# CARE AND MAINTENANCE, CLOSURE AND COMPLETION

PHASE 5


Husab mine - Swakop Uranmium
Swakopmund
Erongo
Namibia
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# ACKNOWLEDGEMENTS

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NAMIBIAN CHAMBER OF MINES
One of the publication's joint initiative partners and key stakeholders, is the Namibian Chamber of Mines (CoM).

The CoM is an industry body that aims to effectively promote, encourage, protect, foster and contribute to the growth of responsible exploration and mining in Namibia, to the benefit of the country and all stakeholders.

NAMIBIAN CHAMBER OF ENVIRONMENT
Another of the publication's joint initiative partners and key stakeholders, is the Namibian Chamber of Environment (NCE).

One of the core NCE objectives is to promote best environmental practices, including habitat rehabilitation, and to support efforts to prevent and reduce environmental degradation and pollution. This project aligns to several of the NCE core objectives.

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Case studies supplied:
- Corporate social responsibility
- Rehabilitation

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Case studies supplied:
- Air quality monitoring

TREKKOPJE MINE
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- Restoration trials

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ENVIRONMENTAL COMPLIANCE CONSULTANCY
*Authors of this publication*
Contact details:
+264 81 669 7608
info@eccenvironmental.com

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# FOREWORD

The first two decades of the 21st century have starkly revealed our unprecedented impact on the natural world. The level of impact threatens our very existence. Climate change, biodiversity loss and pollution are at the top of the list. No longer can we do business as usual, with sectors being isolated from one another, and business focusing only on the financial bottom line. We need a new approach that is more holistic, inclusive and responsible. In short, we need a "profit, people and planet" triple bottom line approach whereby companies generate profit for shareholders and national revenue while simultaneously improving people's lives and safeguarding the planet from climate change, biodiversity loss and pollution. This new holistic and responsible approach to business will not necessarily reduce profit but can certainly enhance opportunities, attract discerning investors, increase sector resilience and social acceptance, reduce risk and reputation damage, and leave a nett positive legacy.

This Best Practice Guide applies the new triple bottom line approach to the Namibian mining sector to ensure a lasting legacy for mining companies, the country and her people. From the outset this initiative embraced transparent governance and a collaborative approach which involved the Namibian government – the Ministry of Mines and Energy and the Ministry of Environment and Tourism; the private sector – the Chamber of Mines and its member mining companies; and the environmental civil society sector – represented by the Namibian Chamber of Environment.

Namibia is rich in a variety of mineral deposits such as zinc, gold, uranium and diamonds, some of which are considered world-class. The Namibian Government recognises the importance of prospecting and mining to social and economic development, as expressed in various national development plans. Equally important is Namibia's commitment to ensuring a safe and healthy environment. The Best Practice Guide for mining in Namibia highlights leading practices in social, economic and environmental aspects at all stages of the mining life cycle, namely Exploration, Projects and Construction, Operations, and Mine Closure and Completion. Further, this Best Practice Guide brings together all the regulatory requirements for the mining sector from all government agencies into one reference document, with links to download forms, submit reports, etc. The Guide is available in electronic format, and we would encourage all mining companies to ensure that it is available to their staff, management, boards of directors and investors.

The Namibian mining industry strives to play an active role in sustainable development by implementing world class environmental practices in their operations. Through the implementation of these practices, exploration and mining companies can maintain a good relationship with regulators, lawmakers, investors and the communities in which they operate. This guide is ultimately aimed at assisting the Namibian mining industry to implement their "planet, people and profit" approach as they develop Namibia's mineral resources, by delivering practical mining solutions that are benchmarked against best practices and striving for ever more ambitious legacy impacts.

Finally, the mining sector has taken the lead in Namibia by being the first economic sector to develop such a Best Practice Guide. It is our wish that other sectors follow suit and that, sector by sector, we implement a "planet, people and profit" philosophy and programme of action across Namibia.

Tom Alweendo, MP
Minister of Mines and Energy

MINISTRY OF ENVIRONMENT AND TOURISM
REPUBLIC OF NAMIBIA
2019 11 19
OFFICE OF THE MINISTER
PRIVATE BAG 13346, WINDHOEK

Pohamba Shifeta, MP
Minister of Environment and Tourism

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## DEFINITIONS AND ABBREVIATIONS

| | |
|---|---|
| **AMD** | Acid Mine Drainage |
| **ARO** | Asset Retirement Obligation |
| **CoM** | Chamber of Mines |
| **EIA** | Environmental Impact Assessment |
| **EMA** | Environmental Management Act |
| **EMP** | Environmental Management Plan |
| **IAEA** | International Atomic Energy Agency |
| **ICMM** | International Council on Mining and Metals |
| **KPI's** | Key Performance Indicators |
| **LoM** | Life of Mine |
| **MCP** | Mine Closure Plan |
| **ML** | Mining Licence |
| **MET** | Ministry of Environment and Tourism |
| **MME** | Ministry of Mines and Energy |
| **NMCF** | Namibian Mine Closure Framework |
| **NSW** | New South Wales |
| **SEMP** | Strategic Environmental Management Plan |
| **SENEREP** | The Sendelingsdrif Ecological Restoration Research Programme |
| **TSF's** | Tailings Storage Facilities |

PART ONE

# GETTING TO GRIPS WITH MINE CLOSURE

## 1.1 WHAT IS MINE CLOSURE PLANNING?

The entire process of preparing a mine for the eventual termination of business and developing a preferred future beyond mine completion, is known as mine closure planning. For this context, the definition of mine closure is the process of withdrawing from an operation and meeting company policies, and community and government obligations associated with ceasing production. It is a whole-of-mine process, which typically culminates in tenement relinquishment and includes decommissioning and rehabilitation. Decommissioning, in turn, is defined as the process that begins near, or at, the cessation of mineral production, and ends with the removal of all unwanted infrastructure and services. Some management activities would be required in the post-decommissioning phase, i.e. before final relinquishment of the lease. Mine completion is defined as the phase of mine closure where mining lease ownership can be relinquished.

Closure planning should be integrated into day-to-day operations of a mine and requires both continuous management and technical expertise. Rehabilitation, for example, needs to be done as an ongoing closure activity at a mine and not only as an intervention towards the end of the mining life cycle. Rehabilitation requires continuous prominence to ensure that topsoil storage, backfilling, reclamation, landform design and revegetation form an integrative, progressive approach, as part of a concerted effort to reduce the operation's footprint.

## 1.2 WHY IS MINE CLOSURE PLANNING IMPORTANT?

The main purpose of mine closure planning is to avoid the creation of unintended consequences for a business; to allow methods to be implemented for concurrent rehabilitation; to maximise end land use options, to reduce operating and closure costs; and to protect the reputation of a business, the mining industry and regulators. Post-mining reputation and the implementation of effective and proper closure practices is becoming increasingly important for a company trying to develop new mining projects, as the company's corporate reputation is interlinked with its ability to gain access to resources.

## 1.3 LEGAL CONTEXT OF MINE CLOSURE PLANNING

Although legislation with respect to mine closure in Namibia is implicit and vague, it is implied that every mine in Namibia should have a Mine Closure Plan (MCP) in place. The Environmental Management Act, No 7 of 2007, amongst other things, states that applications for environmental clearance certificates should be accompanied by environmental rehabilitation, restoration, decommissioning and an aftercare plan; financial guarantees to cover the costs that may occur as a result of environmental impacts; as well as financial guarantees to cover the costs envisaged from decommissioning, rehabilitation, reclamation, restoration, and aftercare, based on an approved work plan that is reviewed annually. The regulations of the Act provide clear reference regarding the compilation and enactment of rehabilitation and closure plans. Section 31 of the regulations, particularly, outlines details about the content of a rehabilitation or closure plan.

The Minerals (Prospecting and Mining) Act, No 33 of 1992 stipulates that an Environmental Management Plan (EMP) is one of the conditions of a Mining Licence (ML) (Section 48) and that a licence holder should apply "good mining practices" with respect to environmental protection, natural resource conservation, and the removal of accessory works or other goods that were erected, constructed or brought onto the land for the mining activities (Section 57). Licence holders are obliged to demolish accessory works, remove all debris and other objects brought onto the land, and to take the necessary steps to remediate *"to reasonable satisfaction"*, when mining activities cease (Section 54). As a licence holder, a mine is obliged to notify the Minister of Mines and Energy of its intention to permanently cease mining operations at least six months prior to cessation, 30 days prior to temporary cessation of operations, and 7 days prior to an intended reduction of operations (Section 99). In the event of an unexpected cessation of mining activities or reduction of mining activities, the holder of the licence should inform the minister as soon as possible after the event has occurred.

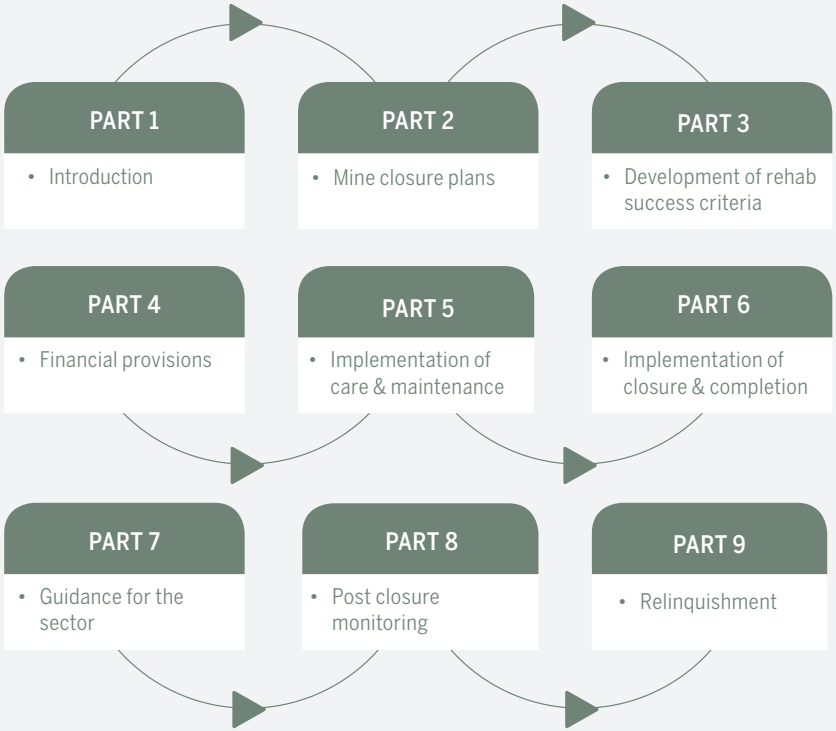
The Minerals Policy of Namibia of 2002 stipulates that mine closure should be properly planned and *"form part of an integrated land use strategy involving engagement with communities"*. It encourages the alternative use of land through rehabilitation, and the use of remaining infrastructure for ongoing economic benefits.

Especially relevant to Namibia, mine closure planning inevitably acknowledges the importance of the principles of public participation in decision-making affecting the environment, the precautionary principle and the principle of preventative action, the principle of 'the polluter pays', the constitutional principles that promote sustainable development and forbid the dumping or recycling of foreign nuclear and toxic waste in Namibia, and the protection of the environment for current and future generations.

## 1.4 HOW TO USE THE GUIDE

Highlighted in the guide are guidelines for navigating mine closure and completion, including care and maintenance, considering relevant legislative and regulatory guidelines, developing criteria, planning for financial provisions, reporting requirements and additional information, to ensure clear and streamlined navigation through the closure and completion phase, in accordance with leading international practices. Illustrated in FIGURE 1 are key issues addressed in each section of the guide.

