre-existing exploration holes are discovered, a simple site audit will be undertaken at each sampling site post-rehabilitation. This will primarily serve as a check that the site is left in a state that is safe for humans and animals. Additional vegetation surveys may be warranted after 5 years to ensure that flora-related completion criteria are achieved.

4.10.8.5 Timing

Rehabilitation of each exploration site will proceed immediately following completion of sampling at the site.

4.11 Trials

MRM have undertaken the following research to inform the design of final landforms and to provide confidence in the assessments of risk of rehabilitation failure. Each of these studies is summarised within Appendix S – Conceptual Mine Closure Plan:

- small- and large-scale kinetic leaching experiments, including oxygen consumption, humidity cell tests, column leaching tests and field cell tests;
- stability analysis of in-pit dump;
- geotechnical parameters;
- erosion performance trials;
- mine pit lake water quality modelling;
- modelling of tailings consolidation in the mine pit lake;
- modelling of the limnology of the mine pit lake;
- experimental placement of large woody debris in artificial waterways to encourage recolonisation by aquatic fauna;
- assessment of sheeting surfaces on the OEFs;
- site-wide groundwater and surface water modelling investigations;
- in-situ runoff coefficients;
- NOEF cover trials;
- investigations into reprocessing PAF material;
- geomorphological assessment of diversion channels; and
- investigations of contaminated sites.

As progressive rehabilitation continues, cover system and revegetation trials will be completed to provide large-scale infield data for application and refinement of proposed rehabilitation activities. A
program for addressing knowledge gaps has been developed and is presented in Section 4.2 of Appendix S – Conceptual Mine Closure Plan.

4.12 Contingency Plans for Premature or Temporary Closure

In the event that operations are required to prematurely or temporarily cease due to unforeseen circumstances, there is a need to ensure such closures do not lead to unacceptable risks to the environment or community. A contingency plan has been developed, as part of the closure plan (see Section 8.2 of Appendix S – Conceptual Mine Closure Plan). This is summarised in the following paragraphs.

Care and maintenance occurs when mining operations enter a period of temporary suspension. This is distinct from premature closure, in which mining operations are prematurely terminated on a permanent basis. A premature closure will trigger the full implementation of a Mine Closure Plan (Appendix S – Conceptual Mine Closure Plan), whereas a temporary suspension of mining activity must allow for the recommencement of mining in the future. Care and maintenance periods may be short (one to two years) or long (more than two years), depending on the reasons for cessation of operations. These scenarios could occur at various times during the Project’s life, making it impractical to have a detailed plan for all possible permutations. Nevertheless, the approach to be taken is summarised below.

Within three months of a decision to place the Project under care and maintenance, and prior to the commencement of any period of care and maintenance, an internal audit would be conducted to review the current status of the mine site and progress of the Project against any outstanding commitments from relevant documents such as the EIS, Mine Closure Plan, Mining Management Plans, etc. From this, a detailed list of commitments and obligations would be compiled for the period of care and maintenance to ensure that ongoing compliance, monitoring, and reporting obligations continue to be met.

Contingency plans for each of the rehabilitation management units are summarised in the following subsections.

4.12.1 General Strategy for Short-term Care and Maintenance

4.12.1.1 Open Cut

The top bench surface will be capped with clay if there are any exposed Potentially acid forming (reactive) (PAF(RE)) materials. Unnecessary ramps will be closed. Benches will be shaped to control drainage. Pumping infrastructure will be consolidated. A monitoring program will be developed for the care and maintenance phase.

4.12.1.2 Overburden Emplacement Facilities

Any ore left on stockpiles will be processed. Wet season covers will be completed over exposed OEF core and PAF(RE) cells. The surface of the OEFs will be designed to have slopes, drains and windrows that direct water into PRODs, rather than allow water to pool on, and infiltrate into, the OEF surface. The PROD operations manuals will be updated in accordance with the new design and plan, and the relevant maintenance personnel will be trained accordingly. Slopes, drains and windrows will also be engineered to manage the risk of overtopping of crests of the OEFs. Sumps and
sediment management infrastructure will remain operational. Flood levees will be completed to provide at least 1:20 year average recurrence interval (ARI) protection to non-benign materials.

### 4.12.1.3 Tailings Storage Facilities

The Operations Maintenance and Surveillance (OMS) manual will be updated in accordance with the new plan and the relevant maintenance personnel will be trained accordingly. Pipelines will be shut down. Pond water levels will be maintained as per the OMS, using suitable water management infrastructure. Water will be sprayed over the exposed beach to manage dust. Seepage mitigation infrastructure will continue to operate to meet MRM’s objectives.

### 4.12.1.4 Infrastructure

Infrastructure will go through a shutdown procedure, including the isolation and tagging out of equipment. Chemical storages will be secured. Stocks will be run down, sent to other sites or returned to suppliers, as required. Contaminated materials will be removed to an appropriate OEF. The magazine and blasting compound stocks will be reviewed, run down, sent to other sites or returned to suppliers, as required. Any infrastructure that will not be active during the care and maintenance phase will be secured.

### 4.12.1.5 Borrow Pits

The walls of active borrow pits will be battered to a safe angle. Drainage will be installed to manage erosion of sediment.

### 4.12.1.6 Water Dams

The mill will cease operating, removing a large consumer of water. An updated water balance will be developed that has defined strategies for managing site waters within the commitments/approval conditions, and that reflects to the site geometry and inventories at the time. The water treatment plant will be used to maintain and manage a suitable site water inventory. All dams would remain during short-term care and maintenance, although pump and pipe infrastructure may be altered to meet the revised requirements of the new water balance.

### 4.12.1.7 Roads

Dirt roads may be closed during short-term care and maintenance to reduce maintenance requirements.

