5 Rehabilitation and Decommissioning

5.1 Introduction

This chapter outlines the proposed rehabilitation and decommissioning methods to be used at the McArthur River Mine Phase 3 Development Project (the 'Project'). More detailed information about rehabilitation and mine closure is available in Appendix E4 – Mine Closure Plan.

5.2 Environmental Values

The environmental values that have been considered in relation to rehabilitation and decommissioning at the Project include:

- the health and well-being of people
- the diversity of ecological processes and associated ecosystems
- maintaining soil resources and agricultural land capability
- maintaining water quality and flows in waterways
- the creation of safe, stable, non-polluting and sustainable landforms.

5.3 Rehabilitation Objectives

The main objectives of the Project rehabilitation program are:

- plan the placement of materials in a strategic manner to facilitate progressive rehabilitation where practicable and to minimise material handling costs
- conduct studies that will enable effective techniques to be implemented when carrying out rehabilitation
- complete construction and rehabilitation works that will, at the completion of the Project, result in stable stream channels and vegetated landscapes having minimal impact on the surrounding environment
- mining and rehabilitation will aim to create a landform with a land use capability similar to that prior to disturbance unless other appropriate beneficial land uses are pre-determined and agreed
- mine wastes and disturbed land will be rehabilitated to a condition that is self-sustaining or to a condition where the maintenance requirements are consistent with an agreed post-mining land use.

Clean disturbed areas, where appropriate, will be returned to native bushland, which will be stable enough to tolerate intermittent grazing, as was the pre-mining land use.

The rehabilitation strategy will remain flexible and will be amended as new rehabilitation techniques emerge and as environmental investigations progress, or when the Proponent's Sustainable Development Mining Management Plan is modified. This will ensure the most appropriate technology is utilised as and when it becomes available. The rehabilitation of disturbed areas will be carried out progressively throughout the life of the Project, consistent with operational requirements.

5.4 Rehabilitation Strategy

The Proponent maintains a strategy to ensure that rehabilitation will be sustainable and, where operationally practicable, undertakes ongoing rehabilitation and contaminated site remediation. Estimates of costs to remediate contaminated land and to close the operation have been made. Financial provision for rehabilitation and closure is reviewed annually.

To achieve the above objectives for rehabilitation and ultimate closure, the Proponent has established the following measures:

- an unplanned and Life of Mine Completion Plan (LOM)
- rehabilitation requirements, plans and timelines, which are annually reviewed
- security and decommissioning life of mine costs which are calculated annually
- a rehabilitation accrual, which is annually reviewed
- post-mining land use objectives, which are reviewed annually.

5.5 Rehabilitation and Decommissioning Success Factors

Potential impacts on the success of rehabilitation and decommissioning at the Project include:

- surface disturbance: during the life of the mine, the following approximate land disturbance areas are proposed (including currently approved operations);
    - open pit with an overall footprint of 210 ha
    - 1,190 ha Overburden Emplacement Facilities (OEFs)
    - 460 ha Tailings Storage Facility (TSF).
- overburden characterisation: overburden analysis has been undertaken during previous environmental assessments by URS (2005). This study indicates that there is a high percentage of Non-Acid Forming (NAF) material in comparison to relatively low percentage of Potentially Acid Forming (PAF). Overburden characterisation for the Project will be examined further in a scheduled drilling programme to improve predictions of PAF material on-site
- the final open pit (final void) will be a significant feature of the post-mining landform
- the McArthur River will be permanently realigned from the open pit (as assessed previously by URS, 2005, and is not in the scope of this Environmental Impact Statement).

5.6 Rehabilitation Guidelines and Objectives

The rehabilitation of mined lands is an important component of any mining project. The existing rehabilitation program at the Project will continue throughout the mine life. The program consists of detailed planning and design of post mine landforms, the implementation of rehabilitation activities including erosion control, and design for long-term geotechnical stability.

The proposed rehabilitation and decommissioning strategy for the Project has used the following documents as reference sources:

- Guidelines for Preparing Mine Closure Plans (Western Australia Department of Mines and Petroleum 2011)
- Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure and Completion (Department of Resources, Energy and Tourism 2006)

- Leading Practice Sustainable Development Program for the Mining Industry - Mine Rehabilitation (Department of Resources, Energy and Tourism, 2006)
- Leading Practice Sustainable Development Program for the Mining Industry - Landform Design for Rehabilitation (Environment Australia, 1998).

Specifically, the rehabilitation strategy for the Project will have the following objectives:

- mining and rehabilitation will aim to create a landform with a land use capability similar to that prior to disturbance unless other appropriate beneficial land uses are pre-determined and agreed
- mine wastes and disturbed land will be rehabilitated to a condition that is self-sustaining or to a condition where the maintenance requirements are consistent with an agreed post-mining land use
- the water management system will aim to capture all mine affected water and will aim to maximise on-site storage capacity to achieve water quality objectives in the receiving environment.

5.7 Land Disturbance Areas

During the life of mine, the following land disturbance areas are predicted:

- 210 ha will be disturbed by the open pit, (MLN 1121)
- 460 ha will be disturbed by the TSF (MLN 1123)
- 1,190 ha will be disturbed by three OEFs (MLN 1122 and 1124).

Both remnant and regrowth vegetation is required to be cleared for the Project. Vegetation is cleared in accordance to existing land disturbance procedures which involves the completion of a specific 'Permit to Clear' form. Part of this procedure is to gradually clear vegetation to enable fauna to relocate from the disturbed area.

A sustainable approach for any land clearing, including flora, fauna and cultural heritage surveys of the area is undertaken if they have not previously been completed. If significant artefact locations or protected species are identified, appropriate management measures will be applied. Vegetation that has been cleared for mine development will be assessed for use on site, including as a medium to be spread on the final landform to assist natural habitat establishment. Excess vegetation that has no re-use potential will be burned in accordance with current site practices.

5.8 Mine Rehabilitation Processes

5.8.1 Design Criteria

Rehabilitation design at the Project will be based on the following criteria:

- all areas significantly disturbed by mining activities will be rehabilitated to a stable landform with a self-sustaining vegetation cover
- outer OEF slopes will be designed at no greater than a 1(V):4(H) overall slope.
- the OEF will have a 600 mm layer of growth media (mix of NAF rock, alluvials and soils) to provide a layer for storing water and nourishing vegetation
- the surface of the OEFs will be shaped with a gentle slope of 1(V):100(H) and will be directed towards drop chutes to transport water down to ground level
- the walls of the open pit will remain benched as long as the rock is geotechnically stable under these conditions. The pit will drain internally into the final void

- the pit walls, if geotechnically stable, will remain at the final batter angles and made safe to ensure humans and animals do not harm themselves
- until further geotechnical and geochemical assessments are completed, PAF cells must have at least 20 m of NAF surrounding them at the end of construction. No PAF material shall be placed below the 1-in-100 year flood level in any ex-pit OEFs
- perimeter stormwater diversions will be designed and constructed to meet appropriate standards
- appropriate fencing will be utilised to restrict access where required.

5.8.2 Rehabilitation

All areas disturbed by mining activities will be rehabilitated to a stable landform with a self-sustaining vegetation cover, with progressive rehabilitation commencing within one year of when areas become available for rehabilitation purposes. Land will be regarded as successfully rehabilitated when nominated targets for land suitability, land use (including vegetation cover and composition), landform stability, and land contamination have been met.

