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Rehabilitation, decommissioning and closure

18. Rehabilitation, decommissioning and closure

18.1 Introduction

This chapter describes the potential impacts from the rehabilitation, decommissioning and closure of the Nolans mine site on the surrounding environment. A detailed conceptual mine rehabilitation and closure plan (MRCP) is provided in Appendix W of the EIS.

The TOR for the preparation of an environmental impact assessment issued by the NT EPA for the project provided the following environmental objectives in relation to the rehabilitation, decommissioning and closure of the Nolans mine site:

- *As far as practicable, rehabilitation will achieve a stable and functioning landform which is compatible with the surrounding landscape and other environmental values.*
- *Potential impacts to downstream water quality / potable-water supplies, ecosystems, beneficial uses, environmental / cultural values or human health, associated with closure and rehabilitation of the Project will be identified, and adequately avoided, mitigated and/or minimised.*
- *Rehabilitation of areas impacted by mining, will ensure:*
  - *Health risk to members of the public, including traditional owners, will be as low as is reasonably achievable.*
  - *Members of the public will not receive a radiation dose which exceeds applicable limits recommended by the most recently published, relevant Australian standards, codes of practice, and guidelines.*

This chapter addresses the potential impacts resulting from the closure of the Nolans mine. This includes closure timeframes, risks of ongoing environmental, social and/or economic legacy, natural events, including earthquakes, rainfall events, fire and flood, as required in the TOR for the project.

18.2 Approach to mine closure

Planning for rehabilitation, decommissioning and closure for the whole of project has been initiated as a conceptual process and will be refined as the project progresses through detailed design and construction.

The overriding intent of mine closure and rehabilitation is to return the land to as close as is reasonably practical, its pre-disturbance condition. This will be achieved through establishment of a safe and stable post-mining land surface which supports vegetation growth and is erosion resistant over the long-term.

The objectives of mine closure and rehabilitation are:

- To establish a safe and stable post-mining land surface which supports vegetation growth over the long-term
- To return the land, as close is reasonably practical, to its pre-disturbance land use
- To make the site suitable for future leaseholders likely uses for the site.

The Northern Territory DME requires that a post mining land use is discussed with all stakeholders and agreed to by the Department, and that this process should be recorded in the earliest planning documentation for the site.

To date, no commitments have been made by Arafura to third parties in relation to the closure of the Nolans Project. As the project proceeds through the approval process and (presumably) into construction and operation, a mine closure commitments and obligations register will be prepared and maintained that will record progress towards fulfilment of this requirement.

This chapter should be read in conjunction with the Mine Rehabilitation and Closure Plan (MRCP) provided in Appendix W, which details the mine closure domains and describes the key closure landform concepts.

The MRCP is designed to take into consideration the legal obligations, best practice and environmental risks associated with the Nolans mine project.

18.2.1 Post closure land uses and completion criteria

Post closure land use will be balanced, with the target ecosystems and pre-mining land use and land condition identified in the EIS flora and fauna technical reports (Appendix M and Appendix N). Targets for rehabilitation will be native flora species. The target ecosystems will evolve with the post-closure rehabilitation planning and the results of rehabilitation trials.

The final, post-closure land use will be developed and refined through the operating life of the mine. Various factors will influence its development (as described in detail in Appendix W) including:

- Consultation with stakeholders
- Post-Closure Land-use Alternatives Assessment undertaken in parallel with consultation
- Emerging knowledge of the nature of the deposits, and the composition and quantity of waste products and
- Any future changes to mine design.

Completion criteria provide a means of evaluating the successful achievement of the closure objectives. The level of detail of completion criteria will be appropriate to the stage of development. The conceptual closure plan described in Appendix W is submitted pre-approval, and further detail and definition will be added to the criteria during Project design, construction and during operations.

Specific performance indicators will be determined to demonstrate that rehabilitation trends are following the predicted performance, particularly where mathematical modelling is utilised to predict any long term environmental impact. In agreement with the regulators, the criteria may be reviewed and amended in response to operational and post-closure management and monitoring programmes.

