BEST PRACTICE GUIDE

ENVIRONMENTAL PRINCIPLES FOR MINING IN NAMIBIA

Setting the Namibian best practice standard for the entire mine life cycle from exploration, projects & construction, mining & processing, through to care & maintenance, closure & rehabilitation.

A joint publication proudly published by the Chamber of Mines (CoM), Namibian Chamber of Environment (NCE), the Namibian Government and members of the Namibian mining industry.

Ministry of Mines & Energy

Namibian Chamber of Environment

Republic of Namibia
Ministry of Environment & Tourism

ACKNOWLEDGEMENTS

This Best Practice Guide was developed through extensive engagement with government and industry, along with expertise from consultants and specialists who availed their time to make this publication possible. The following organisations contributed substantially to the development of the Best Practice Guide, and without their expertise, this publication would not be possible.

	Ministry of Mines and Energy The Ministry of Mines and Energy provided indispensable input, in terms of government expectations for bi-annual reports, as well as for permit and licence obligations throughout the mining life cycle.
Republic of Namibia Ministry of Environment & Tourism	**Ministry of Environment and Tourism** The Ministry of Environment and tourism provided input with regard to streamlining government expectations for bi-annual reporting with industry standards.
Ministry of Agriculture, Water & Forestry	**Ministry of Agriculture, Water and Forestry** The Ministry of Agriculture, Water and Forestry provided input on permit obligations during the mining life cycle phases.

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.

Otjikoto Gold Mine

Case studies supplied:

- Corporate social responsibility
- Rehabilitation

DEBMARINE Namibia

Case studies supplied:

- Environmental monitoring

Dundee Precious Metals Tsumeb

Case studies supplied:

- Air quality monitoring
- Community health and safety
- Water quality monitoring

Namdeb

Case studies supplied:

- Biodiversity monitoring
- Concurrent rehabilitation
- Heritage

NamPower – Namibia Nature Foundation Partnership

Case studies supplied:

- Powerline monitoring

Namibian Uranium Association

Case studies supplied:

- Namibia's uranium SEA

Skorpion Zinc

Case studies supplied:

- Water management

SWAKOP URANIUM	**Husab Mine** Case studies supplied: – Airborne contaminants, noise and vibration – Tailings management – Water quality monitoring
orano	**Desalination Plant** Case studies supplied: – Securing a mine’s water supply

FOREWORD

This Best Practice Guide was produced in collaboration with key stakeholders, including the Chamber of Mines (CoM), the Namibian Chamber of Environment (NCE), the Namibian Government, and members of the Namibian mining industry

Namibia is rich in a variety of mineral deposits such as zinc, gold, uranium and diamonds, some of which are considered world-class deposits. The Namibian Government recognises the importance of prospecting and mining in the social and economic development of the country, as enunciated in the National Development Plan. Equally important, is ensuring safe and environmentally sound practices in the mining sector, whilst using leading practices to warrant the responsible and sustainable development of mineral resources.

The term 'best practice' refers to a methodology or practice that, through research and experience, has demonstrated desirable outcomes. The Best Practice Guide for mining in Namibia, highlights leading practices in social, economic and environmental aspects throughout all facets of the mining life cycle, namely exploration, projects and construction, operations, and mine closure and completion.

The Namibian mining industry strives to play an active role in the pursuit of sustainable development, by implementing leading environmental practices in their operations. Through the implementation of leading practices, exploration and mining companies can maintain a good relationship with regulators, lawmakers, and the communities in which they operate.

This guide is aimed at assisting the Namibian mining industry in the responsible development of mineral resources, by delivering practical mining solutions and by benchmarking best practices from companies who conform to sound environmental and social principles.

Pohamba Shifeta, MP

MINISTER OF ENVIRONMENT AND TOURISM

Tom Alweendo, MP

MINISTER OF MINES AND ENERGY

BEST PRACTICE GUIDE

ENVIRONMENTAL PRINCIPLES FOR MINING IN NAMIBIA

OVERARCHING CHAPTER

Setting the scene. What you need to know before you start mineral development in Namibia.

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DEFINITIONS AND ABBREVIATIONS

AMV	African Mining Vision
AU	African Union
CoM	Chamber of Mines
DEA	Directorate of Environmental Affairs
DWAF	Department of Water Affairs and Forestry
EA	Environmental Assessment
ECB	Electricity Control Board
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EMP	Environmental Management Plan
EPL	Exclusive Prospecting Licence
EQOs	Environmental Quality Objectives
GSN	Geological Survey of Namibia
I&AP	Interested and Affected Parties
MARC	Minerals Ancillary Rights Commission
MAWF	Ministry of Agriculture, Water and Forestry
MDRL	Mineral Deposit Retention Licence
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
ML	Mining Licence
MLIREC	Ministry of Labour Industrial Relations and Employment Creation
MME	Ministry of Mines and Energy
MoHSS	Ministry of Health and Social Services
NCE	Namibian Chamber of Environment
NEPL	Non-Exclusive Prospecting Licence
NGOs	Non-Governmental Organisations
NHC	National Heritage Council
NRPA	National Radiation Protection Authority
NUA	Namibian Uranium Association
NUI	Namibian Uranium Institute
RL	Reconnaissance Licence
SEA	Strategic Environmental Assessment
SEMP	Strategic Environmental Management Plan
SME	Small-Medium-sized Enterprise

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FIGURES

1 ESTABLISHING A BEST PRACTICE GUIDE FOR MINING IN NAMIBIA

This Best Practice Guide was produced in collaboration with key stakeholders, including the CoM, the NCE, the Namibian Government, and members of the Namibian mining industry.

Given the enormity and complexities of the mining sector, and the importance that the mining sector plays in the Namibian economy, it is vital that key stakeholders work together to ensure that the sector can continue to develop in a sustainable way, in order to secure and protect the future of the sector and ensure long-term success and sustainability in perpetuity.

Engaging with authorities and regulatory bodies was a crucial part of the formulation of the Best Practice Guide. This allowed relevant information to be captured and incorporated into the guide, as well as identifying key issues to be addressed and improved across the mining industry. The Ministry of Mines and Energy (MME) and the Ministry of Environment and Tourism (MET) provided indispensable input in developing this Best Practice Guide.

The Namibian Chamber of Environment and the Namibian Chamber of Mines provided both technical and financial support in developing this guide, which was supported by the chambers' members, whose technical assistance and input provided paramount contributions towards developing this Best Practice Guide.

1.1 WHAT IS BEST PRACTICE?

The term 'best practice' refers to a methodology or practice that, through research and experience, has demonstrated desirable outcomes (Rouse, 2018), and has become a standard way of doing things because it is compliant, ethically correct and generally accepted as better than any proposed alternatives. Put differently, these are leading practices that are based on repeatable procedures, which have proven themselves most effective over time.

1.2 PURPOSE AND SCOPE OF THE BEST PRACTICE GUIDE

The purpose of this document is to serve as a guiding framework during all phases of the mining life cycle in Namibia. By highlighting the best practices that have proven to be effective in the Namibian context, this guide will assist the mining sector in effectively addressing potential challenges, such as environmental and social impacts, and developing joint action engagement that is best suited to specific circumstances. Companies in the mining industry that conform to sustainable environmental and social principles, were selected for benchmarking best practices and are highlighted throughout this guide.

This Best Practice Guide highlights leading practices in social, economic and environmental aspects of mining operations in Namibia. Leading practices demonstrated at various mines, as well as international best practices, have been used to develop solutions and to formulate "Namibian standards", which can be applied to all exploration and mining companies in Namibia.

The document provides a clear indication of all regulatory requirements during all phases of the mining life cycle, thereby creating a shared sense of risk, responsibility and benefit to guide operators and shareholders, regulators and authorities, stakeholders and non-governmental organisations (NGOs), and Interested and Affected Parties (I&APs). Although the focal point of this guide is mineral prospecting and mining, many of the principles contained herein can be applied elsewhere, and other sectors may also find the guidelines presented here, to be insightful and useful.[1]

1.3 How Case Studies are Used

The case studies used in this Best Practice Guide were obtained from various Namibian mines who have demonstrated commendable practices in key areas of environmental, economic and social aspects pertaining to sustainable resource development. The mines were selected based on their key performance areas, and are used for benchmarking best practices that can be applied throughout the mining life cycle, from exploration through to mine closure and completion.

1.4 The Best Practice Guide and the Mining Life Cycle

All development projects have a life cycle; a beginning and an end. Mining projects have a life cycle too, and the total lifetime is normally limited to a few decades. During its lifetime, a mine has distinctive phases: exploration (and prospecting), feasibility, planning and design, construction, commissioning, operation, decommissioning, and completion.

For practical purposes, this Best Practice Guide divides the mining life cycle into four prominent phases: Exploration (which includes prospecting); Projects and Construction (comprising the feasibility, planning and design stages, as well as infrastructure development); Operations (starting with commissioning and continuing with the processing and extraction stages); and Closure and Completion (the phase ending with decommissioning and eventual relinquishment).

This Best Practice Guide has been set out with key chapters and sections, to guide the reader directly to information of importance and relevance, as set out in Figure 1.

[1] This guide has not been developed to capture the regulatory framework for petroleum exploration or operations; these activities are governed specifically by the Namibian Petroleum Acts and licences and are not part of the scope of this guide.

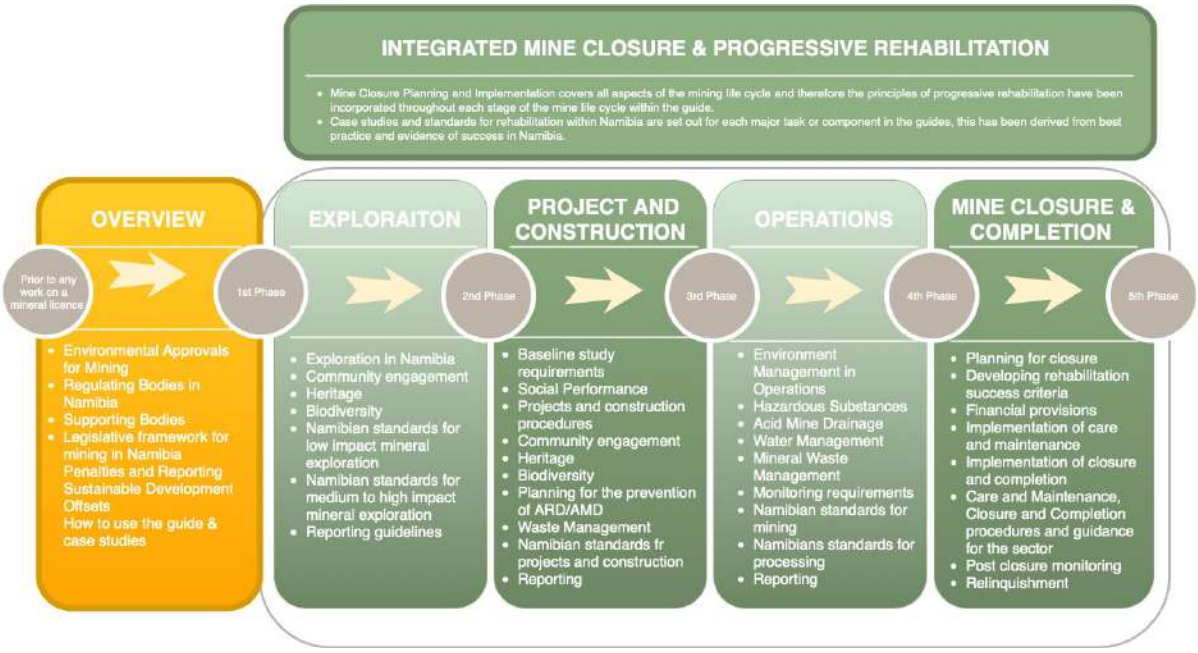

FIGURE 1 - KEY CHAPTERS AND SECTIONS TO GUIDE THE READER THROUGHOUT THE GUIDE

1.5 THE BEST PRACTICE GUIDE AND THE RISK MANAGEMENT PROCESS

Mining is inherently risky. All phases of the mining life cycle are infused with a certain level of risk, and how these risks are addressed often determines the success of a project.

Extensive work has been conducted around the globe, in order to understand and assess the risks within the mining sector—most notably the work conducted in the EU and the ICMM, in the development of the Metals Environmental Risk Assessment Guidance (MERAG) publication. The MERAG project was initiated in 2004 to consolidate the science of determining and assessing the risks associated with the minerals and metals sector. This is not repeated here, but these documents can be consulted at https://www.icmm.com/merag. Other useful resources can be found on the internet, including a publication on risk management, which is part of the "Leading Practice Sustainable Development Program" series of handbooks of the Australian Government (https://www.industry.gov.au), for the mining industry.

The types of risks can be broadly grouped together, however risk assessments and the management of risks, should be site specific. Even though risk assessments are often similar in nature, a risk assessment might not necessarily be suitable for one site, compared to another. There isn't a one-size-fits-all approach. Extensive work has been conducted and published in terms of providing generic frameworks for the identifying, analysing, evaluating, registering (or listing), managing (or treating), monitoring, reporting, updating, and communicating of risk, (ICMM, ISO 31000:2018, IFC and EU risk management standards, to name a few).

Sound principles of risk management should be a core process throughout all phases of the mining life cycle. This risk management section is applicable to all phases covered within this best practice guide. It is a systematic, holistic process. During the exploration phase, for example, risk may arise from geological, environmental, social and economic aspects. During the operational phase, risk is associated with community, health, safety, environment, compliance and reputation; the closure phase, again, will involve risks related to community, compliance and reputation. The risk groups might be very similar, but the specific nature of the risks vary and require separate analysis and control.

This section provides practical risk management guidance for the mining industry, and outlines common risks affecting the industry. Risks applicable to each phase of the mining life cycle are set out within the respective chapter, for example, exploration risks are discussed in the exploration chapter. Examples of risk management tools are also provided, and may be used to assess and manage risks.

Effective risk management can minimise the potential for a project or operation to suffer unplanned and unwanted events and outcomes. When applied well and transparently, it can:

- Protect financial performance
- Maintain the health, safety and well-being of employees, communities and the environment
- Build confidence with internal and external stakeholders
- Secure the legal and social licences to operate

1.5.1 DIFFERENT APPROACHES, ONE UNDERSTANDING

Risk is defined as an uncertain event or condition that, if it occurs, will affect the achievement of one or more objectives. It is measured in terms of the likelihood of an occurrence and its potential consequences, and is assigned an overall risk classification accordingly. Likelihood can vary between rare, unlikely, possible, likely, and almost certain. Different consequence types can be applied, for example, financial (capital or operating costs, project schedules, annual production or annual revenue, investments or business value, and resources or future business value), health, safety, on-site and off-site environments, social, cultural/heritage, community, stakeholders, authority, media, corporate knowledge, reputation, security, or compliance, to describe the outcome in terms of insignificant, minor, moderate, major, or catastrophic results.

Distinction can be made between inherent risk (raw risk rating as originally identified before controls have been considered in the assessment) and predicted or residual risk (the risk remaining if proposed controls are implemented). The analysis of risk indicates threats and opportunities, and implies specific actions in terms of controls. To reduce negative risk or enhance positive opportunities, a control (any process, policy, device, practice or other measure) is required. The source of potential harm, or a situation with the potential to cause actual or perceived loss or damage to people, the environment, the plant, equipment, customer expectations, or product quality, is called a hazard.

Typical objectives of the risk analysis process are to identify the hazards, potential threats and subsequent risks of a project, to rank and prioritise the risks through an assessment process, and to evaluate the risks for the purpose of determining management and mitigation measures. Typical hazards can include: environmental and economic conditions, which are variable and unpredictable;

threats to humans and facilities; impacts on the environment, communities or neighbouring land; and threats related to hazardous materials and dangerous goods.

Risk assessment can be done at three levels – firstly to intuitively identify the hazards; secondly to qualitatively describe the risks; and thirdly to deductively quantify the risks. The risk management process is furthermore based on an identification of causes (triggers/indicators), and impacts (results or consequences). Further classification of causes and impacts is possible, for example, between low, moderate, high, or critical, or between severity, duration, spatial scale, probability, and significance. By using these categories, the risk assessment process helps to determine the severity of the risk, to evaluate the effectiveness of control measures, to identify the actions to be taken to control the risk, and to stress the urgency for actions to be completed.

If levels of uncertainty can't be robustly qualified, the Precautionary Principle is adopted. This is done, in order to avoid a scenario where a lack of full scientific certainty is used as a reason for postponing the implementation of mitigation and management measures. Another relevant principle is the 'As Low As Reasonably Practicable' (ALARP) concept, which can assist in identifying and ranking potential risks according to the ability of the operation to manage the risk.

Ultimately, risk management aims to significantly reduce the likelihood of risks, to eliminate high and critical risks, and to manage moderate and low risks. Classification of risk is thus directive for the process of managing risks. Low risk, for example, indicates a rating below a threshold, and does not require active intervention; moderate requires active monitoring; high risk exceeds the threshold and requires proactive management; and critical risk implies that the threshold has been significantly exceeded and requires immediate and focused action.

Risk planning can be incorporated into a monitoring program by developing a risk register for each stage of the mining life cycle. This allows for the easier identification of risks and controls at each stage during the mining life cycle, and the risk registers can be updated as the project advances. Reviewing risks is of critical importance, and it is imperative that risk assessments are a continual iterative process, conducted throughout the mining life cycle. Assignment to risk owners is essential. The risk owner is accountable for the overall management of the hazards in his work area, and all of the contributing risk scenarios associated with it. The risk owner has to ensure that the controls are in place, the risk is communicated, and that any identified treatment/improvement measures are incorporated into the relevant operational plans.

There are various risks associated with the mining life cycle—relevant risks for this guide can broadly be categorised as: Health and Safety Risks, Environmental Risks, Community Risks, Compliance Risks, Production Risks, Reputation Risks, and Closure and Post-closure Risks. Table 1 describes these broad categories of risks.

TABLE 1 – CATEGORY OF RISKS

TYPES OF RISK	DESCRIPTION
Workplace Health and Safety Risks	Health and safety risks are often put together, but present different challenges to management. Safety risks are associated with acute consequences, ranging from a minor injury requiring first aid treatment, to a fatality, thus varying from relatively low-consequence events that may occur quite frequently, to rare but potentially catastrophic events that may occur occasionally. Health risks may result from single events, or multiple exposures leading to acute or chronic illness or disability, sometimes only materialising over long time periods, and can easily be overlooked in the urgency to manage more immediate concerns.
Environmental Risks	Mining activities can pose significant impacts to the environment. They may be direct, such as dust and noise generation, water pollution and spills, waste disposal, or infrastructure development. They may also be indirect, such as the use of water, habitat fragmentation, and air pollution. Environmental impacts may vary widely in terms of spatial scale, duration and severity.
Community Risks	Community risks include both direct influences on local populations and neighbours, and multiplying effects on society. Direct impacts range from issues such as access to resources, to the potential displacement of people. Impacts are interlinked to health, safety and the environment, and can be immediate or long-term. In-migration of workers is a typical multiplying impact, resulting in health, social, and economic issues in society.
Compliance Risks	Many risks are closely coupled to regulation. Failure to comply with regulatory requirements creates serious consequences, including protracted permitting time frames, prosecution, enforced shutdown, endless disputes, and production and reputation damage. Failure to recognise new and emerging regulatory requirements can limit an operation's agility and ability to adapt to change. Regulation reflects public expectation, which can escalate to local, national, and even international repercussions.
Production Risks	Production risks relate to production volume or product quality and, ultimately, the costs and revenue streams of the business. Although largely economic, these risks can have social and environmental compliance issues too. Similarly, many factors may affect production (for example, weather conditions, workers unrest, and extra taxation, etc.).
Reputation Risks	Reputation risks, in many cases, are knock-on consequences from many other risks. Ineffective risk management may have negative impacts on reputation, even resulting in premature cessation, permanent business damage, lawsuits, or even an inability to maintain the social licence. Effective risk management, on the other hand, is likely to create a positive reputation, access to markets, and new opportunities for growth.
Closure and Post-closure Risks	Closure and post-closure risks entail several economic and non-economic consequences, many of them long-term and multifaceted. Closure is a process that implies long-term planning, and if it is done well, can prevent huge costs, opposition and protracted relinquishment. Ultimately, a closure strategy should aim at leaving positive and enduring legacies, instead of lingering and contentious unfinished business.

2 SUSTAINABILITY

2.1 SUSTAINABLE DEVELOPMENT IN THE MINING INDUSTRY

Mining has always been a critical sector of the Namibian economy. In earlier years, mining was the single largest component of the Namibian economy, accounting for nearly 40% of the GDP. Although this figure has declined, mining still accounts for more than 12% of the GDP, and on average around 50% of exports annually, as well as employing roughly 3% of the formal labour force in Namibia. Mining generates a significant amount of revenue for the country, through a variety of mechanisms, including taxation (corporate, income, VAT), royalties, fees and equities. The more indirect socio-economic impacts of mining in Namibia are multiple and even more impressive, by providing livelihoods to many families and reasoning the existence of several towns (Oranjemund, Rosh Pinah, Uis, Tsumeb, and Arandis). Mines thus have a tremendous socio-economic influence in Namibia. On the other hand, the environmental footprint of individual mines—although concentrated, intense and visually striking—is relatively small in surface cover, compared to other industries.

Continuous exploration for commodities—albeit at varying intensity over the years—and the apparent wealth produced by a number of prominent mines during the last century, fostered the view that Namibia is rich in minerals, and that Namibia's mineral assets form a major source of national wealth. In recognition of the importance of the mining industry towards social and economic development in Namibia, the State strives to establish the country as Africa's most attractive mining environment, through conducive legislation related to land access, tenure and tax. Technical infrastructure is continuously improved, and an excellent range of high-quality geological information is available to exploration companies, including a geological archive that is one of the most extensive in Africa, and incorporates a complete inventory of previous exploration work that stretches back almost a century, with the results from modern surveys.

The principles of sustainable development in the mining sector of Namibia are becoming increasingly important, as mining companies are placing emphasis on operations that are environmentally sound, socially responsible and technically feasible. The reputation of mining companies as responsible corporate citizens, with a strong sustainable development agenda, has become increasingly important, to ensure a social licence to operate, to attract and retain employees, and to stimulate prosperous relationships with service providers and customers, authorities, the media, stakeholders, and all affected and interested parties.

One way of achieving sustainable development in the mining industry, is offsetting and reinvesting the benefits realised from extracting mineral assets.

2.2 NAMIBIAN SUSTAINABLE DEVELOPMENT OFFSETS

Traditionally 'offsets'—specifically biodiversity offsets—are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse impacts arising from development plans or projects, after appropriate prevention and mitigation measures have been taken. The aim of biodiversity offsets is to achieve no net loss, and preferably a net gain, of biodiversity on the ground, with respect to species composition, habitat structure, ecosystem function, and people's use and cultural values associated with biodiversity.

The Namibian mining sector, in response to a request from the Ministry of Mines and Energy, have developed a blueprint for sustainable development offsets, linking offsets to non-mining regions across Namibia. In this context, sustainable development offsets encompass all facets of the environment, including the biophysical, social and economic environments.

Sustainable development, as defined by the United Nations, recognises that strong economies depend on equitable societies and a healthy environment. At a minimum, efforts to strengthen the national economy through industries such as mining, should not jeopardise the environment or perpetuate social inequalities. The Namibian Mining sector aims to go further than complying with these minimum requirements, and their vision is to "…be widely respected as a safe, environmentally responsible, globally competitive and meaningful contributor to the long-term prosperity of Namibia."

Offset schemes in other countries focus on biodiversity conservation, mainly by buying and protecting land of high biodiversity value, to make up for land lost to mining. In Namibia, 17% of the land is formally protected by the state, and over 26% is managed through the communal and freehold conservancy system. In contrast, mining operations directly impact <1% of Namibian land. The offset scheme for Namibia is therefore designed to address more pressing socio-economic needs in the country than land acquisition for conservation—namely, sustainable development.

The new Strategy and Action Plan takes the mining sector's contribution further and expands its strategic impact by implementing a national offset scheme, whereby the mining industry can contribute to sustainable development projects throughout Namibia. Aside from mining companies maintaining their local contributions to society and the environment, the mining companies have committed to contributing to a central offsets fund, jointly managed by the Chamber of Mines and the Namibian Chamber of Environment.

The new offsets scheme will focus on supporting projects in non-mining regions of Namibia, which previously have seen little benefit from the mining industry. In rural areas, the scheme will focus on communal conservancies, as they are integral to the sustainable development plans for Namibia. The committee also recognises the needs of urban areas, which continue to struggle with rapid urbanisation and the resulting social and environmental challenges. The environmental committee reviews all potential projects using a standard list of criteria (see below), and provides recommendations for funds to be disbursed from the offsets account.

In 2018, the first year of the scheme, N$1,360,000 was granted by the mining sector to fund two sustainable development projects. This was seen as a start-up year to test and fine-tune the approach and allow everyone to become comfortable with the process.

Sustainable development projects applying to the offsets scheme must meet these twelve criteria.

Evaluation checklist criteria
1. Non-mining area?
2. Promotes sustainable development?
3. Supports national development priorities?
4. Priority for local community?
5. Has support of local, regional and/or national government?
6. Clear benefits to poor?
7. Investment has clearly defined output/product?
8. Initiative has clear and credible budget?
9. Implementation process is clear and credible?
10. Project is potentially catalytic in terms of expansion and co-funding?
11. Project has no perceived environmental, social or economic risks?
12. There is an own contribution?

The sustainable development offset programme is in its early stages of development; it will be refined and continually improved throughout the implementation phase.

2.3 Legislative And Regulatory Frameworks

This section aims to highlight the statutory framework applicable to all phases of the mining life cycle. The mining sector in Namibia is principally governed by the Minerals (Mining and Prospecting) Act of 1992, however several other Acts and Policies pertaining to the mining sector are discussed in this section.

The following factors are especially relevant to the context of the Namibian mining industry: existing bodies of legislation acknowledge the importance of the principles of public participation in decision-making that affects 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 into Namibia; and the protection of the environment for current and future generations – in accordance with Namibia's constitution.

The African Mining Vision (AMV) was adopted in 2009 by the African Union (AU) Heads of State, with the focus of integrating mining into development policies at local, national and regional levels. It is a developmental approach for growth through the building of socio-economic linkages, to the benefit of Africa.

Although no legislative framework is contained in the African Mining Vision, it is based on the rationale that mining can better contribute to local development in Africa by ensuring that workers and communities obtain real benefits from large-scale mining projects, while securing the protection of the environment at the same time. This approach establishes a platform for negotiating contracts with mining multinationals, to generate fair resource rents and stipulate local inputs for operations at a regional level, integrating mining into national industry and trade, as well as sustainable development agendas.

2.4 The Constitution of the Republic of Namibia, 1990 (amended 1998)

Namibia's constitution was adopted in 1990, prior to independence. The constitution contains several articles relevant to the country's natural resources and the mining sector. Article 100 of the Constitution of the Republic of Namibia states that "*all-natural resources below and above the land and in the continental shelf and within the territorial waters shall belong to the state*" unless otherwise lawfully owned. The maintenance and protection of ecosystems, ecological processes, and biodiversity 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 ...*"

In addition, Article 15 prohibits the employment of children under 14 years in a mine, and prohibits children under sixteen from doing hazardous economic exploration work.

2.5 Minerals (Prospecting and Mining) Act, No. 33 of 1992

The Minerals (Prospecting and Mining) Act, No. 33 of 1992 is the central piece of legislation governing the mining sector in Namibia. Subsequent to the passing of the Act, mining rights are vested in the state and not in the landowners. The rights and obligations of mineral licence holders and the role of the Minerals Ancillary Rights Commission (MARC) are outlined in the Act, along with details of how the sector is to be administered. Included in the Act is information on penalties for non-compliance and also information on royalty rates.

Section 48 of the Act stipulates that an EMP is one of the conditions of a Mining Licence 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). The Act does not deal specifically with mine closure in Namibia, although reference is made to mine closure arrangements, such as notices that need to be given to the relevant minister, and 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 54). Section 130 of the Act states that mining companies have a general duty of environmental care, and are expected to practice continuous rehabilitation at their own cost and to arrange immediate clean-up in cases of spills or other forms of pollution.

2.6 MINERALS POLICY OF NAMIBIA, 2002

The Minerals Policy was adopted in 2002, and sets guiding principles and direction for the development of the Namibian mining sector, while communicating the values of the Namibian people. It sets out to achieve several objectives in line with the sustainable development of Namibia's natural resources. The Policy strives to create an enabling environment for local and foreign investments in the mining sector, and seeks to maximise the benefits for the Namibian people from the mining sector, while encouraging local participation, amongst others. It furthermore stipulates that mine closure should be properly planned and "*form part of an integrated land use strategy involving engagement with communities*", and encourages the alternative use of land through rehabilitation, as well as the use of remaining infrastructure for on-going economic benefits.

Moreover, the objectives of the Minerals Policy are in line with the objectives of the national development agenda, which includes the reduction of poverty, employment creation and economic empowerment in Namibia.

2.7 ENVIRONMENTAL MANAGEMENT ACT, NO. 7 OF 2007

Namibia's Environmental Management Act, No. 7 of 2007 provides a framework for conducting environmental assessments as well as the implementation of monitoring and auditing measures. Associated Regulations of the Act were promulgated in 2011 only, replacing the Environmental Assessment Policy for Sustainable Development and Environmental Conservation of 1994.

The regulations govern the environmental issues associated with the mining life cycle. This includes exploration, construction, production, closure and completion, as well as post-closure. Regulation 29 (List of Activities that may not be undertaken without an environmental clearance certificate) of the Act outlines a number of listed activities that require an Environmental Clearance Certificate. Outlined in the Act are the steps and conditions that must be met in order to grant an Environmental Clearance Certificate. These steps include preparing an initial Scoping Report and

Environmental Management Plan (EMP). In the event that significant impacts are expected, an Environmental Impact Assessment (EIA) is also required. A valid Environmental Clearance Certificate is required upon application for a mineral licence(s) and for licence renewals.

The regulations also provide clear reference regarding the compilation and implementation of rehabilitation and closure plans, and Section 31 of the regulations outlines particularly details about the content of a rehabilitation or closure plan. The Act states that applications for Environmental Clearance Certificates should be accompanied by environmental rehabilitation, restoration, decommissioning and aftercare plans; a financial guarantee to cover the costs that may occur as a result of environmental impacts; as well as a financial guarantee to cover the costs envisaged from decommissioning, rehabilitation, reclamation, restoration, and aftercare, based on an approved work plan that is reviewed annually.

2.8 Namibia's Environmental Assessment Policy for Development and Environmental Conservation, 1994

This Policy provides guidance for the promotion of economic growth and sustainable development, while ensuring environmental protection in the long term.

Section 5 of the Policy states that the proponent is required to enter into a binding agreement (based on the procedures and recommendations contained in the EIA report) to ensure that the mitigation and other measures recommended in the EIA, are accepted by all parties and fulfilled. This agreement should address the construction, operational, and decommissioning phases in the mine closure process, as applicable, as well as its monitoring and auditing.

2.9 Water Resources Management Act, No. 11 of 2013

Although the Water Resources Management Act, No. 11 of 2013 has been promulgated, regulations in the new Act are absent. By implication, the Water Act, No. 54 of 1956 is still relevant. The latter deals with issues associated with water pollution and abstraction. The same Act requires the fencing of land on which tailings and waste rock are deposited, and that the subsequent use of such land requires the prior approval of the regulatory authority, i.e. the Ministry of Agriculture, Water and Forestry. Post-closure water quality management is implied by the same Act, as well as the Water Resources Management Act, No. 11 of 2013. 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 as a result of seepage. In addition, the new Act includes aspects such as the licencing of water use, prevention of water pollution, protection of water resources, efficient use of water, water conservation measures, and the safety of dams.

2.10 Atomic Energy and Radiation Protection Act, No. 5 of 2005

The Atomic Energy and Radiation Protection Act, No. 5 of 2005 deals with radiation protection, including protection on mines, as well as the permitting, auditing and safeguarding facilities that are used in the handling and final disposal of radioactive materials in Namibia. Regulations of the act came into operation in January 2012. The Act makes provision for the adequate protection of the environment and people (in current and future generations), against the harmful effects of radiation, by controlling and regulating the production, processing, handling, use, storage, transport, and disposal of radiation sources and radioactive materials. In the regulations, reference is made to the decommissioning and handling of radioactive waste, as well as the keeping of health records for each employee "*until the person to whom the record relates has or would have attained the age of 75 years but in any event for at least 50 years from the date of the last entry made in it*."

In contrast to the clear guidelines applicable to the operational phase of a uranium mine by the Namibian Atomic Energy and Radiation Protection Act, No. 5 of 2005, the accompanying regulations do not specifically refer to the closure of uranium mines. Regulation of radiation exposure falls under the jurisdiction of the National Radiation Protection Authority (NRPA), which was established in 2009 and is currently situated at the Ministry of Health and Social Services. Since then, mines have been required to compile and implement a Radiation Management Plan (RMP) according to guidelines supplied by the NRPA. The RMP is approved by the NRPA and audited annually. Each operation has to report uranium exports and worker exposures to the NRPA twice per year. The transport, storage and/or possession of radioactive materials is subject to permission by the NRPA.

2.11 Labour Act, No. 11 of 2007

The Labour Act, Act 6 of 1992 came into operation in 1992, and a comprehensive set of legal rules covering the health and safety of employees at work came into operations in 1997. On the 31st of December 2007, the new Labour Act, Act 11 of 2007, was promulgated in Namibia and came into operation on the 1st of November 2008. The regulations of 1997 remain valid. The Labour Act, Act 11 of 2007 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, as well as requirements for severance payments and other benefits. These aspects apply also in the case of mine closure.

2.12 Biodiversity-Related Legislation

Biological diversity (biodiversity in short) is described as the variety of different types of life on Earth, which includes all organisms, species and populations, and describes the genetic variations among these, and their complex assemblages of communities and ecosystems (Benn, 2010). Biodiversity is about the variety of life—variations within species present in different ecosystems, genetic variation, ecosystem variation, and the number of species (species variation). To comprehend biodiversity in totality, one needs to understand the variety of species, the different habitats, the spatial arrangements and patterns that constitute the habitats, and all the factors that affect the species, the habitats and ecological processes as a whole.

The Convention on Biological Diversity aims to pursue the conservation of biological diversity and the sustainable use of its components. Namibia signed the treaty on biological diversity in 1992 and ratified it in 1997. In essence the work done in Namibia since 1992 introduced appropriate procedures for conducting environmental impact assessments of projects that are likely to have significant adverse effects on biodiversity, with a view to avoiding or minimising such effects, to provide an opportunity for a more positive approach in impact assessments, and to identify opportunities for enhancing biodiversity. Some key principles endorsed in Namibia include: the protection of sensitive habitats; the maintenance of species and ecological processes, such as surface hydrology and groundwater movement; the prevention of secondary impacts and unnecessary collateral damage; monitoring; the avoidance of adverse impacts on biodiversity, wherever possible; and rehabilitation where avoidance is not possible. Although the implementation of these principles depended on voluntary commitment by all parties, and as such has relatively little legal standing, by virtue of its topic, it stands central to the identification and assessment of (biodiversity) impacts, and to devising ways to manage these.

Plant species are protected by various mechanisms in Namibia, including the Nature Conservation Ordinance No. 4 of 1975 and the Forest Act No. 12 of 2001, as amended in 2005. The latter aims to maintain biological diversity and to use forest produce in a way that is compatible with the forest's primary role as the protector and enhancer of the natural environment. The Act also requires the removal of any living tree, bush or shrub growing within 100 meters of a river, stream or watercourse, to be done under the auspices of a permit issued by an appropriate official from the Directorate of Forestry. In August 2015, the regulations of the Act were promulgated. Included in the regulations, is a list of protected plant species for Namibia, which replaces the list of the Forestry Act No. 72 of 1968.

The Nature Conservation Ordinance No. 4 of 1975, as amended, provides for the declaration of protected areas and for the specific protection of scheduled species where they occur. A permit from the Ministry of Environment and Tourism is required for the removal or destruction of protected species. Species and numbers/quantities involved need to be specified. The conservation of terrestrial birds and animals in Namibia is governed by this legislation.

All of Namibia's national protected areas were proclaimed under the Ordinance, enacted by the previous South African colonial administration. Although the Ordinance sets a framework for establishing state-protected areas, and for regulating hunting and other wildlife uses, both within and outside conservation areas, it is outdated and suffers from shortcomings such as unclear management objectives and harmonised management objectives with adjacent land units.

In 1998, parks were opened for prospecting activities. A white paper for Mining and Prospecting in Protected Areas and National Monuments (1999) was drafted, which underlines the importance that mining-related activity in protected areas is only initiated when rehabilitation is assured. This Policy identifies critical biodiversity areas and recognises that mining, and the land uses within protected areas, will continue to interact. Although the Policy does not offer strict guidelines for regulators to implement, it recognises the right of the State to issue mining and prospecting licences in protected areas and aims to promote responsible mining in Namibia. Furthermore, the Policy aims to find a sustainable manner for the coexistence of mining and tourism in protected areas, and provides guidelines for exploration and mining companies wishing to operate within a protected area. A need for inter-sectoral cooperation where mining and prospecting is allowed in parks, is emphasized.

2.13 National Heritage Act, No. 27 of 2004

Heritage could potentially be impacted by various activities during the mining life cycle. Heritage refers to the legacy of intangible attributes as well as physical artefacts of Namibian society inherited from past generations, maintained in the present generation, and preserved for the benefit of future generations (National Heritage Council of Namibia, 2018). "Heritage significance" includes cultural, historical, social, scientific, aesthetic, archaeological, and architectural significance, according to the National Heritage Act, No. 27 of 2004. Heritage includes objects (archaeological artefacts, palaeontological and rare geological specimens, meteorites, and many other objects that hold cultural significance), places (immovable assets or resources such as structures or archaeological and palaeontological sites), tangible (such as recorded historical information) and intangible cultural attributes (such as unrecorded information, songs, music, drama, skills and crafts passed on orally).

Namibia is fairly rich in sites of cultural and natural heritage importance; therefore prior to the commencement of any mining activity, it is crucial to identify heritage resources in and around the project area. Archaeological sites in Namibia are protected under the Act, which makes provision for the archaeological assessment of large projects such as mining. The Act provides for the protection and conservation of places and objectives of significance, as all archaeological and palaeontological objects belong to the state. Section 55 of the Act compels exploration companies to report any archaeological findings to the National Heritage Council, after which a heritage permit needs to be issued, which is required when disturbing any heritage resource. The competent authority is the National Heritage Council. If any archaeological sites will be disturbed and/or destroyed, they will be subject to a routine survey. This information will be used to apply for the necessary permits that are required in terms of the Act.

The following heritage-related impacts are relevant throughout the mining life cycle:

- Disturbance or damage to heritage sites causes a loss of cultural worth or historical and scientific information about the past and potential damage to local and national cultural identity
- Access to currently used heritage sites might be lost or impacted
- Changes to the setting of a heritage site causes potential damage to local and national cultural identity and values
- A loss of cultural knowledge and activities causes the potential loss of cultural identity and cohesion
- Infringement of cultural norms can cause offence to local communities and the possible exacerbation of social impacts, and create unnecessary negative sentiment towards a project

Specialist archaeological assessments were conducted as part of the overall environmental assessments of mining projects since the Act came into use. These assessments were also done as a precautionary principle, in respect of public concern, and to make decisions that considered the interest, needs and values of stakeholders.

3 REGULATING AUTHORITIES AND SUPPORTING INSTITUTIONS

The Namibian minerals sector is regulated by several governing bodies, as set out in the following section. These regulating bodies each have a distinctive role in the minerals sector, relating to the sustainable development of mineral resources, the protection of the environment, and ensuring compliance to regulatory requirements. In addition, a number of supporting institutions exist, the assistance of which, during the various phases of the mining life cycle, might be vital.

The role of these bodies is discussed in this section and their contact details are contained in Table 2.

TABLE 2 - CONTACT DETAILS OF RELEVANT AUTHORITIES

ORGANISATIONS	POSTAL ADDRESS	TELEPHONE	WEBSITE
Ministry of Mines and Energy	Private Bag 13297 Windhoek	+264 (0)61 284 8111	http://www.mme.gov.na
Ministry of Environment and Tourism	Private Bag 13306 Windhoek	+264 (0)61 284 2111	www.met.gov.na
National Heritage Council	Private Bag 12043 Ausspannplatz	+264 (0) 61 244 375	www.nhc-nam.org
Ministry of Labour, Industrial Relations and Employment Creation (MLIREC)	Private Bag 199005 Windhoek	+264 (0) 61 210 047	www.mol.gov.na
Association for Local Authorities in Namibia	P.O. Box 2721 Windhoek	+264 (0) 61 240 915	www.alan.org.na
Ministry of Trade and Industry	Private Bag 13340 Windhoek	+264 (0) 283 7334	www.mti.gov.na
Ministry of Health and Social Services	Private Bag 13198 Windhoek	+264 (0) 61 203 9111	www.mhss.gov.na
Electricity Control Board (ECB)	ECB House, 8 Bismarck Street Windhoek	+264 (0) 61 374 300	www.ecb.org.na
Chamber of Mines	PO Box 2895 Windhoek	+264 61 23 7925	www.chamberofmines.org.na
Namibian Chamber of Environment	PO Box 40723 Ausspannplatz Windhoek	+264 61 240 140	www.n-c-e.org
Telecom Namibia	PO Box 297	+264 61 201 921	www.telecom.na

ORGANISATIONS	POSTAL ADDRESS	TELEPHONE	WEBSITE
	Windhoek		
Anti-Corruption Commission	PO Box 23137 Windhoek	+264 61 435 4000	www.accnamibia.org

3.1 Ministry of Mines and Energy

The Namibian mining sector is governed by the Ministry of Mines and Energy (MME). MME regulates the mining industry through the administration of the Minerals Act. The three mining-focused directorates are:

- Geological Survey of Namibia (GSN)
- Directorate of Mines
- Directorate of Diamond Affairs

The MME's mandate is to attract private investment in resource exploration and development through the provision of geological and geochemical information on minerals and energy resources, as well as through the management of an equitable and secure system of licences for the mining, energy and geothermal industries. The regulatory role is principally the assessment of applications, the issuing of licences, and the auditing of exploration projects and mines.

3.2 Ministry of Environment and Tourism

The Ministry of Environment and Tourism (MET) consists of three departments through which it enforces and develops environmental legislation and policy. These departments are the Department of Environmental Affairs (DEA); the Department of Natural Resources Management; and the Department of Tourism, Planning and Administration. Each department of the MET plays a distinctive role.

The Environmental Commissioner serves as head of the DEA, and the main role of the DEA is to encourage environmental sustainability across the private sector, all other ministries, and non-governmental organisations. The DEA consists of three divisions namely:

- Division of Environmental Assessment, Waste Management and Pollution Control
- Division of Environmental Information and Natural Resource Economics
- Division of Multilateral Environmental Agreements

The DEA is also responsible for administering the environmental impact assessment process and the granting of Environmental Clearance Certificates. Furthermore, the DEA ensures compliance of mining companies to EIA-related obligations through regular monitoring and inspection, which allow them to maintain their exploration or mining licences.

3.3 MINISTRY OF AGRICULTURE, WATER AND FORESTRY

The Ministry of Agriculture, Water and Forestry (MAWF) promotes efficient and sustainable socio-economic development for a prosperous Namibia, by ensuring that resources are sustainably and equitably used for improved livelihood, well-being and wealth for all Namibians. This is achieved through the promotion, development, management, and utilisation of Agriculture, Water and Forestry resources.

Relevant to the mining industry, is that the abstraction and use of controlled water sources (surface and groundwater), and discharge of wastewater, is administered by the Department of Water Affairs and Forestry (DWAF). DWAF is responsible for the issuing of such permits, and for conducting inspections of all the development sites that abstract/discharge water for their activities. Furthermore, the removal of any living tree, bush or shrub growing within 100 meters of a river, stream or watercourse, has to be done under to auspices of the Directorate of Forestry, and a permit issued by an appropriate official of the Directorate is required, prior to the removal of such plants.

3.4 NATIONAL HERITAGE COUNCIL

The National Heritage Council is an organisation established under the National Heritage Act, No. 27 of 2004, which replaced the National Monuments Council. This body is responsible for safeguarding the nation’s natural and cultural heritage through sharing the benefits of Namibia’s heritage and growth in the distinct cultural individualities.

All mineral exploration and mining activities to be undertaken, must therefore take cognisance of the conditions stated in the Act, by conducting a heritage assessment for the purpose of legal compliance and the preservation of heritage artefacts.

3.5 MINISTRY OF LABOUR INDUSTRIAL RELATIONS AND EMPLOYMENT CREATION

The ministry’s mandate is to guide labour relations, employment and social protection services in Namibia, as per the Constitution of the Republic of Namibia. Productivity, an effective labour force, the maintenance of harmonious industrial relations, decent working conditions, equality of opportunities, and fairness for all, are some of the priorities for the ministry, which are based on the following directives:

- The Labour Act, 2007 (Act No. 11 of 2007)
- Affirmative Action (Employment), 1998 (Act No. 29 of 1998)
- Social Security Act, 1994 (Act No. 34 of 1994)

3.6 LOCAL AND REGIONAL AUTHORITIES

Prospective and mining companies should make it a priority to involve and engage the local authority in the respective town and region in which they operate, with special emphasis on community empowerment, employment, waste management, and heritage and cultural aspects.