The disturbance and handling of soils, landform recreation and stabilisation will be guided by the following principles:

- if not deposited directly onto shaped OEF, all topsoil and soil forming materials will be stockpiled in a manner that retains soil qualities (i.e. topsoil and subsoil stored separately)
- stockpiles will be fertilised and seeded where necessary
- reuse of all soil-forming materials to enable the establishment of vegetation
- limit topsoil stripping to the minimum area required for operational purposes at any one time
- achieve physically and chemically stable landforms
- achieve appropriate landform profiles, revegetation and surface water management to minimise erosion and sedimentation
- revegetate new landforms with selected plant species, appropriate for achieving a stable landform
- perform rehabilitation trials during the early operational period to refine the rehabilitation design.

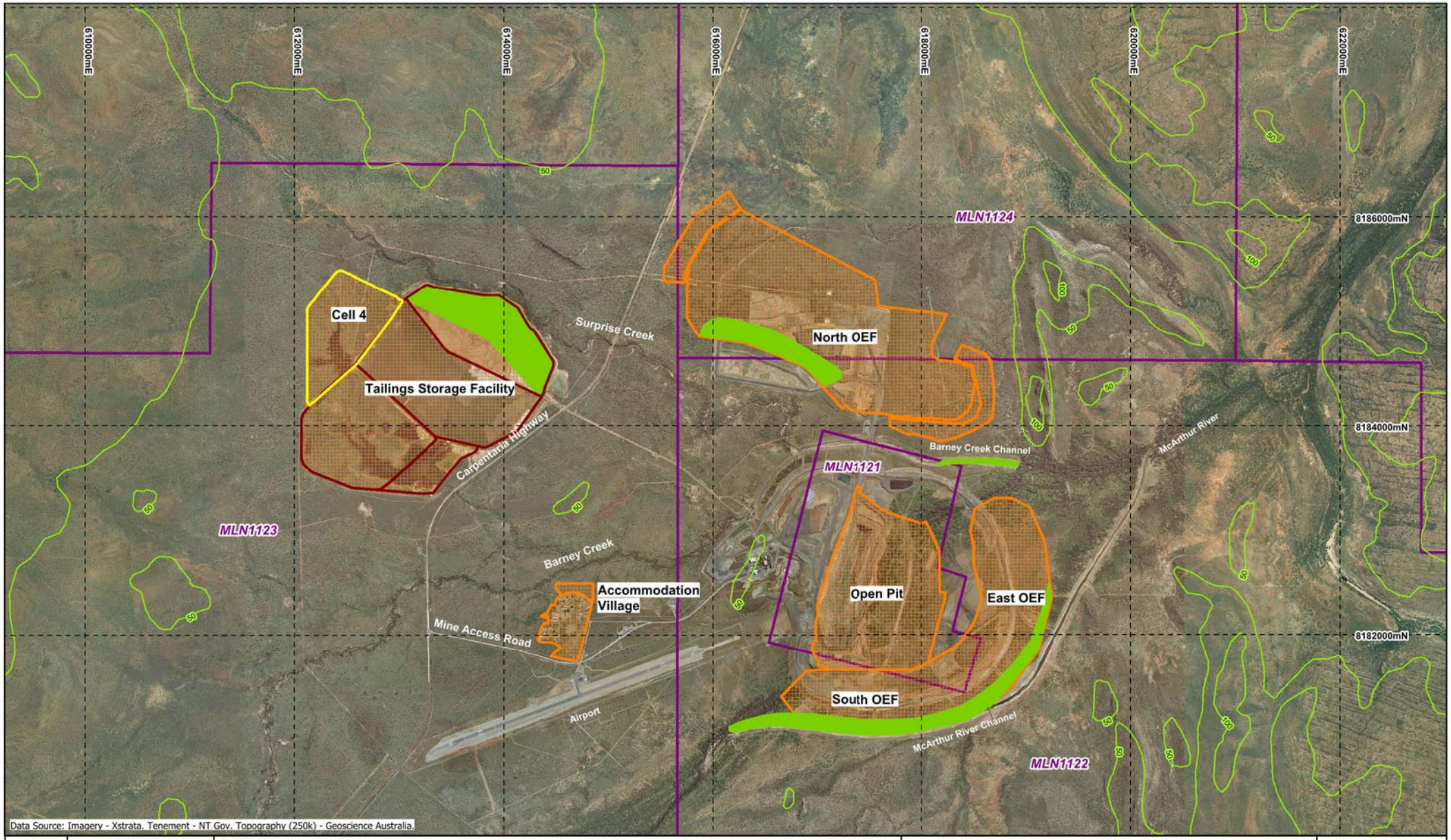
The standard rehabilitation processes are those that can be applied to any kind of land disturbance at the Project.

The Proponent will progressively rehabilitate where practicable, however there will be large areas of disturbed land that will not be available for rehabilitation until later in the mine life for the following reasons:

- the disturbed area is effectively integrated with nearby, unavailable areas
- it necessitates an uneconomic use of resources to undertake the work at the time
- the chemical characteristics of the OEF may improve with time of exposure, thereby improving the success of the rehabilitation.

The rehabilitation of the Project over time is shown from Figure 5-1 to Figure 5-3.

S:\Projects\XZ003 MRM Extension EIS_MapInfo\Workspaces\XZ003_M075B.wor



Data Source: Imagery - Xstrata. Tenement - NT Gov. Topography (250k) - Geoscience Australia.

METSERVE

xstrata zinc

0 1
Kilometres
Scale: 1:50,000 (A4)

LEGEND

- Project tenement
- Mine operation
- Existing and Approved TSF Boundary
- Topsoil spreading and rehabilitation
- Cell 4