18.2.2 Risk assessment

The risks associated with closure, rehabilitation and post mining land use were examined as part of a risk assessment undertaken for the Nolans Project. This process was completed in accordance with the requirements outlined in *Australian Standard AS/NZS ISO 31000:2009 Risk Management* and *HB 436:2004 Risk Management Guidelines*. The methodology for this process is described in Chapter 5 and Appendix F.

18.3 Key closure risks

Table 18-1 summarises the risks arising from the closure of the Nolans mine site and the potential impacts on environmental, social and economic receivers that may arise from this activity. The level of risk is residual risk following implementation of controls. Controls incorporated into the design of the mine site are discussed in Section 18.5 with further mitigation measures required to minimise any residual impacts.

Table 18-1 Closure risks and potential impacts

Potential closure risks	Potential environmental and socio-economic impacts	Level of residual risk (from Appendix F)
Decommissioning and closure		
Unexpected early closure	Unanticipated events could result in unplanned closure before adequate closure and rehabilitation planning and design is in place, resulting in ineffective or incomplete rehabilitation, including: Contaminated seepage Loss of containment of hazardous materials Failure to achieve proposed closure land uses and target ecosystems.	Medium
Insufficient funds / bonds for closure activities	Inadequate closure designs, poor assumptions or failure to recognise impact of changes to operations on MRCP results in insufficient bonds or funds on closure; causing delays to effective rehabilitation and potential ongoing environmental hazards.	Low
Operational practice creates difficult to manage waste facilities during closure	Failure of operational process (e.g. neutralisation prior to RSF disposal, maintenance of containment facilities, partitioning of radionuclides) leaves a legacy of difficult to manage waste facilities during closure resulting in: — Impacts associated with rehabilitation failure or post-closure emissions — Costly and complex remediation — Delays to effective rehabilitation — Cost overruns.	Medium
Insufficient cover material available on closure	The lack of availability of suitable low permeability material on site, or prohibitive cost of importing large volumes from elsewhere, prohibits the creation of proposed capping for TSF and RSF preventing long term stabilisation and containment of waste.	Medium
Ineffective closure designs and execution	Closure not implemented satisfactorily due to: Closure designs not being developed to sufficient detail or based on incorrect assumptions; and Poorly managed execution of closure works. This may result in the failure of post-closure landforms and waste containment, extensive cost overruns, delays to relinquishment, damage to reputation.	Medium

Potential closure risks	Potential environmental and socio-economic impacts	Level of residual risk (from Appendix F)
Incomplete removal of infrastructure	Incomplete removal of equipment, structures, hardstand and concrete footings, buildings, water storages created health and safety hazards for future land users.	Low
Incomplete remediation of contaminated sites	Contamination resulting from operations is not remediated to an agreed level, resulting in: • Harm to the health of flora and fauna • Harm to public health including that of future land users and/or • Failure of effective rehabilitation.	Medium
Environmental impacts from closure activities	Closure activities are poorly managed leading to impacts on local communities, flora, fauna, water resources, such as: • Noise and Vibration • Light • Dust • Unnecessary damage to vegetation • Spreading of weeds • Contamination of surface water or groundwater.	Medium
Landscape and ecological rehabilitation		
Rehabilitation failure due to rehabilitation design / execution	Rehabilitation fails to achieve sufficient vegetation to stabilise ground, allow proposed land uses or achieve target ecosystems, due to inappropriate design or execution of rehabilitation, including: • Inappropriate planting strategies, seed mix etc. • Inappropriate distribution growth medium • Inappropriate landform design • Inappropriate post-closure drainage.	Medium
Rehabilitation failure due to post-closure conditions	Rehabilitation fails to achieve sufficient vegetation to stabilise ground, allow proposed land uses or achieve target ecosystems, due to extreme events (i.e. natural events such as bushfires, drought or flood), uncontrolled grazing by wildlife, pests or livestock or unsuitable post closure conditions.	Low
Weed infestations prevent achievement ecosystem targets for rehabilitation	Weed infestations created or exacerbated by operation or closure activities lead to failure to achieve ecosystem targets for rehabilitation.	Low