**[FIGURE 1]**
Navigating through the guide

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PART TWO

# PLANNING FOR MINE CLOSURE

## 2.1 THE NEED FOR A MINE CLOSURE STRATEGY

An essential part of the mine closure planning process is to have a closure strategy in place. All relevant obligations—as manifested in national and international legislation, other relevant legislative and regulatory frameworks, best practices, corporate commitments, and the management systems in place, are covered in the closure strategy of a mine. A closure strategy is based on a closure vision, which states the preferred future or destination of mine closure.

The purpose of a closure strategy is to identify the key closure issues at a mine, to outline specific closure objectives and associated risks, and to identify initiatives and programs to manage these risks by considering the various options, costs and stakeholder expectations. Moreover, the closure strategy provides a holistic and consistent coordinating approach to decommissioning and post-decommissioning management, aligned with the overall business objectives and, ideally, is incorporated in the operational activities of the business.

### THE STRATEGY THUS AIMS TO:

- Enable stakeholders to have their interests considered during the mine closure process
- Ensure the process of mine closure occurs in an orderly, cost-effective and timely manner
- Ensure the cost of mine closure is adequately represented in company accounts
- Ensure there is clear accountability and adequate resources for implementation of the closure plan
- Establish criteria that demonstrate the successful completion of the closure process
- Reach a point where the company has met agreed completion criteria to the satisfaction of the responsible authorities

A closure strategy is prepared for planned mine closure. Unexpected cessation of operations or premature closure is not addressed in a strategy, although many of the principles and activities will be applicable.

## 2.2 THE NEED FOR A MINE CLOSURE VISION

A closure vision describes, in simple language, the desired future and final destination, i.e. at mine completion, whereto the closure strategy aims. Although the vision is defined within a certain context at a certain point in time, it remains valid and relevant to reflect periodically on the applicability of the closure strategy and its objectives and activities against the key closure issues, which may change as conditions change. The vision furthermore helps to guide the evaluation of alternatives and to identify the preferred options by considering also the expectations of stakeholders. Progress on implementation of the closure strategy can thus be measured against the overarching closure vision.

## 2.3 DEVELOPMENT OF A MINE CLOSURE PLAN

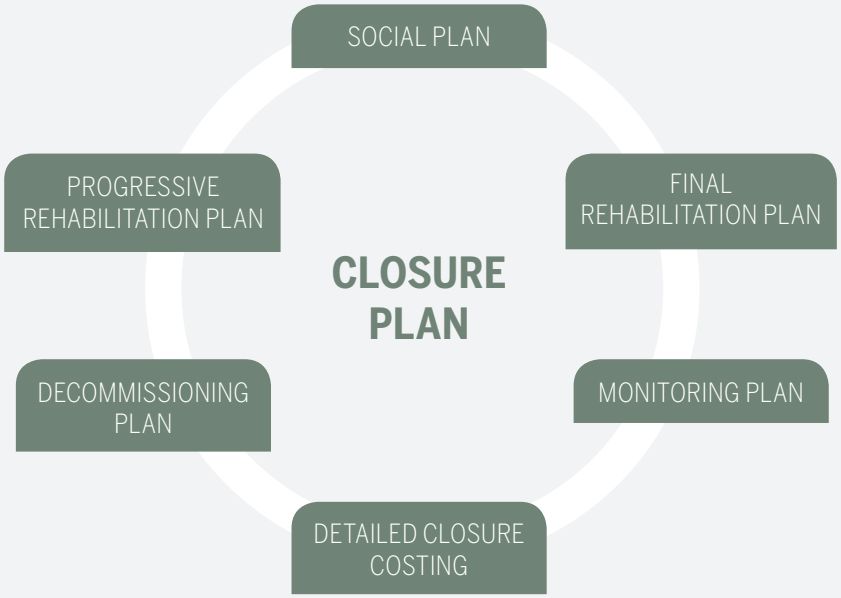
Mine closure planning should start as early as possible during the mining life cycle, preferably as part of the application process for an Environmental Clearance Certificate and subsequently a mining licence. Establishing a MCP before the projects and construction phase of the mining life cycle, enables a mine to realise potential risks early, and to introduce adequate initiatives and programs to manage these risks, to realise cost savings early, and to timeously ensure that planned operations are aligned with stakeholder expectations and the closure vision, strategy and objectives.

The Namibian Mine Closure Framework (NMCF) of 2010 outlines some of the planning objectives relevant to mine closure in Namibia:

- Prepare for the social impacts associated with changes in employment conditions when the mine moves into closure
- Comprehend the risks associated with closure and mitigate risks on communities and businesses that are dependent on the mine, accordingly
- Use responsible and environmentally sound closure practices to protect public health and safety
- Reduce adverse environmental impacts once mining operations cease
- Establish conditions that are suited to the identified post-closure land use
- Establish chemical, ecological and physical stability of disturbed areas, thereby reducing the need for long- term monitoring and maintenance

The initial MCP is conceptual. As the mine advances into the operational phase, the MCP will increase in detail and accuracy. It is, however, important to keep this momentum, to maintain the closure vision, to refine the closure strategy, and to review the closure objectives regularly. Content that should be entailed in a closure plan is illustrated in FIGURE 2.

**[FIGURE 2]**
Suggested content of a mine closure plan




Content for a MCP can be obtained from sources such as an operation's risk register, the aspect and impact register, and the EMP with all its management measures. Additional information needs to be obtained about the workforce, service providers, contractors and suppliers, external stakeholders, safety, health and security aspects, technical aspects such as open voids, tailings storage facilities (TSFs), waste dumps and stockpiles, infrastructure and mine facilities, and demolition-related needs, etc. TABLE 1 provides more detail about some of the aspects and triggers to be considered during mine closure planning in Namibia.

**TABLE 1 |** Aspects and triggers to consider when developing a mine closure plan

| ASPECT | TRIGGERS |
|---|---|
| **Workforce** | • Redundancy, unemployment, loss of income, retrenchment, retrenchment provisions, retraining and relocation obligations<br>• Early exit of employees with critical skills, brain drain, loss of institutional memory, knowledge and experience<br>• Industrial disputes, job insecurity, unrest, drop in morale/ disgruntled employees, anti-lobbying, unproductivity, compensation claims, challenges with unfair dismissals, speculative and assumptive entitlement and accusations<br>• Manning during and after decommissioning; staff retention measures<br>• Retention of employee records; loss, tempering and absence of records |
| **Sustainability of associated communities** | • Protracted and no relinquishment; unable to exit from agreements and supported projects<br>• Issues with authorities (e.g. licence renewal, transfer of responsibilities, institutional arrangements, unable to relinquish)<br>• Consultation, information sharing, awareness, stakeholder perceptions<br>• Disagreement and/or no agreement on end land use, unclear/unconfirmed completion criteria and expected outcomes, unachievable and unrealistic expectations<br>• Redundancy of service providers, income loss and unemployment, knock-on socio-economic effects because of termination of contracts with local suppliers<br>• Early exit of service providers, quality loss, shortage in supplies and services<br>• Planning of contract termination of redundant service providers; obligations beyond mine completion, breach of contracts<br>• Disenchantment, disputes, boycotts, sabotage upon notification of mine closure |

**TABLE 1 |** Aspects and triggers to consider when developing a mine closure plan

| ASPECT | TRIGGERS |
|---|---|
| **Decommissioning of the site** | • Infrastructure demolition, removal of unwanted infrastructure inappropriate, insufficient<br>• Security and access control during decommissioning and post-decommissioning; illegal movement of people; harm to third parties; unsafe areas<br>• Work safe and health impacts, insufficient contractor management, lack of supervision during and after decommissioning<br>• Health disputes and claims, retention of medical records, liabilities; radiation exposure<br>• Decommissioning activities uncoordinated; undetailed decommissioning plan and schedule; inadequately supervised, uncontrolled, unauthorised<br>• Remediation of contaminated areas impossible; costs inhibit decontamination and clean-up<br>• Disposal of demolished items, contaminated equipment and materials go offsite; inadequate knowledge, inappropriate management of waste |
| **Rehabilitation of the site** | • Interruption, prolonged and discontinuing of rehabilitation efforts (insufficient knowledge, inadequate methods, poor planning and design, failures because of errors)<br>• Rehandling of cover material is too costly; cover material contains contaminants; remaining landforms are unsafe and unstable<br>• In situ contamination, water pollution, above ground and underground, on-site and offsite; unable to reinstate surface and underground water systems; premature reinstatement results in re-disturbance<br>• Ecological disconnection, dysfunction; unable to restore ecological disturbance<br>• Re-disturbance of rehabilitated areas (scavenging, public access, seismic activity, flooding)<br>• Unable to backfill all open voids; insufficient material; inadequate cover; unsafe |
| **Post-closure monitoring and maintenance** | • Should include progress towards meeting the socio-economic objectives<br>• Not limited to biophysical parameters<br>• Environmental monitoring during decommissioning and post-decommissioning is inappropriate and non-confirmatory<br>• Indefinite period for the transfer of accountability |
| **Closure cost provision** | • Inadequate closure provision, poor closure descriptions and cost estimates, absence of cost-preventative measures, uncertainties and contingencies; unavailability of funds<br>• Inadequate provision for unplanned mine closure and/or care-and-maintenance scenario<br>• Compensation claims; anti-lobbying; contractual disputes; breach of contracts; reputation damage<br>• Protracted and no relinquishment |

The requirements of an MCP form part of an operation's EMP and, as such, are evaluated in each annual report. As an example the 2012 Strategic Environmental Management Plan (SEMP) of the Central Namib Uranium Province highlights requirements for the development of an MCP for uranium mines:

- The planning process should start at the feasibility study stage
- The MCP should be based on stakeholder and expert input
- The plan should consider site risks, threats, opportunities and cumulative issues
- Socio-economic opportunities should be available for the workforce and communities
- Demolition, rehabilitation and post-closure monitoring and post-closure maintenance are important
- The plan should contain accepted and agreed objectives, indicators and targets
- The plan should be subject to internal and external reviews
- A written approval of the plan from authorities is desirable
- The plan should be consistent with International Atomic Energy Agency (IAEA) guidelines
- The plan should consider all Namibian regulations and policies

## 2.4 THE DOMAIN MODEL

A useful model for setting out the work to be carried out during closure is the domain model, which separates the entire footprint of an operation into specific domains. Each domain is subsequently treated as a separate entity with a specific task and specific responsibilities in terms of addressing the key issues of the MCP.

**WHEN DEVELOPING THE TASKS FOR EACH OF THESE DOMAINS, THE FOLLOWING SHOULD BE CONSIDERED:**

- The level and area of disturbance, i.e. the footprint
- Risk assessment and hazardous areas
- Applicable legislations
- Mitigation measures (erosion / seepage control, decontamination, etc.)
- Concurrent rehabilitation plan
- Cost estimates
- Monitoring and research
- A plan for demolition and decommissioning
- Required earthworks and mechanical repair of the disturbed area (footprint)
- Final rehabilitation (including restoration of ecological system functioning)

Assumptions and all inclusions and exclusions should be stated. Each domain should have its own plan. Examples of different domains at a mine site include: workshops, offices and infrastructure, TSFs, mineral waste dumps, open pit(s), processing area, etc.