McArthur River Mine
Phase 3 Development Project

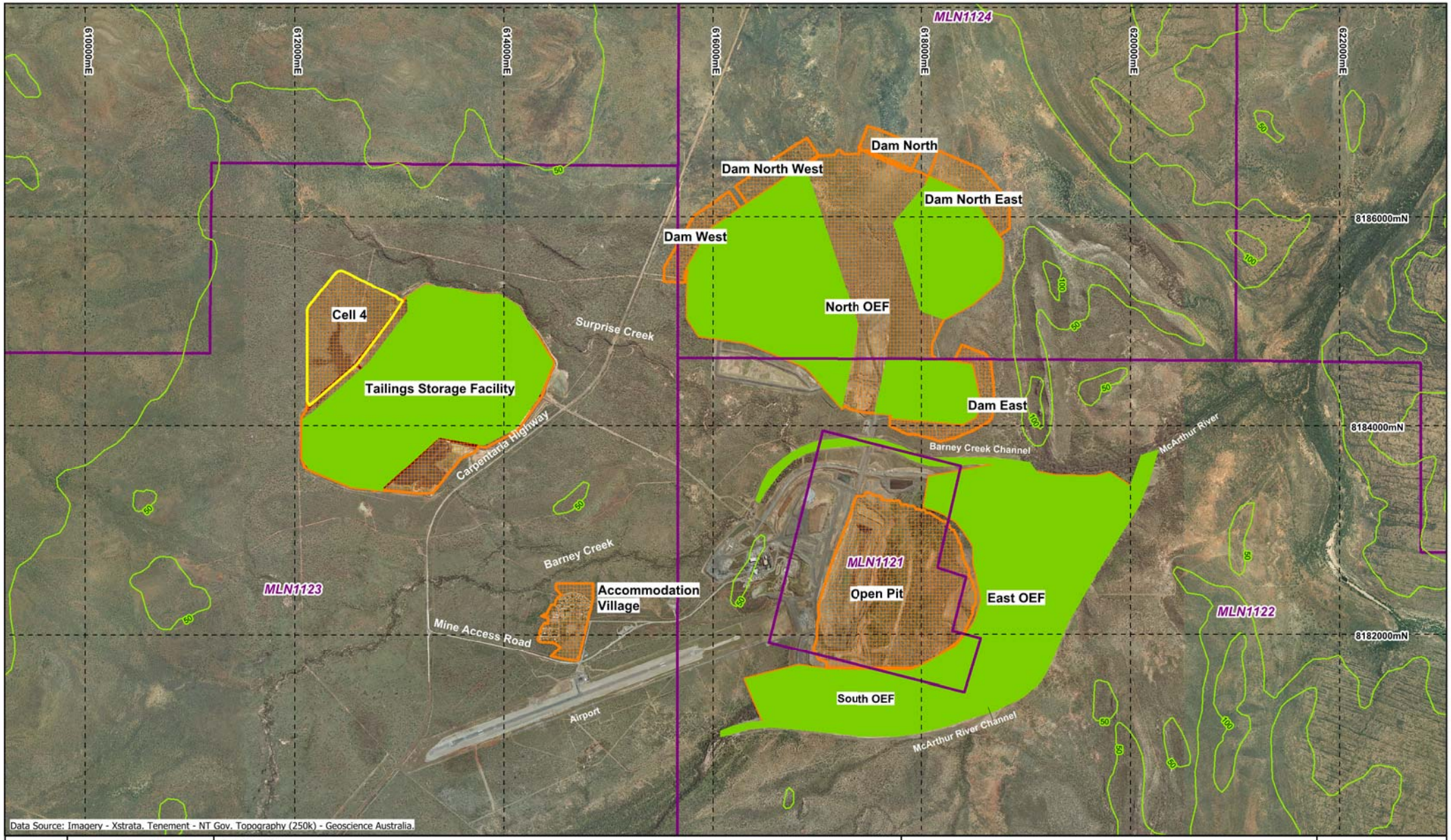
Progressive Rehabilitation Plan - 2015

16/01/2012

Datum: AGD84
Projection: AMG53

FIGURE 5 - 1

S:\Projects\XZ003 MRM Extension EIS_MapInfo\Workspaces\XZ003_M078B.wor



METSERVE

xstrata zinc

0 1
Kilometres
Scale: 1:50,000 (A4)

LEGEND

- Project tenement
- Mine operation
- Existing and Approved TSF Boundary
- Topsoil spreading and rehabilitation
- Cell 4

McArthur River Mine
Phase 3 Development Project

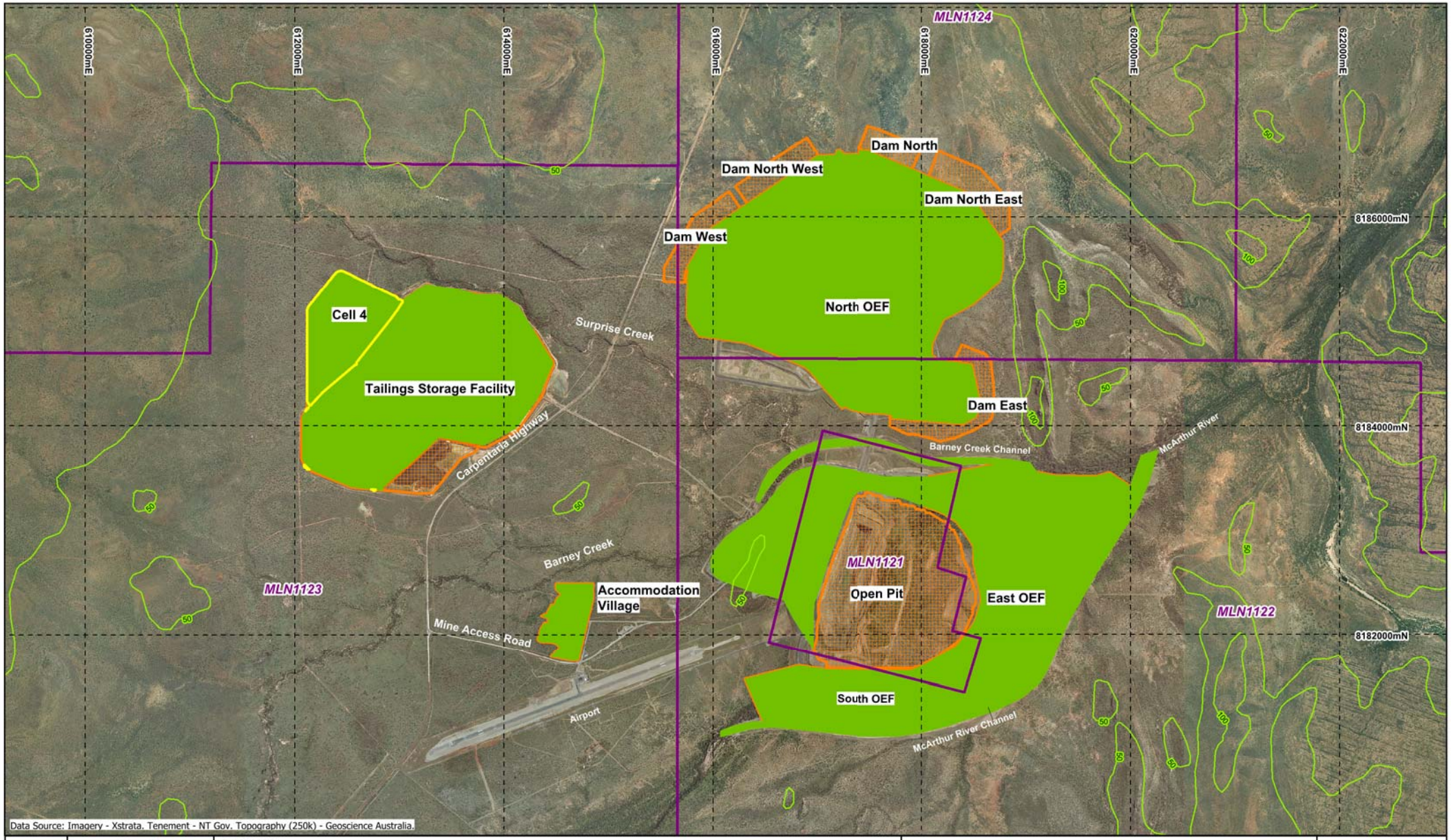
Progressive Rehabilitation Plan - 2030

16/01/2012

Datum: AGD84
Projection: AMG53

FIGURE 5 - 2

S:\Projects\XZ003 MRM Extension EIS_MapInfo\Workspaces\XZ003_M079C.wor



METSERVE

xstrata zinc

0 1
Kilometres
Scale: 1:50,000 (A4)

LEGEND

- Project tenement
- Remaining Facilities
- Existing and Approved TSF Boundary
- Topsoil spreading and rehabilitation
- Cell 4

McArthur River Mine
Phase 3 Development Project

Progressive Rehabilitation Plan - End Of Mine

16/01/2012

Datum: AGD84
Projection: AMG53

FIGURE 5 - 3

5.8.3 Shaping and Contouring

Where practicable, any areas of land that have been significantly altered from the existing topography e.g. OEFs will be reshaped to appropriately designed and approved landforms to meet the rehabilitation criteria.