Potential closure risks	Potential environmental and socio-economic impacts	Level of residual risk (from Appendix F)
Failure of recovery of fauna populations including those of threatened species, to recover to pre-project levels	Failure to achieve fauna habitats within target ecosystems due to: • Weed infestation • Wildlife ingestion or exposure to radioactive due materials to airborne deposition of dust or waterborne sediment • Increase in pest animal species (cats, rabbits, foxes, rats, mice) • Wildlife ingestion or exposure to supernatant material in pit lake.	Low
Post-closure releases or emissions		
Seepage of site contaminants impacting surface and to groundwater quality	• Seepage from site contamination, TSF, WRD and RSF causing loss of surface and groundwater quality • Risk of post closure impacts on groundwater quality from WRD seepage is low. TSF tailings seepage composition is expected to mirror that of the WRD and are also not expected to result in adverse groundwater impacts, particularly given the liner systems proposed (below) • Leaching from land contaminated during operation and from an on-site landfill could result minor localised in release of harmful material if not correctly rehabilitated • Existing groundwater has elevated levels of metals, salt and fluoride and if expressed to surface and allowed to concentrate through evaporation may result in waters with potentially harmful concentrations of salt, metals and radionuclides.	Medium
Contaminated runoff	Low rainfall and very high evaporation rates mean that site drainage is ephemeral and impacts on surface water quality will only occur during flood events when sediment levels will naturally by elevated and dilution of harmful contaminants. In these instances, the closed site becomes an ongoing source of surface water pollution, as a result of: • Accelerated erosion and sedimentation resulting from unstable soils and landforms or failure to contain hazardous materials • Seepage from waste facilities and concentration by evaporation at surface.	Low
Dust	Dust emissions caused by post-closure wind erosion and transport of wind-borne material may cause: • Exposure of wildlife, livestock and humans to toxic metal compounds • Exposure of future users of the site and local communities to fine particulate dust (TSP and PM10) with impacts to human health • Vegetation dieback from dust deposition • Degradation of surface water quality • Nuisance dust for surrounding communities.	Low

Potential closure risks	Potential environmental and socio-economic impacts	Level of residual risk (from Appendix F)
Radiation from post closure sources	The credible consequence to human health and safety of public located at nearby off-site receptor, is the potential for measurable increase to radiation exposure, up to 1 m/Sv per year. Exposure to radiation from post-closure sources may occur through the following routes: direct irradiation, inhalation or ingestion.	Low
Long-term Sustainability		
Long term landscape instability	Rehabilitated landscape experiences long term higher erosion rates, reduced vegetation cover and slope instability reducing the life of waste cover systems leading to exposure and mobilisation of hazardous waste materials. Exacerbation by long term climate change resulting in more frequent and extreme storm events droughts and bushfires.	Low
Groundwater recharge rate is slower than expected	Overuse of groundwater during operation, changes to the groundwater regime caused by drawdown from evaporation at pit lake, and / or changes to recharge rates due climate change result in slower than predicted aquifer recovery. This could result in: • Decline in availability of water to ecosystems, including riparian vegetation associated with Day Creek with downstream impacts to Lake Lewis • Loss of future availability of water resource from the Southern basins borefield • Water table drawdown in the Ti Tree or basins associated with Alice Springs water supplies from the cumulative effect of the Southern basins borefield and mine dewatering • Ongoing impact on water dependant cultural heritage sites from dewatering.	Medium
Long term risks from hypersaline pit lake	Contaminants in groundwater are concentrated by evaporation from the pit lake post closure, resulting in elevated concentrations of harmful materials and then become mobile through: • Animal ingestion • An extreme event resulting in a flood release • An unexpected increase in hydraulic conductivity (e.g. preferential pathways or large fractures not identified during initial assessment) • A density-driven flow where sinks leak into surrounding aquifers and offer a potential pathway.	Low
Stakeholder and social impacts		