## 2.5 ACCOUNTABILITY FOR CLOSURE

The mining company is responsible for meeting closure objectives and as such, roles and responsibilities for mine closure needs to be outlined early in the mine's life. To meet the closure objectives, a dedicated team needs to be assigned to conduct closure responsibilities, which reports to a central closure plan convenor or project manager. Moreover, activities of the MCP need to be aligned to the operational plans of the business.

## 2.6 ONGOING MANAGEMENT

The goals of all tasks of the MCP should be to achieve a maintenance-free post-closure environment and socio-economic stability. The closure vision should express these desired outcomes pertinently, also addressing the end land use and a liability-free scenario.

During the implementation of the MCP, consideration needs to be made of management and monitoring requirements that will continue post-closure, to meet the requirements for relinquishment. It is critical that the post-closure requirements are proactively provided for with clearly identified objectives, roles, responsibilities and time frames. Sampling and research done on the mine site during the operational phase should determine the type and level of post-closure monitoring requirements. Some of the matters that need to be managed, post-closure, include infrastructure related to post-closure monitoring, data and record management, and the final transfer of accountabilities.

## 2.7 OBJECTIVES, TARGETS AND TIME FRAMES

To remain on track with mine closure objectives, realistic time frames need to be set, during which certain tasks need to be carried out. By means of an example – two main objectives underpin the biophysical part of an MCP: To repair the disturbed landscape mechanically and to ensure the ecological functioning of the repaired landscape. Several target-based tasks can be identified to achieve these objectives against timeframes. Mechanical interventions may entail tasks such as backfilling, levelling and shaping, cover with growth medium, scarifying, ripping and dragging, etc. These activities can run concurrently with business operations, as soon as disturbed land becomes "available". Interventions to reinstate ecological functioning of the landscape follow mechanical repair and entails activities such as preparation for active, assisted and passive revegetation, reactivating of surface drainage channels and ensuring the flow of water as ecological driver, reintroduction of species, etc.

Monitoring is required to determine the level of adherence to the implied target-based tasks, against set timeframes. Should established targets not be met in the given timeframe, interventions need to be implemented to ensure compliance with the requirements of the MCP.

## 2.8 FINANCING CLOSURE IN NAMIBIA

Section 130 of the Minerals (Prospecting and Mining) Act, No. 33 of 1992, stipulates that mining companies have a general duty of environmental care and are expected to practice continuous rehabilitation at own cost and immediate clean-up, in cases of spills or other forms of pollution. Section 54 of the Act states that licence holders are obliged to demolish accessory works, remove all debris and other objects brought onto the land, and to take the necessary steps to remediate *"to reasonable satisfaction"*, when mining activities cease. Section 23(2) of the Water Act, No. 54 of 1956 allows the minister to recover costs from a mining company, to prevent pollution of water that occurs after mine closure because of seepage.

In terms of Internal Financial Reporting Standards and Namibian Companies Act, No. 28 of 2004 compliance, a mine has a responsibility to review the value of the mine closure provision, which represents the discounted value of the present obligation to rehabilitate the mine and to restore, dismantle and close the mine. The discounted value reflects a combination of management's assessment of the cost of performing the work required, the timing of the cash flows and the discount rate.

The NMCF strongly suggests having a consistent and transparent financial costing and provisioning methodology in place. In fact, the framework advocates detailed closure costing as a prerequisite component of a MCP. Without a realistic closure cost estimate, it is likely that provisions will be inadequate at the time of planned mine closure. Subsequently, a mine should aim at a high level of detail in estimating costs. In this way future constraints on, and costs of, mine closure can be minimised, and innovative strategies initiated. The benefit of detailed closure costing is also that a stepped reduction in financial liability, as mitigation targets are met, can be followed. Detailed closure costing is closely coupled to the accuracy of site-specific information and will avoid a blanket approach, and the costing should also be regularly reviewed to obtain greater accuracy and incorporate changing circumstances. The level of accuracy should reach at least +/-30 %. A schedule for financial provision needs to be part of a MCP, typically accrued over the life of the operation. Accounting standards form the basis of the financial provision.

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PART THREE

# DEVELOPMENT OF REHABILITATION SUCCESS CRITERIA

## 3.1 REASONING REHABILITATION

The reason for rehabilitation is closely linked to the closure vision of a mine, which states the preferred future or final destination of mine closure and ultimately directs compliance and the principles of sustainability development at a mine against the desired end land use.

The Constitution of the Republic of Namibia states that any activity must comply with Section 95(l), which provides for *"the maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilisation of living natural resources on a sustainable basis..."* Especially relevant to the Namibian context, rehabilitation inevitably acknowledges the importance of the precautionary principle and the principle of preventative action, the promoting of sustainable development and protection of the environment for current and future generations, and public participation in decision-making.

The Draft Regulations of the Environmental Management Act, No. 7 of 2007 provide clear reference regarding the compilation and implementation of rehabilitation plans (Section 31). The act also states that applications for environmental clearance certificates should be accompanied by an environmental rehabilitation and restoration plan, as well as the financial guarantees to cover the costs envisaged from rehabilitation, reclamation, restoration, and aftercare based on an approved work plan that is reviewed annually.

The Minerals Policy of Namibia, 2002 encourages the alternative use of land through rehabilitation, and the use of remaining infrastructure for ongoing economic benefits after mine closure. The Minerals (Prospecting and Mining) Act, No. 33 of 1992 stipulates that mining companies have a general duty of environmental care and are expected to practice continuous rehabilitation at own cost. Licence holders are obliged to demolish accessory works, remove all debris and other objects brought onto the land and to take the necessary steps to remediate *"to reasonable satisfaction"*, when mining activities cease (Section 54).


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Rehabilitation is a continuous program, with an early start, to minimise the consequences of disturbance and to assist disturbed areas into becoming stable, self-sustaining ecosystems that are connected to the surrounding environment, and similar to what existed prior to the commencement of operations. Rehabilitation is a good indicator of a company's environmental commitment. Therefore, rehabilitation is a process that should be carried out in a transparent manner and provide meaningful consultation to ensure accountability to stakeholders, including communities whose livelihoods are dependent on the success of mine rehabilitation and closure (Vivoda & Fulcher, 2017). Poorly rehabilitated mine sites may leave substantial impacts on the environment, the government and communities.

Like many other Namibian mines, Namdeb practices concurrent rehabilitation as illustrated in the case study below.

# SENDELINGSDRIF

## NAMDEB

### BRIEF DESCRIPTION:

To meet Namdeb Diamond Corporation's objective of sustainability, the company added the diamond deposit at Sendelingsdrif to the mine plan in 2014. It is the second largest deposit, after the Daberas mine (about 25 km west of Sendelingsdrif) and extends the overall LoM along the Orange River. Sendelingsdrif mine has an expected LoM until 2020.

The resource is located in a biodiversity hotspot area, in particular where the vulnerable white flower Juttadinteria albata occurs. Namdeb developed a rehabilitation plan for the area, approved by the Namibian government, which earmarked the Sendelingsdrif area for future nature-based tourism.

### KEY ISSUE(S) ADDRESSED:

Namdeb developed a structured and dynamic approach to the LoM and closure planning that includes concurrent rehabilitation and restoration ecology. Mine planning for concurrent rehabilitation was initiated in the project phase and was further refined during the operational phase. A multidisciplinary team drives the process for concurrent rehabilitation. Namdeb has successfully integrated the backfilling of mined-out voids into its mine plan for Sendelingsdrif. Progressive backfilling of mined-out areas forms part of the rehabilitation plan of the mine. Backfilling of mined-out areas is, however, dependent on the mining sequence of the various zones.

### DESCRIPTION OF THE CASE STUDY:

The Sendelingsdrif resource is a near-surface deposit containing diamonds that are exploited with conventional open pit mining methods. Essentially, diamond-bearing material is mined with heavy earthmoving machinery, such as hydraulic excavators, rigid frame trucks, bulldozers, front-end loaders and graders. Articulated dump trucks may also be used. Ore retrieval is comprised of stripping, ore excavation, bedrock cleaning, drilling and blasting, stockpiling, and loading and hauling.





Considering the sensitivity of the area in which the Sendelingsdrif mine operates, the integration of concurrent rehabilitation and conservation of biodiversity into the mining life cycle, became major business case drivers. Three key objectives were identified:

- Adopt an integrated LoM and closure approach that would result in the development of a feasible mine that managed biodiversity impacts and which is aligned with the future land use of nature-based tourism for the area
- Ensure the licence to operate in this area, through integration of biodiversity management throughout the mining life cycle by:
- Establishing biodiversity partnerships with academic and research institutions
- Developing a restoration ecology framework and implementation of the programme
- Capacitating young Namibians in the field of restoration ecology
- Prevent future value destruction by using an innovative mine design to reduce the LoM and premature closure liability by implementing concurrent rehabilitation during mining operations
- Ensure early availability of areas for rehabilitation and optimising live placement of topsoil and plant rescue
- Use a multidisciplinary team to oversee the concurrent rehabilitation and restoration ecology processes with aligned production and closure key performance indicators (KPIs)

### MONITORING METHODS

The Mine Site software programme is populated with mining parameters, and then the design and mining plan for the month is assessed and communicated at the mine planning meetings. An action tracker consisting of key deliverables, such as alignment with the mine plan, topsoil harvesting and storage, changes to the mine plan and anticipated impacts, and time lines when the dumps will be ready for restoration, are used to ensure that the area is backfilled and rehabilitated. This is done so that the end land use of nature-based tourism is not compromised, and to ensure that there is no significant loss of biodiversity (in this case *Juttadinteria albata* plants) at the mining site. At the same time, it helps to better understand aspects of an arid ecosystem for its ultimate restoration after mining. The Sendelingsdrif Ecological Restoration Research Project (SENEREP) objectives are to provide Namdeb with ecological information and advice for the ecological restoration of Sendelingsdrif; to use the rehabilitation of Sendelingsdrif as an experimental platform on which to conduct innovative ecological research; and to contribute to the Namibian society by facilitating postgraduate training and capacity building in the fields of restoration, ecology and mining environmental management.