Although the Association of Local Authorities in Namibia is an overarching body that represents all local authority members with the aim of advocating, promoting, and assisting socio-economic development and sustainability, it would be advisable to approach the local (and regional) authority directly for collaboration and the building of good relations.

3.7 TRADITIONAL AUTHORITIES

It is the mandate of the Ministry of Regional and Local Government and Housing to spearhead decentralisation in Namibia, and to involve the relevant local and regional population groupings through its Directorate of Regional and Local Government and Traditional Authority Coordination in this regard.

Namibia straddles both traditionality and modernity, attaching great importance to its traditional leaders for development within their respective communities. Thus, the ministry realises the importance of traditional leaders in Namibia, and recognises that the role of these leaders should be increased under the decentralisation approach.

Furthermore, it is factual that chiefs/heads play a crucial role as far as the governance of their local communities is concerned, and organisations that blindly undervalue their potential, will reach a dead end. Exploration and mining companies should consult with the local population, through their traditional authority, prior to and during all phases of the mining life cycle, to ensure good collaboration and the building of healthy relations.

It is advisable to be familiar with arrangements of the traditional authority in the area of operation, and to be in close contact with the relevant leadership.

3.8 MINISTRY OF TRADE AND INDUSTRY

The Ministry of Industrialisation, Trade and SME (Small and Medium Enterprise) Development is responsible for developing and managing Namibia's economic regulatory framework, and for promoting economic growth and development through the invention and implementation of suitable policies with the view of attracting investment, increasing trade and development, and expanding the country's industrial base.

3.9 MINISTRY OF HEALTH AND SOCIAL SERVICES

The Atomic Energy and Radiation Protection Act, No. 5 of 2005 provides the mandate of the Directorate of Atomic Energy and Radiation Protection within the Ministry of Health and Social Services. Instruments are implemented by the National Radiation Protection Authority (NRPA) and Nuclear Applications divisions in the directorate, to govern the handling of radioactive material. Functions of the NRPA include:

- Monitoring the radiation occupational exposure of persons and the environmental radiation levels
- Inspection at intervals, as may be necessary, of any radiation source or nuclear material, in order to assess radiation safety conditions and other requirements imposed by or under the Act

- Launching, implementing and maintaining a register of radioactive materials, imported into, or produced in, Namibia and of premises licenced to install, store and use radiation sources or dispose of radioactive waste

Functions of the Nuclear Applications department include:

- Developing and implementing policies, strategies and regulatory standards
- Facilitating compliance with the obligations of Namibia under international agreements relating to nuclear energy, nuclear weapons and protection against the harmful effects of radiation
- Providing secretariat support to the Atomic Energy Board

3.10 Electricity Control Board

The Board aims to exercise control over, oversee, and regulate the Namibian energy industry in a sustainable manner, for the interest of all stakeholders with regards to the pricing, quality, reliability, and safety of electricity. Its main functions include the managing of licences and the provision of expert advice on electricity production and supply. In addition, the department of regulatory support services ensures that regulated aspects within the electricity industry are operating in accordance with the set objectives and performance frameworks. Monitoring of these areas ensures growth and financial health, as stipulated by the Board, and as guided by the Electricity Act of 2007. As part of its directive, the Board is responsible for making recommendations to the MME with regard to the issuing, transferring, amendments, renewal, and cancellation of licences.

No person should carry on or generate, transmit, distribute, supply or import electricity unless you have a licence.

Apply for a licence today with the Electricity Council Board!

3.11 Chamber of Mines

The CoM was formed in 1969, with the sole mandate being to promote the sustainable growth of exploration and mining, in order to maximise economic gain while protecting the interests of its members. The CoM is a non-profit organisation, which acts as an advocacy body and serves as a voice for the mining industry to authorities. The CoM is governed by a prudent Code of Conduct and Ethics, which authorises the organisation to expel non-compliant members.

The mission of the CoM is to "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".

3.12 Namibian Chamber of Environment

The Namibian Chamber of Environment is a non-governmental membership-based organisation, established as a voluntary association and body corporate, separate from its members under Namibian Common Law. Its members constitute the "Council"—the highest decision-making organ of the NCE. The NCE's objectives are to conserve the natural environment, and to protect, promote and support efforts to reduce environmental degradation and pollution. Operationally, the NCE sets out to represent its member's interests, to consult and engage on policy and law, to build skills, and facilitate improved environmental practices across Namibia.

The core values of the NCE are based on upholding principles for sustainable use, the protection of biodiversity, compliance, and developing best environmental practices to protect the environment in all its forms, including the physical, social and economic environments.

A unique partnership between the mining and environmental sectors was initiated in June 2017, when the Chamber of Mines and the Chamber of Environment co-organised and facilitated the first ever workshop for those working in the environmental departments of mining companies in Namibia. The Chamber of Mines Environmental Committee was established in 2017, as a result of this workshop.

The Chamber of Mines Environmental Committee developed the National Environmental Strategy and Action Plan, which was unanimously adopted by the Council of the Chamber of Mines in September 2017. This strategy provides clear guidance for actions to be taken for the period 2017-2020, falling under eight focal areas identified by the workshop participants.

To drive these actions, the Chamber of Mines established a sub-committee dedicated specifically to environmental issues, which includes the director of NCE, a representative of the Ministry of Environment and Tourism (MET), and a representative of the Ministry of Mines and Energy (MME).

3.13 Namibian Uranium Association

The NUA is the advocacy body that represents the Namibian uranium industry exclusively. Members of NUA include all Namibian uranium mining operations, most of Namibia's leading uranium exploration companies, and associated contractors. The NUA promotes industry's adherence to strong sustainable development performance, product stewardship, and compliance with the

Namibian legislative framework, and seeks to balance environmental protection values with exploration for and mining of uranium.

3.14 ANTI-CORRUPTION COMMISSION

The Anti-Corruption Commission (ACC) is an independent agency recognised by an Act of Parliament, the Anti-Corruption Act (No. 8 of 2003), to combat and stop corruption in Namibia. As the leading agency in Namibia that investigates corruption offences, the ACC is accountable for acting to prevent corruption in public, as well as private bodies, and to ensure that offenders are brought to justice.

4 NAVIGATING APPROVALS

The process of obtaining approvals for mineral licence applications can be very tedious if the correct documents are not supplied along with the application submission. This section discusses the various approvals, licences, permits and authorisations required, in order to conduct mining and exploration activities in Namibia, along with the relevant Ministries to be consulted, to obtain these approvals.

4.1 Permits for the Mining Life Cycle

This section sets out the permits required during the various stages of the mining life cycle. Although the particular legal and regulatory requirements with regard to the quarrying and mining of sand, aggregate and gravel is slightly different, many of the permit requirements are similar.[2] The relevant permits must be obtained prior to commencing with activities. The permits are activity specific and details on the permit application process and relevant ministries are outlined in this section. Implied permits are shown in Table 3.

TABLE 3 - RELEVANT PERMITS FOR THE MINING LIFE CYCLE

PERMITS	ACT	RELATED ACTIVITIES REQUIRING PERMITS	RELEVANT MINISTRY	LINK
Environmental Clearance Certificate (renewal every 3 years)	Environmental Management, Act No. 11 of 2011	Required for all operations and processing activities	MET	Form 1
Application for permission to remove controlled minerals or the sale or disposal of any minerals; required in terms of Section 16(4), 31(4)(b), 67(4) or 90(3) of the Minerals Act – **A high-value mineral permit** – **Export permit** – **Transportation Permit**	The Minerals (Prospecting and Mining), Act No. 33 of 1992	– Processing of high-value minerals – Transportation and export of minerals mined for further processing	MME	
Application for permission to export minerals, required in terms of Section 127 of the Minerals Act	The Minerals (Prospecting and Mining), Act No. 33 of 1992	Required during operations and processing activities	MME	

[2] The legislative and regulatory frameworks relevant to sand, aggregate and gravel quarrying and mining are discussed in Section 5.2

PERMITS	ACT	RELATED ACTIVITIES REQUIRING PERMITS	RELEVANT MINISTRY	LINK
Permit for borehole	Permit is issued under the Water Act No. 54 of 1956 (enforced)	Required before the drilling of boreholes for abstraction of water	MAWF	Form WA-001
Permit/licence to utilise a controlled water resource	Permit is issued under the Water Act No. 54 of 1956 (enforced), and the Water Resources Management Act, No. 11 of 2013	For water abstraction for operations and processing of mineral ore	MAWF	WA-002
Tailings waste disposal permit	– Permit is issued under the Water Act No. 54 of 1956 (enforced) – The Water Resources Management Act, No. 11 of 2013	Required for disposal of tailings effluent/waste water	MAWF	
Waste water discharge licence issued in terms of the Water Act of 1956	Permit is issued under the Water Act No. 54 of 1956 (enforced) but the form of the Water Act No. 24 of 2004 is used	Required for treatment and discharge of waste water for the duration of mine life cycle	MAWF	DWA_EFF PER
Domestic and industrial waste water and effluent disposal exemption permit	Permit is issued under the Water Act No. 54 of 1956 (enforced)	Required for disposal of mine domestic and industrial effluent	MAWF	
Forest licence for harvesting, issued under (section 22, 23, 24, 27 and 33/ regulation 8 and 12)	– The Forest Act No. 12 of 2001. – Policy for Prospecting and Mining in Protected Areas (PA) and National Monuments (1999)	Required for clearing of vegetation before earthworks in preparation of infrastructure	MET	
Permit for destruction of heritage objects and artefacts	The Heritage Act No. 27 of 2004	Destruction of heritage artefacts during site layout or operational phase of a mine	NHC	
Radioactive Authorisation (import and export) for the use of radioactive source for logging in accordance with Sections	– Atomic Energy Radiation Protection Act No. 5 of 2005 – Radiation Protection and Waste Disposal	Required for used of radioactive substance, e.g. mining activities for uranium	MoHSS: National Radiation Protection Authority	

PERMITS	ACT	RELATED ACTIVITIES REQUIRING PERMITS	RELEVANT MINISTRY	LINK
17(1), 19(1), 21(1) of the Atomic Energy and Radiation Protection Act	regulations (No.221 of 2011)		(NRPA)	
Continuous operations permit	Labour Act No. 11 of 2007	For continuous operations and permit for working in continuous shifts	MLIREC	

4.2 SAND, AGGREGATE AND GRAVEL QUARRYING AND MINING

Aggregate refers to naturally occurring material, which may include sand, gravel and crushed stone used for the construction industry. It is a significant contributor to the construction of roads, railways, and buildings, and it is also extensively used in the mining sector at times.

Namibian legislative and regulatory frameworks, which govern the regulation of quarrying/mining of sand, aggregate and gravel, have several weaknesses; the main reason being that aggregate is not listed as a commodity in the Minerals (Mining and Prospecting) Act, No. 33 of 1992, despite the fact that the Act gives provision to the Minister to determine that sand, aggregate and gravel quarrying and mining are subject to mining licences and mining claims.

The Environmental Management Act, No 7 of 2007 captures quarrying as a listed activity, which requires an EIA and subsequently an Environmental Clearance Certificate. Unfortunately, there is no specific licencing procedure in place for the quarrying/mining of sand, aggregate and gravel in Namibia, although several permits are implied before a proponent can start with sand, aggregate and gravel quarrying and mining. This includes permission from the land owner (local authority, private owner or Land Board/Traditional Authority in the case of communal land), and approvals from various authorities, such as the MET (Environmental Clearance Certificate), MME (Mining Licence) and MAWF (Approval to mine sand, rocks or gravel from a watercourse).

For example, in Windhoek, aggregate quarrying within the municipal boundaries is regulated through a provisional policy dated June 2017, titled “City of Windhoek’s Policy Towards Sustainable Sand Mining”. This policy provides guidelines for operators when applying for permits for quarrying aggregate in the area under the auspices of the City of Windhoek.

Moreover, it means that the quarrying/mining of sand, aggregate and gravel is not exempted from legal and regulatory requirements. The most significant requirement hereof, is an Environmental Impact Assessment and subsequently an Environmental Clearance Certificate, as the quarrying/mining of sand, aggregate and gravel in Namibia is a listed activity that requires such an assessment and certificate, according to the Regulations of the Environmental Management Act, No 7 of 2007.

4.3 Penalties for Non-Compliance

To carry out exploration or mining in Namibia, strict compliance to regulatory requirements is required from all mining and exploration companies. To ensure adherence, the government maintains a database displaying all records of companies operating in the country - if issues of non-compliance are recorded, companies do not only tarnish their corporate image, they face the risk of having their licences revoked or their licence renewals declined.

All companies are therefore urged to ensure the necessary permits and licence requirements are met, as discussed below, to avoid non-compliance.

4.4 Corruption and Bribery

In the event that any persons are suspected of being guilty of corruption, involving but not limited to the bribery of government officials, such persons shall be investigated by the Anti-Corruption Committee (ACC) and may face heavy penalties or fines and imprisonment.

4.5 How to Avoid Delays

The application for mineral licences can be a rather lengthy process; the estimated time periods for obtaining feedback, are shown in Table 4.

TABLE 4 - APPROXIMATE TIME IT TAKES TO GET FEEDBACK ON LICENCE APPLICATIONS

TYPE OF APPLICATION	TIME IT TAKES TO GET FEEDBACK
Non-Exclusive Prospecting Licence (NEPL)	– One (1) day after an application is received
Reconnaissance Licence (RL)	– 3-4 months
Exclusive Prospecting Licence (EPL)	– 3-4 months
Mineral Deposit Retention Licence (MDRL)	– 3-4 months
Mining Licence (ML)	– 6-12 months

When applying for mineral licences, a smoother process can be expected when the following is ensured:

- The required documents and paperwork for the requested licence are in order, as per the Minerals Act of 1992, and submitted with the application
- Most recent contact details are provided
- Timely responses are provided (If additional information is requested from the MME or MET)

4.6 Application Forms and Web Links

To apply for an exploration or mining licence, the application forms can be found on the MME's website. Table 5 provides the links for downloading the application forms.

TABLE 5 - APPLICATION FORMS AND WEB LINKS FOR MINERAL LICENCES

LICENCE TYPE	APPLICATION LINK
NEPL	http://www.mme.gov.na/forms
EPL	
RL	
MDRL	
ML	

4.7 Mineral Licence Penalties

In the event that the holder of a mineral licence(s) fails to comply with sections relating to the abandonment of reconnaissance, prospecting or the reconnaissance area, the holder of such licence(s) may be fined or risk imprisonment. The requirements for mineral licence holders with regards to this matter, are outlined in the Minerals Act of 1992 and are dependent on the type of licence. Throughout the guide, fines and penalties relating to the discussed subject matter are outlined.

4.8 Environmental Approvals

4.8.1 Obtaining an Environmental Clearance Certificate

Prior to the commencement of an exploration and mining project, there are certain environmental requirements that the exploration/mining companies need to comply with.

ENVIRONMENTAL REQUIREMENTS

The Environmental Management Act, 2007 stipulates that an Environmental Clearance Certificate is required to undertake listed activities under the Act and associated regulations. Listed activities typically triggered by exploration and mining activities, in accordance with the Act and supporting regulations, are as follows:

MINING AND QUARRYING ACTIVITIES

(3.1) The construction of facilities for any processes or activities that require a licence, right, or other form of authorisation, and the renewal of a licence, right, or other form of authorisation, in terms of the Minerals (Prospecting and Mining Act), 1992.

(3.2) Other forms of mining or extraction of any natural resources, whether regulated by law or not.

(3.3) Resource extraction, manipulation, conservation and related activities.

Several listed activities are triggered when developing a mineral project, therefore the list above is not exhaustive.

In accordance with the Environmental Management Act, 2007, an Environmental Impact Assessment (EIA) of a proposed project is required, and a subsequent report needs to be submitted as part of the application for Environmental Clearance.

A requirement under section 31 of the Act and Regulation 8(1)(a) is the completion of Form 1 as shown in Appendix A. In the event that the anticipated impacts are not severe, a scoping report and an EMP has to be submitted to the competent authority, along with Form 1. For high-impact exploration and mining projects, a scoping report, full EIA, and Form 1 are likely to be required to be submitted to the competent authority during the application for an Environmental Clearance Certificate.

An Environmental Clearance Certificate is valid for a period of 3 years, after which a renewal is required. Form 2 should be submitted to government upon request for renewal; Form 2 is shown in Appendix B.

The Environmental Management Act 7 of 2007 (enforced) has undergone extensive review and stakeholder revision during the course of 2018. The proposed changes to the Environmental Management Act No. 7, 2007 (EMA), and the Environmental Impact Assessment Regulation, 2007 (No. 30 of 2011) gazetted under the Environmental Management Act No. 7 of 2007 (EMA), (referred to herein as the EIA Regulations) and the proposed Strategic Assessment (SEA) Regulations.

Minor amendments to the EMA are proposed. The proposed changes to the EMA include provisions for the use of Strategic Environmental Assessments (SEAs), which could be considered at a sector level or region level, to avoid the piecemeal approach to EIAs for mineral licences.

Changes to the environmental clearance certificate process and listed activities are the most significant changes as set out below. Furthermore, the changes propose that all clearance certificates will now include a detailed set of licence/permit conditions that must be complied with.

Furthermore, slight changes have been made to the format of the application for an Environmental Clearance Certificate, making it more efficient to use (Appendix C). Similarly, there has been an introduction of an application for the amendment of the renewal of an Environmental Clearance certificate (Appendix C). This helps the Environmental Commissioner in determining whether Environmental Clearance can be renewed without any further information or not, and will be included in form 2 of the Act.

Amendment to the EIA regulations have included provisions for categorising Listed Activities. At the time of writing this best practice guide, the proposed changes separate listed activities into two schedules:

- **Schedule A - Listed Activities:** A significant impact is likely, due to the nature of the listed activity, and an EIA is required in every case.
- **Schedule B – Listed Activities:** If a project meets the thresholds and is likely to result in a significant impact, an EIA is required. If a project meets the thresholds, but does not result in likely significant impacts, the project could be screened out, with an appropriate screening letter to the MET. Projects listed in Schedule B, which are located in, or partly in, a sensitive area, also need to be screened, even if they are below the thresholds or do not meet the criteria.

In addition to the proposed changes, several amended forms are proposed, and these additional forms are attached in Appendix C as follows:

- Form 3: For amendments to conditions of the Environmental Clearance Certificate
- Form 4: To be completed for the transfer of an Environmental Clearance Certificate
- Form 5: An issue and response template
- From 6: Form to be completed when the Environmental Commissioner forwards an application for environmental clearance to a competent authority and for response by the competent authority

4.8.2 Environmental Impact Assessment Process

The first stages of the EIA process are to register the project with the competent authorities and to undertake a screening exercise. The screening exercise determines whether the proposed project is considered as a Listed Activity in terms of the Environmental Management Act, 2007 and associated regulations, and if significant impacts may arise. During this process, the location, scale and duration of project activities are considered against the environment, to determine the approach to the EIA.

The proponent should be acquainted with the regulatory arrangements in terms of the supply of bulk services such as water and electricity, as well as the implied application processes (see also Table 3).

The EIA process in Namibia is shown in Figure 2.

Before You Start With Exploration / Mining Activities:

Make sure that you have conducted an Environmental Impact Assessment process and that you have an Environmental Clearance Certificate issued by the Ministry of Environment and Tourism.

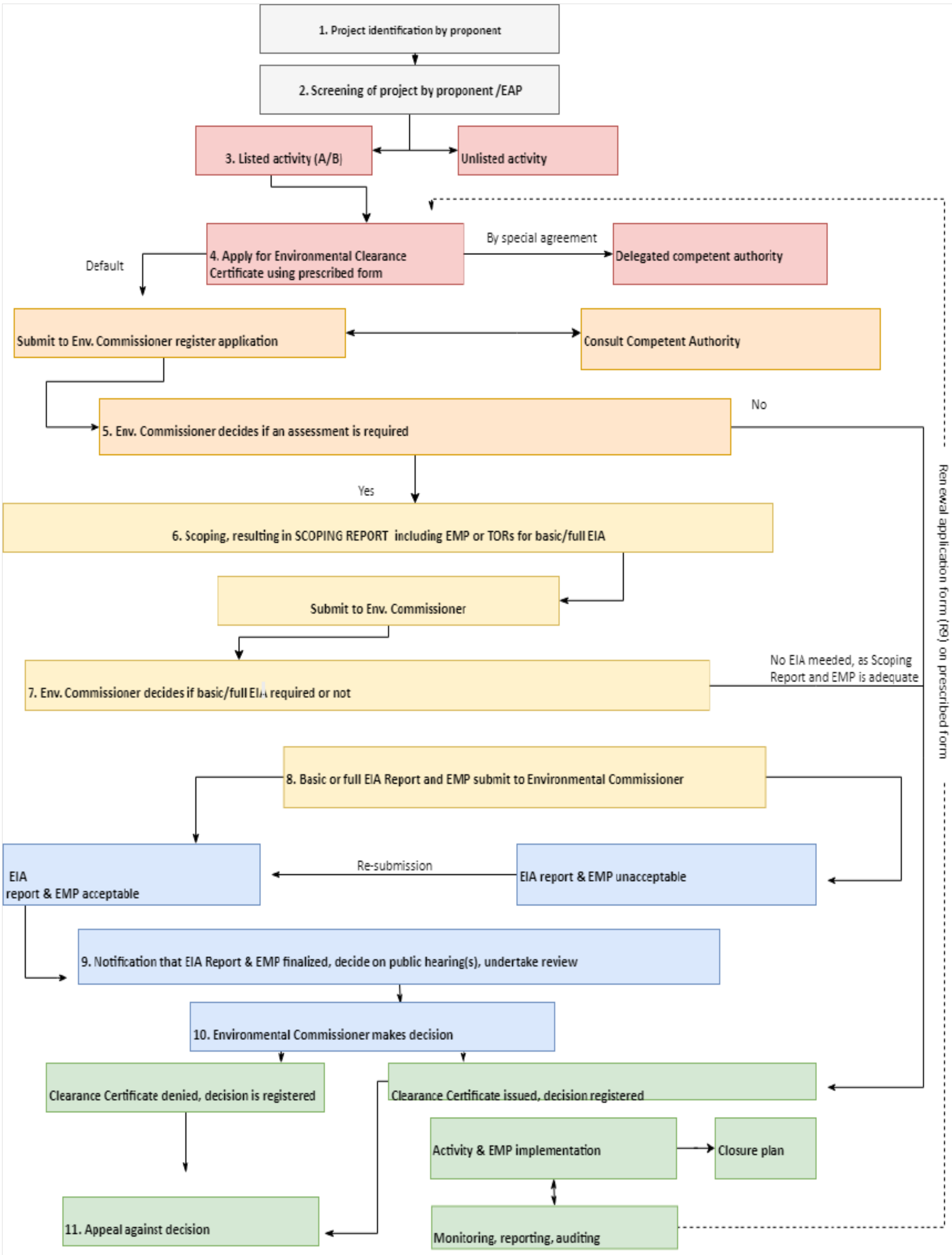

FIGURE 2 - EIA PROCESS IN NAMIBIA (WILL BE RECREATED BY GRAPHIC TEAM AND INTERACTIVE)

The relevant authorities involved during the approval stage for exploration and mining are outlined in Table 6, along with the minimum conditions that need to be met. Additional conditions are outlined in the Minerals (Mining and Prospecting) Act of 1992.

TABLE 6 - NAVIGATING APPROVALS DURING THE MINING LIFE CYCLE

PHASES OF MINING CYCLE	RELEVANT MINISTRY	LICENCES	DURATION	CONDITION
Mineral Exploration	– Ministry of Mines and Energy – Ministry of Environment and Tourism – Ministry of Agriculture, Water and Forestry	– Non-Exclusive Prospecting Licence (NEPL) – Exclusive Prospecting Licence (EPL) – Reconnaissance Licence (RL) – Mineral Deposit Retention Licence (MDRL)	– NEPL is valid for 6 months and is non-renewable – EPL is valid for a period of three years with the possibility of extension twice for two-year periods if evident progress can be shown	NEPL: – Applicant should be at least 18 years old EPL: As above, plus: – Namibian citizen
Projects and Construction	– Ministry of Environment and Tourism – Ministry of Agriculture, Water and Forestry – Ministry of Mines and Energy	– Mining Licence (ML)	– ML gives the holder an exclusive mining right in the licence area for a period of 25 years with renewals valid for 15 years. The holder should be able to demonstrate the technical and financial ability to operate a mine	As above, plus: – Environmental Clearance Certificate – Approved Environmental Management Plan – Mining licence Refer to Table 3 for additional activity specific permits required.
Mining and Processing	– Ministry of Mines and Energy – Ministry of Environment and Tourism – Ministry of Agriculture, Water and Forestry	– Mining Licence (ML)	– ML gives the holder an exclusive mining right in the licence area for a period of 25 years with renewals valid for 15 years. The holder should be able to demonstrate the technical and financial ability to operate a mine	As above, plus: – Environmental Clearance Certificate – Approved Environmental Management Plan – Mining licence Refer to Table 3, for additional activity specific permits potentially required.

5 REPORTING

Namibian reporting requirements for exploration and mining companies are outlined in the Minerals Act of 1992. Reports submitted to the authorities allow for the transparency of an operation, and enable the State to monitor several aspects of the operation, including environmental damage, exploration activities, rehabilitation, and the status of compliance of exploration and mining companies. Any specific reporting requirements for proponents are stated within each guide. During the projects and development or operational phase of a mine, the proponent is the holder of a Mining Licence (ML), and as such, the reporting requirements for an ML are applicable. Reports are to be submitted to the Mining Commissioner during the periods shown in Table 7.

TABLE 7 - REPORTING PERIOD DEPENDENT ON MINERAL LICENCE TYPE

TYPE OF LICENCE	REPORTING PERIOD
Non-Exclusive Prospecting Licence	– Upon request from Commissioner
Reconnaissance Licence (RL)	– Within 60 days after the end of the currency of the RL
Exclusive Prospecting Licence (EPL)	– Quarterly – Within 60 days after the end of the currency of the EPL
Mineral Deposit Retention Licence (MDRL)	– Within 60 days after the end of the currency of such MDRL
Mining Licence (ML)	– Monthly – Annually (60 days before the 31st of December)

5.1 Reporting and Auditing Requirements in Protected Areas

The following requirements apply when carrying out prospecting and mining operations in a protected area in Namibia, in accordance with the Minerals Policy of Namibia of 2000 and the whitepaper on Mining and Prospecting in Protected Areas and National Monuments of 1999:

- The Directorate of Mining (the Mining Commissioner) and the Directorate of Environmental Affairs (the Environmental Commissioner) shall be provided with a report every 6 months. Both directorates are at liberty to conduct inspections at any time, to monitor the compliance of mining companies with conditions set out in the EIA, EMP and Environmental Clearance Certificate, along with any other stipulated conditions
- In addition to inspections conducted by the authorities, a technical committee will be established, to conduct inspections on mines situated in protected areas. The committee will include officials from the MET, MME and Ministry of Fisheries and Marine Resources (MFMR)
- The Directorate of Mining and the Directorate of Environmental Affairs shall conduct an annual audit on MLs/EPLs in protected areas. An independent expert may also be commissioned to conduct the audit at the licensee's cost.

5.2 Penalties for Non-compliance During Reporting

The consequences for non-compliance to the reporting requirements are listed in the Minerals Act of 1992. These consequences are dependent on the licence type.

*Carrying out exploration and mining activities without a licence(s) is an offence, and you may be subject to a fine of **N$ 100,000** or imprisonment of up to 5 years, or both.*

6 CASE STUDY – A COMMODITY-BASED EXAMPLE OF BEST PRACTICE

The Namibian Uranium Association (NUA) has developed a strategic approach on environmental assessment and management. The NUA is the advocacy body that represents the Namibian uranium industry exclusively. Members of NUA include all Namibian uranium mining operations, most of Namibia's leading uranium exploration companies, and associated contractors. The NUA promotes the industry's adherence to strong, sustainable development performance, product stewardship, and compliance with the Namibian legislative framework, and seeks to balance environmental protection values with exploration for, and mining of, uranium.

Product stewardship is a pillar that supports the overarching concept of Sustainable Development. Product stewardship ensures that business management focuses simultaneously on economic development, environmental impact management and social responsibilities. NUA members accept the responsibilities of uranium stewardship through building partnerships throughout the life cycle of the product, to ensure that production, use, and disposal are consistent with global sustainable development goals.

As part of its stewardship mission, the NUA has established the Namibian Uranium Institute (NUI). The mission of the NUI is to support the Namibian uranium exploration, mining and export industry through continuous development of health, environmental, and radiation safety best practices, accessible research, training, and social responsibility. The NUI also acts as a communication hub for the Namibian uranium industry. The NUI ensures adherence to strong, sustainable development performance through compliance, and indeed, active participation in the Strategic Environmental Assessment (SEA) of the Namibian Uranium Province conducted in 2009/10 and the subsequent Strategic Environmental Management Plan (SEMP) implemented by the Namibian Ministry of Mines and Energy. This SEA/SEMP process is characterised by the following key issues:

- The Uranium SEA was the first study of its kind in the world
- It was proposed by the industry, but conducted by the government, to ensure credibility
- It was an entirely voluntary exercise, as no legislation was in place at the time
- It addressed the cumulative impacts of all the uranium activities in a holistic way
- It identified issues that would not have been detected by individual project EIAs
- It allowed for proper planning informed by the SEA, identification of synergies amongst companies, and avoidance of opportunity costs
- It allowed for joint minimisation of negative impacts identified, which in turn greatly assist in the implementation of international best practices
- It is recognised worldwide and is a major tool for promoting the Namibian Uranium Brand
- It is a major planning tool for the government in the delicate balancing of development of mineral resources with environmental protection

Namibia's Erongo Region is characterised by its aridity, vast desert landscapes, scenic beauty, ecological sensitivity, high biodiversity and endemism, and heritage resources. Large parts of the region are under active conservation in the form of national parks, and it is here, where most of the Namibian uranium exploration and mining activities occur, clustered in one area—the Central Namib. Clustering leads to cumulative impacts, and an integrated approach is therefore required, so that the development of one resource will not jeopardise the potential of another, and the country can reconcile development objectives in mineral exploitation with environmental protection, for long-term socio-economic growth.

The need for proper environmental planning in the framework of a comprehensive environmental assessment was therefore realised by the uranium industry at an early stage, when the high uranium prices of the mid-2000s caused a uranium exploration rush. Industry therefore formed a uranium stewardship committee, and made a proposal for an SEA, which was subsequently carried out by Geological Survey of Namibia (GSN), the MME, and the Southern African Institute for Environmental Assessment. The Uranium-SEA, as it has become known, dealt with a variety of aspects, such as water, air quality, energy, radiation, health, transport, tourism, biodiversity, heritage, economics, education, and governance. It was independently assessed by the renowned International Institute for Environment and Development. As a result of the SEA, the SEMP was drawn up and was implemented by the Ministry of Mines and Energy. The Namibian uranium industry has at all times supported the SEA process and is an active partner of the government in implementing the SEMP.

Benefits of the SEA/SEMP for industry can, for example, be illustrated by the issues of groundwater and air quality. The SEA established a groundwater model for the Khan and Swakop Rivers, from where water is abstracted by the mines. Monitoring boreholes have been drilled by both the government and mining operations. On the basis of data from these boreholes, industry has jointly updated the groundwater model, and it is a useful tool for future abstraction planning, as well as stakeholder engagement. It also provides for the monitoring of water quality, to ensure that the water is not contaminated, as it is used for irrigation projects downstream of the mines. Likewise, air quality monitoring stations have been put in place during the SEA process and are maintained under the SEMP. Dust and real-time radon monitoring are taking place, and together with the data generated by the mines, ensures that the air quality is at acceptable standards and better for all members of the public, as well as mining and exploration staff. The Water and Air Quality Working Group of the NUI includes all operating companies, it monitors the data on a regular basis, and stands ready to initiate action should it be required.

The SEA/SEMP has been implemented under the guidance of a comprehensive Steering Committee, chaired by the MME, and includes applicable government ministries, regional and local government, utilities, and relevant NGOs. The Environmental Quality Objectives (EQOs) formulated in the SEA and used in the SEMP are linked to desired outcomes, targets and indicators that aim at ensuring the quality that will be met in a particular environment. Implicit within all EQOs, is a minimum management objective that states that any change to the environment must be within acceptable limits, and that pro-active intervention will be triggered by the responsible party to avoid unwanted changes that breach a specific threshold. Achieving the desired outcomes specified in the indicators requires investments and actions by a range of stakeholders, in order to properly manage the activities in the uranium province. Annual SEMP reports are therefore compiled and put in the public domain.

Irrespective of the commodity, wherever multiple mining and exploration activities occur in one area, cumulative impacts can be much larger than the impacts of an individual project, and therefore need to be assessed. With the promulgation of Namibia's excellent Environmental Management Act (EMA), it has become the duty of every player to avoid, minimise and mitigate negative environmental impacts. Today, international best practice is expected of exploration and mining companies wanting to stay in business, and therefore is part and parcel of the management of the corporate profile. Mineral SEAs are therefore not merely a consequence of the EMA and its regulations, but rather a standard that ensures that Namibia's high environmental profile is upheld, and businesses can strive without the negative consequences of poor environmental management.

The Uranium-SEA/SEMP is a huge success, and has received the highest recommendations internationally. It has identified issues that would have otherwise only become apparent at a later stage, and thus caused costs for remedial action. It is an excellent example of industry-government cooperation. However, the promotion of the SEMP and its relevance to decision-makers remains a challenge.

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BEST PRACTICE GUIDE

ENVIRONMENTAL PRINCIPLES FOR MINING IN NAMIBIA

EXPLORATION

A joint publication proudly published by the Chamber of Mines (CoM), Namibian Chamber of Environment (NCE), the Namibian Government and members of the Namibian mining industry.

Ministry of Mines & Energy

Namibian Chamber of Environment

Republic of Namibia
Ministry of Environment & Tourism

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DEFINITIONS AND ABBREVIATIONS

EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management Systems
EPL	Exclusive Prospecting Licence
GSN	Geological Survey of Namibia
ICMM	International Council of Mining and Metals
MARC	Minerals Ancillary Rights Commission
MAWF	Ministry of Agriculture, Water and Forestry
MET	Ministry of Environment and Tourism
MME	Ministry of Mines and Energy
MoHSS	Ministry of Health and Social Services
MPMRC	Minerals (Prospecting and Mining Rights) Committee
MRLGHRD	Ministry of Regional and Local Government, Housing and Rural Development
NCAA	Namibian Civil Aviation Authority
NEPL	Non-Exclusive Prospecting Licence
NHC	National Heritage Council
NRPA	National Radiation Protection Authority
RBS	Risk-Based Solutions
RL	Reconnaissance Licence
ROC	Operator Certificate
SANS	South African National Standards

PART ONE – SETTING THE SCENE

1 INTRODUCTION

Exploration is one of the prominent phases of the mining life cycle, and this chapter focuses particularly on the legislative and regulatory guidance required during this phase. The Minerals (Prospecting and Mining) Act, No. 33 of 1992, governs all mining activities in Namibia. Applied to all phases of the mining life cycle, this Act makes it illegal for any prospecting or exploration activity to occur without the relevant licence(s).

The purpose of this document is to serve as a guiding framework during the exploration phase of the mining life cycle in Namibia. By highlighting best practices from Namibia and internationally, this guide will assist exploration companies to effectively address potential challenges, such as environmental and social impacts, while adhering to all legal and regulatory frameworks, and setting Namibian standards, which can be applied to all exploration companies in Namibia. Based on the legislative and regulatory frameworks particularly relevant to exploration in Namibia, and considering the diverse range of exploration activities, this guide also explains the approval and reporting requirements implied.

This chapter of the Best Practice Guide should be studied in conjunction with the Overarching Chapter, which provides an overview of legislative and regulatory frameworks relevant to mining in Namibia.

1.1 HOW TO USE THE EXPLORATION CHAPTER

This chapter has been structured to allow quick and easy access to key elements of best practice throughout the exploration phase of the mining life cycle. The layout is designed such that exploration personnel, the government, environmental managers, and stakeholders, can conveniently obtain all pertinent information relating to best practices in the exploration phase. FIGURE 1 illustrates the main areas addressed in this chapter relating to exploration in Namibia.

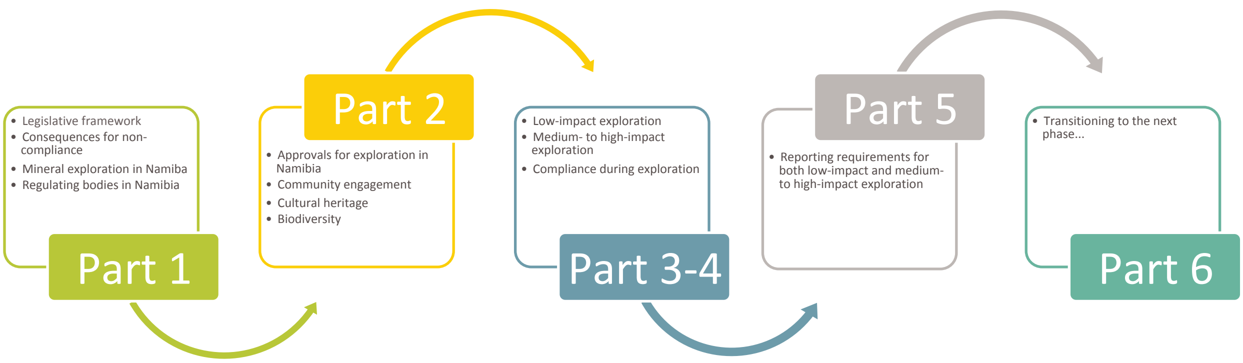

FIGURE 1 - LAYOUT OF THE BEST PRACTICE GUIDE FOR EXPLORATION IN NAMIBIA

1.2 Exploration in Namibia

The importance of the exploration phase of the mining life cycle is heavily emphasised in Namibia's Mineral Policy of 2003:

"The Namibian government promotes exploration by the private sector, and therefore focuses on creating an enabling environment. This is done through appropriate competitive policy and a regulatory framework for the promotion of private sector investment, along with the provision of national databases, which are essential for attracting competitive exploration and mining."

Commitment towards establishing Namibia as Africa's most attractive exploration and mining environment, and encouraging exploration companies, forms a core objective of the Policy:

"Promote and stimulate investment in exploration and mining, so as to discover new ore deposits that will lead to the development of new mines, and also to maintain the existing ones."

The aspects and impacts of exploration activities vary widely; and the effects can be measured in terms of severity, scale, duration, consequences, and significance. Exploration activities range from undertakings with low impacts to more invasive methods. In Namibia, low-impact exploration methods can be defined as those activities that have minimal environmental and social impacts, such as Remote Sensing Techniques, Geological Methods, and Geochemical Techniques. The environmental and socio-economic impacts of exploration escalate with the inclusion of intensive activities such as the construction of access roads and tracks, drilling, and trenching. These activities have the potential to negatively impact the environment and to create socio-economic impacts of note, depending on the type and scale of the exploration project being undertaken. To fully comprehend the possible impacts of exploration, however, demands an understanding of land ownership in Namibia first.

1.2.1 Exploration and land ownership

There are two major categories of land owners in Namibia: Central and local government owns about 59%, while private individuals and companies own about 41% (freehold land). State-owned land is comprised of protected areas (almost 17%), communal land (37%), and land for other official uses, such as resettlement, quarantine, and agricultural research (5%).

The state manages state land directly through the line ministries of the government. Protected areas are formally proclaimed, belong to the State, and are allocated for nature conservation, under the auspices of the Ministry of Environment and Tourism (MET). The entire coastline of approximately 1,570 km is included in the protected area network of Namibia, and the mandate to look after the coastline is the combined responsibility of the MET and the Ministry of Fisheries and Marine Resources. The Ministry of Lands and Resettlement is the custodian of surveyed and unsurveyed state land, while the Ministry of Works and Transport administers infrastructure on governmental land. Water management is mandated through the Ministry of Agriculture, Water and Forestry (MAWF). Urban land is managed as municipalities, town councils, village councils, or settlement areas, under the auspices of the Ministry of Regional and Local Government, Housing and Rural Development. A number of parastatal enterprises provide services of national importance: TransNamib (railways); NamPower (bulk electricity supply); NamWater (bulk water supply); Roads Authority (roads); and Telecom (telecommunication).

1.2.2 EXPLORATION ON COMMUNAL LAND

Communal land is formally owned by the state – the land may be used, but not owned by the people living there. Communal land is vested in the state by constitution and not surveyed. The state is obliged to administer communal land in trust, for the benefit of the traditional communities residing on these lands. In contrast to state land managed as protected areas and for other official uses such as agricultural research, is the land allocation and administration of unsurveyed communal land, which is impeded by the absence of clear and coherent legislation. Shortly after independence, Namibia adopted a land redistribution programme aimed at equitable ownership. Initial work to develop reform on land ownership began in 1995 and resulted in the enactment of the Communal Land Reform Act, No.5 of 2002. This Act deals with access to rural land in communal areas, regulates the allocation of land rights and the establishment of Communal Land Boards, and clearly states the powers of Chiefs, Traditional Authorities, and Land Boards. The Act stipulates two broad categories of land rights allocations: Customary Land Rights and Rights of Leasehold. The rights that may be allocated under Customary Land Rights, are rights to residential units and rights to farming units. Chiefs and Traditional Authorities allocate Customary Land Rights, and Land Boards verify these allocations. Rights of Leasehold are mainly relevant to land for agricultural use, and vest in the Land Boards.

Communal conservancies are legally gazetted areas on state communal land through Namibia's Community-Based Natural Resource Management Programme. Most of the conservancies in Namibia are run by elected committees of local people, to whom the government devolves user rights over wildlife within the conservancy boundaries. Technical assistance in managing the conservancy is provided by government officials and local and international non-governmental organisations (NGOs). To qualify, communities applying must define the conservancy's boundary, elect a representative conservancy committee, negotiate a legal constitution, prove the committee's ability to manage funds, and produce an acceptable plan for the equitable distribution of wildlife-related benefits. Once approved, registered conservancies acquire the rights to a sustainable wildlife quota, set by the ministry. The animals can either be sold to trophy hunting companies or hunted and consumed by the community. As legal entities, conservancies can also enter into contracts with private sector operators. At the beginning of 2019 there were 86 registered conservancies in Namibia, covering a combined surface area of close to 20% of the entire country.

1.2.3 EXPLORATION ON PRIVATELY OWNED LAND

Privately owned land (including urban land) is freehold, which means that it may be bought and sold, and the owners hold the full title to their property. The system under which privately owned land is regulated, is well organised. Land is properly surveyed and is held under title deeds kept in a central deeds registry. Privately owned land may be used as security for financing.

In Namibia, all minerals are vested in the state. If prospecting activities are intended on private property, there are certain conditions that must be met in terms of the Minerals (Prospecting and mining) Act, No. 33 of 1992, prior to and during any prospecting or exploration activities. These include, but are not limited to, the following:

- Prior to any prospecting or mining activities, an agreement must be reached between land owners and the mineral explorers

- If the land owner waives the right to compensation, a written copy of this agreement needs to be submitted to the Mining Commissioner
- The holder of a mineral licence shall not exercise any rights conferred upon such holder by the Act in or on any private land, until such holder has been granted an ancillary right as provided in section 110(4) to exercise rights on such land
- Holders of mineral licences are not allowed to exercise their rights in or under any private land until:
    - The holder has entered into agreement in writing with the owner of the land
    - Conditions of compensation are included
- Compensation is discussed between the land owner and the exploration or mining company
- Arbitration shall be used if the land owner and the mineral licence holder are unable to decide on a price. The price and mode of payment shall be fixed by arbitration
- The Minerals Ancillary Rights Commission (MARC) offers an opportunity for the implementation of a co-operative process between land owners and mineral explorers if a dispute arises
- The holder of the mineral licence shall be liable to pay compensation to the land owner for damages caused (during any prospecting or mining operations) to any surface land, water source, cultivation, building, or other structure

1.2.4 Exploration in protected areas

Namibia has a mining history of more than a century, and much of the early activities took place in today's protected areas. Evidence of environmental degradation in the forms of soil, air and water pollution, loss of vegetation, and a changed ecological state, can all be witnessed (Mansfeld, 2006). Several legacy issues were left behind because of exploration, especially in the central Namib Desert, an area of high endemism with several rare and protected species, as well as sites of archaeological importance. Currently, there are more than 40 abandoned, unrehabilitated exploration and mine sites in Namibia, of which 16 are located within the national parks. This situation highlights the need to address the minimising, avoidance and mitigation of the negative impacts of mineral exploration and mining in protected areas, and is also addressed as a concern in Namibia's national development plans.

On the positive side, there exists a comparatively substantial number of environmental-related studies and investigations in the mining industry. That is mainly because of legislation, which requires proponents to conduct Environmental Impact Assessments (EIAs). In addition, most of the mining companies are foreign-owned, and operate within the parent company's code of conduct, which usually includes adhering to environmental standards and conducting EIAs. As a result, several studies were *post facto*, having been conducted several years after the mines were established (e.g. Rössing Uranium Limited, and Namdeb mines), and this also accounts for the escalation of studies since the second half of the 1990s.

In 1998, parks were opened for prospecting activities. A white paper for Mining and Prospecting in Protected Areas and National Monuments (1999) was drafted. Accordingly, it is the intention of the MET, along with the MME, to ensure that mining-related activity in protected areas is only initiated when rehabilitation is assured. Applying this approach, Langer Heinrich Uranium became one of the first larger scale mines entirely located within a protected area, after a full environmental impact assessment was completed in 2007 and an Environmental Clearance Certificate was obtained. The application process for mining in protected areas is illustrated in FIGURE 2.