Potential closure risks	Potential environmental and socio-economic impacts	Level of residual risk (from Appendix F)
Public access to harmful areas of Nolans site during and post-closure	Unauthorised site access / security breach during closure, leading to exposure of the public to hazards and risking ill health, injury or death. Plant and/or equipment contaminated with ore or process materials leaving the site while still contaminated with radioactive or other hazardous material resulting in off-site radioactive or chemical contamination resulting in harm to the public.	Medium
Failure to agree post closure land use	The future uses proposed by the MRCP are not accepted by DME or stakeholders resulting in delays to approvals.	Low
Failure to achieve approved post closure land use	Post-closure site does not conform to regulator and stakeholder expectations for land-use, leading to DME not accepting relinquishment and associated rehabilitation costs and ongoing liability.	Low

18.4 Closure implementation

The Mine Management Plan (MMP) will establish a system by which environmental impacts are managed during operation, including maintaining the site so it can be closed and rehabilitated practicably and without creating additional environmental impacts.

Key elements of operational management that will contribute to closure are:

- Acid Metalliferous Drainage Plan (Appendix L).
- Process Plant Process Controls, especially multi-stage neutralisation process (pH control);
- A Tailings Management Plan for tailings and residue deposition to support closure will include:
- Site management plans (Appendix X) including the ESCP, Weed and biodiversity Management Plans.

18.4.1 Closure and rehabilitation implementation timetable

Table 18-2 provides an indicative timeline of the phases of closure and rehabilitation planning, implementation and monitoring. The program is provisional and may be subject to change resulting from a wide range of potential factors. The program will be reviewed and updated regularly during the life of the project.

A number of pre closure trials and investigations will be carried out during the operational life of the mine, and the results will be used to inform final landform design and rehabilitation proposals. Trials will include:

- Progressive Rehabilitation trials
- Rehabilitation and closure materials
- Tailings Storage Facility Covers and Rehabilitation
- Waste management
- Geochemical studies
- Radiological testing
- Groundwater Resources
- Long Term Pit Lake Behaviour
- Ecology and Weeds and
- Soil Contamination.

Table 18-2 Closure implementation timetable

Phase	Timetable	Summary of activities	Closure Plan	Closure and Rehab Designs	Closure Costs
Approvals	Pre-operation	Initial Closure Planning and Design.	Preliminary MRCP and Initial stakeholder engagement and Post-Closure Land-use Alternatives Assessment.	Closure Concept (Appendix W).	Conservative preliminary closure costs prepared before operation.
Operation	1st year of operation	Detailed Closure Planning and Design.	First Draft detailed MRCP First Draft detailed Care and Maintenance Plan and Stakeholder agreed post closure land uses.	Outline closure design and Conservative waste storage to cope with early closure.	Prepare robust closure costs estimate in the first year of operation.
	43 years based on current LOM	Progressive rehab of TSF, RSF, WRD; and Vegetation and cover trials.	Annual review of MRCP; Trials, investigations and monitoring; and Regular review of risk assessment and MRCP.	Annual review of closure and rehab designs; Progressive rehabilitation; and Iterations to designs with new innovations in closure design emerging data and amendments to mining plans and activities.	Annual review of costs in response to updated designs and MRCP.
Pre-Closure	5 years pre- closure	Seeding of closure vegetation; Develop tender documents and procure contractors for closure activities; and Pre closure surveys	Final detailed closure plan; Pre-closure surveys; and Closure Waste Management Plan.	Finalised closure design.	Finalised costs.
Decommissioning and Closure	2 years post closure	Capping / covering of TSF, RSF, WRDs; Removal of evaporation / event ponds; Removal of project infrastructure components; Remediation of contaminated land;	Full implementation of MRCP; Annual review of MRCP; and Audit of closure completion.	Designs implemented; and Audit of design implementation.	