## CHALLENGES

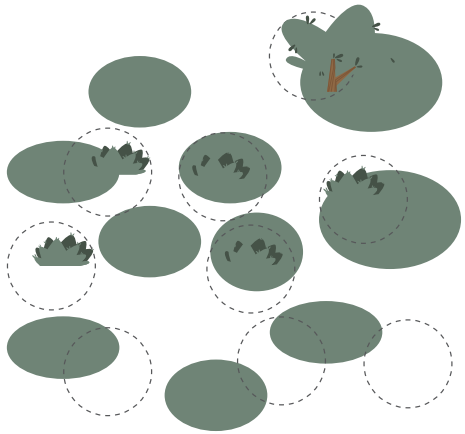
- Mining is a dynamic process—changes happen, and they need to be incorporated into a mine plan. Rehabilitation and back dumping also have to be part of this dynamic process without jeopardizing the end objective
- Dump development must be based on the design
- Complete readiness of the dump area is necessary for vegetation. Some delays on the mining site were experienced and can be attributed to the fact that it was the first time that mining had to execute the shaping of a dump according to ecological specifications. To ensure the delays were not repeated, progressive shaping was to be conducted, which will be continuously monitored by the environmental team prior to vegetation (SRTT minutes February 2018)
- Machine availability is important. The ecological project shared earth-moving machines with the mining production team. At times the production demand was high, which resulted in delays for the ecological project. Machines can be made available if a schedule is provided beforehand. A dozer can shape the dump over a period of time prior to revegetation (SRTT minutes February 2018)
- Water availability has been a major determining factor of the success of this pilot study. Challenges were experienced with readily available water; and sufficient quantities being available (driving for refilling between project area and tank was time-consuming). The water tank was only constructed on the area after the revegetation. Tanks will be procured and placed at the site prior to restoration work for 3S1&2 (SRTT minutes February 2018)
- Due to the rains being poor since 2013, another big challenge was the irrigation system deployed at the site. In retrospect, it was installed after the planting was conducted, which posed various challenges, i.e. the correct placement of sprayers directly onto plants, pipe and pump pressures, and fittings, etc. Other challenges included destruction by animals (baboons and porcupines) and the microjets getting clogged with sand. A review of the current irrigation system is required before Namdeb embarks on backfilling and revegetating another mined out area
- Changing the mindset of people, so that they think differently and act in line with the objectives, even when daily changes are made to the plan, is a constant challenge
- The integration of biodiversity management into the mining life cycle is a long and expensive process. When effectively implemented, it assists with making less costly decisions
- The integrated approach ensures that people on site own it
- Communication is key, especially when running a 24-hour operation
- Tight supervision is needed for some tasks (dump preparation)





## TOPDRESSING AND RE-VEGETATION


ENVISAGED LAYOUT



## CONCLUSION

An integrated LoM planning approach, inclusive of concurrent rehabilitation and restoration ecology, will assist Namdeb in reaching the end land use of nature-based tourism for Sendelingsdrif mine. Since the backfilling is subsequently followed by the revegetation of plants of conservation importance, including *Juttadinteria albata*, Namdeb will ensure that there will be no loss of significant biodiversity in the area. The integrated LoM approach makes a good business case, since value in various forms is added in the process.

A Namibia DeBeers Partnership

Top left:
Orange river mines
Oranjemund
Karas
Namibia
2019 © paulgodard.com

Left center:
Orange river mines - Sedenlingsdrift
Oranjemund
Karas
Namibia
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## 3.2 DEVELOPING REHABILITATION CRITERIA

To measure the success of rehabilitation interventions, criteria must be set, also for application before and after the closure phase, and for the eventual relinquishment of the mining lease. Criteria in turn represent indicators in the biophysical processes of rehabilitation that provide a high degree of confidence that the rehabilitated site(s) will eventually reach the desired end land use and a sustainable, non-dependent state. The establishment of such criteria are essential to benefit both the licence holder and the government and/or land owners, as this will ensure that the costs and liabilities will not be transferred to the next land users.

Before independence, Namibia encountered significant social and environmental damages arising from improper mine closure. This resulted in the government of Namibia inheriting the liability costs for rehabilitating many abandoned mines. Learning from past incidences, institutions in Namibia, including the Ministry of Mines and Energy (MME), the Ministry of Environment and Tourism (MET), and the Chamber of Mines (CoM), are striving to revive the reputation of the mining sector using various pieces of legislation that addresses mine closure aspects.

The process of developing rehabilitation criteria commences with clearly defined objectives and setting KPIs. The objectives can be site-specific, but should be aligned to the closure vision and closure strategy. A time frame and table of responsibilities are also important, in order to ensure a continuous program. Furthermore, rehabilitation and corrective intervention are not independent, nor are they attached to a single department, but need to be integrated into business decisions as a multidisciplinary and constant commitment.

**IN SUMMARY, CRITERIA AIM TO BE:**

- As clear and simple as possible
- Aligned with legal obligations and commitments
- Aligned with the allocated closure objectives
- Assessed at various stages of mine completion

### Steps in developing rehabilitation criteria

Criteria are the agreed tasks involved in meeting the rehabilitation requirements and commitments for mitigating the biophysical risks, and for eliminating all possible residual management liabilities. Therefore rehabilitation criteria are based on biophysical and socio-economic parameters and aim to be:

- Specific enough to reflect the unique set of environmental, social and economic circumstances relevant to rehabilitation
- Flexible enough to adapt to improved knowledge or changing circumstances without compromising objectives
- Measurable against environmental indicators to demonstrate that restoration trends are heading in the right direction
- Measurable against KPIs to demonstrate that interventions are successful in achieving the allocated closure objectives and outcomes
- Developed in consultation with stakeholders

The steps in developing rehabilitation criteria can be summarized as follows:

- Define guiding principles that will allow more specific site criteria to be developed. The principles should include items such as the following:
  - Rehabilitation objectives are met
  - Landforms are integrated into the surrounding landscape and are stable, safe and non-polluting
  - Rehabilitation exhibits sustained growth and is resilient
  - Rehabilitation can be integrated with surrounding areas and requires no additional ongoing resources.

Defining time categories to measure progress against success criteria is important. Assessing the criteria against the following broader time lines can be made:

- Development phases of the mining life cycle
- The entire rehabilitation process
- Early development (0–5-year-old rehabilitation)
- Established rehabilitation (>5-year-old rehabilitation)

Development of site-specific success criteria should commence with a review of the rehabilitation requirements outlined in the permits/licences, (i.e. Environmental Clearance Certificate and ML). Site-specific rehabilitation success criteria need to be clearly defined and communicated. Definitions need to consider the following:

- Intent, purpose and reasoning
- Guidelines for acceptance
- Accepted standards
- Potential corrective actions

The success of rehabilitation is closely linked to specific enablers: Adequate resourcing (manpower and money); support from other departments; benchmarking against criteria and best practices; compliance; and proactive engagement of stakeholders.

### 3.3 MONITORING REHABILITATION CRITERIA

Monitoring of rehabilitation progress is critical for developing a better understanding of how ecological systems respond over time, and to determine how successful rehabilitation activities really are. Monitoring of rehabilitation progress is closely associated with other routine environmental monitoring, such as biodiversity monitoring, which can be a combination of inspections, observations and surveys.

Rehabilitation monitoring is important, as it fulfils regulatory requirements, facilitates transparency, and helps to sustain trust and respect amongst stakeholders. Monitoring of rehabilitation progress continues during the decommissioning and post-decommissioning phases, to confirm that completion criteria have been met. Successful rehabilitation will be accomplished when completion criteria have been met enabling a functioning ecosystem that fits the surrounding area.

The following components are relevant to the monitoring of rehabilitation progress:

- Monitoring of topsoil is done to report on revegetation and to better understand the vitality of topsoil, the need to add fertiliser and/or organic matter, reworking needs (ripping and tilling), drainage and erodibility. Other factors such as the thickness of the topsoil cover application, formation of crusts, and soil characteristics, are also important
- Monitoring of the revegetation progress—to measure the establishment of key plant species and in particular pioneers, annuals and perennials, is important. Species diversity, the presence of alien invasive species and weeds, and signs of herbivory are important aspects for measuring the augmenting and strengthening of natural ecological processes over time
- Confirmatory monitoring on sites representative of areas under rehabilitation, is necessary for measuring progress against areas of similar biodiversity attributes. Seasonal variations are considered and reported for reference purposes, also during the post-decommissioning phase, until the rehabilitation targets have been reached. The movement and presence of mammals, birds and relevant target invertebrates and animals of conservation interest is indicative of successful corridor functioning, for example
- Growth, further development, and the fate of transplanted vegetation needs to be inspected. This is to inform future decisions on plant rescue and relocation, as reference information, and to inform the public



### 3.4 FINAL REHABILITATION

The objectives of final rehabilitation, decommissioning and an MCP are to identify feasible end (i.e. post-mining) land use options. For final rehabilitation, decommissioning and closure actions, it is imperative to provide a plan that is measurable and auditable, to the regulatory authorities within the framework, i.e. the MME and MET, etc., which accounts for the proposed end land use of the affected area.

**THE FOLLOWING ASPECTS SHOULD BE COVERED IN THE PLANS:**

- Outlining the design principles for closure by providing the closure vision and strategy, objectives, targets and criteria for final rehabilitation, decommissioning and closure of the project
- Explaining the risk assessment approach and outcomes, and linking closure activities to rehabilitation risks
- Detailing the closure actions that clearly indicate the measures that will be taken to mitigate and/or manage identified risks, and describing the nature of residual risks that will need to be monitored and managed post-closure
- Committing to a schedule, budget, roles and responsibilities for final rehabilitation, decommissioning and closure of each relevant activity or item of infrastructure
- Identifying knowledge gaps and how these will be addressed and filled
- Detailing the full closure costs for the life of the project at increasing levels of accuracy as the project develops and approaches closure, in line with the final land use proposed
- Outlining monitoring, auditing and reporting requirements

Ultimately, rehabilitation aims at reinstating ecological conditions and self-sustaining ecosystems that allow landscape functioning, similar to what existed prior to the commencement of operations.

Objectives and the design of rehabilitation plans should be set to meet relinquishment criteria. Therefore, the indication of infrastructure and activities that will ultimately be decommissioned, closed, removed and remediated, as well as risk drivers determining actions, should be clear. Rehabilitation plans should show how closure actions will be implemented, in order to achieve closure relinquishment criteria, as well as outline monitoring, auditing and reporting requirements.

In certain areas in Namibia, little information is known on appropriate ecological restoration measures. This was the case for the central Namib Desert. Orano Mining Namibia decided to construct restoration trial areas and commissioned a local consultant to assist with the design and monitoring of these areas, as highlighted in the case study below.

# TREKKOPJE MINE
is owned by Orano Mining Namibia.

**LOCATION:**
The Trekkopje mine, situated 30 km north of Arandis, is in the Erongo Region, Namibia.

**BRIEF DESCRIPTION:**
The Trekkopje mine is a currently inactive uranium mine. The objective of the project was to test various rehabilitation measures and to document their progress throughout the operational phase. Vegetation and soil properties are monitored annually to see how soon plants start growing on topsoil that has been stockpiled for various periods of time, and if they will grow on other fine-grained substrates. Time frames have to be understood and documented in order to determine whether or not active intervention to re-establish biodiversity may be required.

**KEY ISSUE(S) ADDRESSED:**
This case study aims to highlight best practice in restoration testing in Namibia.

**DESCRIPTION OF THE CASE STUDY:**
The trial site consists of ten 100 x 100 m plots, which were constructed in March 2011 in a former ore stockpile area. There is largely undisturbed vegetation adjoining, to the east and south, which serves as source of seeds. The six eastern plots are located on subsoil, while the area of the four western plots was covered with conglomerate overburden as a base for the ore stockpiles. The question whether or not compaction must be loosened, and which types of substrate would allow plant growth, is being investigated through the application of different treatments and cover materials that may be available at mine closure.

The following treatments were applied on the ten plots:

1. Control (no treatment, except for the reshaping and removal of vehicle tracks)
2. Ripping to loosen compacted surface
3. Topsoil application (10 cm layer of soil)
4. Ripping and topsoil application (10 cm layer of soil)
5. Application of granite crusher dust (10 cm thick)
6. Application of heap leach tailings (10 cm thick)
7. Control (no treatment, except for the removal of the conglomerate layer)
8. Removal of conglomerate and ripping to loosen compacted surface
9. Topsoil application on conglomerate (10 cm layer of soil)
10. Ripping and topsoil application (10 cm layer of soil)





Exceptionally high rainfall occurred in 2011 and surface water runoff across the test plots resulted in immediate germination of site-typical plant species on all types of substrates. Some of the inflow areas reached species richness and plant cover values similar to the reference sites. Plant composition still differed, however, with pioneer plants being dominant in the regrowth areas. The vegetation patches established in 2011 did not spread further due to low rainfall in the following years. Vegetation monitoring could only be undertaken in years of good rainfall, when annual plants emerged and plant cover was relatively evenly spread.