Company submits its application to prospect/mine in a Protected Area and/or National Monument to the MME (Mining Commissioner)

The MME registers the application and provides the company with the environmental screening questionnaire

The environmental screening questionnaire is completed by the applicant and submitted to the MME, which passes it on to the MET and/or National Heritage Council (NHC)

The MET and/or NHC review and assess the screening questionnaire and make recommendations to the Minerals (Prospecting and Mining Rights) Committee (MPMRC)

The Mining Commissioner includes the recommendations made by the MET and/or the NHC in the application file and presents the file to the MPMRC, who assesses the application.

If the application is recommended, the MET and/or NHC set environmental conditions and help develop Terms of Reference for an Environmental Assessment (EA) and/or Environmental Management Plan (EMP).

The MME endorses the Terms of Reference for the EA and/or EMP

The EA and/or EMP are conducted according to the procedures in the Environmental Management Act.

The MME/MET/NHC review the EA/EMP and agree to recommend approval/or disapproval

The EA is positive and if the Minister approves that the prospecting or mining should proceed, the MET issues an Environmental Clearance subject to specific conditions as set in the Environmental Contract (EC)

FIGURE 2 - APPLICATION PROCESS FOR MINING IN PROTECTED AREAS

PART TWO – EXPLORATION PROCEDURES

2 INTRODUCTION

Any person or company intending to conduct prospecting or exploration in Namibia, must obtain the appropriate and relevant permits in terms of the Minerals (Prospecting and mining) Act, No. 33 of 1992, prior to any works commencing. Depending on the situation and conditions related to the earmarked area, land ownership, and the type of commodity, etc. an applicant may require one of various types of licences. Legislative and regulatory frameworks are quite clear in terms of the legal requirements, and this section sheds some light on these requirements. In addition, this section provides guidance on key management tasks and procedures required from applicants, such as risk assessment, community engagement, and consideration of environmental conditions.

2.1 Approvals for Exploration in Namibia

Since May 2018, the MME uses a Licences, Rights and Permits Application and Assessment Procedures Document to guide applicants in terms of the application and evaluation processes followed by the authorities in granting licences. This document aims to explain the types of licences and permits administered and issued by the Ministry, and the expected outcome of the document is to provide a quick overview and understanding of how the licensing of mining permit activities is undertaken in the context of the relevant regulatory frameworks.

The licence required by an exploration company depends on the scale and extent of the proposed exploration activity. A brief description of the licence duration (tenure) and restrictions are shown table 1.

Additional conditions are outlined in the Minerals Act, and licence holders should be informed about all conditions stipulated.

TABLE 1 – LICENCE REQUIREMENTS RELATED TO EXPLORATION

LICENCE TYPE	DESCRIPTION	DURATION	RENEWABLE	RESTRICTIONS
Non-Exclusive Prospecting Licence (NEPL)	The holder of such licence has the right to prospect on any land for any mineral or group of minerals	6 months	No	Non-transferable, anyone over the age of 18 can apply
Exclusive Prospecting Licence	Allows systematic prospecting in areas of up to 1,000km^2	3 years	The Exclusive Prospecting Licence (EPL) may be renewed twice. Each renewal is valid for a two-year period. The area decreases by 25% for each renewal	Exclusive exploration rights to the land (Renewals beyond 7 years require special approval by the Minister)
Reconnaissance Licence (RL)	Designed for regional, mainly remote sensing exploration	6 months	No	Not transferable

RED ALERT
DO NOT UNDERTAKE ANY EXPLORATION OR MINING ACTIVITIES IN NAMIBIA WITHOUT A LICENCE
(*REFER TO TABLE 1*)

2.2 Additional Conditions for Exploration

Different fees are payable with respect to the application and renewal of the various licences related to exploration, as well as for inspection or obtaining of copies in the register (see TABLE 2).

TABLE 2 - FEES FOR APPLICATIONS AND RENEWALS OF EXPLORATION LICENCES

NATURE OF APPLICATION	AMOUNT (FEE)
Application for reconnaissance licence	N$ 15,000
Application for renewal of reconnaissance licence	N$ 3,000
Application for exploration licence	N$ 30,000
Application for renewal of exploration licence	N$ 15,000
Application for production licence	N$ 30,000
Application for renewal of production licence	N$ 15,000
Application for transfer of reconnaissance licence	N$ 30,000
Application for transfer of exploration licence	N$ 30,000
Application for transfer of production licence	N$ 30,000
Inspection of register	N$ 300
Obtaining copy of entry in register, per copy	N$ 150

2.3 Key Management Tasks in the Exploration Stage

During the exploration phase, it is beneficial to undertake activities that can guide and assist the future management of a site, i.e. after the exploration phase has been completed. For example, critical information can be obtained during the exploration phase, which is highly relevant for the operational phase (e.g. volume of waste material that could be generated when the ore body is mined). This important information can aid in the planning, establishment and closure of an eventual mine.

Based on recommendations for Australia, it is considered best practice in Namibia to conduct the following activities during the exploration phase (Department of Resources, Energy and Tourism , 2011):

- Collecting baseline environmental data, including vegetation types, soil types, weather data (i.e. install a weather station), and surface and groundwater quality
- Identifying and assessing current land ownership and land use
- Preliminary assessment of waste rock characteristics—this includes testing sulphide ore bodies
- Community and stakeholder consultation on key issues, including anticipated environmental and social impacts and benefits

- Establish a platform to build good relationships with the local community, stakeholders and shareholders

Although some of these activities are implied by the environmental impact assessment process, it is advisable that an exploration company remains sensible and attentive towards these aspects, right from the start. Water, for example, is a scarce commodity in Namibia, and it is advisable to understand the surface and groundwater characteristics of an area prior to exploration activities.

2.4 Risk Management and Exploration

In many cases, the exploration phase of any mining project is a lengthy process, which involves different techniques accompanied by a high level of economic uncertainty, to determine and quantify mineral deposits, in order to warrant mining. Exploration involves the finding, analysing and defining of a mineral resource body, and paves the way forward for the feasibility studies that follow, to determine the economic viability of a project. This phase also involves large capital investments, and not all exploration prospects materialise into a profitable mine. As a result, the exploration phase is thus closely associated with risks, and is decisive for the continuation of a project.

To adequately manage risk throughout the exploration phase, risk management principles need to be effectively applied. Prior to initiating a new exploration project or advancing to the next stage of an existing exploration project, project due diligence should also be conducted. Due diligence assists in identifying, controlling and managing risks, and serves as a broad-based risk management process. Influencing factors relevant to the risks of exploration activities in Namibia are illustrated in FIGURE 3.

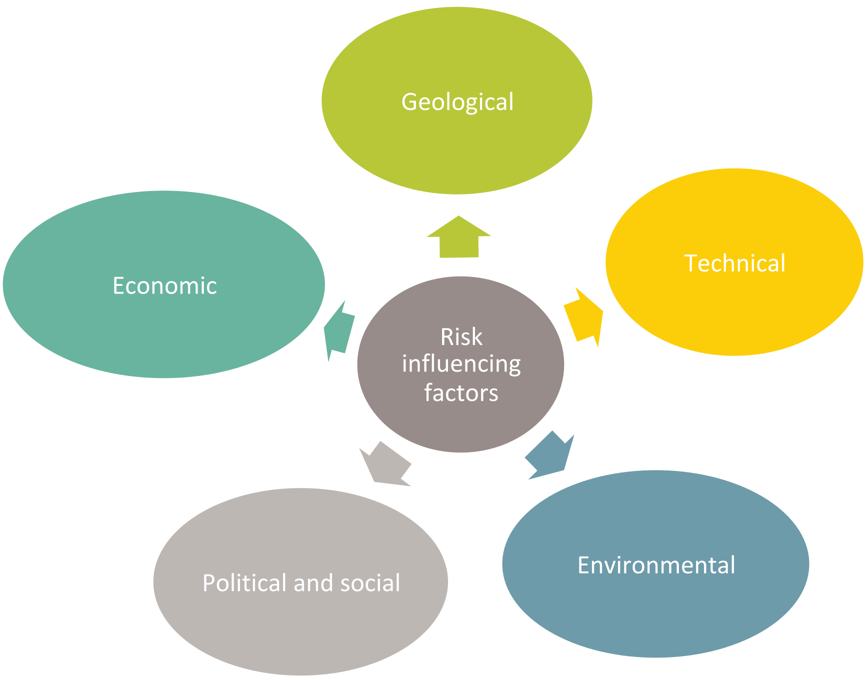

FIGURE 3 - FACTORS INFLUENCING COSTS, REVENUES AND RISK OF EXPLORATION

POLITICAL AND SOCIAL RISKS

One of the risks that foreign companies often face when investing in the minerals sector in any country, is the possibility of political unrest. Fortunately, Namibia offers an attractive investment environment into the minerals sector, as it has a politically stable environment and moderately developed infrastructure, enabling exploration companies to gain access to mineral deposits. In striving to establish Namibia as the country most attractive for mining in Africa, the state places emphasis on creating a conducive political environment through appropriate legislation relating to land access, tenure, and tax. To some extent, many of the risks pertaining to political stability, land ownership and social implications, are mitigated this way.

ECONOMIC RISKS

The economic risks during exploration are high, due to the uncertainty of the existence of a resource; as well as whether it exists in a sufficient quantity and grade to validate mining. When compared to the other phases of the mining life cycle, the exploration phase is classified as a high-risk phase, due to economic factors—a potentially low success rate in combination with high commercial costs, may even cease exploration activities abruptly. Fluctuating commodity prices due to global events, may also influence the viability of a potential project decisively. The Fukushima disaster in Japan (2011), for example, had a devastating effect on Namibia's uranium industry, and many of the exploration activities for uranium in the central Namib Desert have been halted since then.

GEOLOGICAL RISKS

Many mineral prospects could be investigated, but only a few of the holes drilled might advance to extensive drilling operations. Specific risks may result from a low level of geological understanding of the project area, or an inadequate understanding of the mineralisation distribution and the targeted mineralisation style.

TECHNICAL RISKS

In its efforts to establish Namibia as the country most attractive for mining in Africa, the state maintains a strong emphasis on the continuous improvement of technical infrastructure in support of the mining industry. An excellent range of high-quality geological information is available to exploration companies, including a geological archive that is one of the most extensive in Africa—incorporating a complete inventory of previous exploration work that stretches back almost a century. This geological information is publicly available, but the geological data derived from recent and current exploration companies is seen as incomplete and poorly archived.

ENVIRONMENTAL RISKS

Depending on the scope and extent of the exploration programme, there is an associated risk of environmental harm. To ensure that environmental risks are effectively managed, a scoping report with an accompanying EMP must be submitted, in order to obtain an Environmental Clearance Certificate prior to the exploration program. If major impacts are likely to result from exploration activities, an EIA is also required; this will be pointed out by the scoping report and provide the Environmental Commissioner with enough evidence to recommend a full EIA or not, before the project can continue. In the EMP, mitigation measures are based on the risks assessed in the EIA—when applied these measures can ensure minimal environmental damage during the exploration phase.

2.5 Community Engagement

In some instances, consultation with land owners is required prior to exploration. In the event that the exploration area is situated on private land, for example, the exploring company is required to enter into negotiations with land owners prior to exploration, to decide on the compensation amount and method (Refer to Section 1.2.3).

Community relations management and the development of a project, are distinctive but overlapping processes, vital during the exploration phase of the mining life cycle. Community engagement involves more than community interaction, often linking multiple processes and stakeholders, and ultimately improving the quality of life of a community. Put differently, it involves strengthening the viability of a community, whilst giving them an opportunity to participate in the decision-making process of a project.

Although the specific needs of each case may differ, basic community engagement processes start with communication and community-related activities during the exploration phase, which include:

- A socio-economic baseline study of the local community
- Identification of all stakeholders and the compiling of a stakeholder map
- The appointment of a designated staff member responsible for communication and community-related activities
- The development and implementation of a set of standardised communication tools, messages and techniques for the duration of the exploration phase
- The enlightening of stakeholders about the exploration activities by means of two-way liaison channels
- The creation of a communication platform with representatives from both the exploration company and stakeholders, and the establishment of an agreed upon interaction schedule
- The identification and assessment of community initiatives, which can be supported by the exploration company
- The purchasing and hiring of local supplies and services whenever possible

The International Council of Mining and Metals (ICMM) has developed a toolkit, which provides practical guidance in community relations management through all stages of the mining life cycle. The toolkit serves as a good reference for international best practices for community engagement during the exploration stage, and includes guidance for building relationships, planning, assessment, management, monitoring and evaluation. Tools for building relationships and performing assessments are most relevant during the exploration phase (see TABLE 3).

TABLE 3 - COMMUNITY DEVELOPMENT TOOLS DURING THE EXPLORATION STAGE

CATEGORY OF COMMUNITY ENGAGEMENT TOOL	TOOL NAME	INITIAL USE	FULL IMPLEMENTATION	UPDATING
Relationship tools	Stakeholder identification	Exploration	Feasibility	Regular, ongoing – annual full update
	Stakeholder analysis	Exploration	Feasibility	Regular, ongoing – annual full update
	Grievance mechanism	Exploration	Feasibility	Regular, ongoing – annual full update
Assessment tools	Social baseline study	Exploration and feasibility	Construction	Annual review

Assessment Tools – Socio-economic baseline study

As early as possible, and preferably during exploration, a socio-economic baseline study is necessary, to describe the social and economic environment of the area. Key components of a socio-economic baseline study include:

- Demographic factors (numbers, age, sex, growth, mortality ratios, household heads and size, trends and tendencies, population distribution and density, and the urban-rural continuum, etc.)
- Socio-economic determinants (schooling/education, skills, housing and accommodation, access to necessities, institutions and facilities—schools, health, sport and recreation, religion, access to potable water, sanitation, electricity, transport, and the provision of government services such as Law and Order, and Home Affairs, etc.)
- Social organisation (social networks and dynamics, history and culture, needs, norms and values, tenure and ownership, and political and governance context, etc.)
- Economic factors and determinants (employment and unemployment/labour force participation, in-migration and out-migration, sources of income, average income, employment per sector, livelihoods, living standards, income dependencies, vulnerability and marginalisation, and deprivation, etc.)
- Economic organisation (importance of agriculture, tourism, mining, manufacturing, trade and retail, services, public investments in municipalities, regional infrastructural and services development, sport, recreation and leisure, youth development, employment creation, urban and regional development patterns and expectations, regional and local economic growth trends, business trends and spending patterns, long term prospects, economic challenges and opportunities, policies and views of local and regional authorities, public views, and perceptions and concern, etc.)

2.5.1 Good consultation

Meaningful and participative community engagement should commence at the same time an exploration project is initiated. It is imperative that there is early communication, in order to maintain an open and transparent process of information sharing, and in order to ensure clear understanding and collaboration between the explorer, land owners, neighbours, the local community, the government, and all other stakeholders. A late start, on the other hand, may easily lead to constant misunderstandings, confrontation and opposition. An early start can also assist in the process of identifying potential risks, aspects and impacts, and the avoidance, management and mitigation thereof.

Good community engagement practices during the life cycle of an exploration project, set a basis for an eventual positive post-mining legacy. It is mutually beneficial for the exploration company and the community, if emphasis is placed on engagement from the early stages of a project. In doing so, the company gains credibility from the community, making future endeavours easier. The establishing of good community engagement protocols, and the enabling thereof, prevents a potentially destructive process and the possible cessation of exploration activities (in extreme cases). Sound consultation with the community also assists the exploration company in understanding the viewpoint and expectations of the community.

The initial stages of exploration should place emphasis on building good community relations, which involves:

- Considering the views and opinions of stakeholders on issues impacting the community before making decisions
- Making the purpose of consultation clear, and documenting consultation processes to indicate compliance
- Providing feedback to stakeholders on how their inputs have influenced decisions
- Enforcing regular stakeholder consultation sessions by means of a communication platform with representatives from both the exploration company and stakeholders, and an agreed interaction schedule

Red Alert:

The licensee should identify the affected communities for the proposed operation(s) and consult with the identified communities.

2.5.2 Stakeholder analysis

To assist in developing a consultation matrix, and to determine how frequently stakeholder engagement is required, the level of interest of each stakeholder is required. The more information is known about each stakeholder, the more success will be realised when building and retaining good relationships with them. A stakeholder analysis normally results in a stakeholder map, which is updated during reviews, and portrays stakeholders in terms of influence and importance.

2.5.3 Heritage

Heritage—legacies of tangible as well as intangible attributes in its widest sense—could potentially be impacted by various activities during the mining life cycle, in particular during the exploration phase. Activities that could potentially impact heritage sites include (Yukon Tourism and Culture , 2010):

- Land clearing
- Access track and road construction
- Trenching and drilling
- Camps and infrastructure construction

> ✘ *Disobeying the National Heritage Act No. 27 of 2004, by relocating or disturbing the position of a fixed protected object/artefact can lead to a fine of up to N$ 100,000.*

As a precautionary principle, in respect of public concern, and to make decisions that consider the interests, needs and values of stakeholders, it would be wise to conduct an early archaeological assessment of an exploration area. Taking precautions with regard to heritage resources, is not only to prevent damage or destruction, but should also been seen in a positive light. For example, there is a close link between exploration and the discovery of palaeontological finds. If it was not for exploration, some of these important treasures would have remained unknown, as the case study below highlights.

To mitigate and minimise impacts on heritage sites by exploration activities, actions in line with global best practices are recommended (see TABLE 4).

TABLE 4 - RECOMMENDED PRACTICES TO MITIGATE IMPACTS ON HERITAGE SITES

ACTIVITY	NAMIBIAN RECOMMENDED PRACTICE
Access track and road construction	– It is a good practice to georeference or map existing roads on EPLs, as this can be used at a later stage during the project – If there is a need for new track construction, avoid sensitive areas – Use existing tracks and roads whenever possible – Minimise stream crossings whenever possible – Ensure that vehicles have a rake and broom, because raking and sweeping are key rehabilitation activities in arid environments
Trenching and drilling	– Areas cleared and levelled to install drilling platforms should be minimised – Use backhoe equipment when carrying out trenching, whenever possible, to minimise ground disturbance
Land clearance for the construction of camps and infrastructure	– Locate camps near existing roads and tracks whenever possible – Locate camps in existing clearings whenever possible
What could go wrong? If tracks are not rehabilitated, the resulting impact could be: – Loss of heritage resources, if heritage surveys/assessments are not conducted, and continuity may be lost – Visual impacts of the environment – Unauthorised persons could be encouraged to enter an area (e.g. protected areas) – A company's reputation may be damaged	

Heritage Case Study

Mine:

Arrisdrift

Location:

At Arrisdrift, on the banks of the Orange River, some 30 km inland from the river mouth at Consolidated Diamond Mines (CDM)—the precursor of today's Namdeb—a fantastic palaeontological find was made.

Brief description:

Namibia has an extraordinary natural heritage, including a wealth of different fossils spanning a period of 830 million years. Many of them distinguish themselves in global fossil records, such as the Ediacaran fauna from the Nama Group of southern Namibia, which is amongst the best preserved and most extensive early multi-cellular biota in the world. This case study deals with two superlatives amongst Namibian fossils that were only found because of exploration and mining activities: the richest and most important Miocene fossil occurrence in Africa, and the first known Miocene hominoid south of the equator.

Key issue(s) addressed:

This case study highlights how exploration and mining activities led to the discovery of fossils in Namibia.

Description of the case study:

A vast number of Middle Miocene, mainly vertebrate, fossils in a very good state of preservation, occurred in an old river channel within the proto-Orange River valley. Since the discovery of these first fossils, systematic excavation and research has yielded more than 10 000 specimens from the site. They belong to 36 mammalian taxa, many of which were new to science at the time of the find. There are also crocodiles, tortoises and other members of the reptile family; 13 different bird species; and fish, including sharks. To this day, the site remains the richest and most important Miocene fossil occurrence on the African continent (Schneider, 2009).

A diamond was also discovered in one of the fossils. Not only did this eventually prove the theory that the diamonds mined in Namibia travelled from the southern African interior via the Orange River to the coast, it also gave scientists the opportunity to date this event (Corbett, 2002). Arrisdrift is a good example of the close link between palaeontology and mining, since the search for and exploitation of minerals has uncovered many fossil occurrences, which would otherwise have remained beyond the reach of palaeontologists. When exploration geologists working at Arrisdrift first realised that the site contained fossils, an expert palaeontologist, Dr Gudrun Corvinus, was immediately called in to undertake research and excavate the fossils. Her pioneering studies are remarkable, considering that, in general, the Middle Miocene faunas of Africa were poorly understood at the time (Pickford & Senut, 2003).

Unfortunately, the fossils were all deposited at the South African Museum in Cape Town. However, after Namibian Independence, the fossils were repatriated, and many are now on display at the National Earth Science Museum of the Geological Survey of Namibia (GSN). It was also during the time after Independence, that Namdeb geologists decided that further palaeontological studies were needed, to throw additional light on the ages of the Orange River terrace deposits, and palaeontologists Dr Brigitte Senut and Dr Martin Pickford have been working at Arrisdrift on a regular basis since 1993, finding more new species and genera, and tremendously contributing to our understanding of the lineages of African faunas as we know them today.

Work on the Arrisdrift fossils has also allowed researchers to establish valuable facts about the local palaeoclimate during the Middle Miocene, a time when biodiversity was higher than today. The local environment must have been considerably more humid than it is today, and the climate was most probably tropical. The main fossil occurrence is associated with a shallow channel, which contained flowing water only during flood events, but otherwise was a quiet pool a mere 1-2 m deep. The presence of brackish water-dwelling worms indicates that the sea level must have been much higher during the Middle Miocene, and the area around Arrisdrift most probably constituted an estuarine environment (Schneider & Marais, 2004). This sheds light on climate change as it happened in the past.

The second case, the find of the first known Miocene hominoid south of the equator, is associated with the vanadium-lead-zinc mine of Berg Aukas in the Otavi Mountainland. Berg Aukas made world headlines, when the fossil jawbone of the creature was found in 1991, and aptly named *Otavipithecus namibiensis*. The hominoid family, which includes both the great apes and humans, is part of the order of primates. The fossil record of the shared ancestry of humans and other primates is extremely patchy, and hence, any new find is met with enthusiasm. Recent evidence increasingly suggests that many critical events in human evolution occurred in Africa, and there is a likelihood that modern humans originated in southern Africa and spread to other places from there. The significance of the Berg Aukas find must be seen in this light.

The Berg Aukas Mine had ceased production in 1978, but during its operation, the entire central ore body, which had been located within a karst palaeontological cave structure, had been mined out. Apart from massive ore, the structure contained partly mineralised breccias. These are so richly fossiliferous, that Berg Aukas has yielded by far the most comprehensive series of micromammal faunas known, from the African continent. The breccias were mined together with the ore and dumped on the northern side of the Berg Aukas hill. To this day, the breccias still provide a valuable source of research material for palaeontologists, and are yet another outstanding example of the benefits that palaeontological research in Namibia has derived from mining activities.

Otavipithecus namibiensis was a medium-sized ape, and its lower jaw, part of its skull, some isolated teeth, and parts of the neck, arm and a finger bone have been recovered. Although Miocene apes have long been known to be from near the equator, none had ever been found to the south of it. The Namibian discovery is therefore the first proof that apes were also present in southern Africa during the Miocene (Schneider & Marais, 2004).

References:

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Schneider, G.I.C. (2009): Treasures of the Diamond Coast. 320 pp., Macmillan Education Namibia, Windhoek.

Schneider, G.I.C. & Marais, C. (2004): Passage through Time: The Fossils of Namibia. 158 pp., Gamsberg Macmillan, Windhoek.

Photographs courtesy of G. Schneider, paintings courtesy of the Marais family.

2.6 BIODIVERSITY

Exploration activities have the potential to negatively affect biodiversity. Direct impacts typically result from activities involving physical destruction and land-clearing activities such as creating access tracks or roads, infrastructure construction, exploration drilling and overburden removal. Direct impacts are typically easy to identify, but indirect impacts are harder to identify, and might only appear later, even as cumulative or knock-on effects. For example, the restriction of water as an ecological driver may only show its detrimental effects later. Significant impacts are most likely to occur when extensive exploration activities, such as closely-spaced, and large-scale drilling operations are conducted in sensitive, remote, or protected areas. A number of causes can potentially destroy biodiversity composition in terms of species and their abundance. Key species and rare, vulnerable, threatened or endangered species are particularly important, because a limited change may have a disproportionate effect on the stability or resilience of an ecosystem, or effects beyond the site where these species occur.

Taking a proactive approach in the management and assessment of the negative impacts of exploration on biodiversity is considered global best practice. Namibian best practice standards are set out in section 4.

Why should exploration companies consider biodiversity?

There are a variety of sound business reasons for mining and exploration companies to address biodiversity. Adopting reasonable practices with respect to biodiversity management is increasingly important with respect to:

- Reputation, which has a significant influence on the perception of stakeholders
- Land access and tenure at the initial stages of project development and for ongoing exploration
- Compliance with legislation and commitment towards values, such as land stewardship and conservation
- Access to capital for exploration—with environmental protection becoming increasingly important across the globe, investors are keener to invest in projects that place emphasis on biodiversity and the protection thereof

The impacts of exploration on biodiversity is dependent on the nature and magnitude of the exploration process. Potential impacts on biodiversity associated with the exploration phase are illustrated in FIGURE 4.

Impacts on terrestrial biodiversity

- loss and fragmentation of ecosystems and habitats
- loss of species
- restriction of water as an ecological driver

Impacts of discharges and effluents

- increased heavy metals, acidity or pollution can poison aquatic life
- manipulation of run-off and groundwater can introduce non-indigenous species

Air quality impacts on biodiversity

- increased particulates (dust, fumes, smoke) and increased pollutants (noxious and offensive gases) may repel or evict species

Social interfaces with biodiversity

- loss of grazing and browsing potential can alter migration routes
- can encourage poaching, illegal fencing, off-road driving, collecting of firewood and timber, collecting of plants, and pet trade

FIGURE 4 - POTENTIAL IMPACTS ON BIODIVERSITY ASSOCIATED WITH THE EXPLORATION PHASE

PART THREE – NAMIBIAN STANDARDS FOR LOW IMPACT MINERAL EXPLORATION

3 INTRODUCTION

Exploration companies should always aim to have the smallest environmental footprint possible, because it instils a culture of environmental commitment and care, awareness and respect, and enhances the chances of successful remediation of a project site, once exploration activities have ceased.

Typical exploration activities, with low environmental and social impacts, entail Remote Sensing Techniques, Geological Methods and Geochemical Techniques. Although the impacts of these activities are low, it is considered best practice for exploration companies to always be compliant, to minimise disturbances, and to monitor and mitigate their impacts, nevertheless.

This chapter outlines the prominent low-impact exploration methods and seeks to provide guidance on identifying and mitigating the associated possible impacts during this phase.

3.1 Remote Sensing Techniques

WHAT IS REMOTE SENSING?

Remote sensing during mineral exploration enables explorers to find and assess deposits without having to undertake massive exploration operations such as drilling and excavation. Remote sensing involves using an airborne platform to gather and record spectral data from the surface of the earth by means of geophysical surveys, photo-geological maps, aerial sensing techniques, and image gathering from airborne platforms. In addition, it entails the application of several tools and techniques, to extract information from satellite images, geographical information systems, radar and sonar. The images collected can be used for identifying fractures and faults, and the geology of an ore deposit, and to identify hydrothermally altered rocks by using their spectral signature (Kay, 2018). In Namibia, it is fairly common to use a high-flying aircraft for validating the data during these processes, as illustrated in FIGURE 5.

FIGURE 5 - HELICOPTER USED IN REMOTE SENSING MINERAL EXPLORATION (RISK- BASED SOLUTIONS (RBS) , 2017)

WHAT ARE THE BENEFITS OF USING REMOTE SENSING TECHNIQUES?

Remote sensing is a useful tool when searching for minerals. It gives a good indication of where deposits are situated, and aids in narrowing down the field survey area. Remote sensing techniques aid in identifying which areas to explore first, thereby reducing the risk of the exploration project, whilst deferring costly operations such as drilling, to only after sufficient data has been collected (Kay, 2018).

COMPLIANCE

To conduct exploration using aerial sensing techniques in large areas (more than 10,000 ha), the proponent must be in possession of a reconnaissance licence, as the Minerals Act of 1992 stipulates. This licence is valid for a period of 6 months and is non-exclusive and non-transferable. The option is available to apply for exclusivity over minerals.

The use of any form of aircraft for remote sensing during the exploration phase, is subject to all current civil aviation regulations in Namibia.

According to Namibia's Civil Aviation Authority, flying a drone is legal in Namibia if it is compliant to specific regulations. For commercial purposes, users need to apply for permission from the Authority prior to a drone's usage – for foreigners this must be done at least 120 days prior to the planned flight, and for Namibians it must be done 90 days prior to the planned flight. Additional legal requirements include: restrictions on height, distance from controlled and air traffic zones, aerodromes, restricted and protected areas, public roads, safety, weather and visibility conditions, and liability. Drones need to be registered, each with a document specifying the technical standards, proof of insurance, proof of payment for the registration, risk analysis, a safety management plan, and its purpose of use. Furthermore, it is recommended that a map and the coordinates of the location are declared prior to its usage, and that permission is required from property owners before each flight. The use of drones within protected areas is illegal. Once the necessary permit(s) has been obtained to operate drones in Namibia, the rules in TABLE 5 apply (Namibia Civil Aviation Authority, 2017).

TABLE 5 - NAMIBIAN STANDARDS FOR OPERATING DRONES

	NAMIBIAN STANDARDS FOR DRONES
Maximum altitude	Limited to 45 meters
Maximum horizontal distance	Allowed to only operate within direct range of sight
Compulsory insurance	Aviation liability insurance is mandatory
Distance to airports	A distance of 9.3 km (5 nautical miles) of the outer boundary
Flight bans	– Public roads may not be used for landing or take-off sites – Not permitted to fly within protected areas – Not permitted to fly over crowds
Other safety distances	A minimum distance of 50 m must be maintained for uninvolved persons and other objects such as vehicles, and buildings, etc.
Special legislation	Each drone is only allowed to be registered under one Operator Certificate (ROC)
Operating hours	Only permitted in daylight
Rules for commercial pilots	Commercial pilots are obliged to apply for an Operator Certificate

Intending to fly a drone for your exploration activities?

Make sure to get a permit from the Namibia Civil Aviation Authority.

NAMIBIAN STANDARDS

In line with global best practices, Namibian standards have been established to ensure that remote sensing exploration activities have the smallest environmental footprint possible, as illustrated in TABLE 6.

TABLE 6 - NAMIBIAN STANDARDS FOR REMOTE SENSING EXPLORATION

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practice/Namibian Standards**
Conducting aerial sensing techniques over large areas, including photo-geological mapping or image gathering from a helicopter in search of minerals.	– Effects on animal feeding and migratory patterns because of the noise generated from aircraft – Disruption of human activity due to excessive noise	– Correspond with the responsible authorities to determine the best time to conduct aerial surveys – When possible, avoid flying directly over human settlements – Only conduct exploration activities during the day, and adhere to respective regulations relating to noise in the South African National Standards (SANS) regulations, outlined in TABLE 7
What could go wrong If exploration companies do not comply with the standards set out relating to operation time, and flying over settlements or protected areas without permission, this can result in an unwanted incident and possible criminal charges. The noise and increased level of activity associated with remote sensing equipment can lead to nuisance disturbances or in disruption of animal feeding, and migratory and mating patterns.		

The biggest issue to address during aerial surveys, is noise. The South African National Standards (SANS) 10103 is used to address the way environmental noise measurements are to be assessed and taken. SANS provides guidelines on recommended noise levels and typical recommended noise levels are illustrated in TABLE 7.

TABLE 7 - TYPICAL RATING LEVELS FOR NOISE AS PER SANS 10103

TYPE OF DISTRICT	EQUIVALENT CONDITIONS RATING LEVEL ($L_{REQ,T}$) FOR OUTDOOR NOISE
	Day-time $L_{Req,d}$ [a] (dBA)
Rural districts	45
Suburban districts with little road traffic	50
Urban districts	55
Urban districts with business premises and roads	60
Central business districts	65
Industrial districts	70

a) $L_{Req,d}$ = The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for daytime, where the daytime period is from 06:00 to22:00.

3.2 Geological Methods

INTRODUCTION

Geological maps provide explorers with geophysical and geological information, which allows potential mineral deposits to be identified. During the mapping process, geologists spend time analysing mineral indications and rocks, to create a high-quality map on a small scale. These maps are generally built on existing maps obtained from the government or other sources.

Geological surveys provide mineral explorers with scientific data on rock types, structures, and minerals, to determine further exploration or termination of efforts. Field surveys typically have limited impacts on biodiversity, however, in some instances, subsurface sampling is required. Subsurface sampling is usually carried out using the pitting or trenching method. Pitting and trenching are a fast way of determining local geological structure and assay information in areas of shallow soil cover. Pits and trenches are used to obtain a clearer picture of the rock composition, where pitting is used to test flat lying, shallow bodies of mineralisation, and trenching is mostly used to expose steeply dipping bedrock, which is covered by a thin layer of overburden. Trenches are typically excavated by either manual labour, bulldozer or a mechanical digger. Pitting and trenching are high-impact methods, involve land clearance to some extent, and their impacts on biodiversity are more severe in comparison to remote sensing techniques. Access tracks are needed, and heavy equipment is sometimes brought in. Usually bulk samples are taken, which leaves visual impacts and causes traps for animals. The pits created are usually relatively shallow and square-shaped, whereas trenches are longer, as illustrated in FIGURE 6 and FIGURE 7.

FIGURE 6 - PITTING DURING EXPLORATION

FIGURE 7 - TRENCHING DURING EXPLORATION

COMPLIANCE

To apply geological methods where prospecting rights are allocated to a certain area, the first and foremost requirement is that the proponent acquire an NEPL. This permission allows the holder of such licence the right to prospect anywhere in the country, except for game parks and reserves. The licence is valid for 6 months and it is non-renewable.

Designed for regional, mainly remote sensing exploration, a Reconnaissance Licence (RL) is valid for six months on a non-renewable basis and facilitates the identification of exploration targets.

An EPL serves as a more formal ownership right and confers exclusive rights to the land (up to 1,000 km^2) for an initial period of 3 years. The exclusive rights are granted for only the minerals specified in the licence; another entity may therefore have an EPL for a different mineral on the same land. The EPL may be extended twice for two-year periods, if demonstrable progress is shown.

Specific legal requirements, relating to geological methods during the exploration activities, might be necessary and are illustrated in TABLE 8.

TABLE 8 - COMPLIANCE REQUIREMENTS FOR ACTIVITIES ASSOCIATED WITH GEOLOGICAL METHODS AND GEOCHEMICAL TECHNIQUES DURING THE EXPLORATION

ACTIVITY	ACT	PERMIT	RELEVANT MINISTRY	LIVE LINK
Vegetation clearing	– The Forest Act, 2001 – Policy for Prospecting and Mining in Protected Areas and National Monuments (1999)	Vegetation clearance permit	MET	**form 10 under the forest regulations (page 33 of 62)

NAMIBIAN STANDARDS

Pitting and trenching are typically more cost-effective in comparison to drilling or large-scale excavation. Although the environmental impacts of pitting and trenching are not as severe as those of an extensive drilling programme, best practices should be applied, to reduce and mitigate environmental damage.

In accordance with global leading practices, the following should be ensured during pitting and trenching, to reduce environmental harm (Department of Primary Industries, 2008):

- Where possible, select sites in a manner that minimises earthworks
- Where possible, use existing tracks and roads
- Opt for human labour instead of equipment, where practical. If earthmoving equipment is used, use the minimum sized earthmoving equipment required to complete the task
- During backfilling, replace subsoil first and top soil afterwards, with the organic matter on top

In accordance with global leading practices, the following should be ensured during pitting and trenching operations, to optimise the sampling and mapping process (Geology Hub , 2014):

- To ensure safety, both sides of the trench should be cut back to a depth of 50-100 cm, as this ensures that unconsolidated material does not fall into the trench
- Stack bedrock and any loose unconsolidated surface material on opposite sides of the trench. This enables easier sampling and bulk sampling from the bedrock heap
- Avoid entering deep trenches 24 hours after excavation, as wall collapses typically occur within the first few hours after excavation
- Avoid entering trenches after heavy rains, as the chances of wall collapses are increased during this period—good practices entail waiting 24 hours before entering a trench after heavy rains
- If the trench is deep and longer than 50m, an access ramp should be provided at its midpoint.

Additional impacts can potentially occur when conducting geological methods. Namibian standards have been outlined in TABLE 9, to ensure the least environmental damage in line with global best practices.

TABLE 9 - NAMIBIAN STANDARDS FOR GEOLOGICAL METHODS DURING EXPLORATION

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practice/Namibian Standards**
Carrying out field surveys to obtain basic geological data and to map rock types, which sometimes involves subsurface sampling (pitting and trenching).	Loss of flora and fauna due to land clearing during subsurface sampling and construction of access tracks. Conflict with local community and land owners.	– Select sites that minimise earthworks – Use existing tracks or roads – Inform communities about the nature and scope of exploration activities prior to starting exploration – A month prior, write to the land owner detailing what activities will occur and when. This should include, but not be limited to: o Map of exact area o Duration o Number of people o Security, etc. – Rehabilitate pits and trenches as soon as possible/practical.
What could go wrong If the exploration activities are not fruitful, exploration companies go in search of new areas to be explored. These relatively small excavations can trap small animals, and they should therefore be backfilled as soon as practically possible.		

3.3 Geochemical Techniques

INTRODUCTION

Geochemical techniques refer to the chemical analysis of materials, which involves sampling and testing. Samples are collected from the exploration site and sent to a third-party lab for analysis. Typically, there are three types of samples of rocks used. These are (New Pacific Metals Corp., 2018):

- Grab – grab samples are typically used to define further exploration work. These samples are simply pieces of rock collected from the exploration site at random, or at the highest level of visual mineralisation, and therefore the resulting concentrations should not be regarded as being representative of the overall potential of the exploration site
- Channel – the objective of a channel sample is to continuously sample the length of a rock. This is commonly achieved by using a chisel and rock saw to make several cuts into the chosen rock

- Chip – a rock sample made by continuously chipping an exposed rock to obtain a composite rock sample. Information about the grade and width of mineralisation can be obtained from a chip sample

Sample preparation for analysis is conducted at the lab. This involves drying and milling to create fine material, which is tested to determine the chemical elements contained in the sample, as well as the respective concentration of these elements. In Namibia, the chemical analysis of samples can be carried out at the Bureau Veritas Laboratory in Swakopmund.

COMPLIANCE

To apply geochemical techniques where prospecting rights are allocated to a certain area, requires, first and foremost, that the proponent acquire an NEPL. This permission allows the holder of such licence the right to prospect anywhere in the country, except for game parks and reserves. The licence is valid for 6 months and it is non-renewable.

Designed for regional, mainly remote sensing exploration, an RL is valid for six months on a non-renewable basis and facilitates the identification of exploration targets.

An EPL serves as a more formal ownership right and confers exclusive rights to the land (up to 1,000 km^2) for an initial period of 3 years. The exclusive rights are granted for only the minerals specified in the licence; another entity may therefore have an EPL for a different mineral on the same land. The EPL may be extended twice for two-year periods, if demonstrable progress is shown.

Specific legal requirements, related to the geochemical techniques during the exploration activities, might be necessary.

NAMIBIAN STANDARDS

To ensure leading practice when using geological methods, Namibian standards have been formulated in accordance to global best practices, to minimise damage to the environment. This is illustrated in TABLE 10.

TABLE 10 - NAMIBIAN STANDARDS FOR GEOCHEMICAL METHODS DURING EXPLORATION

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practice/Namibian Standards**
Collecting samples for further examination, testing and assaying.	– Disturbance of activity on privately owned land (farms) – Loss of flora and fauna due to land clearing – Migratory patterns of animals disrupted by human presence	– Follow standard procedure in terms of reaching an agreement with the farm owner as outlined in earlier section – Monitor environmental impacts from baseline study – Minimise earthworks as much as possible
What could go wrong? Sample collection during geochemical methods can lead to disputes with land owners if prior arrangements have not been made.		

PART FOUR – NAMIBIAN STANDARDS FOR MEDIUM- AND HIGH-IMPACT MINERAL EXPLORATION

4 INTRODUCTION

During medium- and high-impact exploration, there are more visible impacts in comparison to those caused by low-impact exploration. This is mainly because medium-/high-impact exploration often involves extensive close-spaced drilling over vast areas in search of mineral deposits. During the drilling operations, several activities are carried out, including but not limited to, the construction of access tracks/roads, sumps, drill pads and drill holes (Eggert, 2010). To carry out exploration activities, one must be in possession of the necessary licence(s) and permit(s) governing high-impact exploration activities. Special considerations should be made with respect to the validity of such licences.

4.1 CONSTRUCTION OF ACCESS ROADS AND TRACKS

INTRODUCTION

Properly constructed and carefully sited access roads and tracks will remain visible and environmentally acceptable. Well-planned access roads and tracks cost less than ones that are badly placed and require frequent maintenance (Mansfeld, 2006). When planning access roads and tracks, the maintenance, rehabilitation, and flora, fauna and heritage surveys, must be considered, along with the cost evaluations (NSW Mineral Council Ltd., 2013). Suitably qualified personnel should be employed, to ensure that the best environmental and cost outcomes are achieved (Department of Primary Industries, 2008). In addition, the location of access roads and tracks is closely related to land ownership and tenure, which requires permission from land owners and neighbours. Consequently, explorers are advised to familiarise themselves with all specific requirements for constructing access roads and tracks.

COMPLIANCE

The Acts and permits provided in this section do not exempt prospective explorers from any other laws. A scoping report with an accompanying EMP must be submitted, to obtain an Environmental Clearance Certificate prior to exploration activities, and in cases where major impacts are likely to result from the construction of access roads and tracks, an EIA is also required. In the EMP, mitigation measures are outlined, which ensures minimal environmental damage.

Further legal requirements relevant to the construction of access roads and tracks are illustrated in TABLE 11.

TABLE 11 - COMPLIANCE REQUIREMENTS FOR THE CONSTRUCTION OF ACCESS ROADS AND TRACKS

ACTIVITY	ACT	PERMITS/LICENCES	RELEVANT MINISTRY	LIVE LINK
Clearing of vegetation for construction of access roads and tracks	– The Forest Act, No. 12 of 2001, and – Policy for Prospecting and Mining in Protected Areas and National Monuments (1999)	Forest licence for harvesting, issued under (section 22, 23, 24, 27 and 33 / regulation 8 and 12)	MAWF	**Form 10 under the forest regulations (page 33 of 62)

Provision of false information during the permit application process, is subject to a fine of N$ 12,000 or imprisonment.

NAMIBIAN STANDARDS

Global best practices can be benchmarked to mitigate impacts associated with the various activities carried out during the construction of access roads and tracks, to set the best standards for Namibia as shown in TABLE 12. Therefore, the following standards can assist in selecting best practices to work with and achieve set targets, whilst optimising Environmental Management Systems (EMS).