Phase	Timetable	Summary of activities	Closure Plan	Closure and Rehab Designs	Closure Costs
		Creation of closure landforms; and Decommission / closure of borefield.			
Rehabilitation	5 years post closure	Soil conditioning and planting and Weed and fire control.			
Post Closure	10 years post closure	Weed and fire control; and Monitoring and maintenance of rehabilitation areas			

18.4.2 Planning for closure

Responsibilities

The MMP will establish a system to manage environmental impacts during operation, including maintaining the site in a form that can be closed and rehabilitated practicably and without creating additional environmental impacts.

During operation the Mine Manager will have responsibility for the development of the mine closure plan, designs and costs as well as ongoing closure related activities such trials, monitoring, progressive rehabilitation.

Specialised contractors will be used for the decommissioning where required. In the final year of mining, tender documents will be prepared and procurement will be programed for completion before the closure date, so that decommissioning commences as soon as possible after the end of production.

Arafura is responsible for ensuring that there are adequate resources available for rehabilitation, particularly for the premature closure of the mine.

Post-closure maintenance

Where monitoring identifies failure to meet completion criteria or trends that are likely to result in a failure to meet the criteria, the causes will be investigated and if possible, maintenance determined and implemented.

Post-closure reporting

Reports detailing the monitoring results will be issued annually to DME for the 10 year period post closure. The reports and monitoring are to be undertaken by suitably qualified individuals and provided to the relevant governing authorities.

The completion criteria and monitoring programme may change as research and development findings and monitoring trends emerge.

Rehabilitation audit

Prior to the relinquishment a rehabilitation audit will be undertaken to assess the achievement of the completion criteria. The results will be issued to DME who will determine whether the site can be relinquished.

18.5 Mitigation and monitoring

Prior to closure the MRCP (including the following sub plans), will be reviewed to include potential impacts to the environment due to closure activities and update the control measures:

- Air and noise management plan
- Biodiversity management plan (including the pest animal management plan)
- Hazardous substances management plan
- Radiation management plan
- Radioactive waste management plan
- Transport management plan
- Water management plan
- Closure waste management plan

- Weed management plan
- Tailings management plan
- Erosion and sediment control plan
- Operation of an environmental management system including a system for the reporting of spills and maintaining a contaminated sites register and
- Prior to closure the safety management system will be reviewed and updated to include potential hazards and risks associated with closure activities.

18.5.1 Decommissioning and closure

A summary of the mine closure mitigation measures is provided below to address the key risks outlined in is Table 18-1. More detail is provided in Appendix W.

Table 18-3 Closure risks and mitigation measures

Potential closure risks	Potential environmental and socio-economic impacts
Decommissioning and closure	
Unexpected early closure	The site will be designed and operated to be ready for closure iteratively through the operational life of mine.
Insufficient funds / bonds for closure activities	Closure costs will be developed iteratively throughout the operational life of the mine. A bond will be agreed and issued to NT Government, and reviewed annually.
Operational practice creates difficult to manage waste facilities during closure	A waste management plan will be developed prior to closure which will identify the waste stream, proposed treatment and disposal destination.
Insufficient cover material available on closure	A preliminary mass balance will be created for the critical volume of the growth medium requirement based on the current mining plan, geotechnical and geochemical data. Clean inert waste rock will be available in significant volumes for closure works. Detailed specifications for closure materials will be developed in a detailed MRCP in the first year of operation.
Ineffective closure designs and execution	Prepare detailed closure designs as part of iterative closure design development program, costing and good practice requirements.
Incomplete removal of infrastructure	Pre demolition surveys and contaminated land surveys of plant and infrastructure will be completed with works undertaken by a suitable demolition contractor. Options for reuse, recycling and waste disposal for used plant will be investigated.
Incomplete remediation of contaminated sites	a process of assessment, remediation planning and design will be implemented prior to closure. An independent audit of the remediated site will be completed.
Health and safety risks to personnel during closure	Prior to closure the health, safety and environmental management systems employed during operation will be reviewed and updated to include potential hazards and risks associated with closure activities and will remain in force while activities continue at the site.
Environmental impacts from closure activities	Prior to closure the mine management plan will be reviewed and updated to include potential impacts due to closure activities.
Landscape and ecological rehabilitation	