**CONCLUSIONS FROM THE FIRST SEVEN YEARS OF THE STUDY CAN BE SUMMARISED AS FOLLOWS:**

- It appears that given enough rainfall and a source of seeds, plants will grow on any of the tested substrates
- Soil properties are highly variable within a site and detecting trends is therefore difficult
- Differences between rehabilitated and reference sites were only detected in the soil properties, electric conductivity, sodium and calcium content. These indicate alkaline and, in some instances, also sodium-rich conditions in rehabilitated sites
- Organic matter content—a widely used indicator for soil fertility—remained extremely low and variable, not showing any clear trends
- Comparing the various treatments, the soil data showed that ripping has a negative effect on soil properties by mobilising sodium and calcium. But this needs to be balanced against the positive effect of reducing soil compaction

Scorpion Zinc Mine
Rosh Pinah
Karas
Namibia
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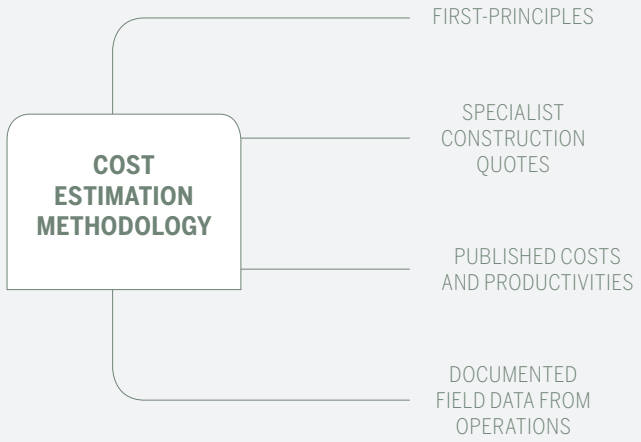
PART FOUR

# FINANCIAL PROVISION

## 4.1 COST ESTIMATION

Financial arrangements may be included in the MCP along with an estimated closure cost. Various financial surety instruments are available, which can be used to ensure that funds are available for mine closure, rehabilitation and monitoring when needed. The selection of the mix of financial surety instruments is usually agreed between authorities and the mining company, and may to a large degree be dictated by legislation in certain jurisdictions (World Bank, 2008; Nazari, 1999) Therefore, the process and methodology for calculating cost estimates must be transparent and verifiable, in order to meet requirements as stipulated in the framework and regulations. FIGURE 3 illustrates the various methods which can be used for cost estimation.

**[FIGURE 3]**
Several cost estimation methods that can be used by mining companies (Parshley, 2014)



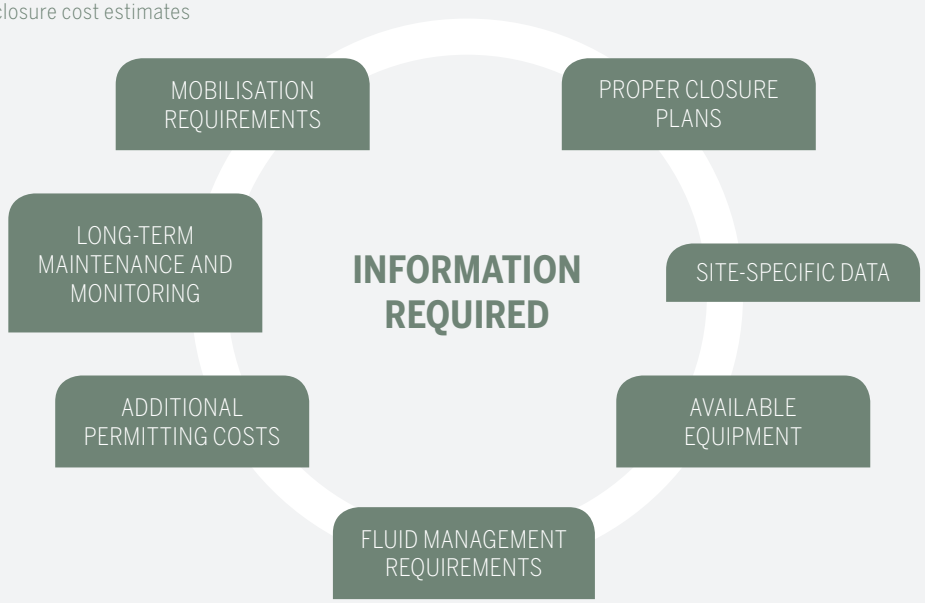
## 4.2 CLOSURE COST ESTIMATE

A cost estimate is often derived from the closure strategy and plan. Cost estimates for severance payments, final rehabilitation, social closure, project management and final closure activities, as well as for environmental monitoring and long-term site management aspects, are provided in closure plans. This will in turn provide the basis for the value of closure funds required, and provide reasonably accurate estimates, if socioeconomic and site-specific information/data from research is sufficiently available. By gathering sufficient information regarding site-specific closure needs, the use of blanket calculations is minimised, subsequently reducing the risks of underestimating real closure costs and that of carrying out inadequate implementation planning. In addition to adequate and swift execution of mine closure project activities, provision for a dedicated team and resources must be in place.

### Planning for cost estimate

When planning for cost approximation for mine closure, considerable data and information is needed. There are different methods that mines can use to achieve cost estimates. The diagrams in FIGURE 3 and FIGURE 4 demonstrate the methods of cost estimates and the nature of information need for closure cost estimation. These guidelines can be assumed by prospective and current mining companies, if not already incorporated in the Life of Mine (LoM) plans.

**[FIGURE 4]**
A summary of information needed for closure cost estimates




The primary use of closure cost estimates by the mining industry is to plan, budget and manage actual closure activities. Furthermore, the estimated costs are a surety measure for what the government would incur should a mining company default on their commitments to close their operation in accordance with an approved closure plan. For mining companies, closure cost estimates ensure compliance with financial reporting requirements. Further planning for closure costs allows for the mining companies and the government to take cognisance of liabilities, which need to be well defined, quantified and reported. The three types of closure cost estimates commonly used by the international mining industry today, and their specific requirements, are summarised in TABLE 2.

**TABLE 2 |** Summarises the different types of closure costs used

| | LIFE OF MINE (LoM) | FINANCIAL ASSURANCE | ASSET RETIREMENT OBLIGATION (ARO) |
|---|---|---|---|
| Use(s) | Planning, financing, budgeting and cost monitoring: | Financial security required under governing regulations | Financial reporting to shareholders |
| Rate Basis | • Pre-feasibility/ feasibility<br>• Due diligence<br>• Accrual allocation<br>• Operator<br>• Third party | Third party | • Operator<br>• Third party |
| Included Development | All Planned development | Current/Maximum (near-term) | Current financial year |
| Government Contracting Rules | No | May be subject to government contracting laws | No |
| Cost Basis | Cash flow | Current cash | Cash flow |
| Salvage Value | Yes | No (varies) | No |

## 4.3 FINANCIAL PROVISION

Mine closure requires considerable resources and funding, and such costs should already be considered in the feasibility studies, although it is tempting to view them as a distant future expense that has little effect on the Net Present Value (NPV) or the internal rate of return of the project (International Council on Mining and Metals, 2008). Nevertheless, an essential element of a closure management plan is always the estimation of the costs of completing each of the required closure arrangements. The summation action activities are considered as the minimum amount of funds required for mine closure.

Mine closure is a progressive activity throughout the mining life cycle of any mine, and outstanding and upcoming costs constantly change with time. It is for those reasons that most are updated at regular time intervals, to provide conclusive data for the annual or quarterly financial planning and reporting of the mining operations (Nazari, 1999).

Different financial sureties are often employed to ensure that enough funds will always be available for mine closure, including the early phases of the project. Therefore, it is imperative that any mining company operating in Namibia has mechanisms in place to ensure that adequate financial resources have accumulated at mine closure. Furthermore, mines may adopt their own optimum methods of funding during operations. Additionally, for final closure, an independent fund needs to be established in conjunction with the government. Currently, the favoured instrument is a trust fund. If there are deficits, the specific mining company is liable for any extra costs of rehabilitation.

LoM closure cost estimates, in this case, would be the best practice, as it takes progressive rehabilitation into consideration. This estimates the costs for the mine operator to perform all the actions required to fulfil the closure portion of their current mine plan in the context of operations. LoM estimates are also used for planning, budgeting and cost tracking. Common uses for LoM closure cost approximations include pre-feasibility and feasibility studies, due diligence audits, accrual allocation, annual planning and budgeting, and cost tracking.

## 4.4 CLOSURE ASPECTS TO CONSIDER IN THE COST ESTIMATE

The NMCF makes provision for minimum closure aspects to be considered in cost estimate activities, which are summarised in TABLE 3.

To ascertain that planned cost estimates are realistic, it is essential to have independent audits. Therefore, accounting standards should be the basis for financial provisions, which enables companies to address accounting issues through the acquisition of advice from financial professionals.

**TABLE 3 |** Consideration of closure aspects for minimum financial provisions

| CLOSURE ASPECTS | |
|---|---|
| **Employee Costs** | Reference has to be made to the Labour Act, No. 6 of 1992, and its Regulations of 1997, which refer to the health and safety of employees, as well as the new Labour Act, No 11 of 2007, which deals with the redundancy of human resources, and sets out the procedures to be followed in the event of dismissals for operational reasons or retrenchment, and the requirements for severance payments and other benefits.<br>• Retrenchment provision<br>• New employment opportunities<br>• Re-training costs |
| **Social aspects (sustainability of associated communities)** | • Exit strategy (the process by which mines cease to support initiatives)<br>• Social transition (communities receiving support for transition to new economic activities)<br>• Transfer of responsibilities |
| **Biophysical rehabilitation costs** | • Infrastructure breakdown, demolition, salvage and or disposal at the site, or transition / repair for agreed end uses<br>• Mechanical repair of the disturbed landscape (i.e. contouring, shaping, profiling, flattening, covering, backfilling, etc. of mineral waste dumps, stockpiles, borrow pits, open voids, pits, trenches and exposed bedrock, tailings facilities, etc.)<br>• Reinstating ecological functioning of the disturbed landscape (i.e. through passive, assisted and active revegetation, re-introduction of species, securing water flow as ecological driver, etc.) |
| **Post-closure monitoring and maintenance** | • Monitoring program(s) (to track progress toward set objectives and maintenance)<br>• Maintenance of infrastructure to enable monitoring (e.g. roads, water pipelines, electricity, communication networks, etc.)<br>• Security and safekeeping |

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| **Post-closure monitoring and maintenance** | • Monitoring program(s) (to track progress toward set objectives and maintenance)<br>• Maintenance of infrastructure to enable monitoring (e.g. roads, water pipelines, electricity, communication networks, etc.)<br>• Security and safekeeping |
| **Project management** | • Administration and management costs during the decommissioning period e.g. legal; laboratories; offices; vehicles; and equipment for closure management<br>• Gradual redundancy of workforce |

## 4.5 PROGRESSIVE REHABILITATION AND REDUCING BONDS

One of the challenges that mining companies face globally, is what happens to the mine sites after minerals have been depleted, mining operations are no longer economical, and operations have ceased. In some instances, the companies opt for putting the mine on care and maintenance while waiting for better social, technological or economic conditions. The mine site ends up falling into abandoned status if conditions are not favourable. Therefore, it is essential to have financial assurance in place prior to operations, and should the mining company fall into bankruptcy before the mine closes, the government can use the security deposit or bonds to cover the cost of rehabilitation, maintenance, clean-up, and closure of the mine site. If the mining company conducts proper clean-up and reclamation, the funds are returned to the company (Vivoda & Fulcher, 2017).