5.8.4 Topsoil Management

Any areas of land that have had topsoil removed ahead of mining or have had existing topsoil cover significantly and negatively impacted by mining, will be spread with a layer of topsoil suitable for the proposed rehabilitation purposes when rehabilitation is undertaken.

To maintain the integrity of vegetation in areas adjacent to disturbed areas, appropriate erosion, sediment and dust controls will be established prior to and during soil disturbance. Prior to stripping the soil, regrowth vegetation on areas to be disturbed will be cleared and windrowed. Where practicable, windrowed vegetation will be chipped or retained for fauna habitat.

Application of topsoil to the final graded surface provides the most suitable seed bed for the establishment of ground cover. Topsoil compaction will be minimised during spreading by placing topsoil in windrows on the final surface which can then be distributed by a bulldozer working on the soil. Subsequent machinery passes will be necessary in order to establish vegetation and to construct erosion control structures if required.

Stripped topsoil will be placed directly onto final landforms where practicable. This avoids double handling, eliminates the need to stockpile and maintains the quality of topsoil. If the topsoil cannot be immediately placed on prepared landforms, it will be stockpiled in pre-determined locations as close as practicable from where it is removed and within the immediate area suitable for future rehabilitation activities. This allows topsoil to be used in the rehabilitation of areas where mining, dumping and final shaping has occurred.

Topsoil stockpiling will be minimised as deterioration of soil chemical, physical and biological properties can occur during storage. If stockpiling cannot be avoided, the stockpiling period will be minimised where practicable. Stockpiles will also be kept to less than 5 m in height to reduce soil compaction and the loss of soil integrity.

Some topsoil can be detrimental to rehabilitation due to the presence of weeds. A visual assessment for weeds will be undertaken prior to topsoil stripping. If weeds are present within the topsoil stripping area, then appropriate weed management practices will be applied. If there is a high risk of weeds spreading during stripping, all equipment will be washed down prior to starting work in a new area.

The Project has considerable reserves of topsoil that will be used in the mine rehabilitation program (refer to Chapter 7 – Land Resources for volumes). As a guide, all soils used in rehabilitation should be applied to no less than 100 mm. This provides sufficient depth for re-ripping should follow-up maintenance work be required. Soils placed less than this thickness can be significantly contaminated by overburden when a single pass of deep ripping occurs.

Further discussion of the available soil types and volumes, as well as stripping and stockpiling recommendations for all soils to be disturbed is provided in Chapter 7 – Land Resources.

5.8.5 Seeding and Revegetation

Methods of direct seeding and planting tubestock will be used to revegetate the reshaped and topsoiled rehabilitation areas with varying mixes of native tree, shrub and grass species along with selected pasture grasses. Deep ripping on the contour prior to seeding and fertilisation will be undertaken to a minimum depth of 500 mm. Revegetation will be completed as soon as possible after cultivation and prior to the wet season.

Revegetation will consist of plant species compatible with local vegetation communities, proven as suitable to the final landform topography and regional climate, as well as meeting the short-term and long-term rehabilitation objectives. A list of selected plant species observed within the Project area and recommended for successful rehabilitation of specific habitats is detailed within Table 5-1.

Table 5-1 Plant Species Recommended for Rehabilitation

Project Development Area	Plant Species	Growth Form
Overburden Emplacement Facilities	*Chionachne cyathopoda*	Grass
Overburden Emplacement Facilities	*Chionachne hubbardiana*	Grass
Overburden Emplacement Facilities	*Mnesithea rottboeliodes*	Grass
Overburden Emplacement Facilities	*Eriachne ciliate*	Grass
Overburden Emplacement Facilities	*Heteropogan contortus*	Grass
Overburden Emplacement Facilities	*Triodia bitextura*	Grass
Overburden Emplacement Facilities	*Aristada latifolia*	Grass
Overburden Emplacement Facilities	*Chrysopogon fallax*	Grass
Overburden Emplacement Facilities	*Setaria apiculata*	Grass
Overburden Emplacement Facilities	*Perotis rara*	Grass
Tailings storage facility	*Senna notabilis*	Shrub
Tailings storage facility	*Acacia hammondi*	Shrub
Tailings storage facility	*Acacia thomsonii*	Shrub
Tailings storage facility	*Helicteres isora*	Shrub
Tailings storage facility	*Heteropogon contortus*	Grass to 1.5 m
Riverine channel	*Acacia holosericea*	Shrub
Riverine channel	*Acacia umbellata*	Shrub
Riverine channel	*Acacia thomsonii*	Shrub
Riverine channel	*Barringtonia acutangula*	Low tree
Riverine channel	*Chrysopogon elongatus*	Grass
Riverine channel	*Nauclea orientalis*	Tree
Riverine channel	*Eucalyptus camaldulensis*	Tree
Riverine channel	*Gossypium australe*	Shrub
Riverine channel	*Melaleuca argentea*	Tree
Riverine channel	*Terminalia platyphylla*	Tree

A key species for the McArthur River Channel area is *Barringtonia actangulata*. Direct seeding has proved to be quiet difficult for this species. It is proposed to collect seed from parent trees early in the wet season when seed is produced and germinate and propagate this species as tube stock.

Key species of grasses for the OEF include *Chionachne cyathopoda*, *Chionachne hubbardiana* and *Mnesithea rottboeliodes* which are important to create habitat for the Purple-crowned Fairy Wren (*Malurus coronatus*).

Other species such as *Nauclea* also do not lend themselves to direct seeding and will be similarly propagated as tube stock. Tube stock propagation and planting will therefore focus on large, long lived *tree* species which are unsuitable for direct seeding. Tree seeding will therefore focus on Melaleucas, eucalypts and shorter lived Acacia species.

Fertiliser application rates will be developed as required, after review of the soil and overburden analyses for the area. Any areas of land that have been reshaped and/or topsoiled will be seeded with the appropriate mix of seed species and/or planted with tubestock for the final land use for that area.

5.8.6 Sediment Control and Erosion

Erosion and sediment control is an essential component to achieving site stability, particularly on rehabilitated landforms that have steep or long slopes, and is usually achieved through a combination of vegetation establishment, structural cladding and surface drainage control.

Land that has been disturbed by mining operations and cannot be immediately rehabilitated has an increased erosion potential. Soil sediment from these areas will be managed by:

- minimising the area disturbed
- treating run-off in sediment sumps and dams
- progressive rehabilitation of disturbed areas where practicable.

Soil sediment and runoff control dams will be constructed on the perimeter of the North OEF to prevent sediment runoff downstream.

Where possible, the downstream sediment and erosion controls will be installed prior to disturbance activities commencing. All temporary control measures will be removed after the disturbance site is stabilised. Haul roads will have sufficient surface drainage to prevent run-off eroding the road or adjacent areas.

The overall mine site water management and drainage system is described in detail in Chapter 10 - Water Resources, and the potential for erosion for each soil type is described in Chapter 7 – Land Resources.

The erosion control measures recommended throughout the life of the Project are summarised in Table 5-2.