TABLE 12 - NAMIBIAN STANDARDS FOR CONSTRUCTION OF ACCESS TRACKS AND ROADS

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Carrying out a Cost Benefit Analysis to determine the best access method	Excessive costs for environmental control in the absence of proper planning. Cost benefit analysis help management take precautionary measures to minimise and manage the impacts of all exploration activities.	– Use of helicopters is cheaper and has minimal environmental impacts in the initial phases of exploration. – Terrain vehicles (quad bikes, bulldozers, 4X4) may be advantageous and convenient if narrow access tracks need to be accessed.
Planning	Lack of proper planning consequently leads to exorbitant costs incurred by the exploration company and for environmental remediation.	Once the planner has determined the standard of tracks to be constructed, estimated costs should include the following: – Flora, fauna and heritage survey costs – Allowance for proper drainage and cost of pipes and culverts – Maintenance and rehabilitation costs
Selection of location / siting	– Location of access roads and tracks may raise conflict – Loss of native flora and fauna – Disturbance of indigenous heritage and loss of irreplaceable artefacts	Consult relevant interested/affected stakeholders about local settings and the ideal locations for access roads and tracks. Exploration companies can assist in heritage protection through resource identification and by establishing site avoidance by: – Buffering when heritage resources are encountered – Avoid level tracks, as water will pool on the flat sections – If there is potential for items of heritage significance to occur, or if such items are found, consider relocating exploration activities
Removal of vegetation	– Water contamination – Loss of native flora – Erosion	– If possible, human labour should be used. However, if not practical, then excavators are recommended for exploration

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
	– Threaten existing protected, endemic, indigenous plant species (i.e. *Acacia erioloba* or *Welwitschia mirabilis*)	earthworks – Removed topsoil and vegetation should be stored in a secure windrow alongside the track – If an additional cut is made, subsoil must be stored in a second separate windrow alongside the track – Do not needlessly remove vegetation from either side of the roadway
Construction of drainage system	– Steep sections of tracks are prone to severe erosion and generally incur high maintenance costs – Floods can occur in flat areas along the access roads and tracks	– Grips should be at an angle across the track to best intercept and direct the water into a drain – Grips function most effectively in combination with a table drain – Where excessive silt loads are anticipated, and water quality is an issue, large cross drains and culverts should be constructed in conjunction with a sediment trap
Determine class of access roads and tracks	– Most exploration tracks will never be subject to heavy road use, and are highly unlikely to be of a higher grade – Environmental impacts are minimal because tracks are temporarily erected	The intended function and duration of use of an access track is used to determine the class of access track required. Low-use exploration tracks are typically constructed to the following standards: o 3-3.7m pavement width o No shoulder required o +15%, -15% desired maximum grade
Constructing new access roads and tracks	– Environmental disturbance – Loss of flora and fauna – Disturbance of migratory activities of wild animals in the area	– When developing a new track off an existing roadway, ensure the junction is discreet but is also safe (traffic management may be required) – Where possible, new roads and tracks should join (dogleg) existing roads and tracks – Learn to recognise and avoid rare or valued plant species
Use of public and other pre-existing roads	– Environmental disturbance is minimised – Increased traffic density	– Always use an existing road or track in preference to constructing a new one – Monitor the condition of the track before, during, and after use – Where the mining or exploration activity is in a protected area, operators of such vehicles should not derail from provided tracks – Do not accelerate the deterioration of the

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
		route by speeding – Driving speed should be kept at a speed limit that prevents dust generation
Use of tracks	– Disturbance to migratory activities of wildlife due to increased human and vehicular activities – Loss of biodiversity	– The use of temporary tracks should be confined to the summer months – Carry a spade to unblock grips and culverts – Keeping water off the surface of tracks will reduce the expenditure required for maintenance – Regular maintenance work is advised, to prevent tracks failure – Choose a suitable vehicle to minimise both the expenses and environmental impact on the track
Re-opening of old tracks	Reduced environmental impacts.	– Overhanging vegetation should be cut, not pushed out of the way – Logs across the track must be cut – Re-open old drainage and install additional drainage where necessary
Rehabilitation of tracks	– Introduction of invasive plant species – Restoring the environment to its natural regime	Should ripping be required: – Rip along the contour, and the spacing of rip lines should be approximately equal to ripping depth – Do not rip when soil conditions are too wet to allow the soil to shatter – If ripping brings substantial amounts of rock to the surface, discontinue – Pull out culverts (pipes, logs, etc.) and re-establish natural drainage pathways – Replace stockpiled topsoil over the track (after ripping, if this was needed) to a depth of 0.3–0.4 meters – Tracks should be rehabilitated by seeding with species consistent with the surrounding vegetation, unless other requirements are specified either by land owner(s) or the MET – Tracks, roads and associated infrastructure required as part of the state track network, or by the private land owner, should be left in a serviceable condition – Tracks should be removed by dragging a

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
		used tyre behind a light off-road vehicle, thus smoothing tracks out in this manner

A tyre and a grid are commonly used in Namibia for levelling tracks, as illustrated in FIGURE 8.

FIGURE 8 - APPARATUS OF THE TYRE AND GRID USED TO LEVEL GROUND TRACK CLOSURE IN NAMIBIA (MANSFELD, 2006)

4.2 DRILLING

INTRODUCTION

Drilling is considered an invasive exploration method, and is an important part of exploration because it is used to obtain detailed information about rock types, mineral content, rock fabric, and the relationships between rock layers near to the surface and at depth – depending on the type of information required. The target of all drilling activities is reliant on the results obtained during the preceding phases of prospecting, namely the geological mapping, geophysical and or geochemical methods (van de Giessen, 2017).

The duration, methodology and magnitude of the drilling program depend on the scale of the project, and is often influenced by economic factors such as commodity price, financing support, and competitive advantages, etc. The impact of a drilling program is closely associated with its duration, methodology and magnitude.

COMPLIANCE

With regards to the drilling of boreholes, the Minerals (Prospecting and Mining) Act, No. 33 of 1992 stipulates in part 8 section 53, that no boreholes are to be drilled relating to any prospecting operations or mining operations, unless the licence holder has given written notice to the Mining Commissioner, indicating the intention. Therefore, the licence holder mentioned in section 53, subsection (1), should provide the Commissioner with a report detailing the following:

(a) The location, direction and depth of such borehole
(b) The geological formations through which such borehole was drilled
(c) The widths and assay values of any mineral or group of minerals intersected in such borehole
(d) Such other information as the Commissioner may require

A scoping report with an accompanying EMP has to be submitted, in order to obtain an Environmental Clearance Certificate prior to exploration. In a case where possible major impacts are likely to result from drilling activities, an EIA is also required. In the EMP, mitigation measures are outlined, which ensures minimal environmental damage.

Regulations herein are aimed at protecting natural resources, especially water. Prospective mineral explorers should be supportive, and acquaint themselves with the provisional standards, regulations, permits and/or licences pertaining to all drilling activities (shown in TABLE 13) and should ensure that all legal requirements are in place before commencing with drilling.

TABLE 13 - COMPLIANCE REQUIREMENTS FOR DRILLING

ACTIVITY	ACT	PERMITS/LICENCES	RELEVANT MINISTRY	LIVE LINK
Removal of mineral samples	The Minerals (Prospecting and Mining) Act 33 of 1992.	Application for permission to remove controlled minerals or the sale or disposal of any minerals; required in terms of Section 16(4), 31(4)(b), 67(4) or 90(3) of the Act; ○ A high-value mineral permit ○ An export permit	MME	**Visit the MME website and obtain the necessary documents
Exporting of mineral samples	The Minerals (Prospecting and Mining) Act 33 of 1992.	– Application for Permission to export minerals – Required in terms of Section 127 of the Act	MME	**Visit the MME website and obtain the necessary documents
Drilling of water supply boreholes	Water Act 1956.	Permit for borehole.	MAWF	Form WA-001
Water abstraction	The Water Act No. 54 of 1956 (enforced). Water Resources Management Act 11 of 2013.	Permit/licence to utilise a control water resource.	MAWF	WA-002
Wastewater discharge	Permit is issued under the Water Act No. 54 of 1956 (enforced) but the forms of the Water Act No. 24 of 2004 are used.	Wastewater discharge licence issued in terms of the Water Act of 1956.	MAWF	DWA_EFFPER
Clearing of vegetation for drilling	The Forest Act, 2001. Policy for Prospecting and Mining in Protected Areas and National Monuments	Forest licence for harvesting, issued under (section 22, 23, 24, 27 and 33 / regulation 8 and 12)	MET	**Form 10 under the forest regulations

ACTIVITY	ACT	PERMITS/LICENCES	RELEVANT MINISTRY	LIVE LINK
	(1999).			(page 33 of 62)
Use of radioactive source for logging	Atomic Energy Radiation Protection Act No. 5 of 2005. Radiation Protection and Waste Disposal regulations (No.221 of 2011).	Radioactive Authorisation (import and export) for the use of radioactive source for logging in accordance with Sections 17(1), 19(1), 21(1) of the Act.	Ministry of Health and Social Services (MoHSS); National Radiation Protection Authority (NRPA)	

Don't forget to apply for the renewal of an abstraction and water use permit, 3 months prior to the expiry date.

NAMIBIAN STANDARDS

The following best practices will ensure that the drilling activities are within legal requirements, and in doing so, will protect the environment and achieve environmental sustainability. The practices summarised in TABLE 14 are aimed at reducing, eliminating and minimising impacts from drilling operations.

TABLE 14 - NAMIBIAN STANDARDS FOR DRILLING

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Supplying water to the sites	– If sourcing water from a shared resource, other water users can be impacted – Resource depletion (in the case of borehole)	– Monitor abstraction and comply with the permit/licence conditions – To reduce dust emissions, make use of spray nozzles to apply water to the ground
Installing and use of water and fuel pumps	– Groundwater and soil contamination – Barriers to wildlife movement	– Water pumps must be placed on oil-absorbent material and regularly checked for hydrocarbon leaks because of their proximity to water courses – Pump water away from watercourses and allow it to drain through vegetation, where possible – Fuel pumps, pouring spouts and funnels must always be used – Fuel tanks must be sealed and secured and meet

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
		the engine manufacturers' specification
Installation of drainage systems	Risk of cave ins and flooding.	– Proper placements and installation of drill pads to aid drainage – Where appropriate, facilities such as cut-off drains, and silt traps are installed
Use of sumps	– Possible spillage of drill fluids – Can lead to sink holes if not properly constructed – Can cause soil compaction	– Drill pads should be designed with the sump on the downhill side – Drainage systems should be dug to direct any accidental spills into the sump – Sumps must always have oil-absorbent booms floating in them – Excess water from the supply pump should be redirect away from the sump – Sumps to be backfilled and separately stockpiled topsoil to be re-spread on top – If it is not possible to produce a sump, drill hole return water must pass through an oil-absorbent boom and pumped away, and allowed to sieve through vegetation
Setting up of equipment	Soil contamination.	– Equipment must be in good condition to ensure that oil and hydraulic leaks do not contaminate the site – During drilling, oil-absorbent matting should be placed under and around the rig – Store hydraulic fluids and oils in a fire-safe bund that does not fill up with rainwater – Keep vehicles, water tanks, and core samples, etc. in demarcated working area
Storage of fuels	– Leakage into groundwater – Soil contamination – Fuel spills	– All drums and other containers should be in a sound condition – No hydrocarbons should be stored on drill sites but in approved designated areas in appropriately bunded facilities – Fuels and oil stored on site must be contained in a bund wall, away from any watercourses, which is fireproof and does not fill up with rainwater – A supply of oil-absorbent material should be kept on hand to clean up any minor spills
Accidental spills	– Hydrocarbon spills/drilling fluids/drill water – contamination of soil, surface and ground water – Fauna entrapment and death down drill holes	– Where, and whenever possible, biodegradable drilling fluids such as geo-foam or similar must be used – The drill rig and accompanying vehicles must be free of leaks

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
		– During drilling operations, dust control measures must be implemented (e.g. suppression with water) to minimise impacts on exploration personnel and the surrounding vegetation – Have emergency cleaning equipment in place – Absorbent mats are practical for managing spillages from refuelling or leaks, (available products on the market include: Sunsorb, Peatsorb, Drizit, etc.) – Oil-absorbent booms must be replaced at regular intervals – In the event of a hydrocarbon spill of greater than 200L, the Minister of the MME must be informed
Abandonment of drill holes	– Compacting of soils – Waste generation – Drilling fluids and additive containers	– Waste, such as drilling fluid, additive containers, rags, or refuse of any kind, is not to be disposed of on site – Backfilled, and mounded with soil. Uncollared holes to be plugged at least 1 m below ground level – Drill spoils returned to drill holes and remaining inert material should be re-spread on the drill site or placed in the bottom of the sump – Rehabilitation of the drill holes should be conducted after completion of downhole geophysics and chemical assays returned, no longer than 6 months after drill hole completion – Unrecoverable radiation sources may only be sealed down the drill holes with the permission of the Mining or Environmental Commissioner – Accurate records of abandonment procedures should be kept, for future reference
Rehabilitation	– Attainability of land to its original topography – Introduction of alien invasive species – Erosion due to improper rehabilitation	– For areas supporting native vegetation, tillage and seeding with species native to the area may be required during rehabilitation – Only indigenous plant species must be used during the revegetation of disturbed areas—a plant specialist must be consulted for this purpose – Any excess or waste material or chemicals, including drilling muds, must be removed from the site and must preferably be recycled (e.g. oil and other hydrocarbon waste products) – Waste materials or chemicals that cannot be recycled must be disposed of at a suitably licensed waste facility

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
		– Restoration and rehabilitation of disturbed areas must be implemented as soon as prospecting activities are completed – Sites must be restored to the original condition, with vegetation cover (where applicable) matching the surrounding vegetation cover – All debris and contaminated soils must be removed and suitably disposed of – Natural drainage patterns must be restored and surface infrastructure on site must be removed – Temporary access routes/roads must be suitably rehabilitated – Sites must be monitored by the environmental control officer
What could go wrong? Impacts due to drilling activities can be indirect and unintentional. If precautions are not undertaken, the activities can lead to subsequent detrimental impacts on the environment, including; – Waste generated left onsite – Soil erosion due to improper/inadequate rehabilitation actions – Sink holes are left behind		

4.3 TRENCHING

INTRODUCTION

In areas where soil cover is thin, the location and testing of bedrock mineralisation is made relatively straightforward by the examination and sampling of outcrops. However, in locations of thick soil cover, such testing may involve a deep sampling program by pitting, trenching, or drilling (Marjoribanks, 1997). Pits and trenches can be a quick and cheap way of obtaining lithological, structural and assay information in areas of shallow cover (Department of Primary Industries, 2008; Bain, 2016). Pitting to depths of up to 30 m is feasible and, with trenching, forms the simplest and least expensive method of deep sampling, but is much costlier below the water table. Despite their relatively shallow depth, pits and trenches have some distinct advantages over drilling, in that detailed geological logging can be carried out and, if necessary, undisturbed samples could be collected. Trenches are usually employed to expose steep dipping bedrock buried below shallow overburden and are normally dug across the strike of the rocks or mineral zone being tested (Marjoribanks, 1997).

COMPLIANCE

When erecting trenches for sampling and examining outcrops, various regulations must be considered. The Acts and permits provided in this section do not exempt prospective explorers from any other laws. Prior to any exploration activities, a scoping report with an accompanying EMP must be submitted, in order to obtain an Environmental Clearance Certificate. In cases where major impacts are likely to result from the trenching, an EIA is also required. In the EMP, mitigation measures are outlined, which ensures minimal environmental damage. Further legal requirements relevant to trenching are illustrated in TABLE 15.

TABLE 15 - COMPLIANCE REQUIREMENTS FOR TRENCHING

ACTIVITY	ACT	PERMITS/LICENCES	RELEVANT MINISTRY	LIVE LINK
Removal of vegetation during excavation of trenches and clearing for equipment	The Forest Act, 2001 Policy for Prospecting and Mining in Protected Areas and National Monuments (1999)	Forest licence for harvesting, issued under (section 22, 23, 24, 27 and 33 / regulation 8 and 12)	MET	**Form 10 under the forest regulations (page 33 of 62)

NAMIBIAN STANDARDS

The best practice standards for exploration activities will not only attract investment that delivers outcomes of sustainable development and prosperity, but also helps the holder of such licence to develop a long-term relationship with all stakeholders. In addition, applying the best practices provides opportunities to minimise future costs, because the costs for rehabilitation will be less. Best practice standards to consider during trenching activities are summarised in table 16.

TABLE 16 - NAMIBIAN STANDARDS FOR TRENCHING

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Planning	– Trenching and bulk sampling operations are inherently hazardous activities and should be carefully planned to minimise damage to the environment – Environmental impacts are minimised with advanced proper planning that facilitates effective rehabilitation on the disturbed areas	– Planning should precede the trenching activities – Site selection should be based on the reflection of environmental, cultural, heritage, and occupational health and safety aspects – Supervised by a suitably trained and experienced person (e.g. environment health and safety officer)
Selection of location	– Environmental disturbance	– Where possible, select leveled sites to minimise earthworks – Sites should be located adjacent to existing tracks and within previously cleared or disturbed areas – Work sites should be selected to avoid waterways, drains and channels – Drill pads, trenches and bulk sample excavations should be confined to the smallest area in which it is safe and feasible to conduct operations
Construction of trenches	– Erosion can occur on the steeper slopes – Damage to vegetation through excavation or clearing for equipment	– Avoid unnecessary removal of vegetation – Where temporary trenches are left open for longer than 24 hours and the safety of humans is at risk, temporary fencing and barricades should

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
	access and mixing of topsoil with subsoils – Dust generation	be erected Dust control measures onsite may include: – Vehicular movements and speed limits should be minimised – Utilising recycled or reclaimed water to spray unsealed tracks/roads and disturbed areas
Rehabilitation	– Introduction of alien invasive species – Erosion due to improper rehabilitation	– Rehabilitation entails the revegetating of bare areas with species consistent with surrounding vegetation – Trenches should be refilled in such a way that subsoil is replaced first, and topsoil replaced last

4.4 Decommissioning

Introduction

Decommissioning is strengthened by a decommissioning plan which, inter alia, covers safety, health, environmental and contingency aspects. To achieve environmental sustainability, it is best practice to ensure the removal of all platforms including the removal of camps, concrete plinths, backfilling, drill casing and waste materials generated during exploration activities; and disposed thereof in an environmentally responsible manner. In events where there is hazardous waste, the licensee should have a facility which is fully equipped and licensed to handle such hazardous materials (Risk-Based Solutions (RBS), 2018). If the site is properly constructed and operated during the exploration phase, the tasks of decommissioning and rehabilitation should be unexacting. Therefore, best practices and technologies for determining impacts on the environment should be employed (Tarr, 2014).

Compliance

The state administers and manages the mining sector through several legislative frameworks, which relate to mineral exploration, mining activities and environmental protection. The same frameworks govern, enforce and foster the engagement of all stakeholders and account for all exploration activities, including decommissioning. TABLE 17, shows a summary of the compliance requirements during the decommissioning phase.

TABLE 17 - COMPLIANCE REQUIREMENTS FOR DECOMMISSIONING

ACTIVITY	ACT	PERMITS/LICENCES	RELEVANT MINISTRIES	LIVE LINK
Wastewater discharge	Permit is issued under the Water Act of 1956 (enforced), but the forms of the Water Act of 2004 are used	Wastewater discharge licence issued in terms of the Water Act of 1956	MAWF	DWA_EFFPER

Disposal of hazardous waste	Hazardous Substance Ordinance 14 of 1974 as amended	No permit required for the disposal of hazardous waste at a certified hazardous waste site in Namibia	MET	
Disposal of radioactive waste	Atomic Energy Radiation Protection Act No. 5 of 2005 Radiation Protection and Waste Disposal regulations (No.221 of 2011)	Radioactive Authorisation (import and export) for the use of radioactive source for logging in accordance with Sections 17(1), 19(1), 21(1) of the Act	MOHSS: National Radiation Protection Authority (NRPA)	Form NRPA_AG

Namibian Standards

To minimise the risk of safety and environmental incidents, it is vital to ensure that sites are properly closed and all surface infrastructure on site are removed after the cessation of activities. Temporary access roads and tracks need to be suitably rehabilitated, and sites have to be monitored by an environmental officer (based on specialist inputs if necessary) until the desired rehabilitation objectives have been achieved (State Government of Victoria, 2018). The best practice standards are illustrated in TABLE 18.

TABLE 18 - NAMIBIAN STANDARDS FOR DECOMMISSIONING

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibia Standards**
Closing of sumps	– Drill fluids seepage into ground – Groundwater contamination	– Sumps to be backfilled and covered with separately stockpiled top soil, re-spread on top – Excavations for sumps shall be refilled with the subsoil first and the topsoil last – Where portable sumps are unfeasible, drilling muds and fluids should be contained in appropriately sized and lined sumps or tanks for re-circulation and/or disposal at appropriate waste management facilities – Above-ground tanks are preferred over excavated sumps – At the completion of drilling, the sump shall be drained, and the liner removed – Inspection of sumps should be conducted at the end of the wet season or within six months, to monitor site stability
Closing of drill holes	– Drill cuttings – Surface and groundwater contamination – Loss of fauna and flora	– Effective relocation of drill cuttings – Remove pegs, cut collars and plug holes with plastic cones 300mm below ground level – Holes should not only be filled with sand alone, as the wind will scour the sand out and re-establish

EXPLORATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Exploration Activity	**Possible Impacts**	**Leading Practices/Namibia Standards**
		the hole
Waste management	– Environmental pollution	– Hazardous waste near the structures should be mapped thoroughly to plan for careful removal and disposal – Any excess or waste material or chemicals, including drilling muds etc. must be removed from the site and must preferably be recycled (e.g. oil and other hydrocarbon waste products)
Revegetation surface or seeding	– Introduction of alien invasive plants – Erosion due to improper rehabilitation	– Only indigenous plant species must be used during the revegetation of disturbed areas—a plant specialist must be consulted for this purpose – Natural drainage patterns must be restored
Rehabilitation	– Environmental (habitat) restoration	– To restore the natural functioning of the environment requires a good ecological understanding – Understand the nature of the damage done – Start rehabilitation during the exploration phase – It is a best practice to assess rehabilitation work – If the approach employed does not appear to be working, amending of the methodologies may be required – Record photographs for comparison for the ''before impacts'' photographs – If operations are in a protected area, conservancy or private land, the warden or land owners should be informed, to assess the rehabilitation efforts

What could go wrong?

If the best practices are not applied, the mining company may face liabilities for environmental impacts and greater environmental damage, including groundwater pollution, encroachment due to the introduction of alien invasive species (e.g. *Prosopis* spp. or feral cats), and loss of landscape ecological functioning.

PART FIVE – REPORTING GUIDELINES

5 INTRODUCTION

Reporting during the exploration phase is mainly conducted to give the government an overview of exploration activities and to show compliance to approved programs. In Namibia, there is a need to streamline reporting requirements from both industry and government.

5.1 Low Impact

Reporting is a key component of best practice, even if a company's impacts are low and even when reporting is voluntary. Amongst others, reporting reflects accountability and transparency, respect for stakeholders, and shows that a company is committed to environmental management and is serious about its reputation.

5.1.1 Reporting – from industry to government

The reporting requirements for low-impact exploration varies, depending on the exploration activities carried out. When using non-invasive methods such as remote sensing techniques, environmental impacts are less extensive, as compared to using exploration techniques that involve using subsurface sampling.

In accordance with global best practices, if airborne surveys are conducted, a written notice is required to be submitted to the government prior to conducting the survey. The notice should contain, but not be limited to, the following information:

- Map of area to be surveyed
- GPS co-ordinates of area to be surveyed
- Flight lines
- Aircraft number
- Duration and exact time of survey
- Flying altitude

The requirements related to records, plans and maps by the holder of a reconnaissance licence are stated in section 66 of the Minerals (Prospecting and Mining) Act No. 33 of 1992. If remote sensing techniques are used to obtain aerial photographs or imagery, a description of the remote sensing survey should be included in the bi-annual report. Descriptions should include, but not be limited to (Department of State Development, 2015):

- Standard scale maps indicating flight lines and survey locations
- Specifications of the survey and instruments
    - Survey type, recorded parameters, line spacing and aircraft type
    - Instrument design, type, units of measurement
    - Additional information including data on the nature of ground, conversion factors for any units used other than those in the S.I. system
    - Raw data along with calibration data

- Digital copy of raw and processed data
- Specifications and results from other remote sensing surveys
- Flight specifications of aerial photography
- Details of data processing techniques
- Results and interpretation of surveys including an interpretation of results

Public Consultation for aerial survey operations

Prior to undertaking aerial surveys, both directly and indirectly affected parties are required to be informed in writing of exploration activities. The contact details of these parties can be retrieved from the Ministry of Lands and Resettlement at the office of valuation and asset management.

International best practice dictates that a notice is to be placed in a local newspaper approximately 2 weeks prior to conducting aerial surveys, to adequately inform the community about intended exploration activities. The following information is to be included in the newspaper advert:

- Company name
- Survey dates, time and duration
- Flight altitude
- Survey location
- Map of survey area and flight lines
- Contact details for enquiries

5.1.2 Reporting – from government to industry

In the event that an exploration company submits its bi-annual report capturing the above-mentioned points, there is an expectation to receive feedback from the authorities in a similar fashion. This feedback should entail a written notice from the MET, verifying that the bi-annual report has been received. The feedback expected by industry from government includes:

- Written verification that the bi-annual report has been received by the MET. This verification should be sent within 7 days of receiving the bi-annual report. An example of this notification is illustrated in the appendix toolkit
- Feedback report, stating the level of satisfaction with the status of the project as reported in the bi-annual report. This feedback report is to be sent back to explorers 60 days after receiving the bi-annual report. An example of this is illustrated in the appendix toolkit.

5.2 Medium to high impacts

As per the Minerals (Prospecting and Mining) Act No. 33 of 1992, reports from exploration companies with a medium to high impact, are required to be submitted to the authorities on a bi-annual basis. A detailed description of the records to be kept by the holder of an EPL is stated in section 76 of the Minerals Act of 1992.

5.2.1 Reporting – from industry to government

In accordance with global best practice, the bi-annual reports submitted to the authorities should include:

- General details of licence holder
- Exploration activities (drill holes, drill sites etc.)
- Changes to exploration activities and subsequent environmental hazards
- Compliance with national standards and approved programs
- Status of rehabilitation carried out during reporting period
- Rectification of non-compliance
- Impacts on groundwater
- Complaints
- Relevant maps
- Photographs (to prove monitoring and compliance with approved environmental outcome)

An example of a bi-annual report required by the government is illustrated in the appendix toolkit.

5.2.2 Reporting – from government to industry

If an exploration company submits its bi-annual report capturing the above-mentioned points, there is an expectation to receive feedback from the government in a similar fashion. This feedback should entail a written notice from the authorities, verifying that the bi-annual report has been received. The feedback expected by industry from the government includes:

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PART SIX – TRANSITION TO THE NEXT PHASE

6 INTRODUCTION

Once sufficient data of the mineral resource has been collected and the results are promising, the project advances to the pre-feasibility and feasibility stages. There is often an overlap between the last stages of exploration and the pre-feasibility stage. During the pre-feasibility stage, the objective is to determine whether a probable reserve is economically viable (International Council on Mining & Metals, 2012). From an environmental point of view, it is important to gain a biodiversity context of the project site during the pre-feasibility stage. The following commitments are important to undertake during this stage (International Council on Mining & Metals, 2012):

- Identify important areas for biodiversity and the status of protected species and protected areas
- Identify and assess potential impacts, considering the time frame for development
- Review possible mining options, processing options, waste products, site infrastructure needs, options for waste rock storage, options for tailings facilities and water demands. This should include the merits of each from technical, environmental, social and economic perspectives

6.1 Key Management Tasks during the Planning and Design Phase

The objective during the planning and design phase is to propose a workable model in which minerals can be extracted and prepared to the desired specifications, as cost-effectively as possible and considering social, environmental and legal constraints. During the planning and design phase, professionals need to consider the expected life of the mine, and address potential mine closure issues, as well as considering the expectations of stakeholders for post-closure land use. So, for example, material characterisation is an important aspect during the mining life cycle and should commence as early as the exploration stage. Material characterisation allows for plans to be developed, in order to sidestep potential risks.

To move into the projects and construction phase, the following must be in place:

- The pre-feasibility studies show economic potential
- The development of the resource is supported by stakeholders (investors, local community and the government)
- Financing for development and construction is available
- Commodity prices stance is optimistic

Once the required plans, documentation, design and legal paperwork are in place, the exploration company/mining company advances into the projects and construction phase.

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BEST PRACTICE GUIDE

ENVIRONMENTAL PRINCIPLES FOR MINING IN NAMIBIA

PROJECTS AND CONSTRUCTION

A joint publication proudly published by the Chamber of Mines (CoM), Namibian Chamber of Environment (NCE), the Namibian Government and members of the Namibian mining industry.

Ministry of Mines & Energy

NCE

Namibian Chamber of Environment

Republic of Namibia

Ministry of Environment & Tourism

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DEFINITIONS AND ABBREVIATIONS

ABA	Acid-Base Accounting
AMD	Acid Mine Drainage
ANC	Acid Neutralising Capacity
As	Arsenic
B	Boron
BOD	Biological Oxygen Demand
$CaCO_3$	Calcium Carbonate
Cl_2	Chlorine
Cn	Cyanide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CoM	Chamber of Mines
Cr	Chromium
Cu	Copper
DO	Dissolved
EC	European Commission
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EPL	Exclusive Prospecting Licence
F	Fluoride
FeS_2	Iron (II) disulfide- Pyrite
$FeSO_4$	Iron (II) Sulfate
FOG	Fats, Oil, Grease
H2O	Water
JORC	Joint Ore Reserves Committee
MPA	Maximum Potential Acidity
MBAS	Methylene Blue Active Substances
MET	Ministry of Environment and Tourism
ML	Mining Licence
MME	Ministry of Mines and Energy
MPA	Maximum Potential Acidity
Na	Sodium
NAF	Non-Acid Forming
NAPP	Net Acid Producing Potential
NCE	Namibian Chamber of Environment
NGOs	Non-Government Organisations
NO_2	Nitrogen Dioxide
O_2	Oxygen
O_3	Ozone
PAF	Potentially Acid Forming
Pb	Lead

PM	Particulate Matter
PM_{10}	Particulate Matter less than 10 µm in aerodynamic diameter
S	Sulphide
SAMREC	South African Mineral Resource Committee
SANS	South African National Standards
SO_2	Sulphur Dioxide
TDS	Total Dissolved Solid
TSP	Total Suspended Particles
TSS	Total Suspended Solid
WB	World Bank
WHO	World Health Organization
Zn	Zinc

PART ONE

1 SETTING THE SCENE

Once the findings of the exploration phase indicate that a mineral resource exists in sufficient quantity and grade, planning for the projects and construction phase can commence. This phase has several distinct activities, many of them overlapping. Once the researching, planning, permitting and authorisation process is complete, activities can advance into physical projects and construction work (Toovey, 2011). Extensive paperwork, design and pre-development planning, budgeting and report preparation are all part of this phase. Plans are made in accordance with the proposed technological design and mining method—with an emphasis on safety, economic viability, technological efficiency and environmental management (Newmont Mining Corporation, 2013). In summary, the projects and construction phase refers to a period during which the mine infrastructure and facilities are planned and constructed, as a series of systematic steps with a multidisciplinary approach. Typical activities of the projects and construction phase can be clustered as follows:

- Feasibility studies, research, planning and permitting
- Mine site preparation by land clearance and blasting, levelling and removal of vegetation
- Mine infrastructure construction, including administration buildings, headframes and mechanical workshops
- Installation of linear infrastructure such as roads, waterlines, power lines and substations
- Preparation of mine-specific infrastructure (e.g. tailings storage facility, mine dumps, storage yards, processing plant, comminution lines, stockpiles, crushers, etc.)

1.1 How to Use the Framework

This part of the Best Practice Guide highlights leading practices throughout the mine's projects and construction phase. The guide also incorporates the legislative framework, reporting requirements and additional information, to ensure easy and streamlined navigation throughout this phase, in accordance with both Namibian and international leading best practices and setting "Namibian standards". Illustrated in FIGURE 1 are key issues addressed in each section of this guide.

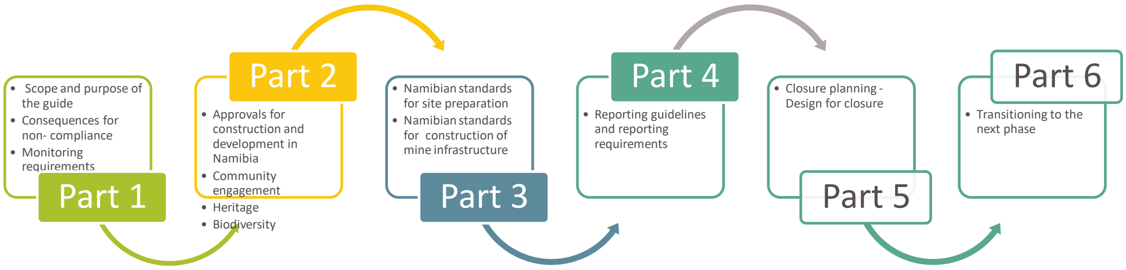

FIGURE 1 - KEY ISSUES ADDRESSED IN EACH SECTION OF THE BEST PRACTICE GUIDE FOR THE PROJECTS AND CONSTRUCTION PHASE

1.2 Mining Licence Application

After fruitful exploration activities, the holder of an Exclusive Prospective Licence (EPL) may apply for a Mining Licence (ML), before commencing with the projects and construction phase. An application for an ML is done in compliance with the Minerals (Prospecting and Mining) Act No. 33 of 1992, Sections 90-101. When successful, an ML is issued for a period not more than twenty-five (25) years. Renewal periods should not exceed 15 years at a time.

A mining licence is not solely issued to maintain the title and rights over a resource—the applicant must adhere to certain requirements, conditions and approvals stipulated by law.

Mining licence applications requirements

When applying for a mining licence, the following requirements need to be met:

- The company should be registered in Namibia, and in the case of an individual, he or she should be a Namibian citizen
- The applicant must have a sound mining budget and program
- Proof of the company's capability to finance the mining project needs to be provided
- Proof of a sound track record in mining should be provided
- A completed pre-feasibility study has to be available
- A detailed design and plans for the mine and processing plant should be available
- The availability of experts to carry out the proposed mining project needs to be warranted
- A sound report detailing the reserves and resources should be submitted, e.g. Joint Ore Reserves Committee (JORC), or South African Mineral Resource Committee (SAMREC) etc.

1.3 Baseline Study Requirements

It is essential for the applicant to be familiar with baseline study requirements and what specific monitoring is required at an early stage. Baseline studies are particularly important, to reflect on a before-and-after scenario, since the establishment of a mine can have a decisive influence and change on its surroundings. Baseline studies may include information about abiotic factors (climate, topography, soils, surface and groundwater), biotic factors (plants, animals and ecological functioning) or even socio-economic factors (demography, land use, etc.). The Environmental Impact Assessment (EIA) process may stipulate—and even include—some of these baseline requirements, especially as far as environmental information is concerned.

One of the most important baseline studies implied, is on air quality. Air quality might be affected by dust, gaseous and nuisance emissions, fumes and odours, and the background conditions of these aspects are essential for monitoring air quality against. Dust and gaseous emissions require immediate monitoring, as well as the establishment of a network of meteorological measuring points. Dust requires the monitoring of particulate matter (PM), in PM_{10}–format, but the monitoring program may require simultaneous measurement of total suspended particles (TSP) or $PM_{2.5}$ as well. The monitoring of these aspects will have much more meaning when background information from a baseline study is available.

In a similar fashion, it could be advantageous to conduct baseline studies on the sense of place as well, since the establishment of a mine can have a decisive influence on aspects such as noise, vibration and aesthetics.

1.4 Aspects to be Monitored

Procedures are used to determine which key impacts or components need to be monitored and managed during the different stages of a mine life cycle. Compliance and a risk-based approach is typically used to achieve this objective, and it incorporates the following aspects:

- Legal requirements are clearly determined and serve as a minimum standard for environmental protection and the associated monitoring that is required
- Baseline studies are used to identify social, environmental and economic values and create management and monitoring programs
- An environmental and social impact assessment has been conducted. This enables stakeholders and regulators to review the possible impacts and the implied management and mitigation measures
- Ongoing monitoring programs are initiated and a system of reporting is in place, in order to assess historic performance and real-time performance.

The minimum environmental impacts that require monitoring during the projects and construction phase are illustrated in FIGURE 2.

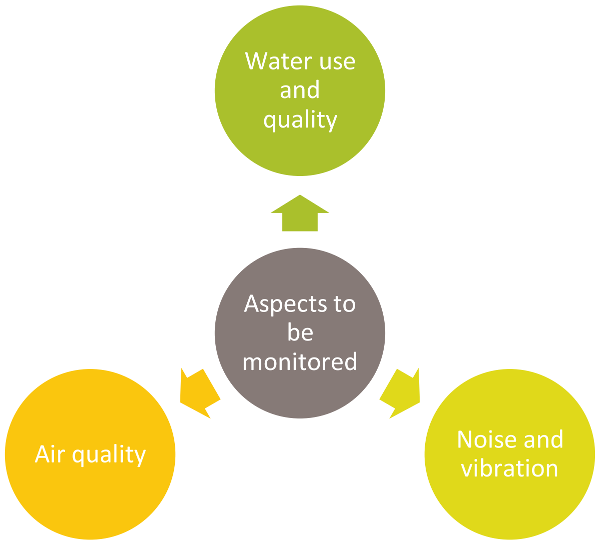

FIGURE 2 - ASPECTS AND IMPACTS TO BE MONITORED DURING THE PROJECTS AND CONSTRUCTION PHASE

Site selection is a crucial step in the development of a new project or the capacity expansion of an existing project. This is governed by various aspects, such as resources availability, construction and the placement of infrastructure and services, as well as environmental conditions such as air quality, water resources, noise and vibration, and waste generation.

Exploration and mining activities are most likely to impact the original environmental conditions and may have an effect on public health (e.g. air quality) and public concerns (e.g. water use) too. If a project does not take cognisance of these potential impacts—as proposed in the EIA or related documents such as an Environmental Management Plan (EMP) and Mine Closure Plan—this may go beyond tarnishing the company's image and reputation. Hence, to be at the forefront of environmental best practices, while at the projects and construction phase, methodological approaches and management measures should be well articulated, to minimise possible environmental bearings.

This section of the Best Practice Guide focuses in particular on air quality, noise and vibration, water quality, and social performance during the projects and construction phase of the mining life cycle.

1.4.1 AIR QUALITY

During the projects and construction phase, dust is generated by several mega-activities, such as earthmoving and access road construction. In fact, there is the potential to generate more dust than during the operational phase. Controlling dust emissions needs to be given special attention when operating in and around sensitive areas, and baseline monitoring will continue during this phase. There may be a need to monitor dust emissions using dust-monitoring instruments, which are strategically placed at the boundary or in sensitive areas. The dust monitoring instruments allow for early detection when allowable dust levels are exceeded. The Namibian Atmospheric Pollution Prevention Ordinance, No. 11 of 1976 does not make provision for any ambient standards for individuals and institutions to comply with. In the absence of a Namibian legislative and regulatory framework on air quality, standards and guidelines derived from the World Bank (WB), World Health Organization (WHO), European Commission (EC) and South African National Standards (SANS) are used in this document—as contained in TABLE 1.

Standards were determined based on international best practices for particulate matter less than 10 µm in aerodynamic diameter (PM10), dust fall, sulphur dioxide (SO2), nitrogen dioxide (NO2), ozone (O3), carbon monoxide (CO), lead (Pb) and benzene (National Committee SABS, 2009; Liebenberg-Enslin, 2012). Short intervals between measurements (10 minutes) are most useful in understanding and determining the source of emissions. As part of the Air Quality Act No. 39 of 2004, South Africa published listed activities and associated minimum emission standards for most significant industrial processes such as mining activities. Standards were published in 2009 and include a margin of tolerance (i.e. frequency of exceedances). Ambient air quality standards for respirable particulates ($PM_{2.5}$) were published in 2011.

TABLE 1 - SOUTH AFRICAN NATIONAL STANDARDS FOR AIR QUALITY

POLLUTANT	AVERAGING PERIOD	WHO GUIDELINES (µg/m³)	EU DIRECTIVES (µg/m³)	SOUTH AFRICA STANDARDS NAAQS (µg/m³)
Particulate matter (PM10)	1 year 24 hours	70 (IT-1) 50 (IT-2) 30 (IT-3) 20 (guideline) 150 (IT-1) 100 (IT-2) 75 (IT-3) 50 (guideline)	40 (n) 50 (o)	50 (l) (f) 40 (m) (f) 120 (l) 75 (m)
Particulate matter (PM2.5)	1 year 24 hours	35 (IT-1) 25 (IT-2) 15 (IT-3) 10 (guideline) 75 (IT-1) 50 (IT-2) 37.5 (IT-3) 25 (guideline)	25 (u) -	25 (q)(r) 20 (q)(s) 15 (q)(t) 65 (q)(r) 40 (q)(s) 25 (q)(t)
Sulphur dioxide (SO_2)	1 year 24 hours 1 hour 10 minutes	- 125 (IT-1) 50 (IT-2) (a) 20 (guideline) - 500 (guideline)	20 (d) 125 (c) 350 (b) -	50 125 (f) 350 (g) 500 (h)
Carbon monoxide (CO)	1 hour	30 000 (guideline)	10 000	30 000 (g)
Nitrogen dioxide (NO_2)	1 year 1 hour	40 (guideline) 200 (guideline)	40 (i) 200 (j)	40 200 (g)

1.4.2 Noise and Vibration Monitoring

It is leading practice to monitor noise and vibration during the projects and construction phase; in doing so, a mine has a continuous record of noise levels during this phase, and enables comparison to baseline (background) information, as well as all the other phases of the mining life cycle. It is wise to not only follow regulatory requirements, but also to practice precautionary principles in considering potential public concerns and to ensure thorough communication processes with stakeholders in this regard.

Blasting events, for example, need to be announced, and one of the means of communicating these events efficiently, is through the use of text messages to alert stakeholders prior to blasting.

SANS (10103) are used to address the way environmental noise measurements are to be assessed and taken in Namibia. SANS provides guidelines on the recommended noise levels, and the typical recommended noise levels are contained in TABLE 2.

TABLE 2 - SANS RECOMMENDED NOISE LEVEL

TYPE OF AREA	EQUIVALENT CONDITIONS RATING LEVEL ($L_{REQ,T}$) FOR OUTDOOR NOISE
	Day-time $L_{Req,d}$ [(a)] (dBA)
Rural districts	45
Suburban districts with little road traffic	50
Urban districts	55
Urban districts with business premises and roads	60
Central business districts	65
Industrial districts	70

LReq, d = The LAeq rated for impulsive sound and tonality in accordance with SANS 10103 for the daytime period, where the daytime period is from 06:00 to22:00.

1.4.3 Water Quality

Potential contamination and alterations of surface and groundwater during the projects and construction phase requires close monitoring. This involves the setting up of monitoring stations at an early stage, to indicate possible sources of contamination and possible flow changes to surface water bodies and aquifers. Groundwater is usually monitored by creating boreholes for sampling.

Any mine intending to discharge waste or effluent water should apply for a discharge permit under section 21(5) and 22(2) under the Water Act (Act 54 of 1956). TABLE 3 indicates the general standards for Article 21 Permits (effluents).

TABLE 3 - GENERAL STANDARDS FOR EFFLUENTS

DETERMINANTS	MAXIMUM ALLOWABLE LEVELS
Arsenic	0,5 mg/l as As
Biological Oxygen Demand (BOD)	no value given
Boron	1,0 mg/l as B
Chemical Oxygen Demand (COD)	75 mg/l as O
Chlorine, residual	0,1 mg/l as Cl_2
Chromium, hexavalent	50 µg/l as Cr (VI)
Chromium, total	500 µg/l as Cr
Copper	1,0 mg/l as Cu
Cyanide	500 µg/l as CN
Dissolved Oxygen, (DO)	at least 75% saturation
Detergents, Surfactants, Tensides	0,5 mg/l as MBAS
Fats, Oil and Grease (FOG)	2,5 mg/l (gravimetric method)
Fluoride	1,0 mg/l as F
Free & Saline Ammonia	10 mg/l as N
Lead	1,0 mg/l as Pb
Oxygen, Absorbed (OA)	10 mg/l as O
pH	5,5 – 9,5
Phenolic Compounds	100 µg/l as phenol
Phosphate	1,0 mg/l as P
Sodium	not more than 90 mg/l Na more than influent
Sulphide	1,0 mg/l as S
Temperature	35°C
Total Dissolved Solids (TDS)	not more than 500 mg/l more than influent
Total Suspended Solids (TSS)	25 mg/l
Typical faecal coli	no typical coli should be counted per 100 ml
Zinc	5,0 mg/l as Zn

1.4.4 SOCIAL PERFORMANCE

During the projects and construction phase, there is typically an influx of people, and this presents several economic benefits, as well as possible social challenges as a result. In addition, the influx of people can be fuelled by the expectation of employment and compensation for relocation, aspects which require proactive attempts to avoid disappointments, confrontation and opposition.

Moreover, the expectations of a new mine underline the importance of a socio-economic baseline study and an early start on communications and a community relations program that engages the public. Socio-economic impacts need to be monitored as a precautionary principle and to ensure that a platform for building good relations with stakeholders is ensured.

One of the key considerations in Namibia is to employ as many local people as possible, depending on the availability of skilled manpower. For this reason, it is essential to have a socio-economic baseline study, which includes information about the skills and qualifications of local people.

PART TWO – PROJECTS AND CONSTRUCTION PHASE PROCEDURES

2 KEY ACTIVITIES AND BASIC MANAGEMENT REQUIREMENTS

The projects and construction phase of the mining life cycle may take several months—up to two years or more—depending on the location, size of development, and complexity of the regulatory framework and review processes. Pre-construction steps include several civil tasks and may also include the building of camps for construction workers. Other steps for the site development may involve earthworks and land clearance, relocation of wildlife and keystone plants, installation of the main mine access and building of internal roads and crossings, the installation of a water supply and other linear infrastructure, and preparations for the construction of the processing plant area.

During the projects and construction phase, a company needs to adhere to all requirements set out in permits and other legal documents. It is also imperative to undertake all activities during this phase with special consideration towards environmental sustainability by applying the mitigation hierarchy: As a first step, the mitigation hierarchy prescribes that all efforts must be made to avoid impact; if this is not possible then the impact must be minimised as far as possible; and then those impacts that cannot be avoided or minimised must be managed and remediated as far as possible. If successfully applied, this approach may assist in avoiding unnecessary environmental harm, allow pragmatic and adapting decisions, and help to create a positive reputation. Moreover, this approach may also create significant cost savings in terms of rehabilitation and closure.

2.1 Key Management Tasks in the Projects and Construction Phase

It is during the projects and construction phase of the mining life cycle that vital decisions are considered for the long-term goals, which may influence and impact the sustainability of a mine. Some of the tasks that require critical management decisions during this phase are:

- Minimise environmental damage and limit rehabilitation requirements
- Establish good community relations with stakeholders
- Initiate a comprehensive monitoring and auditing program to maintain continuous records
- Manage socio-economic expectations—as an employer and source of additional income in the local economy

2.2 Risk Management During the Projects and Construction Phase

To adequately manage risk throughout the projects and construction phase, risk management principles need to be effectively applied. Ultimately, the objective of risk management is to reduce the probability and impact of risks. During the projects and construction phase, many new risks may emerge, and it is essential to identify all of these risks and potential impacts, to quantify the magnitude of the risks, and to set in place the most appropriate and effective mitigation methods. Risks associated with this phase may either bear positive or negative impacts that need to be managed. Hence, the risk management process during the projects and construction phase triggers planning for strategic ways of assessing and dealing with uncertainties during the projects and construction phase and beyond.