Progressive rehabilitation is an approach designed to enable mining companies to implement continuous rehabilitation actions during each phase of the mining life cycle. If mining companies begin their closure process early, by planning early, costs can be spread out over the LoM, rather than being postponed to the end of the mine's life, when the mine is seeing depleted resources and revenues, and the closure costs are ramping up. This gives room for mine stakeholders to be consulted and give input about how closure may affect them. This subsequently reduces the chance of conflicts, and raises the opportunities for a land-use plan that satisfies all stakeholders. Ultimately reducing the final liability of the operation at closure, the following activities and actions can be conducted prior to closure:

- Initial optimal placement of waste material coupled with progressive rehabilitation during mining operations can substantially reduce the closure costs
- Proactively minimise disturbed land areas that have not yet been rehabilitated, as a way of reducing the risk of contamination, and unsafe or unstable conditions. The ideology is to attain a progressively rehabilitated and geochemically rendered inactive mine site at the end of the operational phase and properly enter the closure phase
- Successful rehabilitation includes comprehensive characterisation of soil properties, overburden and mineral processing waste, to determine their capacity to support plant growth, and the potential impact on water quality
- To create a favourable medium for plant growth and the protection of water resources, segregation and selective placement of these materials is vital
- Stakeholder engagement should be an early, regular, honest and transparent process, throughout the LoM and should be documented continuously
- Regular planning and reassessment (water quality, waste, landform, rehabilitation success, etc.) stability from an early operational phase, may avert later criticisms, lead to closure outcomes better directed by years of supporting work, and reduce end of mine costs
- Ensure that water does not come into contact with any geological material with elevated geochemical concentrations, whether it is waste rock, low grade ore, or tailings
- Alleviating closure liabilities is more expensive and unpredictable, and takes longer to achieve than proactive operational management of risk with a view to closure that avoids these liabilities in the first instance (Ziemkiewicz, Skousen, & Simmons, 2001; Fletcher, Hutton, & Dick, 2012)
- Closure forecasting should not simply be thought of as a land redevelopment exercise. Protection of environmental assets should consider a hierarchy of strategies such as avoidance, mitigation, restoration, offsets and additional conservation options (enhancements) (New South Wales Environmental Protection Authority (NSW EPA), 2002; McCullough & van Etten, 2011)
- Significant cost savings can be achieved if rehabilitation activities start prior to the demobilisation of mine equipment and staff/contractors

Without land rehabilitation, the affected areas can be permanently alienated from future socio-economic developments, with consequential environmental impacts. Langer Heinrich Mine demonstrated good practice through planning and engagement with stakeholders as the mine prepared for the care and maintenance phase, as shown in FIGURE 5.

**[FIGURE 5]**
Publication of Langer Heinrich mine in preparation for care and maintenance phase, Namibia (World Nuclear News, 2018)

**NAMIBIAN MINE PREPARES FOR CARE AND MAINTENANCE DECISION**

*Paladin Energy begins preparations at Langer Heinrich ahead of a potential decision to put the Namibian uranium mine under care and maintenance.*

With average spot prices yield the lowest in 2018 in the last 15 years, the uranium market has failed to recover following the Fukushima incident in 2011.

Due to the continued deterioration of macro factors, the stubbornly low spot uranium price, foreign exchange rates and prices of processing reagents, it has become less likely that the company will be able to resume physical mining activity at Langer Heinrich Mine, Namibia in 2018, nor would processing low grade stockpiles be viable.
As a result, Paladin has commenced preparatory steps to be able to formalise a care and maintenance decision with relevant stakeholders. Therefore, Paladin, stated that decisions on whether to restart physical mining, process low grade stockpiles, or place the operation on care and maintenance must be made at least six months before the stockpiles become exhausted.

Upon receipt of the necessary approvals and completing preparatory initiatives, a formal decision will be reached. It is worth noting that consultations with relevant stakeholders including the government, customers, joint-venture partners and employee representatives, and other preparations, including changes in certain supplier arrangements and staffing, have already begun. Production activities of uranium is deemed to cease within 1-2 months, once a decision has been made.

## 4.6 HOW OFTEN SHOULD CLOSURE COSTS BE CALCULATED?

Cost approximations should be reviewed frequently with the LoM, to address and reflect changing circumstances. In the Namibian context, once the project is operational, the licence holder needs to submit proof of an operational financial mechanism in place, supported by financial statements.

**REVIEW OF COST ESTIMATES MUST BE DONE AT LEAST EVERY TIME A CLEARANCE CERTIFICATE IS RENEWED (EVERY 3 YEARS), AND ANNUALLY, CLOSE TO DECOMMISSIONING, TO FINE-TUNE:**

- Inflation and escalation
- Changes in legislation
- Changes in available technology to better address closure risks
- Changes in the LoM plan (i.e. expansions, processing or new activities)
- Changes in stakeholder expectations

During mining operations, it is expected of the mining company to have a more detailed estimate of projected final closure costs. The estimate will be required to demonstrate that the necessary financial provision was not underestimated. Hence, the level of accuracy should at least reach a +/- 30% accuracy midway through its plan, and 2-3 years before the planned mine closure, and cost approximations should reach the level of accuracy expected in the feasibility phase of closure development.

**NB!** Return on the sale of assets or salvage values are difficult to determine and should not be used to offset the cost of closure.

Desalination Plant - Orano
Swakopmund
Erongo
Namibia
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PART FIVE

# IMPLEMENTATION OF CARE AND MAINTENANCE

The term care and maintenance describes a process whereby a mine is temporarily closed with the intention of recommencing operations at a later stage. Even though production has ceased during the care and maintenance process, monitoring is conducted regularly, to ensure the safety and stability of the mine site, surrounding communities and the environment. Several factors result in a mine being momentarily unviable, including economic conditions and declining ore grades.

## 5.1 CARE AND MAINTENANCE IN NAMIBIA

### Introduction

After a mine site is placed under care and maintenance, environmental audits need to be conducted to allocate risk status to all landforms and infrastructure involved for the projected duration of this period. If the expected care and maintenance period is unknown, a minimum of 2 years should be used as a baseline period. There should not be a lack of environmental monitoring and reporting during this period. The environmental risks identified in the environmental audits will be included in the care and maintenance plan.

### Compliance

The pre-existing MCP should be used as a basis for preparing the care and maintenance plan, which will ultimately address the environmental risks identified during the audit. The plan must be submitted to the relevant regulatory bodies, including the MET, and the MME. The care and maintenance plan must highlight that environmental responsibilities will be adhered to throughout the closure period.

### Leading practice standards

A typical care and maintenance plan address the following:

- Waste rock dumps
- Tailings storage facilities
- Treatment plants
- Chemical and hydrocarbon storage
- Open pits
- Underground infrastructure
- Inspection and monitoring
- Emergency response
- Reporting

### Waste rock dumps

Unrehabilitated waste rock dumps may result in the dispersal of the dump material to the surrounding environment due to erosion, and can also contribute to soil pollution because of chemicals seeping from the dump. The mobilisation of chemicals contained in waste rock dumps can pollute ground and surface water over time, and consequently negatively impact the surrounding habitat and vegetation. As such, due diligence relating to the rehabilitation of waste dumps should be observed in protected areas during the transition period from operations into the care and maintenance phase. All possible environmental risks need to be identified and adequately mitigated, to ensure the protection of the surrounding habitat. Severe erosion can also block natural drainage lines and disturb the livelihood of other land users in the area.

### Tailings storage facilities

TSFs present similar risks as waste rock dumps, with the additional catastrophic risk of failure of the facility. During the care and maintenance phase, care should be taken to monitor for seepage through containment walls or directly through the base of the facility into the groundwater.

### Treatment plants

Treatment plants are likely to still contain significant volumes of chemicals and process-related materials when the shutdown is initiated. The correct storage and disposal will be addressed in the care and maintenance plan, and as such, protecting the surrounding environment from the dispersion of harmful chemicals.

### Chemical and hydrocarbon storage

Most mines store significant quantities of various chemicals, fuels, oils and greases, including used chemicals, oils and greases. Proper storage containers should be used, and environmentally safe dispersion protocols observed.

### Open pits

Any open pit operation placed under care and maintenance is exposed to the risk of significant surface water flows. As such, appropriate surface drainage structures should be put in place. Surrounding vegetation systems are prone to water deprivation when an open pit acts as a storage dam, because it results in a disturbance to the normal surface drainage after rainfall events. To minimise environmental problems when operations recommence, saline or low pH water that accumulates in the open pit should be safely disposed of.

### Underground infrastructure
Openings to underground workings such as decline portals and shafts, could potentially become drainage pathways and deprive downstream vegetation and surrounding habitats of normal water supply.

### Inspection and monitoring
Environmental monitoring needs to be conducted on a regular basis during the care and maintenance phase. It is advisable to introduce additional monitoring programs to determine the overall stability of structures that may potentially fail due to erosion and other external factors. Competent personnel should establish an inspection regime and follow it closely. All monitoring results should be recorded in writing and critically evaluated by qualified people.

### Emergency Response
An emergency response plan must be developed and implemented, with clear lines of communication identified. If monitoring results reveal adverse findings that could cause serious environmental degradation, they must be dealt with rapidly and effectively. The emergency response plan should also cater for the worst-case scenario, to ensure minimum injury and damage during a catastrophic event.

### Reporting
Regular reporting should be submitted to the relevant authorities, and transparency needs to be maintained during this reporting process.

## 5.2 FINANCING CARE AND MAINTENANCE
Mining companies need to effectively plan for the cost of care and maintenance. It is essential to include all the activities related to the successful temporary closure of the mine. Other costs relating to the management of human capital within the legal boundaries of the law, should also be factored into cost estimates.

## 5.3 TRANSITIONING BACK INTO OPERATIONS OR ONTO CLOSURE
A mining operation that has moved into care and maintenance could navigate two pathways, namely, permanently ceasing operations or recommencing operations. The choice between the two is largely dictated by changes in the economic climate. Different approaches need to be taken, to safely ensure the transition from care and maintenance into either operations or formal closure.

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PART SIX

# IMPLEMENTATION OF CLOSURE AND COMPLETION

Mine closure is the period where extractive activities at a mine site have ceased completely and final decommissioning, and the mine closure phase, is entered. During this period, the affected land must be made safe and useful again and provide a positive legacy for future generations. It is paramount that mine closure and completion be carried out in a planned manner, so as to mitigate the risk of the site turning into a source of pollution in the future. The aim must be to ensure sustainability for environmental, social, economic and physical impacts.

## 6.1 CLOSURE AND COMPLETION IN NAMIBIA

### Introduction

Closure planning must continue throughout the LoM. Most mines opt for progressive rehabilitation, which allows for continued review and improvement of the closure plans. The aim must be to ensure sustainability for environmental, social, economic and physical impacts. Ultimately, it means that the closure vision and closure strategy must be clear and in accordance with stakeholders' expectations.