Potential closure risks	Potential environmental and socio-economic impacts
Rehabilitation failure due to rehabilitation design / execution	Waste rock dumps will remain on the surface rather than be backfilled into the pit and will be progressively rehabilitated. This is a key component of the rehabilitation strategy for the Project and will be integrated into the MRCP.
Rehabilitation failure due to post-closure conditions	Concept level closure and rehabilitation proposals will include appropriate drainage and erosion control, land management controls (i.e. grazing, fire management) and will employ conservative design. .
Weed infestations prevent achievement ecosystem targets for rehabilitation	Weeds will be monitored and controlled through the mine management plan during the operational phase. A full weed survey of the site will be undertaken pre-closure. The operational weed management plan will be reviewed and updated before closure.
Failure of recovery of fauna populations including those of threatened species, to recover to pre-project levels	Prior to closure, the pest animal management plan will be reviewed and updated to incorporate specific control measures for closure and rehabilitation, including monitoring of feral species numbers around the Nolans site and fauna activity at the pit lake.
Post-closure releases or emissions	
Seepage of site contaminants impacting surface and to groundwater quality	Prior to closure, review and update the AMD management plan to incorporate specific control measures for closure and rehabilitation. Implement a groundwater monitoring program through the closure phase. Prepare detailed closure designs including lining and capping details and management of potentially acid forming waste rock
Contaminated runoff	All water storages and tailings will be designed to an appropriate ANCOLD risk category and relevant design standards for the provision of adequate storage capacity. Sufficient freeboard allowance will be maintained to prevent overflow from TSF or RSF during predictable high rainfall conditions.
Dust	Prior to closure the dust management plan will be reviewed and updated with specific control measures for closure and rehabilitation and implement post closure. The waste rock dump, TSF and RSF will be designed with appropriate containment (cover / capping and liners) and the landform surfaces will be stabilised by re-vegetation.
Radiation from post closure sources	Prior to closure, relevant plans will be updated to incorporate specific control measures for closure and rehabilitation. Suitable containment of waste will be ensured, access to the pit and pit lake will be restricted
Long-term Sustainability	
Long term landscape instability	Past climatic data will be analysed and likely future climate scenarios modelled to identify likely drought conditions to be faced by the rehabilitated site to ensure the proposed rehabilitation systems can cope with a full range of likely conditions.
Groundwater recharge rate is slower than expected	The groundwater model will be recalibrated during the mines operational life and current and potential future users will be identified in advance of closure in order to develop ground/surface water management strategies. Substitute water sources from elsewhere will be provided for existing stock bores if required. Groundwater bores will be monitored during the post closure phase. All project bores will be decommissioned at closure.
Long term risks from hypersaline pit lake	Post closure landforms and drainage will be designed to ensure runoff and seepage directed to the pit is low enough to ensure evaporation of surface water. Inflow to the pit lake will be managed to keep the lake below the surrounding groundwater level, preventing outward flow of groundwater or surface discharge. Model scenarios should be

Potential closure risks	Potential environmental and socio-economic impacts
	run for an appropriate time period (which could be up to 10,000 years), commensurate with the risk of the pit lake, which could be until a geochemical equilibrium is reached.
Stakeholder and social impacts	
Public access to harmful areas of Nolans site during and post-closure	In addition to stakeholder and community engagement during closure, access restrictions and security management will be undertaken. Emergency response procedures, team and equipment will be provided during closure.
Failure to agree post closure land use	Stakeholders will be consulted throughout the life of mine and feedback will be incorporated into the post-closure land-use alternatives assessment.
Failure to achieve approved post closure land use	A continuous stakeholder engagement and communications plan will be developed for informing local and regional communities and other stakeholders of closure planning processes. This will include agreeing on post-mining land uses, closure objectives, completion criteria and implementation strategies.