5.8.7 Flood Mitigation

Where required, flood levees will be constructed to minimise impacts of flooding and any potential for release of contaminants to the environment, including protection of the final open pit at the end of mine life from the Maximum Flood level. No major flood levees will be built as a flood protection bund already exists around the pit. The East OEF will have an erosion protection levee built as part of its construction to protect it from scouring. The location and sizing of flood levees are detailed in Chapter 10 - Water Resources**.**

5.8.8 Geotechnical Stability

Rehabilitation activities will incorporate the effective management of any potential risks associated with the geotechnical stability of OEFs, TSF and open pit. It is recognised that the stability of these final landforms is critical to the overall success of rehabilitation of MRM. Overburden disposal and mine plan designs for MRM will be assessed by qualified engineers and the most appropriate mining and overburden placement methods to ensure the geotechnical stability of working slopes will be implemented.

Based on the topography of the Project area, it is unlikely that there will be any landslides resulting from natural causes. Disturbance to waterways has the potential to create land slippages and mining activities also have the potential to create minor localised slippages within the open pit.

At the end of mine life, an assessment report will be undertaken by a professional engineer covering the geotechnical issues and erosivity of the proposed final landforms, including the final open pit, to demonstrate long-term landform stability.

Table 5-2 Project Erosion Controls for Mining Activities

Area	Control Measure
Cleared Land	• restrict clearing to areas essential for the works • windrow vegetation debris along the contour • minimise length of time soil is exposed • divert run-off from undisturbed areas away from the works • direct run-off from cleared areas to sediment traps
Exposed Soils	• minimise length of time subsoil is exposed • direct run-off from exposed areas to sediment traps
Overburden Emplacement Facilities	• direct all run-off from OEFs to sediment traps or PAF containment dams • ensure NAF waste material is placed on final external batters • control surface drainage to minimise the formation of active gullies • use soil and rock to armour external batters • direct run-off from rehabilitated areas to sediment traps
Open Pit	• re-grade treatments for erosion and geotechnically unstable areas • use of rock armouring to control erosion • apply seed and fertilizer as necessary to ensure rapid re-establishment of pasture in the alluvials zone

Dams	• leave useful water storages to support post mine land use
	• rehabilitate any dam not required post mining by:
	  • re-grading embankments where applicable to meet post-mine land use objectives
	  • capping any residual harmful material
	  • replacing topsoil
	  • ripping on the contour
	  • seeding

Haul Roads	• longitudinal drains on either side of the road • cleaning of drains at set intervals

5.9 Decommissioning

Decommissioning will occur at the cessation of mining operations but prior to formal mine closure and will involve the removal of mine infrastructure and services, and the remediation of all disturbed areas.

The primary post-mining objective will be to stabilise disturbed land and make all areas safe. After this is achieved, secondary values, including the promotion of ecological values and the enhancement of local economically sustainable development industries such as native bushland, grazing and tourism will be promoted. Consultation with government and local stakeholders is expected to continue over the next five years for the development of post-mining land-use strategies for the Project.

Decommissioning and rehabilitation of the Project will be undertaken in a manner that prevents environmental harm and risk to human health. Any dangerous goods or chemicals will be removed from site and any contaminated areas will be managed and rehabilitated to ensure that there is no danger posed to the wider public.

Controls to protect the community include warning signs, fencing-off potentially hazardous areas and safety rills to prevent travel over embankments. The risk to community safety will be low, given that the area will be located on privately owned property and in an isolated area.

A primary risk for the decommissioned mine site is unstable areas causing off-site impacts. It is expected that the TSF, OEF, hardstand areas and open pit may fall into this category and thus their rehabilitation will focus on minimising potential instability.

Different strategies will be used to rehabilitate contaminated and clean areas that both meeting the post-mining criteria and leaving a sustainable post-mining land use that does not require continual post-mining management. It is envisaged that weed control, fire control, monitoring, pump maintenance and fence maintenance will require post-mining attention.

A Mine Closure Plan has been developed and is found in Appendix E1 – Mine Closure Plan**.** However, due to changing circumstances with stakeholders, government and the Project, consultation will continue.

5.9.1 Decommissioning Criteria

Decommissioning criteria for the Project are aimed at reaching long-term stability of the site and the minimisation of off-site impacts. The decommissioning criteria have been derived from Proponent commitments, the generic set of criteria developed by the Department of Resources Energy and Tourism (DRET) as guidelines for the mining industry in the Northern Territory.

The Proponent's closure aim is to ensure that the site is left in a condition which reflects government and community expectations. This will be achieved with adherence to the following criteria:

- compliance
- physical safety
- low risk to biota
- stability
- rubbish clean-up
- revegetated or otherwise improved
- visual amenity
- heritage and archaeological sites.

Compliance will be achieved on specified criteria above, by the methods displayed within Table 5-3:

Table 5-3 Decommissioning Criteria and Methods to Achieve Compliance

Objectives	MRM Proposed Criteria	Measurement Tools
Compliance		
Australian and NT Government closure requirements met	• Maintaining a commitments register • Maintaining a commitments action plan	• Audits of register and action plan
Landforms and Rechannels		
Channel – construct a stable landform and host native vegetation	• Engineering design promoting stability, minimal erosion, minimal downstream impact and sustaining native vegetation	• Erosion reports • Annual monitoring vegetation structure, richness and cover via aerial photographic data and field work in June • Factors to be assessed include the condition of the plot; rock movement, erosion and the presence of debris; numbers and species of tube stock and measures of survival and growth; extent of seed regeneration; vegetation growth; and weed composition
TSF – construct a stable landform and host native vegetation	• Engineering and capping designs promoting stability, minimal erosion and seepage with acceptable run-off quality	• As built design reports • Survey plans • Stability/erosion monitoring reports • Regular monitoring of performance of capping materials and depth; topsoil cover (i.e. evidence of topsoil erosion and loss); vegetation cover species and resilience; integrity of constructed drainage, erosion and silt accumulation in constructed drainages, net sediment loss rates tonnes/ha/year); sediment quality, and runoff quality

Table 5-3 Decommissioning Criteria and Methods to Achieve Compliance (cont)

Objectives	MRM Proposed Criteria	Measurement Tools
OEF – construct a stable landform and host native vegetation	• Maximum height 80m • Engineering and capping designs promoting stability, minimal erosion, and seepage with acceptable run-off quality. The design will ensure that limited rainfall and oxygen infiltrate the facility • Block modelling of waste rock will ensure that Acid Mine Draining (AMD) material are encapsulated	• Cover trial reports • Annual monitoring • Material movement schedule with matching OEF placement schedule
Bing Bong Spoil	• Stable design hosting native vegetation with similar values to local ecosystem	• Annual stability/erosion, flora and fauna monitoring of internally drained spoil
Physical safety		
Employee safety during infrastructure removal	• Safety Management Plan • Risk assessments	• Audit reports • Inspection reports
Evacuations and subsidence to be rendered safe	• Inspection to demonstrate all excavations are complete. • Geotechnical stability • Risk assessment will include subsidence, however it is not expected • Shafts rehabilitated in a safe and stable manner	• Inspection report • Geotechnical stability report • Risk assessments • Shaft inspection
All drill holes, shafts and other openings to be made safe. securely capped, filled or otherwise	• All openings to be capped, filled or otherwise made safe	• Inspection and expense records • Capped drill sites will be mapped
Access of people and livestock to be restricted as appropriate to site conditions	• Agreed dams, roads and infrastructure will remain and be maintained by the post mining landowner. All other disturbance will be rehabilitated • Tailings storage facility, the open pit and Barney Hill hardstand areas will be fenced and a permanent fire break established • Underground entrances will be sealed permanently as approved	• Inspection records • Fencing contracts • Documented agreements with landowners