Prominent risks associated with the projects and construction phase can be grouped under the following headings: Health, Safety, Environment, Community, and Compliance. However, some of these risks may imply considerations for production, reputation, and closure as well. It is therefore important to take a management approach that aims for a long time frame, as well the cumulative risk potential.

A wide range of risk assessment approaches are available to the mining industry nowadays. The effectiveness of risk management at any site is measured by the effectiveness of the controls implemented. Typical questions for reflection include: Are the controls applicable and appropriately designed? Are the controls implemented as intended? Are the controls in place measured in terms of progress and performance? It is essential to introduce risk assessment techniques suited to the application and information needs of the specific site during this phase. In general, more complex techniques deliver more accurate results—but may require more time, increased cost, and the involvement of specialists. Additionally, it becomes inevitable to train and upskill people in the use and purpose of risk analysis and management. Furthermore, risk assessment is not a once-off process, but requires regular reviews of the outcomes.

Communication is increasingly emphasised in contemporary risk approaches—before, during and after the entire process. Key elements of a typical contemporary risk approach include the following:

- Communicate and consult
- Establish the context
- Identify the sources of hazard or threat
- Identify risks
- Analyse risks
- Evaluate risks
- Treat risks
- Monitor and review

Communication is important for sharing information about the context and background of a project with stakeholders—internally as well as externally. Understanding the context and background clarifies the nature of activities, the range of potential impacts, assists with the identification of stakeholders, and enables the stakeholders to list all sources and causes of hazards and threats on an inventory. In this way, all unwanted outcomes, pathways and receptors, vulnerabilities and perceptions can be identified. Once the hazards and threats are known, a clear description of the risk and its contributing factors (what and why) and occurrences (when and where) is needed, in order to identify and describe the risk and to analyse its potential impact on the environment, organisation or activity. Risk analysis is done qualitatively (simple and easy but unlikely to withstand scrutiny) as well as quantitatively (warrant uniformity, and is good to point out critical risks, but not always applicable to all kinds of risk assessments, e.g. environment, community). This enables a risk rating and suggests specific controls. The tools most commonly used to evaluate risks, are consequence and likelihood tables. From their evaluation it is possible to deduce treatment needs, options and priorities. A wide range of treatment options to prevent, correct and avoid, and to allocate resources, are available—elimination, substitution, engineering, administrative (procedure-based) controls, and personal protective equipment. Outputs from the risk identification process need to be documented, in order to communicate risk events. It serves also as a point of reference when developing strategies to identify key intervention points and to develop appropriate actions. At the same time, a risk register is handy when monitoring and reviewing risks after some time has elapsed, to consider changed circumstances, such as the implementation of a strategy or changes to the business, environment, regulations, or social conditions.

2.3 Community Engagement

Continuous involvement of stakeholders that may be affected directly and indirectly by the mining life cycle, often places different emphasis on the social, environmental and economic aspects of sustainability, as relationships between a company and its stakeholders evolve. For example, cultural and social issues may be more important to local and neighbouring people during the exploration phase. On the other hand, some stakeholders might be satisfied if rehabilitation measures meet performance targets for several decades after the projects and construction phase.

Assuming that community engagement processes have started with communication and community-related activities during the exploration phase, the emphasis during the projects and construction phase shifts towards the building and strengthening of relations and the establishment of sustainable principles. Put differently, it means that community engagement during the projects and construction phase ensures that no dependency is created and that stakeholders are left behind in a better position than before.

To establish principles of sustainability during this phase, a company should embrace socio-economic advancements through contributions of value in the communities in which it operates. This could include building relationships based on open, respectful and transparent communication, which promotes better understanding of the impacts on the social and physical environment as illustrated in FIGURE 3. Community and social investment should be in line with the requirements of Namibia's Mining Charter (see appendix toolkit). The Charter, directed by the Chamber of Mines (CoM), aims at positively and proactively addressing sustainable and broad-based economic and social transformation in the Namibian mining sector (Rossing Uranium Limited, 2018).

FIGURE 3 - KEY REQUIREMENTS FOR SUCCESSFUL COMMUNITY ENGAGEMENT

In addition to the key requirements mentioned in FIGURE 3, a company should further consider values such as being subtle to local cultural norms and modifying the engagement process to accommodate those norms; having an early start to allow time for learning, understanding and getting to know each other; supporting community organisations and structures; and having realistic expectations for all parties.

Consultation is part and parcel of public participation, with a wide range of stakeholders, including local people and neighbours, authorities and regulatory officials, shareholders, employees and non-governmental organisations. Community engagement is not a generic approach, but companies should employ a combination of various processes that encourage different stakeholders to engage in ways that are best suited to them. In Namibia, one of the platforms used to invite public participation is through local newspapers and radio announcements. Thus, the choice of processes and instruments will depend on the demands of the stakeholders, the complexity of the agenda and issues involved, the levels of literacy, cultural appropriateness, gender considerations, resources available, and the development phase of the mining life cycle. Building on the foundation laid during the exploration phase, good consultation during the projects and construction phase includes the following features (International Council on Mining and Metals, 2012):

- Considering the views and opinions of stakeholders on issues impacting the community before making decisions
- Making the purpose of consultation clear and documenting the consultation processes, to indicate compliance
- Providing feedback to stakeholders on how their inputs have influenced decisions
- Enforcing regular stakeholder consultation sessions by means of a communication platform with representatives from both the exploration company and stakeholders and an agreed interaction schedule

2.4 HERITAGE

Heritage—legacies of tangible as well as intangible attributes in their widest sense—could potentially be impacted by various activities during the mining life cycle, and also during the projects and construction phase.

Disobeying the National Heritage Act No.27 of 2004, by relocating or disturbing the position of a fixed protected object/artefact can lead to a fine of up to N$100,000.

Assuming that an early archaeological assessment (in the area where the projects and construction phase is planned) has been conducted, it would be wise to maintain existing, and to implement additional, management measures with regard to heritage. Great awareness about the history, archaeology, ethnicity, culture, norms and religions within the project area is advantageous, because in doing so, any possible conflicts between the local people, neighbours and the proponent, are minimised. Furthermore, it shows commitment to the respect of public opinion and precautionary principles.

2.5 BIODIVERSITY

The projects and construction phase has the potential to affect biodiversity, both directly and indirectly.[1] Assuming that a solid biodiversity baseline study has been done as part of an EIA, and that all biodiversity

[1] Direct or primary impacts can result from any activity that involves land clearance and earthworks, including road construction and preparation for construction, overburden stripping, impoundment of water or discharges of water, or the air (such as dusts or emissions). Direct impacts are usually readily identifiable and can easily be managed through the mitigation hierarchy and measures stipulated by the EMP. Indirect or secondary impacts can result from knock-on changes induced by construction activities and create delayed and collective impacts. They are habitually harder to identify immediately and to manage proactively.

risks and potential impacts are managed according to the EMP, it would be wise to maintain existing, and to implement additional, management measures as early as possible. In fact, as a precautionary principle, biodiversity management should be initiated during the exploration phase and continue well after mine closure. It is, however, not only limited to the areas affected by the activities during the projects and construction phase, but should consider all relevant surrounding sites and the ecological functioning of the larger landscape as well.

The primary focus of this Best Practice Guide is to grab the attention of management personnel during the projects and construction phase, to ensure biodiversity management as a leading practice. Research and monitoring activities are vital components in the management of impacts incurred on biodiversity and the rehabilitation employed following disturbances. Furthermore, companies that attain the highest biodiversity management standards, are those that use the findings of research and monitoring activities for continued improvement, and this is a key element of Environmental Management Systems (EMS).

2.6 Planning for the Prevention of Acid Mine Drainage

Namibia is a semi-arid country with limited surface water resources and a high dependency on groundwater resources. Protection of surface and groundwater reserves is thus a high priority. Several mining activities that expose mined materials, have the potential to alter the quality and quantity of both surface and groundwater. Discharge of Acid Mine Drainage (AMD) is a common impact incurred by mining activity, and may originate during the projects and construction phase, causing instantaneous threats to the quality of both surface and groundwater as well as biota.

Often associated with coal and metal deposits, AMD refers to the acidic water that is generated when sulphide minerals are exposed to air and water. Through oxidation and a subsequent chemical reaction, sulphuric acid is generated, which can mobilise significant amounts of pollutants downstream. Various new compounds may form, depending on the mineralogy of the rocks in the given area. The chemicals that make up the composition of the AMD include, most commonly: iron disulphide (also known as “fool’s gold”) (FeS_2); heavy metals; elemental sulphur; radionuclides (where uranium ore is mined); oxyanions; iron; and manganese. The basic chemical reaction is shown below:

$$\boxed{FeSO_4 + H_2SO_4} \leftrightarrow \boxed{FeS_2 + 7/O_2 + H_2O}$$

The resulting waters are usually of low pH and may not be released into an open surface. Treatment of such water involves increasing the pH to 7 by neutralisation with lime. The high concentration of pollutants present in the drainage, forms highly contaminated sludge, which requires proper disposal because it may pose unjustifiable health risks to the public in the surrounding community. Visual pointers of AMD include the following:

- Orange-brown iron oxide precipitates in drainage lines
- Unnaturally clear or red-coloured water
- Dense coatings of green algae filaments on the stream bed
- Poor productivity of vegetated areas
- Deposits of white or coloured salts forming along the bank of drainage channels

FIGURE 4 summarises the different types of drainage that can be formed from the oxidation of sulphide minerals.

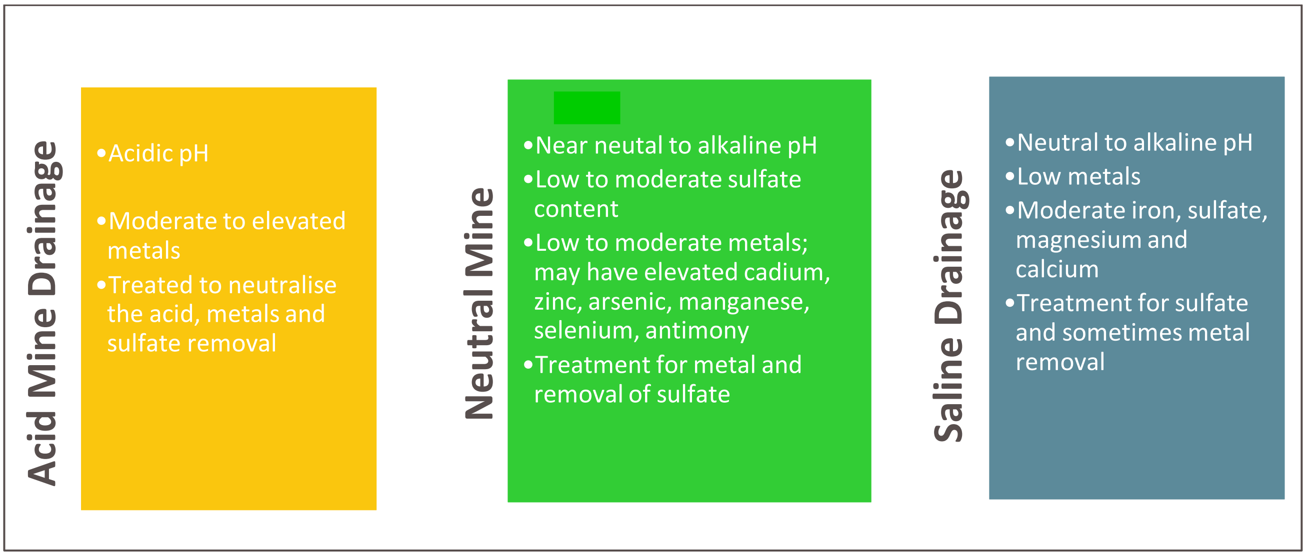

FIGURE 4 - TYPICAL RANGE OF DRAINAGE TYPES PRODUCED DURING THE OXIDATION OF SULPHIDE MINERALS

The first step in assessing the acid forming potential of a mining site is to carry out an acid-base account on various samples. This involves static laboratory procedures that evaluate the balance between acid generation processes (oxidation of sulphide minerals) and acid neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases, and weathering of silicates). The values arising from the acid-base account are referred to as maximum potential acidity (MPA) and acid neutralising capacity (ANC), respectively. The difference between the MPA and ANC values is referred to as the net acid producing potential (NAPP).

Factors such as mineralogy, climate and other environmental factors play a role in the formation of AMD. It is worth noting that AMD can continue to be present after mining operations cease. Hence the need for the implementation of precautionary principles, to manage the potential occurrence of acid mine drainage. Possible risks of acid mine drainage should be fully evaluated before mining operations commerce, preferably during the projects and construction phase. Prevention or minimisation of AMD requires early planning and active management of sulfuric waste. A proponent should make provision for acid mine drainage solutions that require treatment from neutralisation of acids, flocculation, filtration, softening and demineralisation, if needed. Moreover, it implies significant cost savings in comparison with long-term costs that may be incurred, should retroactive implementation control measures such as collection, mitigation or treatment strategies be considered. TABLE 4 contains some of the activities and procedures implied by the planning process.

TABLE 4 - BASIC ACTIVITIES AND PROCEDURES FOR ACID MINE DRAINAGE PLANNING

ACTIVITY/METHOD	PARAMETERS TO BE CONSIDERED FOR PLANNING
Investigation	In order to identify and define the presence of sulphides and determine the most appropriate and practical management strategies, an investigation should include: – Desktop assessment (i.e. geology, bore logs, hydrology) – Sampling – Laboratory analysis – Reporting
Sampling	Sampling should be conducted to quantify the acid-forming capacity of waste material. The parameters to be considered include: – pH – Mineralogy – Electrical-Conductivity – Acid-Base Accounting (ABA) – Multi-element composition
Classification (analysis of results)	Material classification must be performed prior to the proposed excavation. This information is required, to enable the planning of preventative measures, so as to avoid costly long-term mitigation programmes. Mine waste materials classification is as follows: – Non-Acid Forming (NAF): ANC/MPA* ratio ≥ 2 – Potentially Acid Forming (PAF): ANC/MPA ratio < 2
Management Plan	There are a variety of strategies available in mitigating the impacts of AMD, and the use of different mechanisms may vary in the effectiveness of outputs. However, the avoidance of a destruction approach is always the best approach. Other strategies include the use of underwater storage, neutralisation, dry covers, collection and treatment. **Dry Cover System:** – Consider impermeable barriers (i.e. multi-layer barriers) – Minimise the influx of water – Provide an oxygen barrier – Ensure resistance to erosion and support vegetation – For dry cover systems placed on reactive tailings and waste rock, consider oxygen consumption (organic cover materials) and reaction-inhibiting materials (e.g. limestone)
	Water Cover Systems An alternative for preventing AMD, is to bury the PAF material under water, because in water oxygen is about 25,000 times lower than that in the air (dissolved oxygen concentration in water is 8.6mg/L at 25ºC). Organic matter and other reduced compounds can rapidly consume the dissolved oxygen in the water, making it unavailable for sulphide oxidation. Ensure that all PAF material is permanently covered by at least two meters of water.
	Neutralisation – The degree of contaminants from tailings and waste rock depends on the extent of the buffering capacity of the system – Limestone/Calcium carbonate (crushed $CaCO_3$) and similar alkaline reagents have proven to be effective in increasing the pH and thereby precipitating and immobilising metals

ACTIVITY/METHOD	PARAMETERS TO BE CONSIDERED FOR PLANNING
What Could Go Wrong?	
Poor planning and design for AMD at any mine site, may lead to adverse environmental impacts, including the cost of remediation for both the government and the mining company.	

Successful long-term management of AMD requires proactive detection and resolution of problems prior to significant environmental impacts. This also involves monitoring, maintenance, repair and contingency plans. When considering AMD management, best environmental practice requires site-specific adaptation of local resources and environment conditions. FIGURE 5 shows the typical visual impacts of acid mine drainage onto a drainage line in Namibia.

FIGURE 5 - IMPACT OF ACID MINE DRAINAGE INTO A DRAINAGE CHANNEL

2.7 Waste Management

A variety of waste types and quantities may be generated during the projects and construction phase. In simple terms, a distinction is made between mineral and non-mineral waste and each type must be assessed and managed on its own merits. It is also important to review the waste management measures stipulated in the EMP regularly, as the quantities and disposal options may vary over time.

2.7.1 Mineral waste

When ore bodies are located close to the surface, surface mining is typically used – resulting in an open pit. When the ore body is located deeper down, underground mining methods are generally applied. During the early stage of mine development, mineral waste is stripped and dumped in allocated areas—in accordance with the Life of Mine plan and the EMP. Accordingly, these measures need to be in place during the projects and construction phase and regularly reviewed for continuous improvement. Aspects of mineral waste management are discussed in greater detail in the chapter that focuses on the operational phase.

2.7.2 Non-mineral waste

Non-mineral waste items have the potential to cause negative environmental and social impacts when not properly managed. It is assumed that the associated risks during the projects and construction phase are managed according to the EMP. It is also advantageous to maintain existing, and to implement additional, management measures with regard to waste during the projects and construction phase.

Non-mineral waste consists primarily of auxiliary materials that support mining operations. It includes items such as tyres, oils and grease, batteries, empty containers, plastic and wood packaging, scrap metal, paper, building rubble and waste items from processing, maintenance, workshops, laboratories and gardens and other domestic rubbish. Non-mineral waste is produced in much smaller volumes to mineral waste, but is a key indicator for measuring the ecological footprint of an operation.

A number of waste separation and recycling practices can be introduced during the projects and construction phase. Paper and cardboard, wood and plastic from packaging, and scrap metal are some of the waste items that are easily recyclable. Items that are more complicated to recycle, include used oil and grease, tyres, batteries, and empty lubricant containers. Items that have little to no potential for recycling, include chemicals, building rubble and kitchen remains, contaminated containers, oil and grease, and electronic waste.

The early introduction of a waste separation and recycling practice has the potential to gain reputation and raise environmental awareness among employees. Furthermore, employees should be encouraged to avoid, reduce and recycle waste, including the compression of bulky waste items.

2.7.3 Hazardous waste

Hazardous waste needs to be handled with great environmental care and preferably dumped at an approved waste site. An onsite facility for storing hazardous waste (including contaminated and non-recyclable waste items) temporarily before disposal offsite, is highly recommendable. Aspects of hazardous waste management are discussed in greater detail in the chapter that focuses on the operational phase.

2.7.4 Radioactive waste

The Radiation Protection and Waste Disposal regulations (No.221 of 2011) of the Atomic Energy and Radiation Protection Act, No. 5 of 2005 demands adequate protection of the environment and of people in current and future generations against the harmful effects of radiation, by controlling and regulating the production, processing, handling, use, storage, transport and disposal of radiation sources and radioactive materials. Accordingly, waste management procedures, especially for radioactive waste, should be put in place at a uranium mine.

PART THREE – NAMIBIAN STANDARDS FOR THE PROJECTS AND CONSTRUCTION PHASE

3 BASIC COMPLIANCE REQUIREMENTS

Site preparation involves earthworks such as the construction of access roads, land clearance, stripping and grading, and is typically carried out in preparation for the projects and construction phase. It is good practice to stockpile overburden for use in the reclamation process at a later stage. Additional earthworks are normally required, in order to access and mine the ore body—normally also taking place during the projects and construction phase. To carry out the activities related to site preparation, a company must be in possession of the necessary licence(s) and permit(s). Special considerations should be made with respect to the validity of such licences.

3.1 SITE PREPARATION

When mine sites are in remote areas, the initial step in site preparation is usually land clearing. Typically, there are significant environmental impacts associated with land clearing activities, therefore the activities associated with land clearing should be thoroughly assessed in the EIA and management measures stipulated in the EMP. When planning site preparation, the maintenance, rehabilitation and flora, fauna and heritage surveys must be considered along with cost evaluations (NSW Mineral Council Ltd., 2013).

Legislation and regulatory requirements

The Acts and permits provided in this section do not exempt a company from any other laws. All potential environmental impacts that could occur during the projects and construction phase are managed according to the legislative processes implied by Namibia's Environmental Management Act, No. 7 of 2007 and its associated regulations. In the required EMP, mitigation measures are outlined—when applied, these measures can ensure minimal environmental damage during the projects and construction phase.

Vegetation removal as a result of land clearing, is addressed under the Forest Act No. 12 of 2001 prior to conducting such activity. The relevant permits/licences are illustrated in TABLE 5.

TABLE 5 - REQUIRED PERMITS/LICENCES FOR SITE PREPARATION

ACTIVITY	ACT	PERMITS/LICENCES	RELEVANT MINISTRY	LINK
Clearing of vegetation	– The Forestry Act No. 12, 2001 – Policy for Prospecting and Mining in Protected Areas and National Monuments (1999) – Environmental Management Act 11 of 2011	– A forest licence for harvesting, issued under (section 22, 23, 24, 27 and 33/ regulation 8 and 12) – Environmental Clearance Certificate	– Directorate of Forestry, MAWF – MET	**Form 10 under the forest regulations (page 33 of 62)

Namibian standards

International best practices can be benchmarked to mitigate impacts associated with the various activities carried out for site preparation and set the best standards for Namibia as shown in TABLE 6. The following standards can assist in selecting best practices to work with and achieve set targets whilst optimising Environmental Management Systems (EMS).

TABLE 6 - POSSIBLE IMPACTS AND NAMIBIAN STANDARDS FOR SITE PREPARATION

SITE PREPARATION ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Site Preparation Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Vegetation clearing	– Water contamination – Loss of native flora – Erosion – Threaten existing protected, endemic, indigenous plant species (i.e. *Acacia erioloba* or *Welwitschia mirabilis*).	– If possible, human labour should be used, however, if not practical, excavators are the recommended machine for exploration earthworks – Removed topsoil and vegetation should be stored in a secure windrow alongside the track – If an additional cut is made, subsoil must be stored in a second separate windrow alongside the track – Do not needlessly remove vegetation from either side of the roadway
Grading	– Grading equipment can cause disturbance to the surrounding environment – Loss of native flora and fauna	– Grading should only be done when necessary, otherwise select areas for track and road construction where grading has already been carried out – Ensure as little vegetation is removed as possible – Minimise environmental footprint whenever possible e.g. use existing roads etc.
Generation of mineral waste	Disturbances to ecosystems	Use waste rock for backfilling and construction to minimise volume of waste rock generated.
Stockpiling of topsoil	Soil surface erosion	– All planned erosion and sediment control practices should be in place prior to stripping – Use proper procedures to stockpile topsoil, to be used for backfilling later
What could go wrong? If leading environmental best practices are not implemented at the exploration and mine site, the following can occur: – Disturbances to ecosystems – Loss of flora and fauna – High volumes of waste – Contamination of water resources – High rehabilitation costs		

3.2 CONSTRUCTION OF MINE INFRASTRUCTURE

Site preparation is followed by activities to construct the mine infrastructure. Multidisciplinary activities are part of construction and may have significant environmental impacts. To manage these impacts, the measures stipulated in the EMP have to be implemented, which requires close teamwork between the projects and construction team and the operations team.

Legislation and regulatory requirements

Prior to construction, the proponent should have the necessary permits stipulated in the Minerals Act No. 33 of 1992. Additional earthworks and land clearance might be required, and the company has to ensure that all necessary licence(s) and permit(s) are in place and valid. In doing so, the proponent ensures compliance with all relevant legislative and regulatory frameworks.

Namibian standards

International best practices can be benchmarked to mitigate impacts associated with the construction of the mine infrastructure and to set the best standards for Namibia, as can be seen in TABLE 7. These standards can assist in selecting the best practices to work with during construction activities, and achieve set targets whilst optimising Environmental Management Systems.

TABLE 7 - NAMIBIAN STANDARDS FOR PROJECTS AND CONSTRUCTION

ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Construction of on-site facilities	– Excessive dust – Excessive noise – Waste generated	– Arrange dust monitoring stations around the site – Ensure that employee exposure to noise levels remain within limits – Inform communities about the nature and scope of construction activities prior to starting construction – Re-use all suitable material to meet fill requirements
Earthworks	– Erosion and compaction of soils – Transport of sediment and associated contaminants by water and wind – Sedimentation in waterbodies – Loss of vegetation	– Minimise the area of soil exposed by phasing stripping and grading work and/or ensure timely implementation of suitable temporary or permanent stabilisation measures – Implement, inspect and maintain erosion and sediment controls – Ensure traffic travels along pre-defined routes and within the confines of the working areas
Refuelling and servicing of equipment	Hydrocarbon spills.	– Ensure all vehicles have spill kits and workers are trained in using them – Designate areas for refueling located some distance from waterbodies
What could go wrong? If leading practices are not implemented, the following can occur: – If dust emissions are not monitored and mitigated, exposure to dust will have an impact on flora species and human health – Sedimentation and soil erosion – Soil contamination due to fuel spills		

PART FOUR – REPORTING GUIDELINES

4 THE NEED FOR REPORTING

Any new project raises interest—among internal as well as external stakeholders. Without any doubt, the project and construction phase will raise interest, and it is vital that information during this phase is shared in a responsible and transparent way, to avoid confusion, misconceptions and, in the worst case, disputes, confrontation and opposition. For this reason, mechanisms of reporting need to be established—not only for the sake of compliance, but also for building relationships and reputations.

Upon the approval of a project, the relevant authorities may insist on a detailed EMP the scope of which should range across all construction activities through to decommissioning. It is the responsibility of the mining company to report regularly to relevant authorities and display how potential impacts are being mitigated. The purpose of reporting is two-fold. It gives the mining company the opportunity to self-evaluate how effective their operation aligns with objectives set out in the EMP, and as such, the government can evaluate compliance. It is also good practice to maintain a photographic record, to be included in reports. Several reports should be compiled, including daily construction reports, survey reports, field and laboratory test reports, and notes from relevant on-site meetings.

It is best practice to include maps in all reports, as it provides details of land use around the selected site. The identification of areas disturbed during construction, and type of disturbance should be clearly identified on these maps.

PART FIVE – CLOSURE PLANNING - DESIGN FOR DECOMMISSIONING

5 THE NEED FOR AN EARLY START

During the projects and construction phase, considerations will already have to be made for closure and closure planning needs. Progressive rehabilitation can be initiated during the projects and construction phase as the earthworks, excavations, land clearance and stockpiling of ore and waste can offer opportunities for rehabilitation. An early start has many advantages—it is cost-effective, it embeds important corporate values such as responsibility, proactive preparedness and holistic thinking. In addition, it has the ability to mobilise the workforce to be aware of the environmental footprint.

To obtain an Environmental Clearance Certificate and subsequently a mining licence, proper closure planning should be conducted during the feasibility phase. The mines that were already in operation prior to the declaration of the Minerals (Mining and Prospecting) Act, No. 33 of 1992, were not compelled to develop a closure plan during the feasibility stage.

Closure considerations should be borne in mind throughout the projects and construction phase. Due to the high costs involved, environmental damage should be kept to a minimum, in case all activities have to be ceased during the projects and construction phase. Decisions and planning considerations can have long-term environmental and social consequences, which can impact the mine closure and completion process. Elements during the projects and construction phase, which aid in reducing closure costs, include:

- Proper foundation construction for tailings dams to avoid potential groundwater contamination and seepage
- Construction of a basal layer for mineral waste dumps designed to handle sulphuric waste
- Proper erosion controls during construction, to avoid the increase of sediment loads to water courses during rainy seasons
- Adequate classification of growth media and topsoil
- Adequate handling and storage of lubricants and fuels to reduce possible contamination from spills

In order to mobilise resources for the restoration and rehabilitation of impacted sites and abandoned mines, a rehabilitation fund should be set up in the Environmental Investment Fund. The fund will require mining licence holders to fund bonds to ensure that they comply with their environmental and rehabilitation obligations. In the event that the operator is unable to fulfil their environmental obligations, the state will be responsible for paying the rehabilitation costs.

PART SIX – TRANSITION TO THE NEXT PHASE

Once the projects and construction phase is complete, mining operations can commence. Mining operations refer to the process of managing many long- and short-term activities to facilitate the production of a mineral product. As the mine moves into the operational phase and the equipment and processing plant have been commissioned, there are several factors that require consideration.

The operating costs of a mine are typically a function of the equipment used, which is a function of the mining method employed (surface or underground). Risk assessment and management is a critical component during the operations phase, and as such, should receive adequate attention during this phase. When advancing into the operations phase, several types of software can be used to assist in determining the most ideal production schedules at the mine. Selecting the ideal production schedule is key in realising a profit from operations.

Mining operations have five (5) main aspects, which need to be adequately planned prior to moving into the operational phase:

- The excavation procedure of earth and rock
- The processing method that will be used for separating ore
- The storage of waste material on the mine site and the maintenance of these waste storage facilities
- Environmental monitoring (air quality monitoring, noise and vibration monitoring, and water quality monitoring)
- Supporting services required at the mine and their operation (e.g. living areas, workshops, laboratories, warehouses, etc.)

Prior to moving into the operational phase, all necessary licences are required as stipulated in the Minerals (Mining and Prospecting) Act No. 33 of 1992, the Environmental Management Act No. 7 of 2007, the Water Act No. 54 of 1956, as well as the Water Resources Management Act, No. 11 of 2013. All conditions have to be met as stipulated in the Environmental Clearance Certificate.

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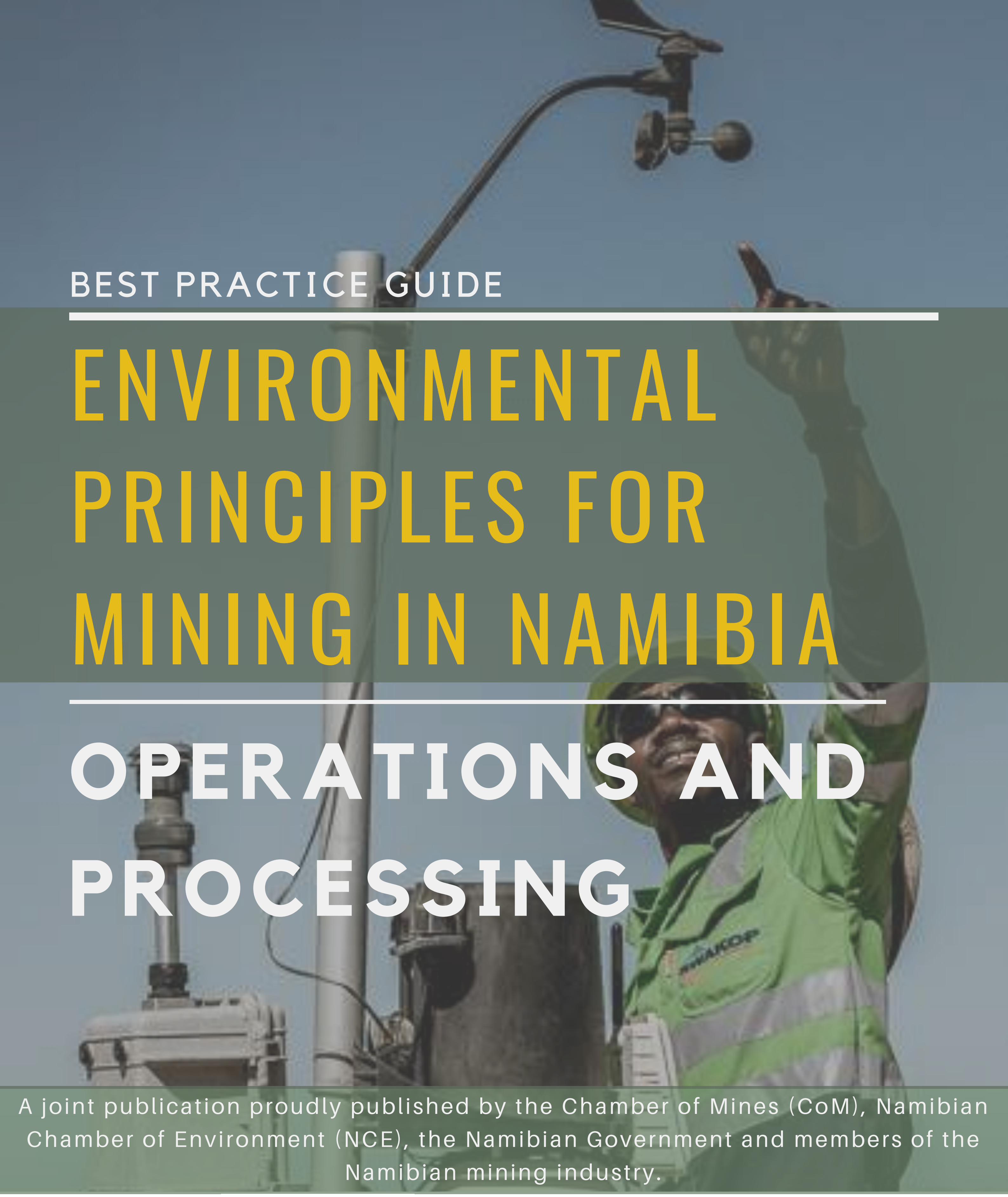

BEST PRACTICE GUIDE

ENVIRONMENTAL PRINCIPLES FOR MINING IN NAMIBIA

OPERATIONS AND PROCESSING

A joint publication proudly published by the Chamber of Mines (CoM), Namibian Chamber of Environment (NCE), the Namibian Government and members of the Namibian mining industry.

Ministry of Mines & Energy

Namibian Chamber of Environment

Republic of Namibia
Ministry of Environment & Tourism

TITLE AND APPROVAL PAGE

Project Name:	Namibian Environmental Principles for Mining - Mining and Processing Operations
Client Name:	NCE, CoM, MME and MET
Ministry Reference:	NA
Status of Report:	Final
Review Period	

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DEFINITIONS AND ABBREVIATIONS

AAQMS	Ambient Air Quality Monitoring Station
AMD	Acid Mine Drainage
CO	Carbon Monoxide
CoM	Chamber of Mines
CSI	Corporate Social Involvement
DEA	Department of Environmental Affairs
DNP	Dorop National Park
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Environmental Protection Agency
EPL	Exclusive Prospecting Licence
ETP	Effluent Treatment Plant
EU	European Union
GCL	Geosynthetic Clay Liner
IFC	International Finance Corporation
LLDPE	Linear Low-Density Polyethylene
MAWF	Ministry of Agriculture, Water and Forestry
MET	Ministry of Environment and Tourism
ML	Mining Licence
MME	Ministry of Mines and Energy
MoHSS	Ministry of Health and Social Services
MSBP	Millennium Seed Bank Project
MSDS	Material Safety Data Sheet
NBRI	National Botanical Research Institute
NCE	Namibian Chamber of Environment
NCRST	National Commission on Research Science and Technology
NEPL	Non-Exclusive Prospecting Licence
NNNP	Namib Naukluft National Park
NO_2	Nitrogen Dioxide

NRPA	National Radiation Protection Authority
O_3	Ozone
OHS	Occupational Health and Safety
PA	Protected Areas
Pb	Lead
RBS	Risk-Based Solutions
REDs	Regional Electricity Distributors
RL	Reconnaissance Licence
RMP	Radiation Management Plan
RO	Reverse Osmosis
SANS	South African National Standards
SHEQ	Safety, Health, Environment and Quality
SO_2	Sulphur Dioxide
TSP	Total Suspended Particles
WB	World Bank
WHO	World Health Organization

PART ONE - INTRODUCTION

1 SCOPE AND PURPOSE OF THIS GUIDE

Mining and processing activities—the operational phase of the mining life cycle—encompasses extraction, processing and selling of the ore and is a complex phase that requires a great deal of planning and management, in order to be profitable. Strategy is the pillar of the operational phase, which in turn determines the success of a mine. During this phase, investment is aimed at the optimal return for shareholders, and as a result, resource expansion, production rates and cut-off grades are key factors, in addition to productivity, safety, and the management of environmental and social impacts.

Documented within this Best Practice Guide, leading practices during the operational phase include: community relations management, heritage and biodiversity management, waste management (mineral and non-mineral, and hazardous substances), acid mine drainage, air quality, water management, monitoring requirements, and applicable "Namibian Standards". The content serves as guidelines for the Namibian mining sector, offering mining companies and interested stakeholders practical examples for leading sustainable activities during the operational phase of the mining life cycle, thereby demonstrating that commitment to sustainable development objectives is a central theme.

The different phases of the mining life cycle can vary in duration, but it is quite common to see the phase of mining and processing—the operational phase—as the longest of the phases. FIGURE 1 shows the mining phases, illustrating the approximate duration of each phase.

FIGURE 1 - FOUR MINE PHASES

Emphasis on sustainability and environmentally responsible and safe operations is increasing globally and these have become sound practices that enable a mining company to build a good reputation during the operational phase. Compliance, in addition, is non-negotiable. If commitments to sustainability and compliance are not incorporated into daily operations and management, or adhered to, a mining company can expect high risk costs of environmental clean-ups, disputes, and lawsuits, etc. Moreover, the reputation of a mining company can be tarnished to an unrepairable extent.

1.1 COMPLIANCE

Mining companies should operate in compliance with all applicable Namibian laws, regulations and other legal requirements at all times. To conduct mining operations, a mining company should be in possession of a valid Mining Licence (ML), as stipulated in the Minerals (Prospecting and Mining) Act, No. 33 of 1992, including all the necessary conditions laid out in the ML and Environmental Clearance Certificate, as being constituted by the Environmental Management Act, No. 7 of 2007. The latter highlights certain activities permitted by an Environmental Clearance Certificate, formalised by management measures stipulated in an obligatory Environmental Management Plan. Management of these measures implies an environmental management system, environmental monitoring and reporting programs, and environmental auditing and enforcement.

In addition to the legal requirements above, a mining company is obliged to have all implied permits, licences and agreements in place, prior to the commencement of operations.

If there are any deviations from the law, corrective steps should be taken to rectify non-compliance.

1.2 TYPES OF MINING ACTIVITIES

Mining activities can generally be divided into two categories: surface mining and underground mining.

The term surface mining describes several methods of mining mineral deposits from the surface, which involves land clearance and the removal of vegetation, top soil, and overburden above the mineral deposit. Topography and the physical characteristics of the deposit influence the choice of the surface mining method and can include contour mining, strip mining, quarrying, dredging, and hydraulic mining. As a result, surface mining can result in a single deep open pit, multiple open pits, or a series of shallow satellite pits, of which some are progressively backfilled with overburden or waste. FIGURE 2 shows an open pit of a mine in Namibia.

FIGURE 2 - THE OPEN PIT OF A GOLD MINE IN NAMIBIA

Underground mining allows for a more selective mining approach. Underground mining methods are typically employed for deep deposits and where there are restrictions to surface land use. Extraction is through a series of vertical ramps, shafts and horizontal drifts, and the ratio of waste rock to the ore generated is lower in relation to that of surface mining activities. From an environmental standpoint, underground mining is a friendlier approach, as it has a smaller environmental footprint than an open pit mine with comparable capacity. Since underground mining is more selective, less waste is mined. Environmental impacts that typically accompany underground mining operations, include the release of compounds into the water and air. **Error! Reference source not found.** FIGURE 3 shows an example of an underground mining operation in Namibia

FIGURE 3 - AN UNDERGROUND MINE IN NAMIBIA

In many cases the open pit approach is preferred over an underground approach for mining, because of its economic advantages. To some extent, it is also safer and easier to operate. Disadvantages again, include aspects such as extensive accessory works and infrastructure, a high waste-to-ore ratio, and a large footprint due to the placement of overburden and waste rock. Furthermore, a mine with an open pit requires heavy machinery and equipment, more personnel, and an extensive network of infrastructure and service support. The footprint of an underground mine is normally small when compared to an open pit mine, but the spatial scale of operations is limited and confined. Accessory works, service support and infrastructure are normally smaller; vital ancillary services include the removal of groundwater and the provision of ventilation and light; machinery and equipment are smaller and specialised, and as a result are relatively expensive.

Both surface and underground mining activities are undertaken in Namibia, although open pit activities dominate. Open pit mines include Rössing, Husab and Langer Heinrich (all uranium mines located in the central Namib Desert near Swakopmund); Navachab and Otjikoto (both gold mines, the former near Karibib and the latter near Otjiwarongo); Skorpion, a Rosh Pinah Zinc Corporation mine (located in the southwest near the Orange River) is currently the only operational underground mine in Namibia. Other mines such as Tsumeb, Berg Aukas, Kombat, Otjihase, and Matchless are either closed or currently not in operation. Other mining activities include the mining of diamonds near Oranjemund (open-cast, beach accretion, dredging and inshore) in the southwest corner of Namibia; salt mining along the central coast; the mining of dimensional stone and marble in the central Namib Desert and around Karibib; cement production at Ohorongo near Otavi; and the smelting of copper ore at Tsumeb. Processing methods and on-site activities used by the different mines in Namibia vary widely.

1.3 Mining Operations and Land Ownership in Namibia

This section is written with the assumption that consultations and compensation contracts have been reached between the various parties and all the necessary permits have been obtained and are in place. It is strongly recommended that both the land owner and the mining company refer to the relevant sections of this Best Practice Guide (Exploration, Section 1.3), prior to, and during, mining operations, for clarity related to mining and land ownership.

PART TWO – ENVIRONMENTAL MANAGEMENT DURING THE OPERATIONAL PHASE

2 KEY ENVIRONMENTAL MANAGEMENT TASKS

Not only is it the longest in duration, but the operational phase of the mining life cycle is often also the most challenging in terms of environmental impacts and sustainability—and underlines the importance of good planning during the projects and construction phase, as well as the implementation of good practices of monitoring and mitigation during the operational phase. Different management systems and tools such as Environmental Management Systems (EMS) are implemented, all legislative and regulatory requirements are adhered to, and the management measures of an Environmental Management Plan (EMP) are incorporated into operational activities (Toovey, 2011).

The Environmental Management Plan (EMP) stipulates various actions, like monitoring and mitigation, to manage the different environmental impacts of the operational activities of a mine. Some of these impacts are illustrated in FIGURE 4.

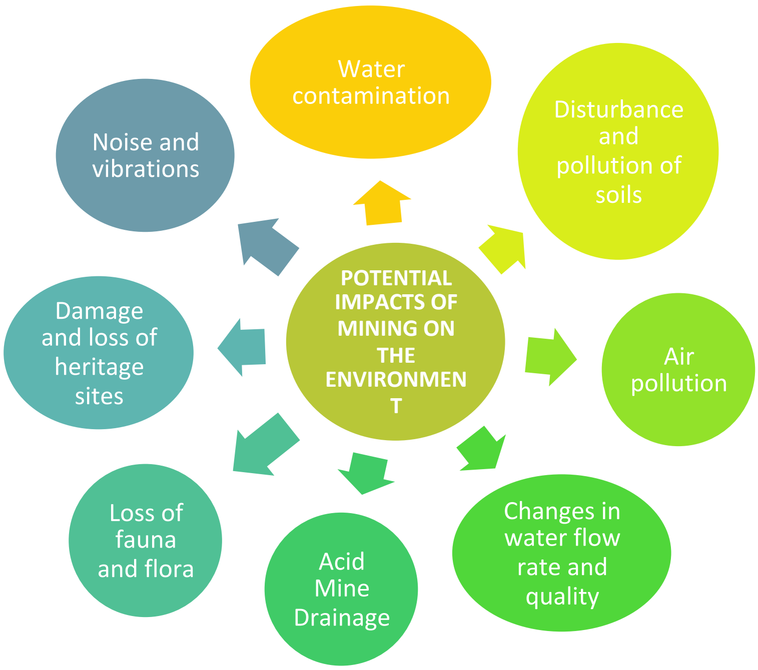

FIGURE 4 - POTENTIAL IMPACTS OF THE OPERATIONAL PHASE OF THE MINING LIFE CYCLE

2.1 Risk Management in Operations

There are several risks associated with the mining industry, and these risks may also differ over time during the mining life cycle. Mining and processing activities necessitate the integration of risk management in all business operations, and the implementation of an effective risk management program becomes inevitable, in order to identify, assess and manage all risks—it is recommended that you read the section on risk management, which is covered in the overarching chapter of this Best Practice Guide.

Risk assessment is a continuous process, of which fundamental work has to be initiated and conducted during the projects and construction phase (i.e. during the inception stages). Moreover, it means that risk management measures need to be in place when the operational phase commences. For this reason, it is also advisable to read the section on risk management in the projects and construction chapter of this Best Practice Guide.

During the operational phase, risk management becomes a continuous and iterative activity and requires a holistic and robust approach for integration into business decision-making. It would also be wise to assign risk management to responsible person(s), to establish a business-wide risk register, and to train the workforce on the application and updating of the risk register.

2.2 Community Relations During the Operational Phase

Community engagement is an ongoing process, preferably started in the exploration phase, continuing during the projects and construction phase, and increasingly maturing during the operational phase. As a result, the emphasis shifts from information sharing and basic communication, towards the building of relations, the commencement of directive communication campaigns and community-related activities, the establishment of sustainable principles, and a definite drive to ensure that no dependency is created and that stakeholders are left behind in a better position than before.

One of the main objectives of community engagement during the operational phase of a mining company, is to establish a prominent role as socio-economic catalyst. More intensive management of community relations, communication, and several new interventions, become necessary. TABLE 1 illustrates some of the recommended community engagement and development activities to be undertaken during this phase.