### Leading practice standards

In 2010, the CoM of Namibia produced the NMCF. An array of key areas relating to mine closure and post-closure land-use are addressed in the document. Accordingly, mine closure objectives should be incorporated into the earliest planning phases of a mining operation. This allows for the thorough integration of closure goals and the inclusion of stakeholder consultation throughout the mine planning process. Ideally, the mine closure strategy should be developed during the feasibility and detailed design phase of project planning.

Section 5 of Namibia's Environmental Assessment Policy for Sustainable Development and Environmental Conservation of 1994, states that the holder of an ML has the responsibility to ensure the implementation of mitigation measures as recommended in the environmental assessment. This agreement is binding for all parties involved and spans the construction, operational and decommissioning phases in the mine closure process (The Chamber of Mines of Namibia, 2010). Mining operations need to comply with strict environmental standards, and need to exhibit sound social responsibility, particularly in protected areas and national parks. Closure objectives should aim to return affected land to conditions that support native habitats and an end land use that is like the surroundings. Post-closure land reclamation should result in self-supporting ecosystems, so that the landscape ecological functioning is similar to the conditions before the mine was established.

## 6.2 FINANCING CLOSURE AND COMPLETION

Mines should have sufficient financial resources to implement closure objectives and sustain post-closure care. All cost calculations should include:

- Personnel costs (retrenchment packages)
- Social aspects (sustainable implementation of support initiatives)
- Demolition and rehabilitation costs (infrastructure breakdown/removal for salvage purposes)
- Ecosystem rehabilitation costs
- Post-closure monitoring and maintenance
- Project management (administrations costs)

Closure and post-closure activities should be highlighted in the planning and design phases of a mining operation. An accompanying mine reclamation and closure (management) plan is also developed, to identify the allocation of sustainable funding for implementation. The MCP will consider both socio-economic and physical rehabilitation considerations, and should be designed in a way that guarantees:

- Future public health and safety
- Sustainable and beneficial post-mining land use
- Minimal adverse socio-economic impacts
- Maximised beneficial socio-economic impacts

PART SEVEN

# CARE AND MAINTENANCE, CLOSURE AND COMPLETION PROCEDURES AND GUIDANCE FOR THE SECTOR

The result of mining activities leaves behind infrastructure including TSFs, waste rock dumps, open voids, pit lakes, and other sources of potential pollution. In addition, less visible infrastructure includes bore caps, barrier walls, declines and shaft entrances, and reclaimed areas. The concern with legacy infrastructure is how the industry ensures that it is sustainable into the future. Therefore, it is important to establish proper monitoring and action plans that incorporate the legacy infrastructure, so that it remains fit for its purpose. The set plans and strategies help address, for example, aspects of seepage from TSFs and waste rock dumps, but it takes time to develop, and sometimes revegetation plots fail to achieve the desired coverage. To lead successful closure objectives, financial provisions must be established to accommodate care, maintenance and monitoring costs. Engaging in proactive management and cleaning up of contaminated activities can substantially reduce costs at closure.

To achieve environmental sustainability in the mining sector, operating companies should keep abreast of leading practices, and must be flexible and innovative as new challenges emerge and solutions evolve. This applies to all mining companies in Namibia, including exploration companies, because the reputation of Namibia's mining industry is affected when sites are abandoned, and long-term substantial environmental impacts are not appropriately addressed. All companies, including exploration companies, should recognise and demonstrate how they can effectively manage and close mines through the inclusion of biodiversity, consultations, community engagement, and risk management features. FIGURE 6 illustrates the inter-relations between the local community, a mining company and the authorities.

**[FIGURE 6]**
The typical contributions, benefits, or roles of the government, a mining company and a community through the life of a mine.

## 7.1 BIODIVERSITY AND CLOSURE

Mining is one sector that has come a long way by voluntarily pursuing actions that seek to reduce and mitigate harmful impacts on sensitive ecosystems and associated biota. As mining and the environment continue to interact, it is therefore through cooperation that this guide was developed, such that Namibia's incredible biodiversity and life-supporting ecological processes are not compromised. The bringing together of stakeholders from conservation entities, mining, the government and non-profit organisations promotes cross-sectional interaction and cooperation focused on improving biodiversity conservation and management in the mining sector. Most importantly, companies that demonstrate responsibility and respect for biodiversity, are those that are committed to sustainability for the future. They are forward thinkers and have an understanding of cost-savings, but they also do comprehensive planning for the sensitivities associated with mineral extraction in areas of biodiversity importance. Moreover, virtuous environmental management practices of mining operations can provide opportunities that achieve biodiversity conservation goals without economic costs, and generate benefits for communities (Department of Environmental Affairs, 2013).

Licence holders in Namibia are obliged to remediate environmental damage to a reasonable satisfaction by complying with existing legislation (The Chamber of Mines of Namibia, 2010).

To effectively address biodiversity issues, six principles can be applied when making decisions on how best impacts can be avoided, minimised, and mitigate impacts throughout the entire LoM. The principles are:

- Application of, or compliance with, the law
- Use the best available biodiversity information
- Engage stakeholders thoroughly
- Use best practice environmental impact assessment (EIA)
- Apply the mitigation hierarchy in planning any mining-related activities and develop a robust EMP
- Ensure effective implementation of the EMP, including adaptive management

These principles should be used when addressing biodiversity issues and the impacts of mine exploration and operations. The principles guide mining companies, stakeholders and regulatory authorities, to embrace quality spatial and temporal biodiversity information for decision-making.

Stewardship toward biodiversity is demonstrated through the implementation of environmental management plans, rehabilitation and monitoring strategies.

## 7.2 CONSULTATION DURING MINE CLOSURE

A best practice approach during consultation can be achieved when engagement with stakeholders is incorporated at the early planning phase of the LoM, and continues throughout the construction, operational, closure and relinquishment phases. Consultation should involve communicating, listening, feedback and dissemination of information with all affected and interested stakeholders.

## 7.3 THE COMMUNITY AND CLOSURE

Mine closure always causes significant social concern, particularly in associated communities where a mine may be the major contributor to economic activity (past Namibian examples include Uis and Tsumeb). In addition, the extent to which communities can be in denial over mine closure should not be underestimated. Therefore, the following aspects should be addressed and made known to stakeholders:

- Stakeholders should be informed about closure as early as possible (specified date)
- To minimise the negative impact on dependent communities, mining companies work with them to manage such impacts and realise potential opportunities
- To avoid disappointment, mines need to ensure that expectations are managed, and real opportunities are identified
- Mining companies explore initiatives that encourage and assist the development of small- and medium-sized enterprises, which can continue after closure
- Support local industries that have a broader focus than the mine
- Working with communities through forums may assist in the development of programs to offset the inevitable changes at closure

## 7.4 MANAGING THE RISK OF ACID MINE DRAINAGE AT CLOSURE

Mining and water are fundamentally linked, as mining operations cannot be undertaken without water. Mine water often presents an insidious side of mine closure that may tarnish a social licence to the mine after the mineral deposit has been exploited (Olias & Nieto, 2015). Mining can contaminate water sources through contact with geochemically enriched strata. Subsequently, poor waste management and poor managed landforms at a mine have the potential to develop contaminated mine waters such as AMD (Acid Mine Drainage) at closure. AMD is arguably one of the single biggest liabilities from unsuccessful mine closure planning and can often be the major management issue post-closure (Gammons & Duaine, 2006). AMD problems may take a long time before they become evident and it is therefore necessary to monitor the success of revegetation, the efficacy of cover systems, and any impacts on water resources for many years until good evidence of stability is available and sign-off can be obtained from the regulator. Given the range of issues needed to address AMD risks, the mining company would require expert services to implement such monitoring.

It is likely that these issues, listed below, require additional management attention:

- Geochemical characterisation of materials
- Monitoring of potential surface and groundwater impacts
- Management of groundwater impacts
- Waste rock segregation
- Optimisation of cover design
- Flooding of workings
- Maintain water values by maintaining water quality at pre-disturbance levels
- Effectively co-ordinating any limited budgets between the mine planning, geology and environment departments at the early mine planning phase, is a sound strategy. This approach seeks to maximise the return on investment, to reduce forward acid mine drainage risk over the long term (Pearce, Beavis, Winchester, & Thompson, 2012)

Demonstrating prediction and quantification of AMD issues early in project development, allows for control strategies to be integrated with mine planning, engineering design and operation phase, to minimise long-term acid mine drainage liabilities. Therefore, mining activities should aim at preserving environmental value and pristine water resources in Namibia by initiating detailed AMD mitigation and management strategies.

Tsumeb smelter - Dundee Precious Metals Tsumeb
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PART EIGHT

# POST CLOSURE MONITORING

The Environmental Management Act, No. 7 of 2007, states the role of the Environmental Commissioner as being responsible for coordinating and monitoring the environmental assessments processes, retaining a register of environmental assessment plans, ensuring the availability of any EIAs submitted in relation to prospecting and mining licenses, providing public notification, and conducting inspections to monitor compliance.

## 8.1 ASPECTS THAT REQUIRE MONITORING

Leading practice recommends that post-closure monitoring accounts for the following aspects:

- The monitoring and management of vegetation succession
- The management and monitoring of erosion
- The stability of embankments and other areas at risk of slope failure
- The state of fencing and prohibition signs
- The functionality and success of water treatment and drainage systems
- Monitoring surface run-off
- Managing and monitoring pollution control facilities (tailings dams, evaporation ponds, etc.)

The above-mentioned aspects can be monitored through a variety of methods or procedures, including the following (Heikkinen, Noras, & Salminen, 2008):

- Visual inspection of the tailings impoundments and embankments
- Measuring the quality and volume of discharged water from waste rock disposal areas and tailings areas
- Measuring the chemical and physical quality of surface water both at the downstream discharge locations and upstream from the mine
- Evaluating the viability and state of the surrounding aquatic ecosystems (measuring the physical and chemical properties of water)
- Chemical and physical characterisation of groundwater
- Monitoring revegetation rates, density of vegetation cover and biodiversity.

## 8.2 COMPLIANCE REQUIREMENTS

The Environmental Management Act, No. 7 of 2007, the Minerals (Prospecting and Mining) Act, No. 33 of 1992, and the Minerals Policy of 2002, explicitly refer to rehabilitation as a requirement for mines, but they lack specific regulations and authorised procedures. Currently there is no formal system for handling the approval of closure plans; there are no incentives in place for progressive rehabilitation; the penalties for inadequate closure are very low; and a legal framework for assessing and auditing closure plans periodically, is absent. Mechanisms for providing guidance in terms of relinquishment and transfer of accountability are non-existent. There are no guiding principles for formulating and agreeing to completion criteria, and there exists no legislation in terms of the retention of records and archiving.

These weaknesses were identified as part of the Mining Policy Framework Assessment in Namibia in 2018 (Intergovernmental Forum on Mining, 2018) as an attempt to recommend prioritised improvements. The Government of Namibia recognizes that its existing legislation can be improved and its eager participation in this assessment process reflects a willingness and openness to strengthen the governance of the sector. As the current scenario presents an ongoing challenge to the mining industry in Namibia, mines in Namibia are guided by international standards, their parental companies, and best practices.Guidance on the closure of a uranium mine, for example, is contained in a number of publications by the IAEA. The IAEA guidelines provide a framework within which radiation safety issues at mine closure are to be addressed and dealt with. This involves the setting of reclamation measures through dose assessment by way of site-specific factors, the use of specific criteria to limit radionuclide discharge into water and air, and the use of design and emission standards for tailings impoundments.