Table 5-3 Decommissioning Criteria and Methods to Achieve Compliance (cont)

Objectives	MRM Proposed Criteria	Measurement Tools
Low risk to biota		
The quality of water leaving the site should be such as to cause no significant deterioration of water quality to the downstream beneficial use(s) of water quality objectives of the receiving waters declared under Section 73 of the *Water Act 1992*	• Surface water will be monitored until relinquishment (eight years after proposed closure) • Contaminated areas will be capped with a capillary layer and erosion resistant material, or disposed of in the tailings storage facility or placed in the open pit, with clean material replaced and rehabilitated • Trials will be undertaken to confirm capillary layer, surface cover material and revegetation requirements • The refuse facility will be capped and revegetated • No contaminated areas will be left uncovered. • Sediment traps will be utilised to minimise off-site suspended solids being discharged off-site where appropriate	• Risk assessments • Management plans • Audits • Inspections • Post closure water and rehabilitation monitoring records • Trial results and reports
Production of groundwater at the TSF should be minimised, and water quality trends should indicate improvement	• Groundwater quality will improve within specified guidelines (long-term results) • An approved groundwater monitoring program for mine relinquishment will be implemented	• Groundwater monitoring program • Monitoring results
Production of polluted surface water (e.g. metals, acid or caustic runoff from pits, stockpiles, waste rock or tailings should be minimised and controlled and trends should indicate improvement	• Mine surface water quality will improve within specified guidelines (long-term results) • An approved surface monitoring program for mine relinquishment will be implemented • All sources of low quality water will be capped with an appropriate mitigating capillary layer, and erosion reducing material, and revegetated	• Surface water monitoring program. • Monitoring results • NAF, PAF and capping scheduling for the OEFs Inspections • Rehabilitation monitoring results

Table 5-3 Decommissioning Criteria and Methods to Achieve Compliance (cont)

Objectives	MRM Proposed Criteria	Measurement Tools
TSF Seepage post closure will have no environmental impact on water quality or biota	• Designed to ANCOLD criteria • Capped and rehabilitated • Install clay liner in Cell 3 • Install liner in Cell 4	• As built design reports • Rehabilitation monitoring reports
Continuing active intervention should not be required for site water management	• Ongoing site water management not required allowing for full availability of water for local values • Groundwater contamination will not impact on the potential post-mining land use and will pose no risk to biota following rehabilitation	• Groundwater monitoring
All sources of radioactivity should be decontaminated, removed or encapsulated such that levels of radioactivity on site conform to contemporary criteria	• Radioactive measuring equipment will be disposed off-site in an approved manner	• Removal records
Stability		
All disturbed areas should be stabilised, including the construction of stable landforms	• A stable landform will be characterised by minimal erosion and presence of a stable and increasing vegetative cover. These features will be measured via visual interpretation and ground data	• Erosion monitoring • Rehabilitation monitoring
Drainage should be consistent with post-mining land use (re-establishment of natural drainage patterns where appropriate)	• Drainage supports the post mining land use of establishment of native vegetation and stable landforms	• Annual mine plan

Table 5-3 Decommissioning Criteria and Methods to Achieve Compliance (cont)

Objectives	MRM Proposed Criteria	Measurement Tools
Erosion by wind and water should be at least comparable with background levels of the area	• Local deposition gauges are used to detect dust emissions • Visual appraisal will be used to determine areas of excessive water erosion • Where identified, rock armouring will be placed to mitigate water forces	• Dust monitoring • Erosion monitoring • Surface water monitoring
Water storage's left in situ should be stable (providing and adequate margin of safety which is dependent on material stored) against floods, erosion and subsidence	• Flooding, erosion, wall failure and subsidence will be assessed for risk (by an independent panel) and modelled. These results will be reported and acceptable risk level agreed	• Modelling results • Risk assessment report
Clean up		
Facilities and equipment to be decommissioned and removed unless they are to remain for an agreed future use	• This criterion is core to the other closure elements. Consultation of closure criteria and practices will be undertaken during the mine life and at closure	• Documented agreement with landowners
No rubbish should remain at the surface, or at risk of being exposed through erosion	• Domestic and industrial rubbish has been disposed of according to the waste management plan. Rehabilitation works will continue to ensure that there is no remaining evidence of domestic and industrial rubbish • All drill sumps rehabilitated and rubbish and cuttings removed or buried • All holes capped • Water management structures to stabilise waste related disturbance will be implemented if required • The position of buried hazards will be mapped and physically marked	• Waste Management Plan • Audits • Inspections

Table 5-3 Decommissioning Criteria and Methods to Achieve Compliance (cont)

Objectives	MRM Proposed Criteria	Measurement Tools
Revegetated or otherwise improved		
Available disturbed areas will be progressively rehabilitated	• Annual plan and budget •	• Rehabilitation reports
Salts will not rise through the cap profile to the surface on tailings	• Profile sampling will be conducted to determine the extent of leaching through the profile over time in rehabilitated areas until rehabilitation criteria have been met • The data should show that a balance of salt level within the capillary layer had occurred on rehabilitated areas and that salt levels do not impact plant establishment • Trials will be established to confirm this and the subsequent establishment techniques •	• Sampling records • Trial reports
The establishment of a revegetated, stable landform with equivalent values as surrounding ecosystems	• Seed mix, collected locally, will be representative of surrounding ecosystems	• Rehabilitation monitoring • Soil monitoring • Seed mix
Vegetation should be able to survive the local fire regime	• Native species known for their fire tolerance will continue to be used in seed mixtures • Permanent firebreaks will be established	• Seed mix • Fire Management Plan • MMP
The introduction and spread of weeds and pests should be prevented and an active program in place to minimise their presence	• MRM has a Weed Management Plan to manage weeds on the Mineral Leases. The post- mining landowner will be responsible for weed management once the lease has been relinquished	• Weed Management Plan •

Table 5-3 Decommissioning Criteria and Methods to Achieve Compliance (cont)

Objectives	MRM Proposed Criteria	Measurement Tools
Visual amenity		
Long-term visual impact should be minimised by creating acceptable landforms, preferably compatible with the adjacent landscape	• Visual impact of landforms like the OEFs and TSF will be minimised through the establishment of vegetation on disturbed areas as indicated by visual interpretation of orthophotos and ground monitoring data	• Seed mix • Construction designs
Heritage and archaeological sites		
Condition of heritage and archaeological sites should meet the requirements of relevant authorities	• No significant archaeological sites exist on the disturbed areas. • Traditional owners will be consulted in the decommissioning plan where there will be opportunity to discuss post-mining management of identified sites • Historical sites will be determined in consultation with stakeholders and will largely reflect the finalised post-mining land use	

5.9.2 McArthur River and Barney Creek Channels

The McArthur River Channel is approximately 5.5 kilometres long and is the main channel to direct the natural McArthur River away from the ore body situated in the vicinity of the open pit.

The Barney Creek Channel is approximately 2.5 kilometres in length and was re-channelled to enable the construction of the Mine Levee wall. The haul road crosses the Barney Creek Channel via two bridges which are used for access to the North Overburden Emplacement Facility.