TABLE 1 - RECOMMENDED COMMUNITY RELATED MANAGEMENT ACTIVITIES TO BE UNDERTAKEN DURING THE OPERATIONAL PHASE OF THE MINING LIFE CYCLE (International Council on Mining and Metals)

DESCRIPTION	RECOMMENDED COMMUNITY ENGAGEMENT AND DEVELOPMENT ACTIVITIES TO BE UNDERTAKEN
Opportunities for the implementation of long-term community development initiatives focusing on locally identified development needs	External support from experts as required
	Qualified staff on board
	Adequate budget for community engagement
	Program for stakeholder engagement
	Functional grievance mechanism in place
	Constant collection of updated data
	Additional studies as required

DESCRIPTION	RECOMMENDED COMMUNITY ENGAGEMENT AND DEVELOPMENT ACTIVITIES TO BE UNDERTAKEN
	Full-scale evaluation and monitoring program in place
	Consistent reporting of internal and external challenges and progress
	Up-to-date stakeholder records and analysis
	Agreements with communities

Throughout the mining industry, it can be noted that when communities benefit significantly from mining operations, they vouch for the operations and take a keen interest in seeing the mine succeed. By contributing to the development of the community, mining companies can realise several benefits, such as:

- Reputation: Properly engaging and developing the community enhances a mine's reputation amongst stakeholders
- Resources: Access to mineral resources (ore bodies) in remote areas can improve
- Local workforce: Building skills within the local communities reduces the dependence of companies on expatriates
- Employees: Employee retention can improve
- Reduced closure costs and liabilities: As a result of better management of the social risks and community expectations, the closure and liabilities costs of the mine can be significantly reduced
- Approval processes can help to resolve disputes: The approval process is generally smoother if a mining company has better relations with its stakeholders.

Like many other mines in Namibia, the Otjikoto gold mine has strong relationships with the local community in which it operates. An example of the work the mine has done with regards to community engagement, is outlined in the case study below:

Case Study – Community Engagement

Mine:
Otjikoto gold mine, owned and operated by B2Gold.

Location:
Otjikoto gold mine is situated approximately 300km from the capital city of Windhoek, in a sparsely populated area near Otjiwarongo in the Otjozondjupa region of Namibia.

Brief description:
Otjikoto gold mine is an open pit gold mine.

Description of the case study:
The mine has taken a holistic view in terms of contributing to the society and environment within which it is situated, demonstrating that a successfully run mining operation can be beneficial to the country beyond the contribution of taxes and royalties. Prior to the construction of the mine, the holding company, B2Gold, committed to the goal of leaving Namibians better off as a result of a mining operation. The organisation set out to understand and align itself with government development objectives for environmental management and social upliftment in particular.

From the outset, the corporate social involvement (CSI) activities of the company were designed to be fair and transparent. Following the stakeholder needs analysis, B2Gold Namibia chose to focus on four development areas, namely: health, education, livelihoods, and conservation. A CSI Steering Committee was established, which assesses all projects based on a fixed set of criteria. One of these is that projects must be outcome-orientated and have clearly articulated and achievable, measurable goals. Projects are voted on by the committee, and the successful projects are recommended to the CSI Board. The board then evaluates these projects and they are either accepted, rejected, or sent back to the committee for additional information.

Adjacent to the mining operation, a 15 000-hectare nature reserve has been established. The reserve, which forms part of the B2Gold land package, was previously heavily overgrazed by domestic livestock and is now being systematically rehabilitated to its natural state. The reserve also includes an extensive education centre where school learners attend a wide variety of complementary learning classes (free of charge), which supports the government's school curriculum, with an added focus on the environment, conservation, sustainable utilisation of biological resources, recycling, responsible living, and alternative energies. B2Gold hopes to inspire a lifelong appreciation for the environment. To date, approximately 4,000 pupils have visited the education centre.

A special focus has also been given to physics, to improve the understanding of applied physics in Namibia. In partnership with the Colorado State University (USA), a practical and fun-based approach to teaching basic physics has been introduced through their "Little Shop of Physics" program. This has positively and significantly impacted the academic achievements of the pupils.

In support of the Ministry of Environment and Tourism (MET) and the School of Veterinary Medicine based at the University of Namibia, the Otjikoto Nature Reserve has invited the Veterinary School to establish a research laboratory on site, and leverage the available facilities and support.

Key learning and success factors:

1. Early commitment to CSI (before project development)
2. Develop a fair and transparent system for reviewing and deciding on investments
3. Investment framework based on the results of a stakeholders' needs assessment
4. Alignment with national (government) development objectives
5. Partnerships with development organisations, and

2.3 Heritage

Operational activities—regardless of all the proactive work done during the earlier phases of the mining life cycle—may still have an impact on heritage. The approach to be taken when there are known or easily identifiable heritage objects on site, is outlined in the Overarching Chapter of this Best Practice Guide. If further heritage sites are discovered during the exploration phase, projects and construction phase, or operational phase, an attempt should be made to preserve the artefacts found.

It is worth noting that disobeying the National Heritage Act No.27 of 2004, by relocating or disturbing the position of a fixed protected object/artefact can lead to a fine of up to N$100,000. It remains a priority to maintain existing, and to implement additional, management measures, as stipulated in the EMP, about heritage. Awareness about the history, archaeology, ethnicity, culture, norms, and religions within the project area, is advantageous, because in doing so, any possible conflicts between the local people, neighbours, and the proponent, are minimised. Furthermore, it shows commitment to the respect of public opinion and precautionary principles.

During mining operations at Namdeb, a significant heritage finding was made. The case study below shows how diamond mining led to the discovery, conservation and management of a 500-year-old shipwreck near Oranjemund, Namibia.

Case Study – Heritage

Mine:

Namdeb Diamond Corporation (Pty) Ltd is owned and operated by Namdeb Holdings (Pty) Ltd.

Location:

Namdeb Diamond Corporation (Pty) Ltd holds mining licences along the south-western coast of Namibia in the Tsau //Khaeb (Sperrgebiet) National Park. ML 43 is the southernmost licence and extends from the Orange River mouth to some 100 km north of it. Open cast mining below sea level is done by using stripped overburden material to construct a seawall to hold back the sea, so that the mining site is dewatered, in order to access the diamondiferous gravel. After stripping, the exposed gravel ore is loaded and hauled to the closest treatment plant. Industrial trans-vacuum machines are used to suck up any remaining gravel in the bedrock areas. Once all ore has been recovered, the seawalls are no longer maintained, and the sites are rapidly swallowed by the sea, leaving only remnants of mining in the form of ponds along the coastline.

Brief description:

During diamond mining operations, artefacts of immense cultural, scientific and intrinsic value were discovered.

Key issue(s) addressed:

The discovery made during mining was one of the biggest heritage finds in Namibia and is of great significance. This case study aims to highlight how mining helped unearth this discovery.

Description of the case study:

On the 1st of April 2008, whilst bulldozing a mining site situated approximately 20km north of the Orange River mouth, Namdeb employee Kapaandu Shatika discovered several half-sphere copper ingots, and therefore stopped his dozer. Namdeb soon found more artefacts in the form of two canons, elephant tusks, pieces of timber, and coins. The area of the find was approximately 7m below sea level, clearly suggesting that these would be artefacts from an old shipwreck. The initial steps taken by Namdeb included halting the mining operation, cordoning off the site, and requesting the full-time assistance of an archaeological specialist. The specialist immediately realised the significance of the find and called for the assistance of a maritime archaeologist. Since Namdeb's mining sites are protected under the Diamond Act, the site was under constant security surveillance. Despite the huge costs involved, Namdeb continued to keep the seawall intact, to ensure that all the necessary steps for the excavation and rescue of the shipwreck could take place. Prior to the 2008 discovery, *ad hoc* reports of elephant tusks found in ML43 were made. In October 2007, a piece with two parallel openings to operate a block and tackle was found (Alves, 2011). However, it was only when the artefacts of 2008 were found, that the pieces of the puzzle slowly but surely fell into place.

It was reported during the initial excavation that 5 438 artefacts of immense cultural, scientific and intrinsic value were discovered, recovered and subjected to preliminary conservation procedures. These artefacts include 2 159 gold coins, 1 845 copper ingots, 109 silver coins, 67 elephant tusks, 14 cannon balls, 8 bronze cannons, 5 anchors, 3 astrolabes, 3 navigation compasses and part of a compass, as well as tin tableware, copper cooking utensils, swords and chains. The copper alone weighs about 20 tons, and there are also 3.5 tons of tin ingots. Among other items, several wrought iron cannons, swords, muskets and a box of sword blades were found (Noli 2008; Noli & Werz, 2008).

Namdeb initially availed a prefab workshop facility for short-term temporary storage of the collection. A survey was executed by Namdeb's professional surveyors under the maritime archaeologist's supervision, thus allowing for the documentation of minute details of the find, inclusive of hundreds of photographs, video footage and a geodesic survey of the site using a laser scan aligned to international standards (Alves, 2011). After the initial excavation, the site was covered with a 1-meter thick layer of sand and rocks.

On the 22nd of August 2008, a team of Namibian government and international specialists came to the site to discuss the way forward. The temporary storage facility was visited, and it was agreed that a more suitable building was needed, to mitigate the exposure of the artefacts to the elements. Namdeb therefore availed a proper brick workshop, which was refurbished and fitted for use as a museum storage facility in the medium term and until such time as an appropriate museum could be built. A common set of objectives was agreed upon by all of the stakeholders.

A second rescue excavation was led by international specialists—in particular, Portuguese specialists—and the Namibian government, with support from Namdeb, and took place from the 5th of September 2008 to the 10th of October 2008. It focused on the excavation and dismantling of two unique fractions of the ship's hull, the elements of which were still structurally connected. Plates were inserted along the planks to make sure they did not fracture when being moved. The planks were labelled, covered in plastic film and taken to a freshwater conservation pool provided by Namdeb, and a distribution map was drawn up (Alves, 2011). The main reason for having these wooden artefacts under water, was to remove the salt and to prevent cracking during drying. Sodium carbonate is used on iron artefacts to lower the rust released. This second excavation included an archaeo-graphic record of full-scale drawings and mosaic photography of the four faces of each piece of the two sets of fragments (Alves, 2011). The work was carried out by the Portuguese team in a house donated by Namdeb, and the company's cartography and topography facilities were used to assist.

Initially it was thought that the ship was of Spanish origin, due to the vast number of Spanish gold coins found. However, the presence of some Portuguese coins allowed a rather precise dating, as these coins were minted during the reign of King João III in the period 1525 – 1538, after which they were recalled, melted down and never reissued. During this time, the Portuguese East India Company was sailing from Europe to India, and hence around Africa. The archives of the Portuguese East India Company show that 21 ships were lost on the way to India between 1525 and 1600, but only one anywhere near Namibia: The *Bom Jesus*, which sailed in 1533 and was lost near the turn of the Cape of Good Hope. It is therefore believed that the artefacts belong to this Portuguese trading ship which was part of a trading ship fleet sent from Portugal to India in 1533. The discovery of the Bom Jesus shipwreck is of tremendous importance because it provides insight into a complete suite of merchandise with which a European trade vessel was loaded at the start of the blossoming trade with India. There are no comparable finds known from this period.

Of interest is the copper, lead and tin ingots, and a provenance study has been carried out since 2014. Most of the 1845 copper ingots show the trademark of the Fugger Company from Augsburg, Germany. Historical accounts testify to massive copper and silver production of the Fugger Company in the area of Neusohl in the Slovak Ore Mountains. Geochemical analyses of 60 copper ingots clearly link the copper to the mines in the Sklowak Ore Mountains, and it was also found that lead was added deliberately to the copper to extract silver by the Liquation Process. This technological innovation is one of the numerous hallmarks of the Renaissance period and the "Age of Discovery". Lead isotope abundance ratios point to an origin from lead deposits in Cracow-Silesia. The ore districts of Neusohl and Cracow-Silesia were intensively connected to mining and metal production during the post-medieval period (Hauptmann et al., 2016). In 2018, the lead and tin ingots were sampled, and the first geochemical analyses point to an origin in the northern Pennines of England for the lead. The analysis of the tin is ongoing. Throughout the study, Namdeb has been rendering logistical support and provides access to the site, thus contributing to research and new knowledge about the complexity of world trade in the 16th century.

In conclusion, Namdeb has provided machinery, equipment and personnel resources to support the excavation and rescue operation of the shipwreck, as well as the conservation efforts of the shipwreck collection during all phases of the project. Consequently, the company was honoured in 2015 with the African World Heritage Fund Award for the company's commitment and exemplary contribution to the conservation and management of the *Bom Jesus* shipwreck. Namdeb continues to support the ongoing research, has updated its Chance Find Policy and Procedures, and continues to educate its workforce on the potential finds of cultural artefacts and the process to follow in such a case. The unique type of Namdeb's mining operations in ML43 has led to the discovery of an extraordinary 500-year-old shipwreck, probably the oldest discovered wreck in sub-Saharan Africa (Alves 2011). The ship links three continents and the protection of a diamond mining area has ensured that it has not been destroyed by treasure hunters, but is being studied today by scientists (Noli, 2008, Noli & Werz, 2008), and has become a proud part of Namibia's cultural heritage.

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Photographs courtesy of D. Noli, Ministry of Youth Sport and Culture, F. Alves (2014) internet report, G. Schneider and Namdeb.

2.4 Biodiversity Management

Each phase of the mining life cycle has the potential to affect biodiversity, both directly and indirectly.[1] It remains a high priority to maintain existing, and to implement additional, management measures, as stipulated in the EMP, during the operational phase and to widen the focus of biodiversity management from site level to the landscape level. Good biodiversity management, normally aligned to fully employed Environmental Management Systems (EMS) during the operational phase, is also important for preventing eventual increased rehabilitation and closure costs; for avoiding demanding social pressure and unrealistic expectations from stakeholders; for allowing the social licence to operate; and for avoiding eventual restricted access to finance.

This Best Practice Guide wants to grab the attention of key personnel, to ensure the establishment of biodiversity management as a leading practice during the operational phase. Continued monitoring activities, application of research findings, implementation of rehabilitation interventions, and attainment of the highest biodiversity management standards, are some of the key elements required for making informed decisions. Some of the benefits associated with a good biodiversity management practice include (Department of Resources, Energy and Tourism , 2011):

- Better relationships with regulatory authorities, often resulting in shorter permitting cycles
- Reduced liabilities and risks
- Better relationships with stakeholders
- Increased employee motivation and loyalty

Like many other mining operations in Namibia, Namdeb has demonstrated best practice in biodiversity monitoring. An example of the work Namdeb has done is outlined in the case study below:

[1] Direct or primary impacts can result from any activity that involves land clearance and earthworks including road construction and preparation for construction, overburden stripping, impoundment of water or discharges of water, or the air (such as dusts or emissions). Direct impacts are usually readily identifiable and can easily be managed through the mitigation hierarchy and measures stipulated by the EMP. Indirect or secondary impacts can result from knock-on changes induced by construction activities and create delayed and collective impacts. They are habitually harder to identify immediately and to manage proactively.

Case Study – Biodiversity

Mine:

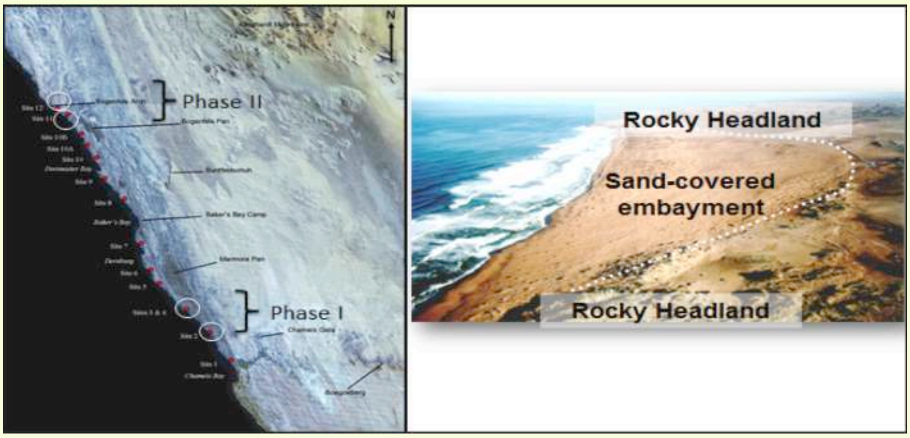
NAMDEB

Location:

Namdeb Diamond Corporation (Pty) Ltd holds mining licences along the south-western coast of Namibia in the Tsau //Khaeb (Sperrgebiet) National Park. ML 43 is the southernmost licence and extends from the Orange River mouth to some 100 km north of it.

Description of the case study:

Namdeb's Pocket Beach areas project was initiated to target the sandy beach deposits in the Bogenfels (ML44) and Mining Area 1 (ML43) licence areas. A pocket beach is a sandy embayment, containing diamonds, between two rocky headlands. The project consisted of two phases, which stretched between Chameis and the Bogenfels Arch, a significant landmark and tourist attraction along the west coast of Namibia. The scope for the biodiversity monitoring work for this case study is focused on the Pocket Beach's Phase 2 project (site 11 and 12 –see map) which commenced production in mid-2007 and mining was completed in 2011.



Resources were dedicated for biodiversity monitoring before mining commenced. Key issues that were addressed included obtaining baseline and subsequent biodiversity monitoring data. The project's team set a vision for no visible signs of mining 5 years after mining. This has set the tone for the biodiversity and rehabilitation work that followed in the areas. The mining methodology was very unique, since it was the first time that Namdeb used a cut-off wall in conjunction with the seawall and dredge.

The Pocket Beach areas are located in the Tsau //Khaeb (Sperrgebiet) National park, where access has been restricted for more than 100 years because of diamond security regulations. In addition to the Bogenfels Arch, the area is considered sensitive, due to its significance for being in the Succulent Karoo Biome, one of the biodiversity hotspots of the world. The scenic landscapes and presence of fossils, archaeological, historical and cultural sites, seabirds and seal colonies, make it an asset to Namibia for conservation and future tourism. The climate is arid with coastal fog and strong southerly and south-westerly winds throughout the year. Winter and summer rains are possible.

Dedicated environmental resources, a reputable team of specialists, a Marine Scientific Advisory Committee, and an Annual Stakeholders Forum Meeting, assist with setting a high standard for rehabilitation and the reintroduction of biodiversity into the area. The approach to biodiversity restoration was developed through extensive research, in partnership with the National Botanical Research Institute (NBRI), the Millennium Seed Bank Project (MSBP) at Kew Gardens in the United Kingdom, and the Gobabeb Training and Research Centre—the oldest of its kind in Namibia. This was done in consultation with the future end land user - the MET.

There was continuous monitoring of the physical changes to the area (accretion, high water line, pond perimeter and bathymetry of the remaining pond, physical parameters of the pond, and the use of satellite images of the area). Other biodiversity monitoring included:

- Procedures for the monitoring of the nearshore subtidal environment
- Sandy beaches including the flagship species *Tylos granulatus*
- Rocky intertidal monitoring
- Monitoring of the survival rate of plants re-introduced back into the -5m beach area
- *Salsola nollothensis* re-vegetation at the beach area, brown hyena monitoring, fish and bird species in and around the remaining pond

Salsola nollothensis seeds were collected and their germination potential assessed. Seedlings were transplanted back into the area. Re-establishment/survival of transplanted Salsola plants in the vicinity of the remaining pond was used as an indicator to evaluate the success of biodiversity monitoring and the major conclusions were:

- The rehabilitation program following the diamond mining was essentially successful
- In some areas, the zones for planting should be more clearly established to avoid planting in the beach zone

- Accurate zonation of the dune system would suggest the planting of distinct species in different zones to result in the restoration of the natural plant communities
- There is little visual impact due to mining in the region
- The ponds resulting in the beach zone following mining can form a natural part of the system and no active rehabilitation is necessary
- Spontaneous restoration may result in the establishment of plant communities in the pond over time. There is only circumstantial evidence of this occurring at present

During the operational phase, there are several opportunities for biodiversity enhancement and protection. For a new mining project, the potential environmental impacts have been identified during the impact assessment process, and addressed by management measures stipulated in the EMP. For existing mining operations, where biodiversity has not been considered prior to the commencement of production, de facto interventions are necessary. Some of the principle guidelines include:

- Consider effects beyond the obvious interfaces such as land clearance. Consider also impacts such as discharges into waterbodies and the downstream effects that can be associated with such effects. Restriction of water as an ecological driver may only show its detrimental effects later, for example
- Consider the interface between society and the environment. Society may have very different views and expectations in terms of biodiversity, and it is essential to align these expectations to the priorities of a mine
- Consider effects beyond the boundaries of the mine site. Dust, noise and vibrations, for example, may affect biodiversity offsite, while incidents such as spillage of hazardous waste on the routes on which the chemicals are transported, have important implications for neighbours and more distant stakeholders
- Ensure that ancillary equipment such as export infrastructure and powerlines are considered in biodiversity management too. An elevated water pipeline, for example, can restrict the migration of animals. A powerline, on the other hand, may cause regular incidents of bird kills

Leading practice involves managing, monitoring and mitigating all biodiversity risks and the management of impacts with the necessary insight. The case study below provides some guidelines on how this should be done.

Authors**:**

NamPower/Namibia Nature Foundation Strategic Partnership

Brief description:

The NamPower/Namibia Nature Foundation Partnership was launched in 2008, with a mission to address wildlife and electricity supply interactions in Namibia, in the interests of promoting sustainable development. The project is generously funded by the European Investment Bank.

The project's objectives are to:

- Monitor, report and manage electricity and wildlife interactions
- Conduct research and incorporate wildlife mitigation into existing electricity supply networks, and into the planning of future networks
- Promote awareness, education, communication and collaboration about the risks that the electricity supply poses to wildlife, and wildlife to the electricity supply.

To include local partners in this monitoring as part of their environmental programmes, three uranium mines in the Erongo region have been included. This case study aims at showcasing generic procedures and guidelines for the monitoring of electricity generation and supply structures and their interactions with wildlife.

Key issue(s) addressed:

The management and mitigation of impacts on wildlife are based on the following dedicated guidelines and procedures with regard to:

- Powerline survey methods
- Incident recording
- Incident reporting

Description of the case study:

A. Dedicated powerline monitoring surveys

Permission and permits

The permission of the relevant electricity supply utility, e.g. NamPower or the Regional Electricity Distributors (REDs) is required for working on any powerline servitude in Namibia. The permission of the land owner is also required. In the case of mines, the mine is the owner; however, for any other powerline, various owners may be involved, including municipalities, the MET (in which case a free entry permit is required), conservancies, and/or farmers.

A research authorisation permit from the National Commission on Research, Science and Technology (NCRST) is not required for normal monitoring; however, the carcass remains should be left on site. (A NCRST permit would be required should any carcass remains be collected, removed from the site, and/or transported.)

Training

An induction for access to NamPower lines is required for working on any NamPower powerline servitude, for which a certificate is issued; this training should be repeated every year.

The NamPower/Namibia Nature Foundation Strategic Partnership is available to conduct additional basic on-site training in wildlife and powerline monitoring; the programme includes a general introduction to common types of wildlife and power supply interactions in Namibia, mitigation measures to avoid powerline incidents, methods for monitoring and feedback on results of monitoring to date, and bird identification. The impacts of wildlife on electricity generation and supply structures are also addressed. As part of the above training, a powerline survey form is discussed and made available. Note that there are separate forms for dedicated powerline surveys, and for records that are obtained on an incidental basis (see below).

Powerline survey methods

Survey frequency

Surveys should be undertaken on a monthly basis for at least two years. Thereafter the frequency could be reduced to a quarterly basis, unless wildlife impacts are found to be significant (in which case monitoring should continue, and mitigation should be investigated for identified problem areas).

Survey equipment

Vehicle, NP/NNF Partnership survey form (see above) and pencil, camera, GPS, bird field guide, binoculars, and gloves (for handling carcass remains).

Survey method

Surveys should be timed for as early as possible in the day, to avoid windy and hot conditions. Note the following aspects, as per the above survey forms: weather conditions, habitat type, vegetation type, tower design(s) and voltage, other infrastructure in the area; live birds and nesting behaviour on or near powerline structures; signs of scavenging activity.

Conduct the survey along the powerline route. Walking is regarded as the best method for spotting carcass remains; alternatively, drive very slowly (<20 km/hr) or use a combination of driving and spot checks with walking. Preferably two persons should walk parallel to each other, a few metres apart; avoid walking directly beneath the powerlines.

Incident recording

When carcass remains are spotted (sometimes only feathers or bones) as illustrated in Figure 1 and Figure 2, record the following details as per the survey form:

- GPS position and time (if no GPS is available, refer to the numbers of the towers on either side of the incident)
- Photograph the incident as follows:
    - A general view showing the carcass, tower/powerline and surrounding landscape
    - Each mortality/injury: from above and beneath; detail of head including beak if possible
    - The nearest electricity pole/tower and its number
- Identify the carcass, if possible; if the species is unknown, record it as such
- State/freshness of carcass
- Position of carcass in relation to the towers and to the centre line of the powerline(s)
- Mitigation devices fitted to the powerline, and whether these devices are present at the site of the incident
- Any pertinent habitat details

Ludwig's Bustard remains after being scavenged **Remains of a flamingo after the carcass has been scavenged**

Reporting

Both the survey reports and incidental reports should be kept on file as required by each mine. Photographs relevant to each survey should be referenced with the survey, incident number and date, and kept in the same folder as the form.

The sharing of the above data would be appreciated by the NamPower/Namibia Nature Foundation Strategic Partnership for inclusion in a countrywide database, which is being built up as a basis for making informed recommendations for the application of targeted mitigation measures. The incidents are also mapped and made available on the Environmental Information Service (EIS; www.the-eis.com, Birds and powerlines tool).

The data should be evaluated regularly, and the survey methods/frequency adapted accordingly. Monitoring of the effectiveness of any mitigation measures should be included in the analyses of data. Regular feedback to survey participants is recommended, to maintain motivation.

B. Incidental records

Records that are obtained on an incidental basis (i.e. not as part of a dedicated survey covering a section of powerline) may be recorded on a separate form. The details required are self-explanatory; in particular, the carcass remains should be photographed as indicated above. The form is downloadable from the Partnership website: http://www.nnf.org.na/index.php/projects.html#nampower-nnf-strategic-partnership

Renewable energy

Guidelines for the monitoring (and assessment) of renewable energy structures, including for both wind and solar energy, are well developed. The comprehensive best practice guidelines below are recommended for monitoring such developments in Namibia (downloadable from http://www.birdlife.org.za/publications/birdlife-south-africa-s-scientific-publications):

Jenkins AR, Ralston-Paton S, Smit-Robinson H. 2017. Birds and Solar Energy: Best practice guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa, South Africa.

Jenkins AR, Van Rooyen CS, Smallie JJ, Harrison JA, Diamond M, Smit-Robinson HA, Ralston-Paton S. 2015. Birds and Wind-Energy Best Practice Guidelines: Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in Southern Africa and the Endangered Wildlife Trust. South Africa.

Ludwig's Bustard (Endangered in Namibia and Globally Endangered) is a partial migrant and prone to powerline incidents (collisions) (photo: Ann Scott)

Lesser Flamingo (Vulnerable in Namibia and Globally Near Threatened) is an intra-African migrant and prone to collisions on power lines (photo: Ilka Schröer)

The team from Orano Mining Namibia investigates an incident on a powerline on the mine (L to R): Richard Gurirab, Helmut Ochurub and Kaarina Nkandi, with Mike Scott

Different mining methods present different opportunities for biodiversity management. Underground mines typically have a smaller environmental footprint as compared to surface mines. Open pits gradually widen and deepen, leading to a steady increase in the total surface area of disturbance. The mineral waste dumps and tailings depository facilities of open pit mines are also increasing, creating an ever-growing footprint. In these environments, the management of water becomes a multidimensional topic—creating challenges for the management of surface drainage, restriction of water as an ecological driver, and the prevention of water contamination. Other related impacts include the accidental release of chemicals, emissions into the air (dust and particulates, and heavy metals and sulphur dioxide from pyro-metallurgical processes such as smelting), seepage from low grade stockpiles into surface and groundwater, and slag disposal from pyro-metallurgical processes, which contains toxic metals.

Debmarine has demonstrated innovative methods in biodiversity monitoring. Their example is outlined in the case study below:

Mine:

Mining Licence Area 47

Commonly referred to as the Atlantic 1 marine diamond mining licence area, Mining Licence Area 47 is situated off the southern coast of Namibia. The Atlantic 1 marine diamond mine is operated by Debmarine Namibia, a joint venture Company, owned in equal shares by the Government of the Republic of Namibia and De Beers Group of Companies. Debmarine Namibia is a wholly-owned subsidiary of Namdeb Holdings (Pty) Ltd.

Location:

Debmarine Namibia's Mining Licence Area

Brief description:

The licence area is approximately 5 987 km^2 in extent, however only a small proportion is mined. By 2020, less than 4% of the mining area will have been mined. The licence area lies about approximately 8 km offshore and stretches from Oranjemund in the south to Chameis Bay in the North. Debmarine Namibia utilises specialised vessels to mine gem-quality diamonds at water depths of between 90 and 150 metres. The diamond-bearing sediments are located in patchy deposits typically located at a depth of less than a metre beneath the sea floor. The gravel and sediment that is removed, is pumped to floating processing plants, where the diamonds are extracted and the remaining sediment—close to 99%—is discharged and settles back to the seabed. No chemicals are used in the mining process. Each mining vessel is a single, unique and totally integrated mine. Sediments are mined and treated on-board with no stockpiling of sediments for later treatment. Access to the resource by the mining vessels is only constrained by the time taken for a vessel to move from one area to another (~24 hours) and mine planning flexibility. No permanent infrastructure is placed in the mining licence area.

Exploration and resource delineation is undertaken by low-energy, geophysical acoustic survey methods (bathymetry, side scan sonar and seismic) to map the sea floor. This is then followed up by sampling, undertaken by Debmarine.

Namibia's dedicated sampling vessel is the mv SS Nujoma. A fleet of six mining vessels operates in Atlantic 1, comprising five drill-vessels and one vessel that operates a seabed crawler. The vessels are manned by a highly skilled and technically experienced crew that work in rotating teams, onboard the vessels for 28 days on and 28 days off. Personnel are transported to and from the vessels and head office in Windhoek via rotary and fixed-wing services from the Company's logistics base at Oranjemund Airport. Debmarine Namibia employs over 900 employees, of whom the majority are seagoing.

Key issue(s) addressed:

Ensuring the sustainability of marine mining requires a unique approach and a reliance on marine scientific research and monitoring to assess sedimentary and ecological changes and rates of recovery. Debmarine Namibia has implemented a comprehensive environmental monitoring program employing various techniques to understand the pre-mining seabed environment and to monitor post-mining impact and recovery. These include:

- Collection of seabed samples using a Van Veen grab sampler to analyse the sediment grain size, as well as the biomass and abundance of macrofauna species living in the sediments, to assess the pre- and post-mining environments
- Use of seabed video footage collected by manned and unmanned submersibles
- Analysis of high-resolution geophysics to assess mining impact and re-sedimentation, including chirp seismic, backscatter, side scan sonar and bathymetric data

JAGO Submersible tool

Description of the case study:

Debmarine Namibia's production targets are based on a Life of Mine Plan, with a planning window until the end of the profitable resource, which is reviewed and updated on an annual basis. The company produces around 1.3 million carats per annum from a mining area of approximately 12km^2.

The De Beers Group, including Debmarine Namibia, has been studying the impacts of marine diamond mining and the subsequent recovery of the seabed, since 1994. The extensive environmental monitoring programme includes the gathering and analysis of sediment samples, benthic macrofauna, geophysical survey data and photographic records, on an annual basis to achieve the following objectives:

- Obtain pre-mining baseline information on the seabed habitat and macrofaunal communities living in the top 30 cm of the seabed. These animals are usually sessile, with a long generation time, which means that the benthic community structure reflects the environmental conditions in a particular area, integrated over a period of time
- Investigate the relationship of benthic community structure with water depth, sediment type, geographic position, and other factors

- Assess and monitor the rate of recovery of seabed habitat and macrofaunal communities following mining disturbance. Current monitoring studies indicate that seabed recovery occurs naturally at a rate dependent on available sediment. The rate can vary from 2 to 3 years in areas of abundant sediment supply, such as close to the Orange River mouth, while in areas of slower sediment infill, recovery can take between 3 and 10 years. In other areas where infill rates are much slower, recovery can take more than 10 years.

There are currently 88 environmental monitoring stations across the Atlantic 1 mining licence area.

The environmental monitoring programme forms part of the approved Environmental Management Program, the Biodiversity Action Plan, and the Closure Plan for the Atlantic 1 mining licence area. The company's overarching closure and rehabilitation objective is to leave a post-mining environment that has returned to a state where ecological function has returned to a state equivalent to comparable undisturbed sites. This is defined as being at least 80% similar in terms of species composition, abundance and biomass measured over a period of at least 3 years.

Debmarine Namibia has a complement of four full-time environmental staff and compliance to environmental objectives is managed within the framework of an ISO14001 certified Environmental Management System. Over N$ 5 million is spent annually on the environmental monitoring programme, which is conducted by independent marine scientists and evaluated by a standing committee. The success of the environmental monitoring programme is measured by the sampling rates and quality achieved during the sampling campaigns, the expansion of biodiversity knowledge, and demonstration of recovery against the rehabilitation objective. Following analysis, Debmarine Namibia's benthic samples are shared with other local entities such as the University of Namibia and the Ministry of Fisheries and Marine Resources, to facilitate educational and capacity-building initiatives to train and develop local marine researchers within Namibia.

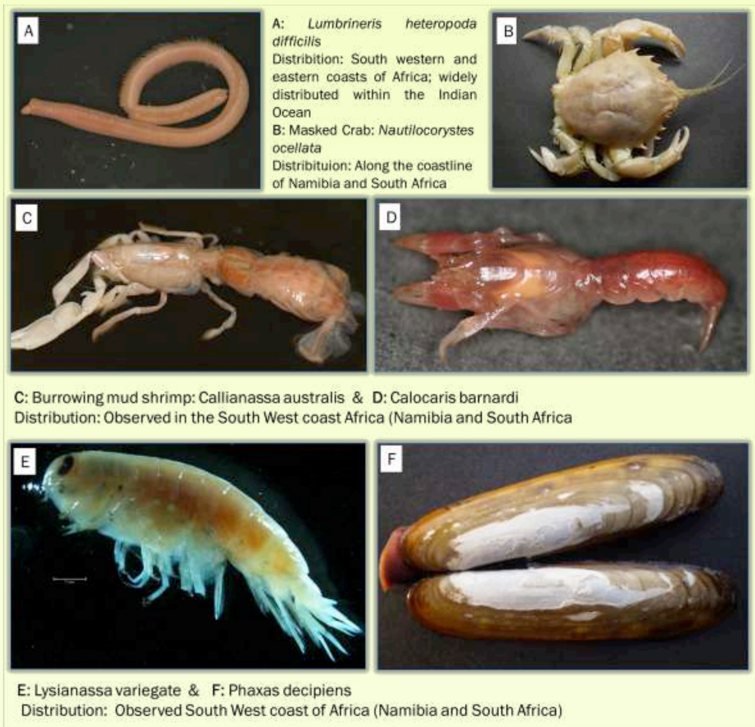
In 2012, Debmarine Namibia established a Marine Scientific Advisory Committee (MSAC), comprising of recognised marine scientists and other key stakeholders. The committee advises on the monitoring of design and research techniques, reviews the results of the environmental monitoring programme to determine its effectiveness, and provides recommendations to Debmarine Namibia. Publication of scientific research in peer-reviewed journals are encouraged.

Some of the key challenges associated with achieving the objectives of the environmental monitoring programme are:

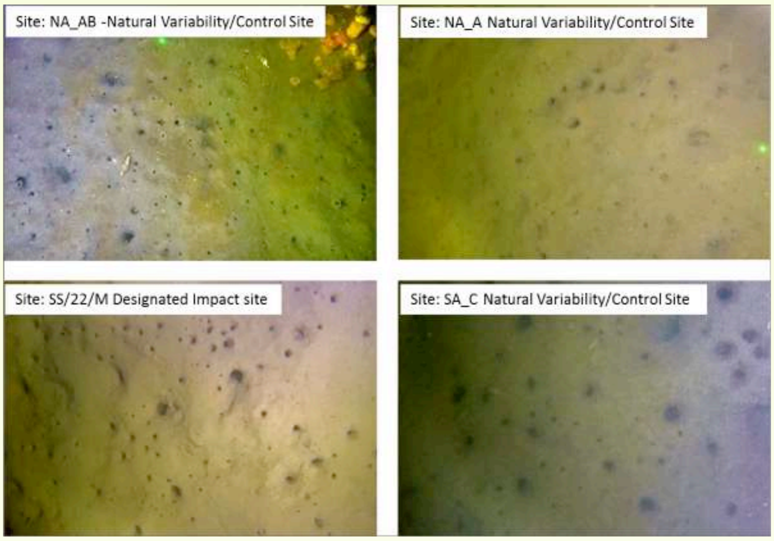
- Insufficient information on key drivers of natural variability
- Inadequate understanding of the links between physical habitat recovery and that of the faunal communities
- Technical and cost constraints associated with the gathering of data in rocky substrates that cannot be sampled using traditional grab sampling methods

Recognition of these challenges has resulted in new innovations being included in the programme. Additional data are now being collected on habitat quality (organic carbon and nitrogen in the sediment), structure (sediment thickness), and water quality (temperature, dissolved oxygen and turbidity). Debmarine Namibia also plans to expand the use of geophysical survey and visual techniques for biodiversity habitat mapping and recovery monitoring.

Debmarine Namibia's ongoing surveys have made a substantial contribution to new biodiversity information, and the monitoring programme continues to provide valuable information on the natural variability in benthic macrofaunal communities in the Atlantic 1 mining licence area, the impacts of diamond mining operations on the benthic environment, and post-mining recovery



Some of the benthic macrofauna collected during the annual sampling survey.



Drop camera images of the monitoring sites in the Atlantic 1 Mining Licence area.

2.5 Non-mineral Waste Management

At any mine, a big variety of waste types and quantities are generated during the operational phase. In simple terms, a distinction is made between mineral and non-mineral waste and each type must be assessed and managed on its own merits. It is also important to review the waste management measures stipulated in the EMP regularly, as the quantities and disposal options may vary over time. In this section, the management of non-mineral waste is discussed; the management of mineral waste is discussed in Part Three of this document.

Non-mineral waste is produced in much smaller volumes to mineral waste but is a key indicator for measuring the ecological footprint of an operation. If not properly managed, non-mineral waste items can cause multiple negative environmental and social impacts. Negligent management of non-mineral waste items is visual and reflects badly on any business. Non-mineral waste items consist primarily of auxiliary materials that support mining operations, and include a very wide range of different types and quantities—tyres, oils and grease, batteries, empty containers, plastic and wood packaging, scrap metal, paper, building rubble, and waste items from processing, maintenance, workshops, laboratories, gardens, and other domestic rubbish.

The Pollution Control and Waste Management Bill remains in draft form and should be finalised by parliament to become an Act. In the absence of national legislation, non-mineral waste management in Namibia is implied through by-laws under the auspices of several authorities (e.g. local and regional government, parks management, etc.). Mines are managing non-mineral waste through the obligations in their Environmental Management Plans, and implementing self-regulatory best practices.

A best practice of non-mineral waste management is based on a separation and recycling system, preferably introduced already during the projects and construction phase of the mining life cycle. The early introduction of a waste separation and recycling practice has the potential to gain reputation and raise environmental awareness among employees. Clean-up campaigns, waste reduction efforts, and recycling challenges are initiatives with great participative rewards and can assist in building morale and boosting a company's reputation. The introduction of a waste separation and recycling practice implies the classification of non-mineral waste, e.g. industrial non-mineral waste (generated in workshops and processing plants); contaminated waste (e.g. industrial and hydrocarbon contaminated soil and sludge, radioactive items in the case of uranium mines, and chemical contaminated items in the case of metallurgic processing); hazardous non-contaminated waste (hazardous items coming from workshops and processing plants, which should be disposed of at a certified hazardous waste site); and non-hazardous, non-contaminated waste (packaging, redundant and discarded items, and household rubbish, etc.).

Recyclable items include wood, paper and cardboard, plastic from packaging and empty containers, scrap metal, oil (in practice at the uranium mines), and electronic waste. More complicated to recycle are items such as used grease, tyres, conveyor belts, batteries, and empty lubricant containers. Items that have little to no potential for recycling include redundant chemicals and chemical waste, building rubble, kitchen remains, sanitary and medical waste, and contaminated containers. A proper waste separation and recycling practice entails clear signage for segregation, designated dump areas, scheduled routines for waste removal and disposal, and a strong awareness campaign about waste. Furthermore, employees should be encouraged to avoid, reduce and recycle waste, including the compression of bulky waste items.

2.6 Hazardous Substances

Most mines store significant quantities of various chemicals, fuels, oils and greases, including used chemicals, oils and greases. Many of these are hazardous substances, i.e. materials in the form of a solid, liquid or gas; vapour, dust or particulates, fumes, mist, solvents, and aerosol, etc., that contains ingredients which may cause environmental damage or degradation of the surrounding area, and could cause health and/or safety risks to persons coming into contact with these substances, when not handled correctly. These substances are grouped by the Hazardous Substances Ordinance 14 of 1974 and all hazardous substances must be controlled and assessed according to the Ordinance.

Due to the legal weaknesses in the Ordinance, most mines implemented a site-specific Code of Practice or Management Procedure for the control of hazardous substances—for purchasing, handling, storage, application and disposal. Best practice is to keep a hazardous substances register, which identifies the name of a substance; contains a material safety data sheet (MSDS) for each of the substances; and stipulates procedures for handling and managing the risks of each substance. The register is maintained and audited accurately.

The ordering or purchasing of a hazardous substance involves an assessment of the substance prior to its ordering and purchasing; consultative research on finding an alternative non-hazardous substance; communication and training about the substance to be ordered or purchased; obtaining a factual and correct MSDS for the substance; purchasing of minimum quantities to limit the risk; emergency procedures; and solutions for disposal of the empty containers and accidental spills and waste generated.

Transportation needs to be compliant with the prescribed containment and packaging guidelines (for example of dangerous goods legislation) and requirements as indicated in the MSDS. Some substances may be transported and delivered in bulk (e.g. acid, ammonium, hydrocarbons, etc.) and stored as such in an enclosed system. Other bulk substances include process reagents (collectors, frothers, alkalis, flocculants, coagulants, solvents and modifiers) or blasting components (ammonia nitrate and other nitrogen compounds) and are stored in isolated containers or designated areas. Substances such as industrial chemicals and flammable materials are stored in areas suitable for the specific type of material and in such a way that it does not pose a safety, health or environmental risk. These areas are secure and appropriately equipped (with access control, bunds, spill kits, etc.). Training and awareness on the handling or use of a hazardous substance needs to be done, according to the understanding of the safety and environmental requirements as indicated in the MSDS of the specific product. Spill management procedures and disposal procedures need to be in place too.

All hazardous substances no longer required, and their empty containers, have to be identified for disposal. Disposal needs to be done in compliance with the MSDS requirements. No hazardous substance or empty containers of a hazardous substance may be discarded in a general garbage bin or enter surface drainage or sewage systems for disposal, emphasising the importance of preventative measures such as bunds, designated areas and correct management procedures. All damaged and redundant hazardous substances have to be returned to suppliers and empty containers have to be returned to suppliers with whom an agreement is in place, or disposed at a certified hazardous waste site.

2.7 Managing Acid Mine Drainage

Apart from water contamination as a result of spills or seepage, Acid Mine Drainage (AMD) is a major environmental threat associated with metallic and coal mines. AMD is caused when sulphuric acid forms as a result of the exposure of sulphide minerals to air and water. Other harmful chemicals in surrounding rock can dissolve in the sulphuric acid and if uncontrolled, AMD has the ability to run off into streams and rivers, and seep into groundwater. The resulting impacts can be detrimental, mainly because AMD causes the water to drop to a pH lower than 4 in some instances, making survival of aquatic plants and animals impossible. The AMD potential of a mine is thus a decisive part of an environmental assessment to determine whether the project is environmentally acceptable or not.

AMD can be released from any part of the mine where sulphide minerals are exposed, such as leach pads, tunnels and channels, tailings, waste rock dumps and open pits. The treatment of AMD is typically accomplished by either using active or passive treatment, where active treatment is commonly used for operational mines and passive treatment is more prominent in abandoned and closed mines. There are different approaches taken when dealing with AMD, the most popular approaches being the following:

- Neutralise the acid
- Prevent exposure of the mineral to water and oxygen
- Avoid/prevent bacteria from catalysing the reaction

A common method for managing AMD is through the reclamation of contaminated land by adding alkaline materials or lime, in order to neutralise the acidity. Other methods include the planting of vegetation, adding uncontaminated topsoil, and the modification of slopes, in order to reduce infiltration of surface water and to stabilise the soil. Direct treatment of contaminated water requires treatment plants, the adding of neutralising material, or through creating artificial wetlands, where microbial action can be used to create oxygen-free conditions to stop the formation of sulfuric acid.

Abandoned mines need to be filled to reduce the formation of AMD, and this can include flooding the mine with water to remove the oxygen necessary for the formation of AMD, or by filling a mine with alkaline material to avoid the formation of acidic water.

Relocation and isolation of contaminated waste that has the potential to lead to AMD if it comes in contact with water, is necessary. Leading practice involves moving the waste to above the water table and covering it with an impermeable layer to keep out surface water.

To ensure that water does not flow through AMD-forming materials, surface water channels should be diverted from the mine site. Prior to using this method, accurate hydrogeological and hydrological studies should be conducted—the lack of proper studies often leads to the failure of this method.

Bacteria control can also be applied, as certain bacteria act as a catalyst in the formation of AMD—to control these bacteria, bactericides can be used.