### 4.12.1.8 Exploration

As exploration is an intermittent activity, any exploration disturbance would be rehabilitated in accordance with the approved Mining Management Plan (MMP) covering those works at the time.

### 4.12.2 General Strategy for Longer Term Care and Maintenance

The size and potential value of the McArthur River deposit would make it unlikely that remedial works jeopardising the future re-opening of operations would be enacted under circumstances where successful operations could be envisaged at some future point in time. However, some additional works beyond those described in Section 4.12.1 may be required to manage high-risk aspects of the site in the event of long-term care and maintenance.

### 4.12.2.1 Open Cut

The open cut will be managed as per short-term care and maintenance, plus gas and power supply contracts will be reviewed to adequately cover the revised site requirements.
4.12.2 Overburden Emplacement Facilities

OEFs will be managed as per short-term care and maintenance, plus:

- a cover system over higher risk areas of the OEFs, such as PAF(RE) and Potentially acid forming (high capacity) (PAF(HC)) cells, will be completed;
- slopes will be revegetated to reduce erosion rates and maintenance requirements;
- sumps and sediment management infrastructure will be upgraded as required for higher intensity rainfall events; and
- any flood levees will be completed to provide at least 1:100 year ARI protection to non-benign materials.

4.12.3 Tailings Storage Facility

The TSF will be managed as per short-term care and maintenance, plus:

- mud-farming of the surface of the TSF will be considered, to liberate pore water, increase density and enable earlier earthworks on top;
- a temporary clayey cap may be installed over the TSF for dust control whilst allowing settlement; and
- a store-and-release cover may be considered if care and maintenance is prolonged.

4.12.4 Infrastructure

Infrastructure will be managed as per short-term care and maintenance, plus removal of mobile or readily removed infrastructure and/or equipment will be considered.

4.12.5 Borrow Pits

The borrow pits will be managed as per short-term care and maintenance.

4.12.6 Water Dams

Water dams will be managed as per short-term care and maintenance, plus it is likely that, without the mill running, a long-term water balance surplus would emerge. After site water dams were at or above the maximum operating level, the open cut and underground voids would become the remaining contingency management facilities. The water level would likely rise in the open cut over time. The care and maintenance management team would have to maintain the open cut lake water level below the weathered rock and alluvial palaeochannel, to mitigate the risk of poorer quality lake water migrating beyond the mine levee wall to the receiving environment.

4.12.7 Roads

Roads will be managed as per short-term care and maintenance.

4.12.8 Exploration

Exploration areas will be managed as per short-term care and maintenance.

4.12.9 Miscellaneous

In addition to the above mentioned considerations prior to entering a care and maintenance phase, the environmental audit must adequately address safety issues on site including:

- all openings are to be capped, filled or otherwise made safe;
• the relevant site Safety Management Plan is to be updated for the period of care and maintenance;
• risk assessments will be undertaken for any works continuing through care and maintenance;
• appropriate access restrictions will be enforced for people and cattle; and
• appropriate fire management procedures and fire breaks are to be maintained.

4.13 Completion Criteria

Rehabilitation indicators provide defensible measurements of progress towards the rehabilitation objectives. At least one indicator will be adopted to assess each risk within any one rehabilitation management unit. The properties of a good indicator are that it:

• has an agreed, scientifically sound meaning;
• represents an environmental aspect of importance to society;
• tells us something important and its meaning is readily understood;
• has a practical measurement process;
• helps focus information to answer important questions; and
• assists decision making by being effective and cost-efficient.

Completion criteria provide a clear definition of successful rehabilitation in the form of a set of measureable benchmarks against which the rehabilitation indicators can be compared to determine if the objectives are being met. At least one completion criteria is used for each rehabilitation indicator.

A complete set of draft indicators and completion criteria to be adopted for the Project are contained within Section 6.2 of Appendix S – Conceptual Mine Closure Plan. Where required, quantitative targets for relevant completion criteria will be developed as the operations progress. These will be reviewed, modified and refined as necessary as operations and mine closure planning progresses, and following further consultation with relevant stakeholders.

Compliance with the specified criteria will be required before any areas of the mineral leases can be relinquished – i.e. compliance with the criteria will be reported in the Application for Certificate of Closure (ACC) as part of the Certificate of Closure process outlined in Section 46 of the Mining Management Act.

4.14 Performance Reviews

McArthur River Mining currently supports an annual independent environmental monitoring review. McArthur River Mining has conducted an environmental monitoring program since MRM’s inception, and the Independent Monitor’s audits have verified that mining and associated related operations at MRM have not adversely impacted the surrounding (off lease) environment. McArthur River Mining’s performance with regard to closure will be reviewed annually by an independent party.

McArthur River Mining will report on rehabilitation and closure monitoring programs as discussed above and will utilise monitoring results to improve future planning and implementation. Reporting will present results against the objectives and criteria presented in Appendix S – Conceptual Mine Closure Plan.

Reports on monitoring results and interpretation of site closure performance and progress towards mine closure criteria will be made available to stakeholders annually.
4.15 Revising the Conceptual Mine Closure Plan

The CMCP is a dynamic document that will inform management of the Project for over 100 years. Over this time, there will be considerable accumulation of environmental data from numerous monitoring programs, which may prompt refinements to the plan. The following situations will potentially trigger revisions to the CMCP:

- government comments arising from this EIS;
- changing community interests, based on ongoing consultation with custodians, neighbouring property owners, local communities and future land holders;
- changes to legislation concerning mine rehabilitation and closure;
- failure of the Project to meet certain completion criteria; and
- new scientific data, either gathered on-site or published from external sources, that indicate that the CMCP is unlikely to meet the stated objectives.

Any modifications of the CMCP will be subject to NT and Commonwealth Government review prior to implementation.