Riparian and riverine species will be used to revegetate the channels. These will either be planted as tubestock or direct seeded (or both). Other locally occurring species may be used after further site investigation. (refer to Table 5-1 for species list).

Tube stock propagation and planting will focus on large, long lived tree species which are unsuitable for direct seeding. This includes *Barringtonia actangulata* a key species for the McArthur River Channel area and *Nauclea*. The two grass species will be similarly propagated as tube stock. Tree seeding will therefore focus on *Melaleucas, eucalypts* and shorter lived *Acacia* species. Species will be planted on the slopes in similar locations to where they occur naturally.

Vegetation growth will be dynamic for at least 10 years as natural recruitment occurs after flood flow and as direct-seeded stands mature. Proposed monitoring will highlight the evolution of the new ecosystem over time.

In addition to slope revegetation it is also proposed that, where practical, vegetation be established along a 20 m wide strip above the batter slopes (as the extension of batter slope vegetation) assisting the transition of slope vegetation into surrounding undisturbed vegetation.

To facilitate faster growth rates and better survival rates over the dry season MRM are employing a water sled with irrigation sprinklers to ensure a more successful rate of germination for direct seeding. Water will be obtained from the channel itself and thus will be recycled.

Weeds will be controlled with non-soil-residual herbicides. The need for a fertilizer application to maintain growth will be assessed as vegetation develops.

The McArthur River Channel and Barney Creek works are protected by rock lining. Rock chutes have been designed in several areas along both channels limiting the amount of clearing required. All revegetated areas will be protected with stock proof fencing (with regular access gates for maintenance) until trees mature and are safe from damage.

Monitoring will measure the effectiveness of revegetation works in the channels as well as the extent of natural regeneration and the characteristics of the evolving ecosystem.

5.9.3 Overburden Emplacement Facilities

Mined overburden from the open pit operations will be stored at the OEFs. In the North OEF, this will consist of contaminated PAF material being encapsulated within NAF material in dedicated cells to reduce any deleterious effects on the receiving environment through leaching. In order to provide a rehabilitated land form that achieves the final land use criteria, the North OEF will require a cover which limits the percolation of water such that downward migration of water to the PAF cells are minimised.

Cover percolation will be reduced by constructing an evapotranspiration (ET) cover that will use water balance components to minimise percolation. The ET cover relies on the properties of the soil to store water until it is either transpired by vegetation where soil moisture is drawn into the plant roots and conveyed up into the leaves or evaporated by the soil surface.

The ET cap on the North OEF and the NAF waste rock in the other OEFs will be contoured and rehabilitated progressively.

The establishment of vegetation on the outer berms will improve the overall aesthetics of the OEFs and will also reduce post-rehabilitation maintenance costs by minimising erosion to these areas. Any significant erosion areas at the OEFs will be identified through a post-rehabilitation monitoring program and repairs carried out, as required.

Rehabilitation and decommissioning of the OEFs is discussed in more detail in Appendix E2 - Overburden Emplacement Facility Management Plan

5.9.4 Tailings Storage Facility

The TSF will be rehabilitated by reprofiling and construction of a cover as discussed in more detail in Appendix E1- Tailings Storage Facility Management Plan.

The effect of this rehabilitation strategy will be to eliminate as far as possible additional water input into the tailings. In this way the head of water available to influence the seepage will be limited to what is in the tailings and will reduce over time as the seepage water is removed by the recovery bores.

5.9.5 Final Open Pit

The final pit foot print will be 210 hectares. The pit will be stabilised, with rock armour placed over the alluvial materials where water will flow back into the pit. The open pit void will be fenced off and allowed to flood. The open pit will be left to fill naturally from groundwater inflows, direct rainfall, surface water flow off the internal slope of the OEFs surrounding the pit, together with TSF seepage pumped to the open pit. No surface water inflows to the open pit from the McArthur River will occur.

Evaporation of the pit water will prevent the pit from filling to the regional groundwater level. Modelling by URS (2005) suggests a stabilisation in the water balance of the open pit over time whereby the inflow rates of groundwater seepage and direct rainfall will be equal to that of evaporation. An advantage of this scenario is that the pit will never overflow as a result of seepage inflow and direct rainfall alone. This is detailed more in Chapter 10 – Water Resources.

Flood modelling of the McArthur River Channel and the open pit suggests the flood protection bunding currently in place around the open pit will not be breached in a 1 in 500 year flood event. As this is a very significant flood event and no flooding is expected to enter the open pit, this closure option is expected to present the least risk.

The open pit walls will contain exposed PAF material which could influence the pit water quality. A scheduled drilling program will improve the geochemistry knowledge of PAF predictions in the open pit walls to determine the influence on pit water. Pit water quality modelling was undertaken as part of the open pit project EIS in 2005. The closure scenario of having the pit fill naturally from groundwater inflows and direct rainfall was modelled – that is, no surface water inflows to the pit from the McArthur River will occur. This is the current closure scenario proposed in Appendix E4 – Mine Closure Plan.

An advantage of this scenario is that the pit will never overflow as a result of seepage inflow and rainfall alone. A disadvantage is that water quality in the pit will continuously decline as a result of concentration by evaporation, with sulphate concentrations (and concentrations of other ions and metals) gradually increasing with time. The 2005 modelling showed that sulphate concentrations would increase to approximately 2,800 mg/L after 33 years, and be in the order of 4,900 mg/L after 99 years. Pit water quality is expected to be similar for the Project. As mentioned previously, further geochemical investigations will verify the final pit wall geochemistry, which is expected to be largely acid neutralising because of abundance of a large dolomite rock unit.

5.9.6 Levee Wall

The mine levee wall was constructed with a clay core and an external 1-in-4 batter slope constructed with NAF material. Rehabilitation of the mine levee wall will be by direct seeding.

5.9.7 Exploration Areas

Any exploration areas will be rehabilitated in accordance with Northern Territory legislative requirements.

The exploration holes on the outer leases will have their collars removed to allow capping with concrete plugs. The tops of the plugs will be further concreted and topsoiled to prevent water ingress, access and erosion to occur. These areas will be seeded and returned to their predetermined post-mining land use.

The exploration holes near the open pit will be temporarily capped with concrete plugs as they will be within the area of the expansion of the Project over the mine life.

The construction and rehabilitation of exploration sumps and drill pads will meet the following requirements:

- all sumps and drill pads have topsoil removed and stored in appropriate locations to better facilitate the rehabilitation process and prevent erosion of the valuable topsoil resource
- sumps are no bigger than 3 m by 4 m in length and 2 m in depth and are lined if they contain contaminated water to prevent seepage and erosion at the site
- a 500 mm layer of inert material is placed over the sumps if drill material is placed into the sump
- drill pads will be deep ripped in order to promote growth and allowed to rehabilitate naturally.

5.9.8 Hardstand Areas

The hardstand areas at the Project include the stores, electrical and metallurgical laydown areas, and borrow pits. Hardstand areas which are not located on overburden or in contaminated areas will be topsoiled, ripped and seeded. Some minor profiling may be required to improve stability and drainage.

5.9.9 Chemical Contaminated Sites

Sites which have been contaminated during the life of the mine will have contaminated soils and aggregates removed and placed into the designated area at the TSF. A 500 mm layer of ungraded material will be placed on top of the sites, and then they will be topsoiled, ripped and seeded. Potential contaminants include tailings, pyritic material, ore, hydrocarbons, reagents or other chemicals.