Contaminated soil needs to be removed to areas where it can be treated and monitored. Dry covers can be placed on acid-forming materials with the aim of stabilising mine waste to prevent water and wind erosion. The key factors that need to be considered during the design of a soil cover, include the climatic regime of the site, the texture and reactivity of the mine waste material, the durability of the economically feasible cover material, along with their hydrogeological and geotechnical properties, and the long-term effects of erosion, evolution and weathering of the cover system.

There are various cover designs used and typically two covers are required. Leading practice requires the first layer to have low permeability, which can hold a large volume of water and decrease the oxygen diffusion. Suitable materials for the first layer are clays (especially bentonite). Clay can however be prone to breaking during the dry seasons—a suitable alternative can be a thick layer of organic matter. The low permeability layer should then be followed by a drainage layer. This layer prevents the capillary migration of metals and safeguards the dump from human influence, erosion, and freezing (SCIELO, 2014). Over the years, dry covers interact with human activity, climate, animals, vegetation and hydrology. The tri-linear plot in FIGURE 5 provides guidance on which cover types are suitable for which climate.

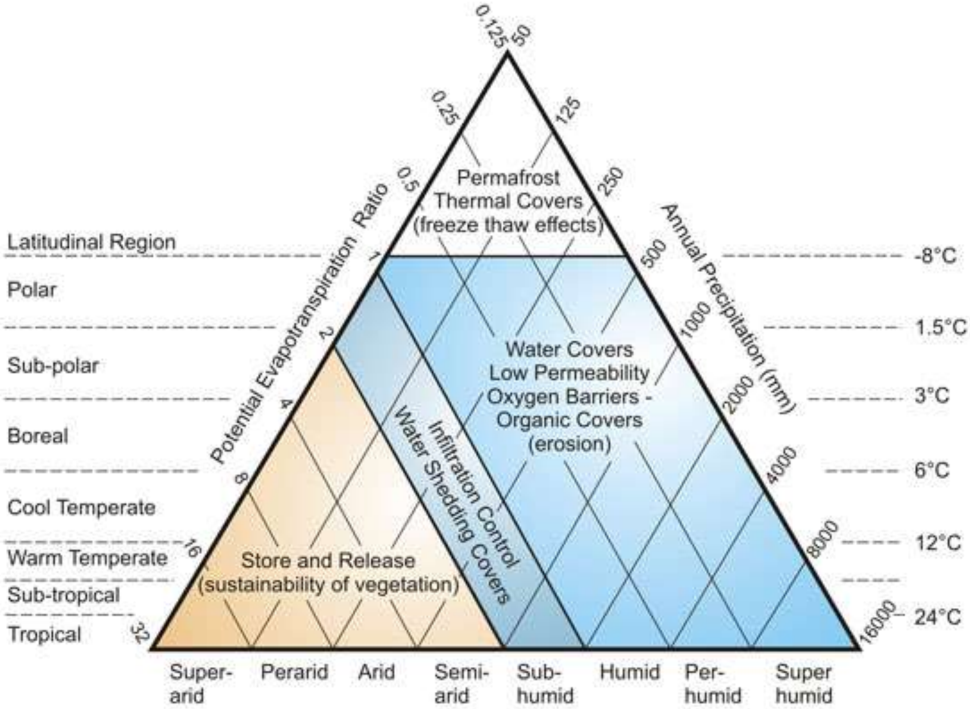


FIGURE 5 - TRI-LINEAR PLOT TO DETERMINE THE BEST COVER TO USE UNDER DIFFERENT CLIMATIC REGIMES IN ORDER TO PREVENT AMD

As can be seen in **Error! Reference source not found.**, the use of soil covers for the prevention of AMD has certain limitations and considerations. The use of dry covers for the prevention of Acid Mine Drainage is outlined below:

Considerations:

- Reactivity of waste
- Climate – freezing, thawing, wetting and drying
- Topography
- Erosion and surface water flow
- Final land use
- Hydrogeological setting
- Construction quality and maintenance
- The availability of cover materials

Limitations:

- When subjected to climatic conditions, the permeability of the barriers can increase with time
- Soil covers do not stop infiltration in all instances and may not stop acid mine drainage
- Oxygen barriers are particularly sensitive to holes caused by animal activity, etc.
- Soil covers have long-term maintenance and monitoring requirements and are prone to erosion
- Soil covers may be sensitive to vehicle, human and animal activity

2.8 Air Quality

The operations phase of the mining life cycle presents the most significant air quality and emissions issues, and during this phase, an ongoing management plan is highly beneficial. As a minimum, an air quality management plan is essential for dealing with issues that can potentially have an adverse impact on operations. In addition to dust, an air quality plan needs to incorporate the management of emissions (release of pollutants and particulates) and fumes as well. It is important to ensure that the management plan can be applied daily by the environmental manager, senior management and site operators. Operations that generate excessive noise and vibration need to incorporate these impacts in their management plans too.

In the absence of Namibian legislation with reference to air quality, standards and guidelines derived from the World Bank (WB), World Health Organization (WHO), European Commission, and South African National Standards (SANS) are used. Standards from these guidelines are used to measure and monitor particulate matter less than 10 µm in aerodynamic diameter (PM_{10}), dust fall, sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3) and carbon monoxide (CO). Specific needs such as stack emissions (for uranium, mercury, and ammonia, etc.) could be measured as well.

Dust generation at Namibian mines is quite common, due to aridity. Therefore, all mines have to manage dust as the minimum requirement of an air quality management plan. The activities with the most potential for dust generation at a mine site are drilling, blasting, loading, hauling and excavation, and screening, crushing and processing.

Managing dust during drilling

Blast hole drilling during operations has the potential to generate a significant amount of dust, particularly during dry conditions. Leading practice involves using measure to minimise dust generation as much as practically possible. These measures include:

- All drills must be fitted with dust extraction systems or water injection to control dust during the drilling of the hole
- Cleaning filtration devices and replacing filters on a regular basis to prevent dust build-up
- If dust is discharged through ducting, position the ducting in a way that avoids dust from blowing back on operators or other people working in the vicinity
- Control dust during the crushing of samples

- Have an air-conditioned cabin that is well sealed for operating drill rigs

Managing dust during blasting

Dust stemming from blasting events can be managed when blasting events are planned in close consideration of climatic factors such as wind speed and direction. It is also important to plan blasting events in consideration of a mine's schedule of activity.

Managing dust during loading, hauling and excavation

Excessive levels of dust are generated during the loading and hauling or the excavation of ore and waste. Measures to control dust generation include the following:

- Installing air-conditioned cabins on all mobile equipment
- Spraying water on haul roads and blasted stockpiles
- Installation of water sprayers at dump pockets

Managing dust during screening, crushing and processing

Dust needs to be adequately managed at each mill, grinder or crusher. This involves fitting dust control appliances at the primary crusher feed hopper—the same needs to be done for the secondary and tertiary crushers. Dust build up and spillage needs to be monitored and removed when necessary. Dust management can be assisted by having dust extraction on transfer points:

- Dust extraction at crushers, conveyor tipping points and screens
- Fine ore stockpiles should be enclosed, otherwise they can be a major dust source
- Conveyors between stockpiles and crushers that are exposed to wind, should be at least partially enclosed, to reduce dust emission

2.9 Water Management

Mine water is produced in various ways at a mine site, and the water produced can vary in quantity, quality, and environmental contamination potential. Effluents can be caused by wash-down, refining, scrubbers, flotation, leaching, or concentration (Condorchem envitech, 2012). Other waste water derived from kitchens, ablution blocks, change houses and workshops, ends up in a sewage system.

It is required that all mine water in Namibia is adequately monitored and analysed, to ensure compliance with regulatory standards, according to the obligatory industrial and domestic effluent discharge exemption permit under section 21(5) and 22(2) of the Water Act (Act 54 of 1956). TABLE 2 indicates the general standards for Article 21 Permits (effluents). TABLE 2 summarises the general waste/effluent water discharge for Namibia.

TABLE 2 - GENERAL STANDARDS FOR WASTE/EFFLUENT WATER DISCHARGE

DETERMINANTS	MAXIMUM ALLOWABLE LEVELS
Arsenic	0,5 mg/l as As
Biological Oxygen Demand (BOD)	no value given
Boron	1,0 mg/l as B
Chemical Oxygen Demand (COD)	75 mg/l as O
Chlorine, residual	0,1 mg/l as Cl_2

DETERMINANTS	MAXIMUM ALLOWABLE LEVELS
Chromium, hexavalent	50 µg/l as Cr(VI)
Chromium, total	500 µg/l as Cr
Copper	1,0 mg/l as Cu
Cyanide	500 µg/l as CN
Oxygen, dissolved (DO)	at least 75% saturation
Detergents, Surfactants, Tensides	0,5 mg/l as MBAS
Fats, Oil & Grease (FOG)	2,5 mg/l (gravimetric method)
Fluoride	1,0 mg/l as F
Free & Saline Ammonia	10 mg/l as N
Lead	1,0 mg/l as Pb
Oxygen, Absorbed (OA)	10 mg/l as O
pH	5,5 – 9,5
Phenolic Compounds	100 µg/l as phenol
Phosphate	1,0 mg/l as P
Sodium	not more than 90 mg/l Na more than influent
Sulphide	1,0 mg/l as S
Temperature	35°C
Total Dissolved Solids (TDS)	not more than 500 mg/l more than influent
Total Suspended Solids (TSS)	25 mg/l
Typical faecal Coli.	no typical coli should be counted per 100 ml
Zinc	5,0 mg/l as Zn

The objectives of Article 21 Permits are to regulate the disposal of effluents produced by a mine and to prevent the spread of groundwater pollution from effluent or waste disposal sites. The permit sets maximum allowable levels for various standards according to the site, and reporting has to be done on a prescribed schedule. In addition, some mines voluntarily apply self-controlled management systems, to prevent pollution and activities or conditions that pose a threat to human health, safety or the environment.

Groundwater is usually monitored from borehole samples, also beyond the mining grant for comparing water quality encountered on site to the ambient water quality in the wider environment, and identifying potential impacts on downstream users. The monitoring schedule includes sites monitored for seepage from the tailings dam, process solutions, natural water quality and leachates from the landfill site and waste rock dumps, as well as samples from sewage plant effluent and septic tanks.

Furthermore, there are measures put in place by NamWater requiring that monitoring and analysis of water quality parameters (physical, microbiological and inorganic) should be conducted at least every six months. A potable water control system is normally also in place to monitor and report on the quality of water for domestic use.

In the past, biological or physio-chemical methods have been used to treat effluents. In a dry country such as Namibia, water is a limited resource and it has become leading practice to adhere to zero discharge, as this allows for maximum water re-use.

Water control techniques

The release of waste water into the environment can lead to detrimental environmental impacts on water users downstream. To prevent this release, various control techniques can be used to aid in reducing the potential of water contamination and reduce the amount of water requiring treatment. The techniques include:

- Diverting and intercepting surface water—this can be achieved by building upstream dams to capture water and to reduce contamination potential from tailings, exposed ore or waste rock
- Capturing drainage water from precipitation at the mine site—this can be done using pipes and liners and directing water to a tailings dams to prevent potentially contaminated water from entering the groundwater or flowing off-site
- Recycling water used for processing ore, to reduce the volume of water requiring treatment
- Allowing water to evaporate in ponds, to reduce the volume of contaminated water to be discharged. Obviously, this option is less favourable in a dry country like Namibia
- Installing liners and covers on waste rock and ore piles, to reduce the potential for contact with precipitation and contamination of ground water

Different combinations of strategies can be applied, and the selection of strategies is site-specific. Variables to be considered are the layout of the mine infrastructure, topography, climate, and hydrological characteristics. Interception and diversion of surface water is a more prominent concern in environments with high rates of precipitation, whereas more emphasis is placed on water recycling in arid regions with very little water availability. Re-use of water, ideally to achieve zero discharge, is the best solution for Namibia. Optimising the water balance can result in major cost savings and environmental benefits, as shown in the following case study by Skorpion Zinc.

Mine:

Skorpion Zinc is part of Vedanta Zinc International (VZI), a grouping of zinc assets located in Namibia, South Africa, and Ireland. VZI is owned by India-based Vedanta Limited, a listed subsidiary of Vedanta Resources plc.

Location:

Skorpion Zinc Mine and Refinery is situated about 25 km north of Rosh Pinah town in Southern Namibia. The mine and refinery site lies just inside the Sperrgebiet National Park.

Brief description:

The Skorpion circuit was commissioned in early 2003 and was the first mine-to-metal operation to commercially apply a purely hydrometallurgical process route, to exploit a zinc oxide ore-body. The Skorpion Zinc process comprises of atmospheric leaching, solvent extraction, electro-winning and final casting of the metal into sizable ingots. The existing Skorpion circuit has a production capacity of 150ktpa of Zn from an open pit oxide mine.

Key issue(s) addressed:

Skorpion Zinc is committed to minimising water use and recycling water, with the ultimate goal of a **Zero Discharge Philosophy.** Skorpion Zinc refinery has a closed loop system, with all water recycled back into the system. This case study discusses how Skorpion Zinc managed to reduce overall water consumption and the challenges faced. Also discussed are the challenges regarding domestic effluent and the method employed to deal with these challenges. Skorpion Zinc is ISO 14001:2015 certified and compiles to the International Finance Corporation (IFC) Standards.

Description of the case study:

The metal production for the financial year (2017/18) was 84,215t against a target of 91,443t, indicating a respectable 92.1% achievement. The metal production deficit being mainly due to the ore shortage and lower

Skorpion Zinc Water Management Process:

The Skorpion Zinc Water Management Process can be divided into two (2) categories. The one category concerns Process Water Management and the other Domestic Water Management. The two will be dealt with separately below.

Process Water Management:

As alluded to above, Skorpion Zinc refinery has a closed loop system (Zero Discharge Philosophy), with all water recycled back into the system. Skorpion Zinc Refinery has a water use design capacity of 7,957 m^3 per day as illustrated in the table below. Over the years, the aim has been to reduce water consumption well below the design capacity. This target was realised through the identification and implementation of various projects, as discussed below.

Skorpion Zinc Water Consumption

	Water-Use Design Capacity (m3)
Total Water to Refinery	**7957**
Thick Floc	306
Filter Floc	162
Acid Plant	1882
Residue belt filters lubrication	432
Cooling Towers	749
Zn Dust	48
Reverse Osmosis Plant	2688
Gland Seal Water	613
Zn Dust and Others	1075

The Reverse Osmosis (RO) plant is the highest consumer of raw water, with an average consumption of 2,688 cubes making up approximately 35% of the raw water to the refinery. Demineralised water from the RO plant is used in Solvent Extraction and Electro-winning. The RO plant is followed by the Acid Plant Cooling Towers which uses an average of 1,884 cubes per day, constituting approximately 27% of total daily water consumption. Gland Seal Water—water used for residue belt filter lubrication—and Floc make-up goes to one holding tank that constitutes about 17% of total water consumption of the refinery. Most reduction efforts were centered on these three process units, as they amount to almost 80% of the water consumption.

Reverse Osmosis Plant and Acid Plant

An opportunity to re-use the treated water from the Effluent Treatment Plant (ETP) circuit was exploited. In the ETP, pH is increased to 9.5 with the addition of lime, to precipitate all metals. The treated water is of lower quality than raw water. A decision was made to install a containerised Reverse Osmosis (RO) plant to treat this solution. As the quality of this treated solution is slightly better than that of raw water, this solution is best utilised at the main RO plant, this reduced raw water consumption by more than 300m^3/day.

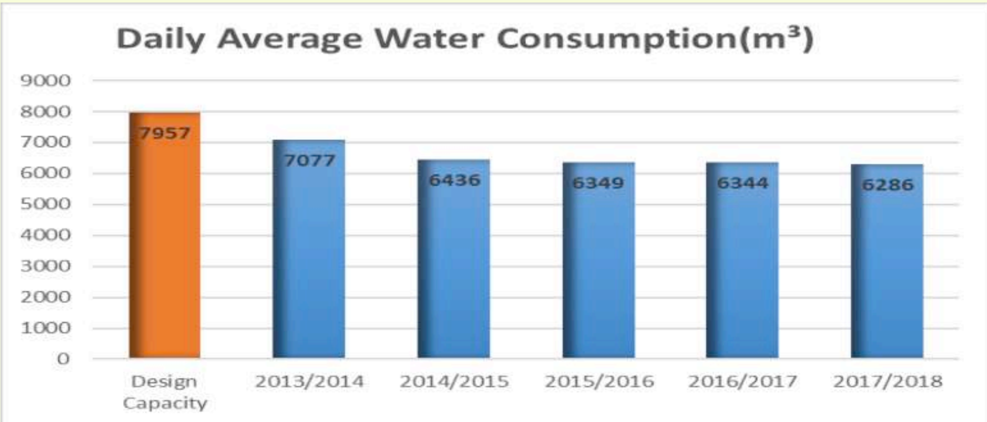
Cooling Tower Blow-downs and Reverse Osmosis Plant Brine

The cooling tower blow downs and RO plant brine was found to be of relatively good quality. This water source was found suitable for flocculent make-up, RBF lubrication water and dust suppression. However, the brine was found marginal for gland seal water because of the high amount of chlorides that could increase corrosion rates of the cast iron pumps in the refinery. To reduce the impact of the high chlorides, the recycle water is blended on a 50/50% ratio with raw water before it is fed to the flocculent make-up plant, gland seal distribution tank and the Belt Filter Lubrication, which otherwise would have been fed using raw water. A recycle water tank was constructed to accommodate surges and to blend the water to the various users above. This change resulted in a saving of more than 400 m^3/day of raw water.

Other initiatives in place that resulted in a further reduction in water consumption are:

- cooling tower chemical dosing optimisation (anti-scalant and biocides)
- optimisation of unit operations to reduce raw water usage
- decreasing raw water usage while process units are not running, especially during maintenance shuts

The above initiatives brought about a significant reduction in water consumption as indicated in the figure below. The refinery is currently operating well below water-use design capacity.



Daily water consumption at Skorpion Zinc

Domestic Water Management:

Domestic water is treated via a Sewage Trickling Filter Plant in compliance with Namibian legislation as well as IFC requirements. The effluent is treated up to a standard fit for animal consumption. In an attempt to divert birds away from the process solution in our holding tanks, an artificial wetland referred to as the Bird Pond (as illustrated in the figures below) was constructed. The treated sewage water is recycled by feeding it into the bird pond in lieu of raw/fresh water. The quality of the water is monitored on a monthly basis through laboratory analysis. The bird pond resembles a natural habitat and as a result the birds are naturally attracted to it, thereby diverting them way from the holding tanks.


Skorpion Zinc Bird Pond (close-up views)

Conclusion:

Skorpion Zinc operates on a **Zero Discharge Philosophy**. All its process and domestic effluent/water is either recycled or re-used. Skorpion Zinc aims to operate below its refinery water-use design capacity—a target that has been achieved for the past 5 years by implementing water reduction initiatives. Domestic effluent is treated and is recycled into an artificial wetland (Bird Pond), aimed at diverting birds away from its processes. Although Skorpion has attained significant success with regards to water management, the mine continues to explore other avenues for further water reduction.

Water treatment

Water treatment technologies can be classified mainly as passive or active treatment. Active treatment requires the input of chemicals and energy. Passive technologies use natural processes such as plant systems, gravity and micro-organisms (Fraser institute , 2012). The level of pollution determines the treatment technology that will be used, and the technology used is also dependent on the water quality requirements.

Active water treatment

Active water treatment is the most popular and effective water treatment at mines. It involves using energy, chemicals, infrastructure and labour to produce clean water, whilst leaving the smallest possible environmental footprint in the shortest time. The chemistry of the effluents at a mine can be predicted using software prior to construction, at which point the best fit water treatment technology is determined. The addition of lime, caustic soda or limestone is often required to raise the pH of acidic mine water. Active treatment of mine water is typically associated with high disposal and maintenance costs, and mines are continuously trying to figure out ways to recycle sludge (Fraser institute , 2012).

Passive water treatment

Passive water treatment takes advantage of geochemical and natural biological processes to remove contaminants without additional chemical and physical inputs. Passive water treatment is usually combined with water monitoring programs. These processes include:

- Bacteria-controlled metal precipitation
- Filtration through sediments and soils

– Reactive barriers, also referred to as a permeable reactive treatment zone

– Uptake of contaminants by plants

Due to the relatively lower operational and maintenance costs associated with the passive treatment of mine water, its use is becoming increasingly popular in the mining industry. However, the biggest challenge with this treatment method is treating highly acidic mine water. This treatment method is especially popular after mine closure. The most common passive water treatment system is constructed wetlands, which act as purification systems that remove contaminants before they are transported to fresh water environments or into a water re-use system. Passive water treatment systems require constant maintenance to remain effective.

2.9.1 Securing a mine's water supply

Like many industries, the mining industry requires access to a reliable supply of water to effectively carry out operations; from supplying drinking water to site workers, washing ore, managing dust emissions, tailings, and wastewater services, etc. Moreover, water can be sourced from surface or groundwater systems, varying from site to site and depending on the size and location of the mine and volume of water required for different ore types. Fortunately, Orano Mining Namibia has ensured water security for its operations through the construction of a seawater desalination plant. Their example is outline in the case study below:

Mine:

Trekkopje Mine is owned by Orano (France) and operated by Orano Mining Namibia.

Location:

Trekkopje Mine is located 70 km north-east of Swakopmund in the Erongo Region, Namibia.

Brief description:

Trekkopje Mine is a large, low-grade uranium deposit in calcretised river sediments, with the main mineralisation covering an area of 14 x 3 km. Mining will take place in shallow open pits with an average depth of 16 metres. The mining process will involve blasting, loading and hauling. The ore will be crushed to <38 millimetres with subsequent agglomeration of the fines to the coarser fraction. The crushed ore will be stacked on a heap leach pad, which extends over an area of 3 km by 810 m, and washed over a 40-day period with fresh water to remove chlorides and sulphates. This will be followed by 160 days of alkaline leaching with sodium carbonate and sodium bicarbonate. The uranium will be extracted from the leach solution in ion exchange columns and precipitated to produce sodium diuranate (yellowcake) for export to France. An "on-off" heap leach pad will be used to reduce the mine's footprint and allow progressive rehabilitation of the mine. Trekkopje was placed under care and maintenance in 2012. Orano has completed two pilot-testing phases and several process improvement studies to prove that large-scale alkaline heap leaching for uranium is feasible. Pilot and full-scale production facilities have been completed, including heap leach pads, crushers and processing plants, as well as roads, powerlines and pipelines. To secure the mine's water supply, Orano has constructed a seawater desalination plant at Wlotzkasbaken, 35 km north of Swakopmund.

Key issue(s) addressed:

This case study addresses the issue of sustainable water provision to mines and the potential conflict with other water users. Members of the public tend to see mining companies as major water consumers who are "wasting" precious water resources that could otherwise be used for domestic or agricultural purposes. The International Council on Mining and Metals recommends that the use of water should be socially equitable, environmentally sustainable and economically beneficial, and achieved through a stakeholder-inclusive process that involves site and catchment-based actions.

In South Africa, for example, Anglo American and South32 (formerly BHP Billiton) are treating mine waste water, to solve regional water problems, in partnership with the eMalahleni municipality. They have built a water reclamation plant that currently treats more than 30 million litres of acid rock drainage per day, transforming 16 million litres into drinking water for more than 80 000 consumers in a highly water-stressed, cash-poor, and rapidly growing urban municipality. It has reduced to net-zero Anglo American's reliance on external water sources, since the recycled water meets the water needs of its mining operations in the area.

To maintain their social licence to operate, mining companies operating in water-scarce areas should consider developing their own supply, not only if their site is far from a supply network, but also to avoid competition with other users. If possible, best practice would allow the public to benefit from mine water infrastructure, either immediately or after mine closure. This has worked well in the case of Trekkopje, because the spare capacity of the Erongo Desalination Plant is available to supplement the Namibian Water Corporation's regional groundwater supply scheme. Without it, Husab Mine could not have started production.

Key bullet points:

- Orano's initiative to provide its own water supply, resulted in the construction of a desalination plant, which has turned into an important asset for the country's economic development
- In a commendable display of best practice, mining companies (Langer Heinrich Uranium, Rössing Uranium and Swakop Uranium) have shouldered the full cost of desalinated water, while residents only pay the groundwater tariff.

Description of the case study:

The Erongo Desalination Plant, one of the largest reverse osmosis plants in Southern Africa, is located 35 kilometres north of Swakopmund and was commissioned in 2010. It is wholly-owned by Orano and managed by AVENG Water Treatment. The plant was initially built to supply water to Trekkopje Mine. When the water supply situation at the coast was assessed during the project feasibility study, it became clear that the local aquifers were already used to full capacity and unable to support another major consumer. The only viable alternative, i.e. seawater desalination, had already been identified in the government's Central Namib Area Water Master Plan in 1996. Orano therefore decided to construct a desalination plant as close as possible to the mine. The design provided for a capacity of 20 million cubic metres per annum according to the initially estimated water demand, though later optimisation studies reduced this figure to 12-14 million cubic metres per annum.

To accommodate future increases in demand, the desalination plant can be upgraded to 26 million cubic metres within the existing buildings, while a second seawater intake pipe was provided to enable a further extension to 45 million cubic metres. Seeing that the groundwater resources were running out, it was planned from the start that the plant would be integrated into the regional water supply scheme after the end of mining (10 years). However, a lack of groundwater recharge forced NamWater to reduce pumping to a more sustainable rate as early as 2013. To make up for the shortfall, Orano and NamWater concluded an agreement to augment the groundwater supply to the coastal region with desalinated water. The pipeline from the plant to Trekkopje Mine was connected to NamWater's pipeline from Henties Bay to Swakopmund. Omaruru River groundwater and desalinated water are mixed in the pipeline, which incidentally results in a lower salinity and hardness of the water supplied to all users.

The Erongo Desalination Plant is subject to Namibia's legislation and standards in terms of health, safety and the environment. To ensure that the water quality complies with the Namibian standards, regular independent tests are conducted and reported to the regulatory authorities. The water is also replenished with all the minerals the body needs, so that it is safe for human consumption. Impact studies by independent experts prior to the approval of the plant, predicted no major effects of the brine discharge on marine life around the outlet. This has been confirmed by monitoring of the seawater quality and marine life.

The addition of desalinated water has allowed NamWater to keep meeting the Central Namib's water demand, while operating the wellfields sustainably. This is important because the continued availability of relatively cheap groundwater will protect domestic consumers from steep water tariff increases, which would be unavoidable if the entire supply were sourced from the more expensive desalination process. In a commendable display of best practice, mining companies (Langer Heinrich Uranium, Rössing Uranium and Swakop Uranium) have shouldered the full cost of desalinated water, while municipalities are still charged as per the gazetted groundwater tariff.

In conclusion, the Erongo Desalination Plant serves as an example of a symbiosis between mine and public water supply, securing the economic growth of the Erongo Region and Namibia as a whole.

Reference

ICMM & ICF (2017): Shared water, shared responsibility, shared approach. www.commdev.org and www.icmm.com

PART THREE – MINERAL WASTE MANAGEMENT

3 INTRODUCTION

Mineral waste includes waste rock, overburden, tailings and ore remains from mineral processing (e.g. ripios and spent heap leach materials). This waste further includes: rock masses disturbed by block caving, rejects from ore beneficiation or concentration, mineral residues, refinery discards and sludge, smelter and other furnace slags and ashes, water treatment sludge, dredging materials, and soils contaminated by mineral waste.

When ore bodies are located close to the surface, surface mining is typically used—resulting in an open pit. When the ore body is located deeper down, underground mining methods are generally applied. Although the volumes of mineral waste from open pit mines, as a rule, are more than the volumes originating from underground mines, all mines are faced with the management of mineral waste—in particular because of the significant footprint size of tailings storage facilities and waste rock dumps.

During the operations phase of the mining life cycle, overburden and waste rock are stripped and dumped in allocated areas, followed by the first disposal of tailings from the processing plant, shortly thereafter. The deposition is done in accordance with the initial Life of Mine Plan and the Environmental Management Plan. Moreover, it means that mineral waste management measures need to be in place when the operational phase commences and must be regularly reviewed for continuous improvement thereafter.

The type and quantities of mineral waste items will differ from mine to mine. As a rule of thumb, waste rock and tailings are generated in the biggest quantities and their repositories are responsible for the biggest part of a mine's footprint size.

3.1 CHALLENGES

Each mine manages the disposal of waste rock and tailings as two waste streams, guided by the Life of Mine Plan, the Environmental Management Plan and, in many cases, an internal mineral waste management plan. Management of the waste streams are further guided by an Environmental Management System with a particular focus on the management of geotechnical (potential failure, stability, slope steepness, erodibility, etc.) and geochemical risks (radioactivity, in the case of uranium mines, AMD and the seepage of residuals such as nitrates, etc.). For the efficient implementation of a mineral waste management plan, and best practice, the assignment of clear accountabilities and responsibilities is essential.

Stability of mineral waste repositories is a priority, and the risk of failure needs to be eliminated. Compliance to all relevant safety standards is non-negotiable. A conceptual geotechnical understanding must be developed for potential modes of failure for mineral waste repositories. All geotechnical factors governing their stability, factors pertaining specifically to the mine site, and directives for the planning, design, construction and operation of the repositories (also the legal and regulatory requirements), have to be part of such a study and the recommendations have to be honoured. In some cases, it could be advantageous to segregate mineral waste types before deposition, so that material with the same geochemical and geotechnical features can be placed together. Full geotechnical reviews have to be done regularly.

An efficient system for managing mineral waste necessitates:

- Characterisation of mineral waste (in terms of the environmental conditions of the mine site, e.g. climate, and site-specific surroundings of the waste repositories) need to be understood
- Physical characteristics (mineralogy) of the mineral waste, as well as the materials that will be exposed, covered or disturbed by mineral waste, need to be identified and understood
- Chemical composition and characteristics of the mineral waste, as well as the materials that will be exposed, covered or disturbed by mineral waste, need to be identified and understood
- All possible hazards of the mineral waste, as well as the materials that will be exposed, covered or disturbed by mineral waste, need to be identified and understood through regular reviews of a maintained risk register
- Reliable estimates of potential water and air quality impacts, direct exposure hazards, erosion potential and geotechnical hazards need to be made
- The AMD potential of mineral waste repositories needs to be identified and understood
- Emergency plans and contingency measures for response to unplanned conditions or unexpected impacts have to be in place
- A detailed mineral waste inventory is necessary. The inventory may contain information such as a description of geochemical and geotechnical characteristics, mass, volume, surface area and storage location; details about the material production and placement, techniques used and dates of disposal; maps and/or photographs showing the location of disposal, repository boundaries, drainage features, permanent test plots and sampling locations, and boreholes.

The mineral waste inventory needs to be accurately maintained and synchronized with a Geographic Information System for the mine site, to enable appropriate calculations, modelling and planning, as well as easy reporting on land use disturbance and footprint size.

3.2 Tailings Management

Tailings storage facilities can pose several environmental challenges. Among these are surface seepage from the impoundment, resulting in an extensive seepage control program and monitoring system in the case of unlined storage facilities; windblown accumulation of precipitates, resulting in an extensive monitoring system and interventions to suppress dust formation; and radioactive release pathways (in the case of tailings at uranium mines) which implies a cover layer at completion. Tailings material, furthermore, is susceptible to wind and water erosion and could be dispersed into the surroundings.

3.2.1 Key principles

A primary driver to the design and location of mineral waste facilities at any mine site, is the placement of tailings storage facilities. It is not good practice to dispose tailings in a manner that makes the recovery and treatment of tailings uneconomic. Failure to adequately manage tailings can tarnish the reputation of a company, even resulting in the loss of a social licence to operate, and can lead to increased costs during mine closure and clean-up, and also result in disasters from dam breaks.

All tailings structures need to be operationally stable, able to be rehabilitated, and retain long-term integrity. To ensure this, a risk-based approach should be used to manage tailings. A risk-based approach should also be used to consider all relevant economic, environmental and social aspects during all stages of tailings management, in order to minimise short- and long-term impacts.

A tailings storage facility at an operational mine should be managed on the basis of a management plan (operation manual) and mineral waste management plan, which have been approved and evaluated by a competent authority. Tailings management is also closely associated with a water management plan and the Life of Mine Plan. The following should be contained in the operation manual:

- A description of the monitoring programs, accompanied by operational procedures and reporting arrangements
- A description of the tailings delivery system around and to the facility
- Standard procedure for reporting non-compliance and failures
- Parameters to assess the suitability and effectiveness of the operational manual
- An in-house emergency plan
- Actions to be applied in the event of non-compliance

Continuous research into strategic issues and improvements in the management of tailings, is essential. This includes geotechnical risk assessments, dam break studies, closure requirements and groundwater studies (including seepage modelling and the management of potential pollution plumes). Knowledge-sharing and benchmarking against leading practices are important directives.

A key principle is to have mechanisms in place to reduce the production of tailings and maximise its potential re-use. Reducing tailings production is cost-effective, aside from leaving a smaller footprint size behind. Although tailings are a waste product of a mine, and are deposited in a repository, which becomes a permanent landform of a mine site, not all types of tailings are non-recyclable. Possible recycling and reuse options for tailings are listed below:

- Bauxite tailings as a source of alum and soda
- Cu-rich tailings as extenders for paints
- Tailings rich in Fe can be mixed with fly ash and sewage sludge as lightweight ceramics
- Mn-rich tailings can be used in agro-forestry, cast resin products, building and construction materials and glass ceramics
- Sand rich tailings can be combined with cement and used as backfill in underground mines
- Clay rich tailings can be used for the manufacturing of bricks
- Phosphate rich tailings can be used for the extraction of phosphoric acid
- Phlogopite rich tailings can be used for sewage treatment
- Ultramafic tailings can be used to produce glass

To minimise environmental impacts, tailings storage facilities can be encapsulated and/or lined. Furthermore, filter drainage systems and a leakage collection system with seepage cut-off trenches around the toe of an impoundment, can capture seepage. In addition, monitoring boreholes are used for the early detection of possible seepage.

Remediation of tailings impoundments is a complex process, often constituting the largest single component of overall decommissioning costs at a mine. For decommissioning, retaining structures at a tailings storage facility need to isolate waste for a reasonably long period of time, and the structures have to restrict the release rate of pollutants from the containment to the surroundings, meaning that long-term monitoring and maintenance is minimised.

Stakeholder engagement is also important for successful planning, management and closure of tailings storage facilities.

3.2.2 Types of tailings storage facilities

Three types of tailings storage facilities are typically used, namely upstream ring deposit facilities, centreline tailings dams, and downstream tailings dams. Tailings can also be backfilled into mined-out open pits (e.g. at Langer Heinrich Mine) or underground mining voids. Mines situated on plains usually build ring deposit facilities (e.g. at Husab Mine and Rosh Pinah Zinc).

Upstream ring deposit facilities

The upstream method requires the least fill material and is the most popular method for raised tailings dams. It also has the lowest initial construction cost. Slurry from the processing plant is conveyed or pumped to the facility, in many cases with run-off or waste water from the processing plant. This method, which was used during the 1970s and 1980s at Rössing Uranium Limited, implies high water consumption. To implement a more water-wise method, the processing circuit at Rössing has been changed to allow water stored on the tailings facility to be recovered, thereby offsetting freshwater intake. A paddock deposit system was also introduced to eliminate the tailings pond permanently, and to reduce the wetted perimeter. A conveyor belt system replaced the pipe system, which required even less water and resulted in even bigger water savings. Currently, the tailings storage facility at Rössing is still operated this way, making it the largest feature of the mine at about 750 ha in surface cover and about 100 m above the surroundings. It is one of the largest uranium tailings in the world and by far the largest located in an arid landscape.

Upstream ring deposit facilities are the most common method of failing, with the key failure mode of upstream embankments being a static/transient load-induced liquefaction.

The tailings storage facility at the Rosh Pinah Zinc Mine is also operated as a ring deposit facility, and is managed by a South African company, which provides an array of mining-related services in accordance with a code of practice. The company provides monthly inspections and an annual report. The tailings dam at Rosh Pinah is constructed by means of wall construction (illustrated in FIGURE 6FIGURE 6 - TAILINGS DAM AT). As the tailing material contains no clay, very little moisture is retained, and it is free-draining. The facility is surrounded by several piezometers for monitoring water table levels, to see if there are any leaks into the surrounding area.

FIGURE 6 - TAILINGS DAM AT A MINE SITE IN NAMIBIA

Centreline tailings dams

The centreline tailings dam is a combination of the upstream and downstream methods, to reduce the volume of construction material placed in the downstream shell of the embankment. The centreline tailings dam is the most effective of the tailings storage facilities.

Downstream tailings dams

The downstream design aims to reduce the risks associated with the upstream method, especially in the event of possible earthquakes. The drainage zones and impervious cores installed when using the downstream method, also enable the impoundment to hold a significant volume of water directly against the upstream face of the embankment.

Valley-fill dams

Another form of tailings impoundment is using natural depressions for tailings storage facilities, in which case the sides of the valley serve to contain the tailings. An advantage of valley-fill impoundments is that it provides relief from the wind erosion of tailings material (U.S. Environmental Protection Agency, 1994). Valley-fill impoundments have several design variations, with the cross-valley design being the most frequently used, as it requires the least fill material and is thus favoured for economic reasons. A disadvantage of this method is that the depth of the storage is limited, which can result in an increase of the reclamation, environmental mitigation and closure costs.

Backfilling

At Langer Heinrich Uranium, the tailings storage facilities are placed in the mined-out voids, inside the paleo valley where the ore body is located. Tailings are deposited as a series of in-pit tailings disposal facilities, all of them below the surface and as high-density facilities, partly with embankment construction. The open voids are first made safe and secure, to prevent contamination through seepage before disposal commences. A disadvantage of this approach is that the first tailings storage facility could not be placed inside a mined-out void and was constructed as a temporary facility. Another disadvantage is that the capacity of the open voids are limited, which means that multiple disposal facilities have to be created.

Using the suitable open voids as in-pit tailings disposal facilities, on the other hand, means major cost-savings as "substitute" backfilling of the open voids, while making the tailings disposal facilities safe and secure at the same time.

Mine:

Husab Mine is owned and operated by Swakop Uranium, representing a partnership between the Republic of Namibia and the People's Republic of China. Taurus Minerals Ltd owns 90% of the shares and 10% are owned by a Namibian company—Epangelo Mining Company.

Location:

Husab Mine is situated in the northernmost part of the Namib Naukluft National Park (NNNP), about 12 km southwest of the town of Arandis. It is in a sensitive and unique biodiversity environment, whereby main Welwitschia mirabilis fields are situated around the mine site. The mine is located upstream from both the Khan and Swakop Rivers.

Brief description:

Drilling activities, as part of the exploration phase, commenced in 2005. The construction of some of the mining infrastructure commenced in October 2012 and mining started in March 2014. Overburden from the mine pit is deposited on waste rock dumps east of the open pits, with a drainage channel located to the east. Commissioning of the processing plant started in December 2016. Tonnage to be mined per annum depends on the business plan for that period. However, the processing plant name plate design production is estimated between 5,000 and 6,000 tons of uranium oxide per annum. It is worth noting that the mine operates its one acid plant. Additionally, the mine generates its own electricity with the steam from the acid plant via a water turbine. Currently, desalinated water is pumped via a 65-km-long pipeline, and travels through the NNNP and Dorob National Park (DNP) from the Swakopmund NamWater reservoir. Drainage systems were established to provide water to downstream receptors during rainfall/flood events.

Key issue(s) addressed:

It is important to know the contents of the tailings, to determine if pollution takes place or if clean-up measures are required for noted spillages. The tailings associated with the Husab Mine are acidic, and therefore need to be treated through neutralisation. Issues considered by Husab Mine regarding tailings, include:

- **General design options**
  - Old design (dry tailings)
  - New design (wet tailings deposits)
  - The tailings storage facility area is approximately 420 ha in size and located to the south of the processing plant operations
- **Information on the Lining System**
  - 1.0mm thick Linear Low-Density Polyethylene (LLDPE) geomembrane liner has been specified, with an ultra-violet-stabilised upper white surface that reflects sunlight
  - Geomembrane liner is placed upon a 0.3 m thick protection layer of selected material derived from the tailings basin area
  - Additional protection is ensured by the inclusion of a needle-punched geotextile immediately above the geomembrane
  - Use of Geosynthetic Clay Liner (GCL) beneath the geomembrane provides further hydraulic containment
  - To prevent wind damage, the exposed geomembrane in the base of the storage facility is held in place by 1 tonne aggregate bags, on a 20 m grid

- **Closure Commitments**
  - The tailings storage facility is designed to have a 2 m thick layer of waste rock and an outer cover of 0.5 m durable rip-rap (2.5 m thick cladding of graded rock and rip-rap)
  - The design allows for no exposure of tailings surface material for a 1000-year period
  - Swakop Uranium is committed to monitoring potential seepage/pollution for up to 200 years

- **Monitoring**
  - Intensive water and air quality networks to determine potential pollution sources

- **Daily monitoring and reporting covers the following aspects (shift and daily)**
  - Seepage sump station levels and pump status
  - Decant pumps flow rates and volume totaliser readings
  - Decant pond levels
  - De-position valves in operation and on standby in the different zones
  - Leakages observed on slurry and other substance pipelines
  - Ambient minimum and maximum temperature
  - pH on seepage and decant return water
  - De-positioning hours
  - Decant pumps running hours
  - Rainfall

- **Safety, Health, Environment and Quality (SHEQ) Management**

To keep senior management, operations management, designers, and SHEQ personnel well informed about the status of the facility, reports are being distributed on a monthly or events-based basis. Design and operations management teams are updated, and quarterly reviews are scheduled, to inform and discuss the operational status, to provide statistics and to determine the way forward. In addition, the SHEQ management of the facility is fully integrated into the Husab Mine policies and programs. Safe operating procedures, and a site-specific baseline risk assessment with control measures, have been developed to minimise and control risks.

Description of the case study:

History and current status

Since commissioning in December 2016:

- A total of 6,528,145 dry metric tons of final tailings against a budget of 8,153,810 tons has successfully been distributed to the storage facility
- 5,616,292 cube/m of decant water has been recovered for reuse in the main process
- Planned civil construction to raise the causeway to the decant facilities has been completed according to specifications and within financial budget
- After initial difficult challenges, the Husab tailings storage facility is currently in an excellent operational condition and ready to progress to the next phase, where its wall raising will be a key focus area

Performance reviews of the tailings storage facility of the Husab mine are carried out on a quarterly basis by design engineers who conduct site visits and monitor performance. Monitoring of the facility is conducted daily by the operational contractor and Swakop Uranium team, whereby daily pH readings and water samples are taken and analysed for chemical/metal content.

For long-term post-closure sustainability, Husab mine has adapted to requirements and standards for tailings storage facilities, as established by the US EPA, as called for by the Uranium Mill Tailings Radiation Control Act (UMTRCA), 1978 (USA), and as part of the design process. The mine also has an emergency response plan for managing large failures and, if required, a cut-off trench will be constructed to pump seepage water back into the storage facility.

The tailings storage facility during construction at Husab Mine.

An aerial view of the tailings storage facility at Husab Mine before operations.

Conclusions:

One underlining challenge experienced by Husab, is understanding the changes in risk profile from the design to the operational phase. The mine has experienced some shortcomings in managing this aspect effectively, which subsequently led to some issues. The facility is currently managed based on the 'no water, no problem' golden rule. Accordingly, Husab strives to achieve environmental sustainability by keeping abreast with ever-changing technologies, maintaining standard requirements, and regular monitoring and reviewing of its operational activities.

3.3 WASTE ROCK DUMPS

In most cases, the footprint size of waste rock dumps is the largest feature of open pit mines. Waste rock dumps may include overburden and low-grade stockpiles, but mostly contain material rejected for processing. As a result, this type of mineral waste varies in size from coarse, angular fragments and large boulders of more than 1 m in diameter, to gravel-sized particles and sand.

In rare cases, in the case of open pit mines that were in production for long periods, it happened that some foreign materials were also accidentally dumped in the waste rock dumps. Nowadays, waste rock dumps are managed with great care and accuracy, closely coupled to the obligations contained in an Environmental Management Plan and Life of Mine plan. For this reason, a detailed mineral waste inventory is maintained—to keep a record of the characteristics, volume, location, and date of disposal. The mineral waste inventory includes information about the material production, techniques used, maps and photographs, as well as a description of repository boundaries, drainage features and the location of test plots, sampling points and boreholes. It is advantageous to have the inventory synchronised with a Geographic Information System.

Waste rock dumps have multiple negative environmental impacts. Among these are alterations to surface drainage systems, depletion and fragmentation of habitats, and destroying of migratory routes. Waste rock dumps have the most intrusive and visible impacts (sometimes also because of colour differences), and because of their presence, it is difficult to return the entire landscape to as close to an original state as practical. They may also pose threats to groundwater (e.g. seepage), safety and stability. In the case of uranium mines, they also have a radiation potential and can emit radon.

3.3.1 KEY PRINCIPLES

Waste rock dumps should only be placed within permitted areas. The management and placement of waste rock dumps need to be closely coupled to a Life of Mine plan, guided by operational manuals such as the Environmental Management Plan and, in some cases, an internal mineral waste management plan. Waste rock dumps need to be designed, constructed and operated by considering the following factors:

- Steep slopes need to be avoided, as they may result in instability, increase the potential for erosion, and require re-shaping as part of closure commitments. Avoidance of steep slopes minimises the erosion potential and likelihood of injury to humans and wildlife, also throughout the closure and post-closure periods
- Access to waste rock dumps has to be controlled and minimised during the operational phase, and prevented after closure. It is advantageous to have the waste rock dumps located in an isolated area, or close to access roads after completion, for example
- Surface water, groundwater, and the biophysical environment have to be protected against exposure to hazardous waterborne chemicals, i.e. water quality parameters, as close as possible to the range of natural variability, have to be ensured. To avoid AMD, the buffering capacity and the presence of residuals and solutes in the mineral waste should be known, and management measures implemented accordingly. A good understanding of the local climate is essential to be able to plan for unusual rainfall events and floods, and to plan for potential wind and water erosion. Run-off and eroded material from waste rock dump surfaces have to be minimised.