Some of the international and industry standards relevant to mine closure planning, consulted in Namibia, include the Strategic Framework for Mine Closure of the Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, and the International Council on Mining and Metals (ICMM) toolkit for planning for integrated mine closure. Mines belonging to global companies, for example, are required to annually provide for the costs of closing a mine, based on the actual disturbance at the reporting date. In terms of compliance with Internal Financial Reporting Standards and the Namibian Companies Act, No. 28 of 2004, mines have a responsibility to review the value of the mine closure provision, which represents the discounted value of the present obligation to rehabilitate the mine and to restore, dismantle and close the mine. The NMCF strongly suggests having a consistent and transparent financial costing and provisioning methodology in place, and advocates detailed closure costing as a prerequisite component of a closure management plan.

## 8.3 LEADING PRACTICE STANDARDS FOR ONGOING POST-CLOSURE MONITORING

### Post-closure monitoring period

The time required for carrying out post-closure monitoring varies from one site to the next. Leading practice indicates that the monitoring period should be long enough to ensure that all slow processes that can impact the site, such as infilling of underground workings and open pits, acid rock drainage, contaminant transport in groundwater, performance of passive water treatment facilities, and other closure structures, are adequately included (Kauppila, 2015). The initial prescribed monitoring period is relatively long and can later be reduced if no alarming trends are detected.

### Documentation of maintenance and monitoring facilities

Adequate documentation of maintenance and monitoring activities, and the performance of post-closure structures, needs to be in place. Documentation shows clear respect and honour to the closure commitments, strengthens the reputation of a company, and is important for the transfer of responsibility.

### Post-closure monitoring of surface and groundwater

Surface and groundwater are monitored after mine closure, to ensure that there is no pollutant discharge into the surrounding environment. If contamination does occur, it can be detected through frequent monitoring and rectified immediately. Adequate background information is an important component for establishing realistic aims and objectives to be met during the closure and rehabilitation.

**THE FOLLOWING BACKGROUND INFORMATION IS REQUIRED (KAUPPILA, 2015):**

- The exact boundaries and magnitude of the surrounding catchment areas
- Nature of the bedrock
- Precipitation
- Surficial and regolith geology
- Hydrology of surface drainage
- Fluctuations in depth and absolute range of the groundwater table
- Whether or not aquifers are present in the area
- Groundwater discharge zone locations
- Results of groundwater investigations carried out in the area
- Status of water prior to the commencement of mining activities
- Use of ground and surface water near the mine site
- Water quality obtained from sampling water under various climatic conditions

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Prior to the preparation of a monitoring plan, the nature of water treatment, drainage systems, and processes should be thoroughly understood.

### Geotechnical surveillance of mine embankments and tailings areas

Geotechnical monitoring is carried out to ensure that the structural integrity of earthworks is maintained according to plan. Monitoring criteria developed during mining can usually be applied to the post-closure phase as well. The design of a geotechnical monitoring plan should be undertaken by accredited specialists. A post-closure surveillance programme is a continuation of the monitoring activities initiated during mining activities, and as such, typical components for routine assessment in this surveillance programme include (Heikkinen, Noras, & Salminen, 2008):

- The determination of the level of pore water and surface water
- The determination of seepage in earthworks and embankments, and the pore water content
- Visual inspection of the overall mine site
- Measurements of potential surface failure and deformation

# AFRITIN MINING LIMITED

is a South African mining company that owns three separate mining licenses (ML 129, ML 133 and ML 134) in the Erongo region, north-western Namibia. AfriTin was established in 2017 and has been listed on the Alternative Investment Market (AIM), submarket of the London Stock Exchange, since November 2017. AfriTin is currently in the process of reopening the Uis Tin Project, once the largest hard-rock tin mine in the world. All construction activities are currently focused on ML 134, incorporating the Uis Tin Project. Mining operations are planned to commence in 2019. All three licenses have historically been exploited to varying degrees.

**LOCATION:**

AfriTin's three mining licenses in the Erongo region, Namibia: ML 129, ML 133 and ML 134.

**BRIEF DESCRIPTION:**

The historic Uis Tin Mine operated between 1958 and 1991 under the ownership of IMCOR Tin (Pty) Ltd, a subsidiary of ISCOR. IMCOR developed the town of Uis and enlarged the mine's capacity becoming the largest opencast hard-rock tin mine in the world in the 1980s. In 1991, the Uis Tin Mine closed due to the collapse in the global tin price.The historic mining footprint of the Uis Tin Mine is approximately 8 km2. AfriTin plans to keep all short-term mining activities within the existing footprint.

AfriTin aims to take advantage of the global tin deficit that has been caused by an increasing tin demand driven by its use in consumer electronics and potential in future technologies. AfriTin is the first and only pure play producing tin company quoted on AIM and once production begins, it aims to fall into the top ten mines in the world (AfriTin mining, 2018). AfriTin is committed to developing the Namibian economy as mining is the economy's biggest contributor.

The tin-bearing cassiterite deposit is hosted within intruded pegmatite bodies. A two-phased development approach has been adopted by AfriTin to utilise the cassiterite deposit and to bring the Uis Tin Mine back into production. Phase 1 of the project involves using a trial processing plant and a 1:1 stripping ratio to produce approximately 65 tonnes of tin concentrate per month. The work completed in Phase 1 aims to enhance operational efficiencies to achieve the estimated production of 780 tonnes per annum and collect information required for the design of the second phase of the project. Milestones to date include the completion of detailed geological mapping, 3D modelling and mine design for the priority V1/V2 pegmatite body.





Phase 2 of the project will involve a full-scale processing plant using a stripping ratio of approximately 1:1.5/2. This stripping ratio will yield approximately 416 tonnes of tin concentrate per month (approximately 5 000 tonnes per annum). Using innovation and new technologies, AfriTin aims to turn a mine that was once deemed non-feasible back into a feasible state.

**THE OVERALL IDEA AND CONCEPTS OF THE TRIAL PROCESSING PLANT:**

AfriTin is committed to establishing a proudly Namibian operation at Uis by appointing local contractors and companies wherever feasible. For Phase 1, AfriTin hired a Namibian based engineering firm to construct and install the crushing equipment for the trial processing plant. A primary jaw crusher has been installed which will feed the crushed material to three screens. Depending on the size of the material, material will either be fed to the secondary, tertiary or quaternary crushers or, if the correct size, will be fed to the Dense Medium Separation (DMS) circuit for beneficiation. The three cone crushers are used to reduce the size of material to the optimal feed size for DMS. Crushing could occur in fewer stages; however, the number of crushing stages was selected to optimize the size range for DMS.

DMS is applied to pre-concentrate; separating minerals of different specific gravities. DMS is being used for beneficiation instead of jigging (which was historically used at Uis). DMS can treat a wider range of material sizes at once, whereas jigging requires many streams that are treated separately, with each stream requiring several stages of jigging. DMS is therefore a more efficient beneficiation process. DMS tests were performed in 2018 using a V1/V2 representative bulk sample of 2 tonnes. Results confirmed the efficiency of DMS to produce a high-grade tin concentrate from the coarse run of mine feed from the Uis pegmatite bodies. The trial processing plant has three DMS sections to maximise tin recovery while optimizing the throughput capacity.

As tantalum has been identified as a potential secondary mineral, a magnetic separation circuit, involving a low intensity magnetic separator (LIMS) and high intensity magnetic separator (HIMS), has been incorporated into the trial processing plant to produce tantalum concentrate in addition to the primary tin concentrate. Filter press systems have been fitted into the trial processing plant to maximise water recovery from the waste and concentrate streams back into the plant. The entire processing plant is a gravity-based system which does not require the use of chemicals and acids for operation.

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**AFRITIN'S ENVIRONMENTAL COMMITMENT:**
Upon embarking on reopening the Uis Tin Mine, AfriTin is entering an area that has previously been degraded through historical exploitation. AfriTin is committed to systematically identifying and examining the risks associated with its activities and operations in Uis and where possible will adopt the necessary mitigation practices to minimise environmental impacts. Through a commitment to protect both the environment and communities in which it operates, AfriTin is demonstrating its commitment to adopting suitable and responsible mining practices. AfriTin has established baseline environmental monitoring at the Uis Tin Mine, this includes the monitoring of surface water, groundwater, noise and air quality.

Uis is situated in the escarpment between the Namib Desert and the Central Plateau. Uis is therefore in a transition zone between a semi-arid (east) and arid (west) climate. Due to these climatic conditions, water is a scarce resource in Uis. The groundwater in the area, however, is brackish and considered unsuitable for consumption by people and livestock. The filter press system will recycle approximately 95% of the water being used in the trial processing plant and is therefore a critical component in reducing water loss. Waste disposal is planned to occur within three of the pre-existing waste rock dumps therefore no additional land will be used for waste disposal.

PART NINE

# RELINQUISHMENT

The terms for relinquishment involve proving that closure objectives have been met. Prior to relinquishment, sign off should be obtained from the involved stakeholders and the various authorities involved. The management and maintenance of the mine site after relinquishment rests with the subsequent land owners. After the sign-off has occurred, the mine is able to transfer liabilities to the succeeding owners.

## 9.1 PREPARING FOR RELINQUISHMENT

Relinquishment should indicate that the closure objectives have been met, as required by the relevant authorities and stakeholders. The Environmental Management Act, No. 7 of 2007, the Minerals (Prospecting and Mining) Act, No. 33 of 1992, and the Minerals Policy of 2002, set out requirements for mineral licence holders with regards to closure obligations.

A detailed relinquishment process is required to be put in place. Accountability reverts to the authorities or the subsequent land owners once relinquishment has been granted. An agreement must, however, first be reached with the organs of state responsible for relinquishment prior to closure, with regards to residual liability.

## 9.2 COMPLETION CRITERIA

Completion criteria are dependent on the nature of the mining operation and may differ from one mine site to the next. The completion criteria should be developed through stakeholder engagement and should be quantitative (where possible), whilst meeting the objective verification during the review and auditing process. The completion criteria need to be based on the following:

- Research outcomes
- The identified closure objectives (closely associated with the consultation process with stakeholders)
- The post-closure intended land use, and the site-specific post-closure conditions required for socio-economic stability

The completion criteria should be met, in order to achieve the satisfactory transition of former mine employees to alternate livelihoods. Best practices involve having ongoing stakeholder engagement throughout the mining life cycle, to ensure that the expectations for post-closure land use and the socio-economic objectives are aligned. During the planning process, an agreed mechanism should be established regarding the modification and periodic review of the completion criteria.

KPIs and targets should be established. Indicator assessment allows the mines to establish progress on achieving the agreed socio-economic and environmental performance conditions. The setting of performance targets aids in demonstrating the achievement of objectives.

## 9.3 FORMAL APPROVAL FOR RELINQUISHMENT

Once the mine meets the required completion criteria and objectives to the satisfaction of the relevant authorities, relinquishment is in the form of a final mine closure certificate. For relinquishment, the following need to be completed:

- Documentation indicating a detailed account of the entire implementation process
- An acceptable outcome from a mine closure audit or review has been achieved
- The holder of the licence has been issued with a mine closure certificate
- The issuing of the mine closure certificate has been discussed with the stakeholders
- A records retention strategy has been employed

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ENVIRONMENTAL
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*Authors of this publication*
Contact details:
+264 81 669 7608
info@eccenvironmental.com
www.eccenvironmental.com