5.9.10 Roads and Access Tracks

There are approximately 5 km of sealed roads and 25 km of access roads at both the mine site and Bing Bong. At the end of mine life, access haul roads will be rehabilitated to blend in with the surrounding landform, or left behind if required by the landowner. This will be agreed at a time closer to the planned closure. However, for the purposes of financial calculations within the Mine Closure Plan, it will be assumed that most roads will be removed, with some remaining for post-mining requirements. Roads around the TSF and mine site hardstand areas will remain and be compacted to provide a permanent firebreak. Bitumen roads around the mine accommodation camp and main road will be ripped and topsoiled.

5.9.11 Underground Workings and Associated Infrastructure

The former underground workings that will be mined through as part of the Project will be transformed into the open pit. Further underground workings will remain beyond the final pit limits. No remedial actions will be required for these as they will be flooded as the pit is inundated.

5.9.12 Infrastructure

Infrastructure on site will be sold and removed with the exception of selected roads, the airstrip and the bridges. It is anticipated that these items will remain and will be utilised for future land assets by the pastorali\st.

Infrastructure such as the mill and crushing facilities will be dismantled and removed off site. All hydrocarbon storage tanks will be removed off site.

Where permanent footings exist they will be removed and the material placed either in the open pit or at the OEF site.

5.9.13 Power Station

The Proponent does not own the power station on-site so decommissioning will be the responsibility of the contractor who operates them. The power station will be decommissioned according to the post-mining land use. Unless there is a post-mining use for power, the power station will be dismantled and relocated at the end of mining activities. The site will then be topsoiled, ripped and seeded.

5.9.14 Gas Pipeline Corridor

The Proponent does not own the gas pipeline, which will be decommissioned as approved by the Northern Territory Government. However, if there is a requirement for the pipeline post-mining, it may be preserved internally with nitrogen.

5.9.15 Mine Accommodation Camp

Transportable buildings and equipment will be sold and the area rehabilitated. Any remaining structures will be dismantled and buried. Once all infrastructure is removed the area will be ripped and allowed to rehabilitate naturally once a suitable seed mix has been applied.

5.9.16 Fences and Groundwater Bores

All fences and groundwater bores not required after closure will be removed. Fences required by McArthur River Station to exclude stock from rehabilitated areas will be retained.

5.9.17 Airport

The fuel storage area and small building associated with the airport will be decommissioned and removed, and the area rehabilitated. Shell will decommission and remove the fuel storage tank.

The airstrip will not be rehabilitated as it is assumed that as it is currently the third largest airstrip in the Northern Territory, there will be post-mine interest in this facility.

5.9.18 Water Holding Structures

Contaminated material in storage ponds such as the Anti-pollution Pond, Concentrate Runoff Pond, Pete's Pond and Van Dunks will be removed, placed in the TSF or final void and the ponds back filled or the walls levelled. Other dams such as Emu and Donkey dam will be retained for pastoral use. The Turkeys Nest Dam constructed for the storage of bore water required for the civil works will remain as a livestock dam. The removal of pipe work will be negotiated with the landholder.

All of the sediment dams and PAF containment dams at the North OEF will remain.

5.9.19 Refuse Facility

Uncontaminated general wastes are currently disposed of at the site refuse facility which is located above the 1 in 100 year flood level. The decommissioning of the refuse facility will be in accordance to the *Guidelines for the Siting, Design, and Management of Solid Waste Disposal Sites Northern Territory (2003)*.

5.9.20 Bing Bong concentrate storage and ship loading facility

The Bing Bong concentrate storage and ship loading facility (Bing Bong) will be of future value for the Northern Territory Government, tourism, and fishing, or as a military or commercial cattle port. Despite this, for the purposes of closure cost calculations, it has been assumed that the area will be decommissioned to the same level as the mine site.

All above-ground infrastructure will be removed and disposed of, or sold, and the topography will be re-contoured to drain all possible areas through the Bing Bong Run off Pond. As rehabilitation would destroy the post-Project values of the port and create additional unnecessary disturbance, the dredged channel will be left as is. Any significant residual contamination will be dredged and disposed of appropriately.

Roads will remain only at the request of the post-mining landowner. However, for the purposes of financial closure cost calculations, the access road will not be decommissioned to allow the local community access for fishing. Sealed and unsealed roads will be rehabilitated as per the rehabilitation plan.

Contaminated material will be cleaned out of both of the runoff ponds, which will remain as the site catchment and discharge point. The pond will collect contaminants and sediments from erosion. It is not intended that these pond be used for post-mining pastoralist values, as cattle are not currently grazed in the area. If required, the ponds will be cleaned out for the first three years after the area is rehabilitated.

Contaminated soil will be disposed of at the mine site and the areas ripped and seeded with native species. Other surface areas that are disturbed and not used for roads or hardstand will only require ripping, fertilising and revegetation.

The Bing Bong dredge spoil over the last several years had been rehabilitated to an extent, although due to further dredging, a large area of the spoil was recovered with marine sediment. Rehabilitation of this area now will initially focus on areas close to the Mule Creek Boat ramp, although the end strategy will be to increase water infiltration for leaching purposes and the establishment of native vegetation.

5.10 Mine Closure Requirements

5.10.1 Decommissioning Personnel

A suitably qualified team of personnel will be employed to undertake decommissioning activities. These would include management, consultants, specialist contracts (such as demolition and rehabilitation companies) as well as machine operators for bulk earthworks required on the North OEF. Any management requirements beyond five years (e.g. TSF) would be staffed as necessary.

5.10.2 Monitoring and Caretaking

Following mine closure, an eight-year monitoring program (water, dust and rehabilitation) will be conducted, plus progress monitoring and reporting on meeting completion criteria. It is assumed that the closure monitoring for security and life of mine will be similar. The need for any ongoing monitoring will be reassessed at the end of the eight years.

Rehabilitation will be monitored during operations and after final rehabilitation has been completed, to validate rehabilitation performance and identify any additional work required to meet success criteria. This monitoring will include an assessment of:

- plant establishment, growth, diversity and cover
- evidence and type of erosion.

Rehabilitation performance criteria will be submitted to the Northern Territory Government for review and comment in a rehabilitation management plan. The rehabilitation management plan will at a minimum:

- develop design objectives for rehabilitation of disturbed areas and post-mining land uses across the mine
- specify soil and overburden characteristics for use in rehabilitation
- detail rehabilitation methods applied to different areas of the Project
- identify rehabilitation performance criteria for different rehabilitation areas
- identify rehabilitation reference sites to be used to develop rehabilitation success criteria
- develop a contingency plan for rehabilitation maintenance and redesign
- describe and illustrate end of mine landform design plan and post mining land uses across the Project
- proposed offset protection.

The rehabilitation success criteria developed for the Project may change as research and development findings and monitoring trends of past rehabilitation areas evolve.

5.10.3 Final Site Relinquishment and Infrastructure Handover

Closure criteria are aimed at reaching long-term stability of the site and the minimisation of off-site impacts. Reports on progress towards mine closure criteria will be issued to stakeholders annually and a summary report in year eight. The Proponent will then seek to relinquish the Mineral Leases after this period and hand over infrastructure to the new landholder.