Seepage needs to be captured and re-directed to collection points. For this purpose, cut-off trenches might be necessary at the toe of waste rock dumps

- Waste rock dumps at uranium mines have to warrant protection against radiation, to ensure that doses to the workforce and public do not exceed the limits and constraints recommended by the International Atomic Energy Agency and International Commission on Radiological Protection
- To minimise rehabilitation liabilities, waste rock dumps need be contoured to minimise their visual impacts as artificial landforms, to blend into the surrounding landscapes, and to enable (active and passive) re-vegetation

To avoid double handling and to minimise hauling costs, to secure scheduling flexibility and to stay within parameters of the geotechnical design, the placement of waste rock dumps is a compromise between environmental and economic factors. Considerations include the mechanical competency of the mineral waste, the distance between the source and the dumps, stability of the foundation surface, topography, surface and groundwater drainage characteristics, wind and water erosion potential, and suitability for closure commitments (such as re-contouring and blending into the surroundings). In some cases, waste rock is temporarily placed for backfilling of an open void later, but it is more efficient if in-pit dumping can be done immediately.

PART FOUR – MONITORING REQUIREMENTS DURING THE OPERATIONAL PHASE

4 THE IMPORTANCE OF MONITORING

Monitoring aims to determine whether the impacts resulting from operational activities meet the appropriate criteria set out in the EMP. Therefore, monitoring activities provide information that indicates if the measures to manage and mitigate the effects are on track with stated objectives, to evaluate performance against set criteria and appropriate indicators, and to check whether operational activities are in line with the legislative framework. Hence, monitoring is a crucial component for leading practice in mining.

An approach commonly considered for assessing mine impacts and recovery is the "before-after control-impacts" (Quinn & Keough, 2002). This refers to the conducting of measurements prior to and after change that is likely to cause impact(s), and controlling the impact(s). The aspects to be monitored might have been identified and assessed during the environmental impact assessments (EIAs), during the planning processes of the projects and construction phase, or by gathering baseline information during the various stages of the operational phase (for example to be compliant and to ensure compliance with evolving legislative conditions). For this reason, monitoring activities are used to ensure that required measures are implemented; to evaluate the progress of mining activity towards environmental protection by implemented environmental management systems; and to validate the efficiency of cross-sectional applied strategies, tools and techniques over time. Monitoring is also done in respect of responsible natural resource management in Namibia, in support of baseline information and data collection processes, to

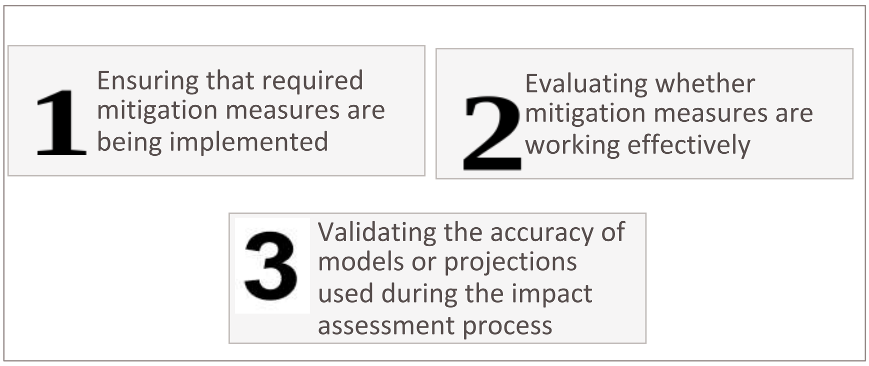


FIGURE 7 - SHOWS THREE PURPOSES THAT MONITORING SERVES

strengthen public participation, to assist with operational decision-making, and as a result of follow-up requirements. FIGURE 7 highlights the purpose of monitoring.

In the past, technical reporting required by the state was largely confined to mining and employment statistics. Since the early 1990s, environmental performance became more prominent as a result of the new Minerals (Prospecting and Mining) Act, No. 33 of 1992, as well as a voluntary adherence of mines to Namibia's Environmental Assessment Policy for Sustainable Development and Environmental Conservation (1994).

Environmental auditing of mines requires ongoing monitoring and inspection by regulatory bodies or independent authorities, to ensure compliance with existing national and international requirements and standards Mines are often associated with international groups, and acquire certification and compliance with international recognised certification such as ISO standards: 14001 and 18000. Audits are an important aspect, and are part and parcel of monitoring and certification. They may be conducted both internally and externally, and are used to gauge the company's performance and compliance against regulatory frameworks, adapted management systems and applied standards. Subsequently, audits are used to demonstrate performance against criteria and indicators, and to reassure continuous improvement. If gaps and/or inadequacies are discovered during the auditing process, they enable the auditee to improve the monitoring programs.

The Environmental Management Act empowers the Environmental Commissioner to undertake inspections on mine sites to monitor compliance with the Act and against the conditions specified in the Environmental Clearance Certificate. The Environmental Commissioner has the power to confiscate or withdraw the certificate and reinstate it once the holder of the ECC has rectified his/her non-compliance. In practice, the MET will first issue a compliance order and give the mine some time to rectify the deficiency.

Environmental monitoring and auditing includes, amongst other things, water, air quality, and mineral waste.

4.1 Water Monitoring

Water plays a key role at any mining operation and managing water is fundamentally part of many operational activities at a mine. Each situation has its own unique water characteristics, but in essence, all mines incorporate environmental concerns and regulations into its water monitoring programs, in order to manage water consumption and effluent, and to avoid water pollution.

All mines in Namibia are obliged to adequately monitor and analyse water in compliance with the industrial and domestic effluent discharge exemption permit under section 21(5) and 22(2) of the Water Act (Act 54 of 1956).

Water usage at mines has the potential to affect the quantity and quality of surface and groundwater downstream. One of the tools needed, in order to achieve the aim of surface and groundwater protection, is an effective water quality monitoring program, which includes water quality sampling and analysis (including surface water, groundwater, sewage effluent, and leachates); monitoring of pH and flow volumes of seepage points; monitoring of water table elevations, and potable water quality monitoring.

The principal source(s) of potential water pollution at any mine needs to be identified, as well as the incidental sources of pollution such as accidental spillage of process solutions, chemicals or hydrocarbons; leachates from waste rock dumps and landfill sites; sewage effluent; and workshop wash-downs. The objective of a water monitoring program is to detect changes in water quality, identify the source(s) of the contaminant(s) and assess their impact on human health or the environment. Remedial actions need to be taken, based on the results of monitoring data evaluation. Ultimately, a water monitoring program should be designed to cover remedial actions and achieve sustainable water management.

At Rössing Uranium Limited, one of the oldest operational mines in Namibia, hydro-chemical data have been collected within the mining grant since the start of operations in 1976. About 150 sites have been monitored for groundwater composition, at varying intervals (mostly monthly or quarterly) initially, later reduced after an evaluation of long-term trends and the composition of a water balance for the mine.

Data obtained from a water monitoring program is evaluated and reported, internally as well as externally. The water monitoring program needs to be audited periodically and corrective and improvement actions need to be taken, if necessary. A water monitoring program includes:

- A description of all monitoring mechanisms in place, namely sampling frequency, sampling locations, checklists and compliance parameters such as pore pressure, drainage system functionality, groundwater level, slope stability, dam movement and surface water diversion
- Full implementation of the EMP's waste and water management plans
- Generation of baseline/background data (preferably before the operational phase)
- Identifying the sources of pollution and the extent—which constitutes legal consequences linked with the risks of contamination
- Monitoring of water usage (including downstream and upstream)
- Verification and calibration of various prediction and assessment models
- Design, identification and monitoring of appropriate water treatment technology
- Controlling unit processes such as process plants and water treatment plants
- Auditing and evaluating the success of implemented management actions such as ISO 14001 standards
- Assessing compliance with set standards and legislation

Mine:

Husab Mine is owned and operated by Swakop Uranium, which is a partnership between Namibia and China. Taurus Minerals Ltd owns 90% of the shares and 10% are owned by Epangelo Mining Company.

Location:

Husab Mine is situated in the northernmost part of the Namib Naukluft National Park (NNNP), about 12 km southwest of the town of Arandis. It is in a sensitive and unique biodiversity environment, whereby main *Welwitschia mirabilis* fields are situated around the mine site. The mine is located upstream from both the Khan and Swakop Rivers.

Brief description:

Drilling activities as part of the exploration phase commenced in 2005. The construction of some of the mining infrastructure commenced in October 2012 and mining started in March 2014. Commissioning of the processing plant started in December 2016. Tonnage to be mined per annum depends on the business plan for that period. However, the processing plant name plate design production is estimated between 5,000 and 6,000 tons of uranium oxide per annum. It is worth noting that the mine operates its one acid plant. Additionally, the mine generates it’s on electricity with the steam from the acid plant via a water turbine. Currently, desalinated water is pumped via a 65-km-long pipeline, travelling through the NNNP and Dorob National Park (DNP), from the Swakopmund NamWater reservoir. Drainage systems were established to provide water to downstream receptors during rainfall/flood events.

The open-pit mining activities of Husab mine has a standalone waste rock dump east of the open pits with the drainage channel located to its east.

Key issue(s) addressed:

Husab mine boasts a comprehensive environmental monitoring network, supported by appropriate baseline data. Water monitoring at Husab aims at the following objectives:

- Compliance monitoring
- Water level measurements
- Monthly groundwater quality monitoring
- Surface water monitoring (ad hoc activity)

In compliance with legal requirements, a borehole monitoring network comprising of 70 boreholes was established for monitoring groundwater levels and quality. Groundwater levels are especially important in a dry country such as Namibia, in particular when abstraction of groundwater from rivers takes place. Results are reported quarterly and bi-annually. Monitoring activities include assessment of rest water levels and quality, and are inclusive of the following parameters: EC, pH, Eh, temperature and metals and ions. A Grundfos submersible pump for purging and sampling is used. Water sampling is only done when the boreholes have recovered from purging. For quality control, a blank sample is collected for every 10 samples from randomly selected boreholes. In addition, ad hoc activity includes the monitoring of surface water when it has rained.

- Monitoring for quarterly reporting
    - Comprises of 15 monitoring sites
- Monitoring for bi-annual monitoring sites
    - A total of 35 monitoring boreholes have been selected for bi-annual reporting and parameters measured remain the same
- Monitoring of radionuclides is done on both bi-annual and quarterly bases

The following radionuclides series are monitored:

- Th-232 series: 232Th, 228Ra
- U-238 series: 238u; 234U;230Th; 226Ra, 210Pb; 210Po
- U-235 series: 235U

For groundwater quality monitoring, early pollution detection is conducted prior to each sampling campaign. Equipment is therefore calibrated before the commencement of the monitoring activities.

Description of the case study:

Potential groundwater and surface water quality, and quantity impacts, are a concern during the life cycle of the Husab Mine and, as such, should be closely monitored. As per the commitments in the Environmental Management Plan (EMP), both the quantity and quality of surface and groundwater should not be adversely affected by mining activities and should remain consistent with baseline conditions.

Additionally, the data obtained assists with a better understanding of the surrounding environment and functioning of the bigger landscape, especially because water is an important ecological driver in the central Namib Desert.

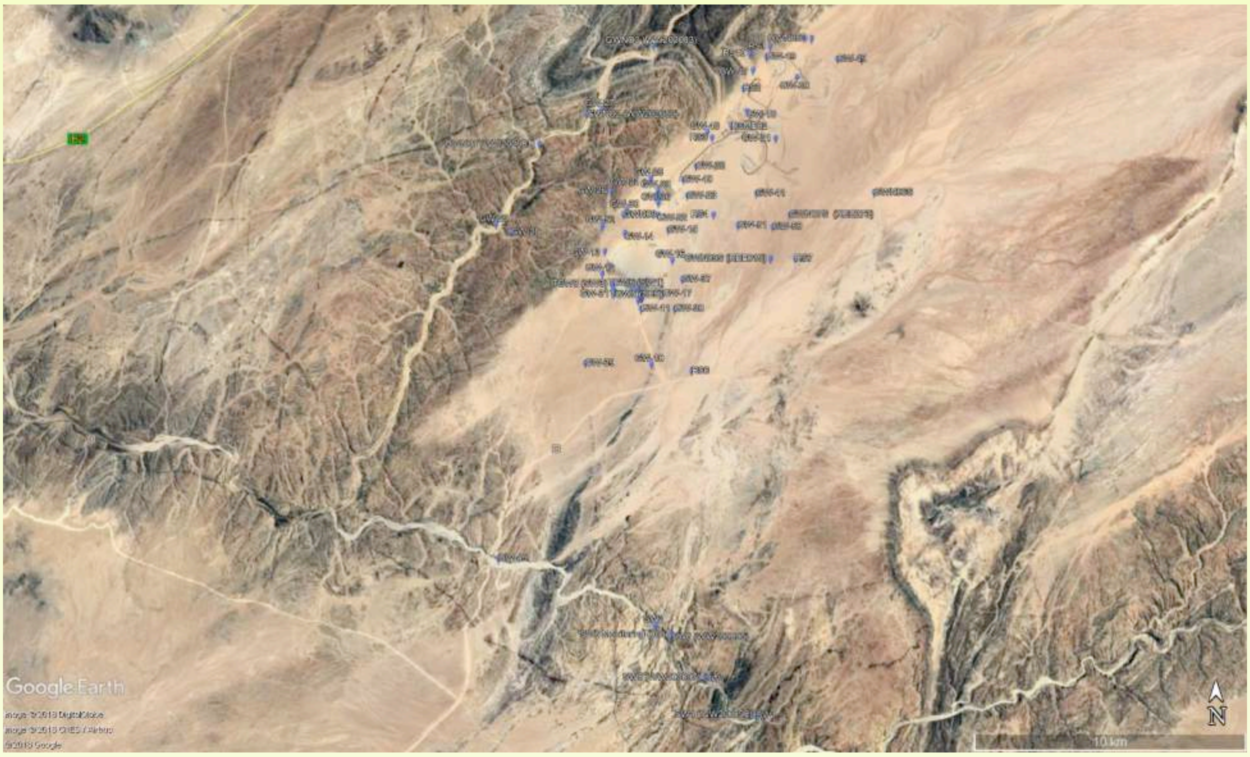
The mine adheres to requirements/objectives from ISO14001, NOSA, SEMP indicators and EMP commitments, based on best practice (such as that of the IFC and ICCM). Additionally, all legal requirements need to be complied with.

The mine’s budget is determined annually, based on the following year’s needs. This takes into cognizance additional monitoring facilities and equipment requirements, as well as possible worst-case scenarios.

Conclusions:

Husab Mine is still gathering baseline data for all groundwater monitoring boreholes. Once there is sufficient data available, thresholds can be established. Currently a lower and an upper threshold have been determined for existing boreholes, based on the recommendations of specialists.

Husab mine considers equipment maintenance, and the storage, handling and control of equipment, as vitally important for ensuring accurate monitoring. This is also in line with best practice and the manufacturer’s specifications. Furthermore, an inventory review is conducted following each sampling campaign, and defects are reported.



The Swakop Uranium ground water monitoring network.

Water level monitoring at Swakop Uranium.

4.2 Mineral Waste Monitoring

The characteristics of mineral waste will differ depending on the type of material being mined, the geology of the mine and the processing technology used. All mineral materials that have little or no economic value are deemed mineral waste. Most mine wastes are benign, hence mining companies are required to manage their mineral waste and to deal with the large volumes of waste produced, in order to protect the environment in which they operate. As part of mine approval and the projects and construction phase of the mining life cycle, waste management plans and strategies are developed. Waste strategies for addressing problematic waste, long-term stabilisation of waste, and the rehabilitation of waste dumps as part of mine closure, should be included in these plans. Most of a mine's mineral waste is produced during the operational phase of the mining life cycle. Read also Part 3 of this Best Practice Guide.

Environmental impacts posed by mineral waste will vary with the type of mining activities. Waste rock and tailings that contain large amounts of sulphide, can release AMD when exposed to water and air, for example. Hence, every mine is expected to have its own approach for the prediction, control, monitoring and treatment of mineral waste. The usual approach to managing mineral waste is to contain and collect the waste from the point of generation to treatment, and to dispose it in an environmentally friendly manner.

Ongoing monitoring and data collection on mineral waste is essential, in order to secure the geotechnical integrity and geochemical stability of mineral waste landforms. Monitoring typically includes regular visual inspections of infrastructure and water management systems, for signs of excessive surface erosion and shallow or deep-seated failure on the outer slopes of mineral waste repositories, water pressure and/or water levels in embankments and within the mineral waste repository. More in-depth rigorous monitoring may include slope movement sensors, periodic topographic surveys and piezometer measurements.

4.3 Air Quality Monitoring

The operational phase of the mining life cycle is a major contributor of particulate emissions. Particulate matter is categorized by size, and as such, have potential impacts on the receiving environment and human health. Particulate matter less than 10 µm in aerodynamic diameter (PM10 and PM2.5) and Total Suspended Particulates (TSP) such as dust fall, are associated with health and nuisance impacts. Other substances that are also monitored, include sulphur dioxide (SO2), nitrogen dioxide (NO2), ozone (O3), carbon monoxide (CO), lead (Pb) and benzene.

The Namibian Atmospheric Pollution Prevention Ordinance, No. 11 of 1976, does not make provision for any ambient standards for individuals and institutions to comply with. The most widely referenced international criteria are those published by the World Bank group (WB), World Health Organization (WHO), and the European Union (EU). Additionally, South African legislation (the Air Quality Act No. 39 of 2004) stipulates ambient air quality standards for the mining sector, which can be regarded as representative indicators for Namibia, because of the similarity in social, environmental and economic features. Short intervals between measurements (10 minutes) are most useful in understanding and determining the source of emissions. The South African standards include a margin of tolerance (i.e. frequency of exceedances), and leading practices at Namibian mines are guided by these thresholds. It is worth noting that the minimum standards for South Africa may be adopted by the mining sector in Namibia, but these are voluntary commitments and are not legally enforceable. Therefore, the standards used must meet the ultimate objective of air quality improvement and management at various phases of the mining life cycle.

The World Bank (WB) Handbook of 1998 stipulates that ambient air quality standards ought to be set once an agreement has been reached on the environmental quality objectives that are targeted, and costs are addressed, which a society is willing to accept, to meet the set objectives. Initially, ambient air quality standards were aimed at protecting human health, but lately ambient standards incorporate the protection of ecosystems in some countries.

During the 1990s the World Health Organisation (WHO) stated that no safe thresholds could be determined for particulate exposures and responded by reproducing linear dose-response relationships for PM_{10} and $PM_{2.5}$ concentrations (World Health Organization (WHO), 2017). These guidelines would serve as a tool of explicit objectives for air quality managers and policymakers when tasked with setting national air quality standards. Given that air pollution levels in developing countries frequently far exceed the recommended WHO air quality guidelines, the interim target levels proposed are more than the air quality guidelines, to promote steady progress towards meeting the WHO air quality guidelines.

The European Union EU air quality criteria standards were designed primarily to safeguard human health. The current standards were developed with due regard to environmental conditions, the economic and social development of various regions, and the importance of a phased approach to attaining compliance. TABLE 3 provides a summary of the various standards and guidelines for air quality.

TABLE 3 - THE STANDARDS/GUIDELINES DERIVED FROM THE WB, WHO, EU AND SOUTH AFRICAN STANDARDS

POLLUTANT	AVERAGING PERIOD	WHO GUIDELINES (µg/m³)	EU DIRECTIVES (µg/m³)	SOUTH AFRICA STANDARDS NAAQS (µg/m³)
Particulate Matter PM10	1 year	70 (IT-1) 50 (IT-2) 30 (IT-3) 20 (guideline)	40 (n)	50 (l) (f) 40 (m) (f)
	24 hours	150 (IT-1) 100 (IT-2) 75 (IT-3) 50 (guideline)	50 (o)	120 (l) 75 (m)
Particulate Matter PM2.5	1 year	35 (IT-1) 25 (IT-2) 15 (IT-3) 10 (guideline)	25 (u)	25 (q)(r) 20 (q)(s) 15 (q)(t)
	24 hours	75 (IT-1) 50 (IT-2) 37.5 (IT-3) 25 (guideline)	-	65 (q)(r) 40 (q)(s) 25 (q)(t)

Sulphur Dioxide (SO_2)	1 year 24 hours 1 hour 10 minutes	- 125 (IT-1) 50 (IT-2) (a) 20 (guideline) - 500 (guideline)	20 (d) 125 (c) 350 (b) -	50 125 (f) 350 (g) 500 (h)
Carbon Monoxide (CO)	1 hour	30 000 (guideline)	10 000	30 000 (g)
Nitrogen Dioxide (NO_2)	1 year 1 hour	40 (guideline) 200 (guideline)	40 (i) 200 (j)	40 200 (g)

Notes:
(a) intermediate goal based on controlling motor vehicle emissions; industrial emissions and/or emissions from power production. This would be a reasonable and feasible goal to be achieved within a few years for some developing countries and lead to significant health improvement.
(b) EC Directive 2008/50/EC (http://ec.europa.eu/environment/air/quality/standards.htm). Limit to protect health, to be complied with by 1 January 2005 (not to be exceeded more than 24 times per calendar year).
(c) EC Directive 2008/50/(http://ec.europa.eu/environment/air/quality/standards.htm). Limit to protect health, to be complied with by 1 January 2005 (not to be exceeded more than 3 times per calendar year).
(d) EC First Daughter Directive, 1999/30/EC (http://rod.eionet.europa.eu/instruments/517). Limited value to protect ecosystems. Applicable two years from entry into force of the Air Quality Framework Directive 96/62/EC.
(e) US National Ambient Air Quality Standards (www.epa.gov/air/criteria.html). 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.
(f) 4 permissible frequencies of exceedance per year
(g) 88 permissible frequencies of exceedance per year
(h) 526 permissible frequencies of exceedance per year
(i) EC Directive 2008/50/EC (http://ec.europa.eu/environment/air/quality/standards.htm). Annual limit value for the protection of human health. Limit value entered into force 1 January 2010.
(j) EC Directive 2008/50/EC (http://ec.europa.eu/environment/air/quality/standards.htm). Not to be exceeded more than 18 times per year. Limit value entered into force 1 January 2010.
(k) US National Ambient Air Quality Standards (www.epa.gov/air/criteria.html). 98th percentile, averaged over 3 years.
(l) Applicable immediately to 31 December 2014.
(m) Applicable from 1 January 2015.
(n) EC Directive 2008/50/EC (http://ec.europa.eu/environment/air/quality/standards.htm). Limit value entered into force 1 January 2005.
(o) EC Directive 2008/50/EC (http://ec.europa.eu/environment/air/quality/standards.htm). Not to be exceeded more than 35 times per calendar year. Limit value entered into force 1 January 2010.
(p) US National Ambient Air Quality Standards (www.epa.gov/air/criteria.html). Not to be exceeded more than once per year on average over three years.
(q) Proposed draft PM2.5 regulations as published in the Government Gazette (no. 34493) on the 5th of August 2011.
(r) Applicable immediately to 31 December 2015.
(s) Applicable 1 January 2016 to 31 December 2029.
(t) Applicable 1 January 2030.
(u) EC Directive 2008/50/EC (http://ec.europa.eu/environment/air/quality/standards.htm). Target value entered into force 1 January .2010 and limit value enters into force 1 January 2015.

All three of Namibia's operational uranium mines are located in the central Namib Desert. All three mines have an extensive air quality monitoring program in place, which are very similar to each other. All three mines are located near sensitive third parties such as tourists, farms, other mines, the Namib Naukluft Park and urban areas (Arandis and Swakopmund in particular). The monitoring is required, to determine whether permitted levels are exceeded, of concern, or remain within legal limits, and to provide necessary recommendations and implement mitigation measures to reduce unwanted emissions. Guidelines used are from an air quality specialist company from South Africa.

The largest contributors to possible emissions on the uranium mines are those derived from daily mining activities, including drilling and blasting, loading and hauling, burning of explosive-related materials etc.; equipment maintenance, construction-related activities, processing activities (i.e. crushing, material handling points, reagent storage points, windblown dust—from mineral waste repositories such as tailings storage facilities); from the Final Product Recovery stacks; and general vehicle emissions. Currently dust suppressions activities/projects are in place to limit exposure, such as wetting of roads, road surfacing, and water sprayers, etc. Dust monitoring entails the measuring of fall-out dust (or Total Suspended Particles), PM_{10} and $PM_{2,5}$ monitoring, chemical analysis of emissions (including stack emissions), radio-nuclide analysis, and passive sampling monitoring. In addition, noise and vibration is also monitored. At each of the three mine sites, more than one weather station is operational and monitored daily.

Air quality trends are interpreted against the relevant background/baseline studies for the central Namib Desert and potential dispersal is modelled accordingly. Regular reporting—weekly, monthly and annually—is done to identify trends and make comparisons.

All three mines rely on suppliers in South Africa or overseas, for equipment, technology, technical services and/or specialist products to do air quality monitoring. In addition, there exists a lack of accredited laboratories in Namibia able to analyse the equipment and samples. Equipment is also expensive, and maintenance can only be done by specialists outside Namibia. These factors can cause delays, which negatively affect the monitoring programs and can influence the accuracy of results.

Dundee Precious Metals Tsumeb also has an elaborate air quality monitoring system in place as illustrated in the case study below:

Mine:

The Tsumeb Smelter is owned and operated by Dundee Precious Metals Tsumeb, a subsidiary of the Canadian-based Dundee Precious Metals. The smelter is registered as a processing factory (not a mine) and produces blister copper (98.5% Cu) and sulphuric acid as its two main products. The parent company, Dundee Precious Metals Tsumeb Inc., is an international gold mining company engaged in the acquisition, exploration, development, mining and processing of precious metals.

Location:

The Tsumeb Smelter is located about 2km north-east of the town of Tsumeb in the Oshikoto Region of Namibia and approximately 430km north-east of the Namibian capital city, Windhoek.

Brief description:

The Tsumeb Smelter and associated infrastructure had gone through various transformations over the years, which include recessions and change of ownership. The current smelter is one of a few in the world that can treat complex copper concentrates.

The smelter consists of a primary smelting furnace, being the Ausmelt Furnace, two Peirce Smith Converters, bag houses and cooling towers, a slag milling plant, two high-voltage distribution sub-stations, a material handling facility, two oxygen plants, a fume extraction system, and a sulphuric acid plant. The arsenic-bearing waste is disposed at an onsite hazardous waste disposal facility, which is an engineered and approved waste landfill.

Key issue(s) addressed:

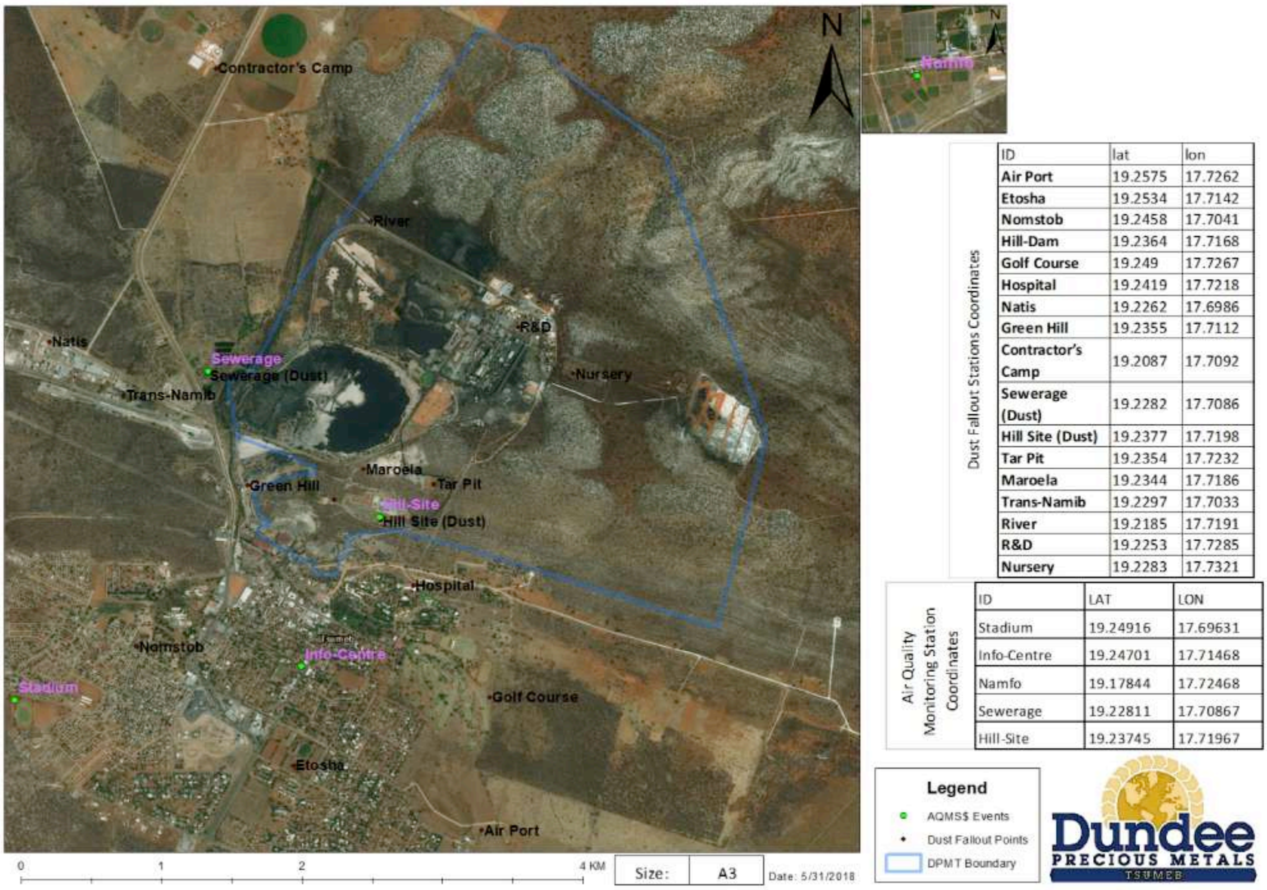
Since 2010, Dundee Precious Metals Tsumeb has made significant investments to address occupational health and safety (OHS) concerns, including industrial hygiene, as well as environmental issues associated with historic and current operations. The key investments included a sulphuric acid plant, which has significantly reduced sulphur dioxide (SO_2) emissions to the atmosphere and improved local ambient air quality. There were also engineering improvements to reduce fugitive emissions, including the installation of new bag houses to capture process dust, construction of a secure hazardous waste disposal facility for arsenic-containing waste disposal, as well as improved monitoring and medical surveillance for the employees.

Challenges:

- Managing the influence and impact of legacy dumps on environmental dust
- Control of SO_2 emissions during plant upset conditions due to external factors like power interruptions

Highlights:

- Dundee Precious Metals Tsumeb uses state of the art Environment Protection Agency (EPA) approved air quality equipment to monitor sulphur dioxide (SO_2), arsenic (measured as PM_{10}), as well as two particulate fractions (PM_{10} and $PM_{2.5}$)
- Dundee Precious Metals Tsumeb currently runs a network of five (5) air quality monitoring stations within the town of Tsumeb and along the smelter boundary. Three of the stations are in residential areas referred to as the community stations, and two along the boundaries of the smelter
- The monitoring sites all meet the requirements as outlined in the US EPA's "Quality Assurance Handbook for Air Pollution Measurement Systems" and "SANS 1929", a South African National Standard covering data and quality assurance requirements for Air Quality Monitoring Systems



Dust Fallout Stations Coordinates

ID	lat	lon
Air Port	19.2575	17.7262
Etosha	19.2534	17.7142
Nomstob	19.2458	17.7041
Hill-Dam	19.2364	17.7168
Golf Course	19.249	17.7267
Hospital	19.2419	17.7218
Natis	19.2262	17.6986
Green Hill	19.2355	17.7112
Contractor's Camp	19.2087	17.7092
Sewerage (Dust)	19.2282	17.7086
Hill Site (Dust)	19.2377	17.7198
Tar Pit	19.2354	17.7232
Maroela	19.2344	17.7186
Trans-Namib	19.2297	17.7033
River	19.2185	17.7191
R&D	19.2253	17.7285
Nursery	19.2283	17.7321

Air Quality Monitoring Station Coordinates

ID	LAT	LON
Stadium	19.24916	17.69631
Info-Centre	19.24701	17.71468
Namfo	19.17844	17.72468
Sewerage	19.22811	17.70867
Hill-Site	19.23745	17.71967

A map of Tsumeb, showing the location of monitoring stations.

Description of the case study:

Air quality pollutants of concern at Dundee Precious Metals Tsumeb emanating from the copper smelting processes are SO_2, arsenic dust and PM_{10} and $PM_{2.5}$. These pollutants can have potential negative impacts if not closely monitored and controlled.

- SO_2 inhibits photosynthesis by disrupting the photosynthesis mechanism leading to stunted growth in plants
- When mixed with rain, SO_2 can form a weak sulphuric acid, which is the main component of acid rain
- SO_2 is an irritant to the respiratory system in humans and can temporarily aggravate the symptoms of asthma

Four monitoring programs are in place to ensure ambient air quality in the operating environment—the Ambient Air Quality Monitoring System (AAQMS); meteorological monitoring; dust fallout monitoring; and the monitoring of community complaints when there are exceedances of SO_2 felt in the community.

Each AAQMS is equipped with a SO_2 analyser, a TEOM (PM_{10}) Monitor, and a Partisol 2025i PM_{10} filter sampler that will determine the arsenic content of the sampled ambient air. In addition to these three analysers, the stations at the Stadium and the DPMT Information Centre are also equipped with the BAM $PM_{2.5}$ Monitors. Each AAQMS is equipped with a meteorological station because weather has a profound influence on contaminant dispersion and concentration. Meteorological data is critical when assessing air quality data. The SO_2, PM_{10} and $PM_{2.5}$ monitors automatically collect, analyse, and report measurements on an hourly basis. Datasets are verified by an external consultant monthly and prepared for reporting. Filter-based arsenic samples are collected manually and shipped to a SANAS Accredited Testing Laboratory, for analysis monthly. The Partisol 2025i PM_{10} filter samplers are scheduled to sample for 24 hours every 144 hours, that is, every 6th day. All five station instruments are programmed to sample.

Dundee Precious Metals Tsumeb continuously monitors seventeen (17) dust fallout sites that are strategically located around the town of Tsumeb and the smelter vicinity. The windblown dust fallout at Dundee Precious Metals Tsumeb is monitored based on the American Society of Testing and Materials' standard method for collection and analysis of dust fallout (ASTM D1739:1970). Dust fallout samples are collected monthly after a 30 ± 3 days' exposure period.

The real-time daily profiles of the SO2 and PM10 and PM2.5 concentrations and meteorological data for each station are accessible via a web-based application. A warning system linked to the monitoring system, and alerts are sent out to operations and other relevant managers when SO2 levels are above the RSA SANS limits. Both the web-based application and warning system are managed by independent consultants for quality control and assurance.

At the emission source, the following systems are in place to prevent, control and or capture off gases:

- The Sulphuric Acid Plant was commissioned in 2015 to capture/treat SO2, which was originally emitted into atmosphere. The plant now converts the emissions to Sulphuric Acid (H2SO4), which is sold to uranium and copper mines, where it is used in the extraction process of these minerals
- Fume hoods extraction system: Two new Peirce Smith copper converters were commissioned in the first quarter of 2016. The new copper converters are fitted with tight sealing water cooled primary hooding as well as secondary hooding to minimise the uncontrolled release of fugitive gas containing SO2 into the atmosphere
- A baghouse and scrubber system is in place and acts as a gas cleaning system to remove particulate matters before gas is consumed by sulphuric acid or released into the atmosphere through the stacks
- Clean gas is emitted through stacks designed and constructed at heights that allow adequate dilution/dispersion of gases into the atmosphere

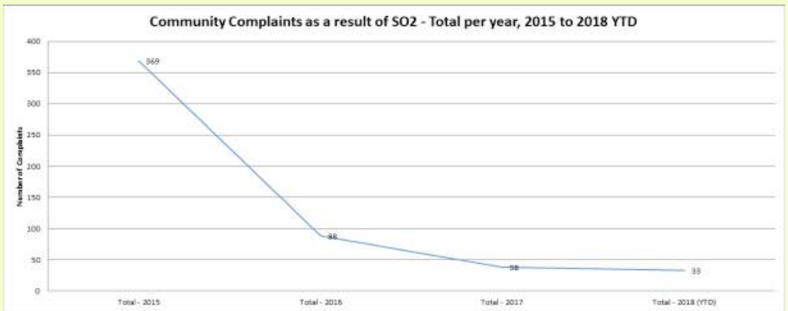
Dundee Precious Metals Tsumeb's air quality monitoring is embedded as an integral part of the business, with a significant budget allocation. Air quality monitoring and dust control is a key performance indicator with above 90% data availability that reflects in performance contracts of employees. The air quality monitoring network is managed by the environment section, with the support of an external consultant and the instrumentation section. An air quality environmental officer oversees the day-to-day operations of the air quality monitoring stations with the ongoing support of the external consultant, who is also responsible for calibration, gathering, processing and validation of the air quality data. The air quality instruments have been integrated into the company's preventative maintenance schedule.

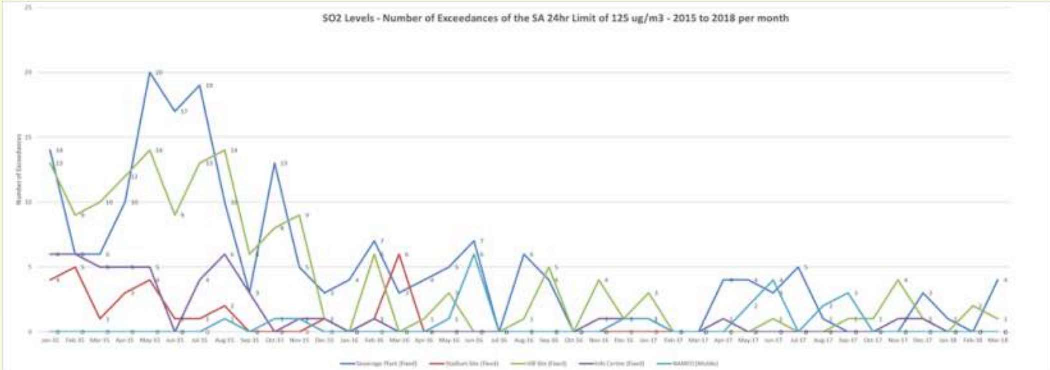
Areas for improvement are:

Modelling and forecasting capacity will be an essential complement to the air quality monitoring network, as it will maximise the value of the data collected. Modelling predictions will be able to fill time gaps when monitors may not be recording data, and enable Dundee Precious Metals Tsumeb to provide an ambient air quality forecast that will ensure more targeted intervention. Dundee Precious Metals Tsumeb is looking into dispersion models based on air quality monitoring data and meteorological data. No network can monitor every area of Tsumeb, but with modelling, reliable predictions can be made. Models will predict the direction of the pollutant plume and enable Dundee Precious Metals Tsumeb to respond appropriately and efficiently.

Conclusion

The air quality monitoring infrastructure has been taken as an integral part of the day-to-day operations of the Tsumeb Smelter in the monitoring and assurance of air quality in and around the smelter. The data collected from the stations has been used in plant improvement options and also assessing the effectiveness of the controls in curbing emissions. The installation of the sulphuric acid plant has had a positive impact on the ambient air quality for the community, as demonstrated by the declining number of complaints in the graphs below:


Community Complaints as a result of SO2 - Total per year, 2015 to 2018 YTD
Number of Complaints
400
350
300
250
200
150
100
50
0
369
88
Total - 2015
Total - 2016
Total - 2017
Total - 2018 (YTD)


SO2 Levels - Number of Exceedances of the SA 24hr Limit of 125 ug/m3 - 2015 to 2018 per month

PART FIVE – NAMIBIAN STANDARDS FOR MINING

5 INTRODUCTION

Mining activities can be divided between drilling and blasting, loading and hauling, and crushing and grinding, before the ore enters the processing plant. Mining activities have the potential to negatively impact the environment and, as such, business operations must comply with all applicable legislation and environmental guidelines that advocate best practices. The production cycle is comprised of the following basic unit operations: drilling, blasting, loading and hauling.

Drilling and Blasting

Drilling and blasting play a significant role in open pit mines, which is crucial in the downstream stages. For open-pit mining, blast holes of 75 to 380 mm in diameter are formed by rotary or percussion drills for the placement of explosives when consolidated rock are to be removed. Explosive charges are then inserted and detonated to reduce the overburden or ore to a size range suitable for excavation. Primary auxiliary accessories for operations include those providing slope stability, power supply, pumping, maintenance, waste disposal, and the supply of material to the production phases (AZO Mining, 2014; Abbaspour, Dredenstedt, Badroddin, & Maghaminik, 2018).

On the other hand, underground mines' production cycles are unlike that of the surface mines. Although equipment may be scaled down in size, smaller drill holes are used, and trucks are sometimes replaced with shuttle cars and conveyor belts. Additionally, certain auxiliary accessories are often required, including; roof support, ventilation and air-conditioning, power supply, lighting, communications, and delivery of compressed air and water supplies to the working sections, etc. (Abbaspour, Dredenstedt, Badroddin, & Maghaminik, 2018).

Loading and Hauling

The process of loading and hauling is a complementary service that contributes to the efficiency of the mining process. It is an essential part of estimating a productive mining process and must be considered when taking into account matters of machinery and equipment utilised, against outsourcing waste movements and haulage, to better predict any mining project's efficiency. Therefore, the Auxiliary for loading and hauling (i.e. excavators, haul trucks, etc.) are critical technologies for mining operations, and are the units around which most mining operations are designed and planned for operational activities (The RAND Corporation, 2001).

Nonetheless, mineral deposits situated near the surface are extracted by open pit mining methods like open-cast and strip mining, whereas underground mining methods are employed in the extraction of deeper lying deposits. The decision between open pit and underground mining is not solely governed by the depth of the deposit, but rather by a host of factors including, but not limited to, economics, ore grade, deposit geometry, and topography, etc. Irrespective of the type of mining methods used, it is essential that mining companies adhere to sound environmental standards to prevent environmental degradation.

5.1 STANDARDS FOR MINING

Open pit mining is a method of ore extraction used for mining shallow ore bodies. This method often provides higher recovery, improved grade control, flexibility, and a safer working environment when compared to underground mining. Environmental concerns associated with open pit mining are attributed to the generation of large volumes of waste rock, the permanence of a huge open pit and associated infrastructure such as a road network, powerlines and other structures, and the creation of dust and noise. All these environmental impacts need to be addressed in the operational Environmental Management Plan, implying that management measures are in place to curb the impacts.

Drilling, blasting, loading, hauling, crushing and grinding activities constitute mining activities and require proper planning and scheduling. TABLE 4 and TABLE 5 propose some Namibian standards for these activities.

TABLE 4 - NAMIBIAN STANDARDS FOR OPEN PIT OPERATIONS

ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Blast hole drilling	– Dust generated could have negative impact on worker's health and surrounding fauna and flora – Lack of guidelines for re-fuelling and chemical handling may result in surface and ground water contamination – Excessive noise generated by the drill rigs – Lack of disposal guidelines for used oil and drill pipe lubricants may result in surface and ground water contamination	– Drills should be fitted with dust collector units that should be monitored during shift inspections – Use of appropriate fuel and chemical storage and handling equipment – Develop and implement spill clean-up plans – Remain within specified occupational health and safety noise limits – Implement used oil collection plans and recycling programs – Train personnel to use appropriate lubricants, avoiding overuse
Blasting	– Air emissions – Vibration and noise – Fly rock – Soil, surface and ground water contamination – Public safety – Workers' health and safety	– Blast designs should always minimise air emissions and noise, and control fly rock and vibration – Blasthole liners and emulsion explosives should be used in wet holes – Blast areas should be restricted to authorised personnel only
Post-blast inspections	– Misfires could have a negative impact on workers' safety if not dealt with correctly – Lack of guidelines for handling unexploded explosives, like emulsion during post-blast inspections could affect surface and ground water	– Only individuals that hold blasting tickets should be allowed to enter blast areas and conduct post-blasting inspections – The Mine Health and Safety Regulations in Namibia, 10th Draft
Loading and Hauling Operation	– Dust generated could have negative impacts on workers' health and surrounding fauna and flora – Lack of guidelines for re-fuelling and chemical handling may result in surface and groundwater contamination	– Drills should be fitted with dust collector units that should be monitored during shift inspections – Use of appropriate fuel and chemical storage and handling equipment – Develop and implement spill clean-up

ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
	– Excessive noise generated by load and haul equipment – Improper disposal of used oil lubricants may result in surface and groundwater contamination	plans – Remain within specified occupational health and safety noise limits – Implement used oil collection plans and recycling programs – Train personnel to use appropriate lubricants, avoiding overuse

TABLE 5 - NAMIBIAN STANDARDS FOR UNDERGROUND OPERATIONS

ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Blast hole drilling	– Dust generated could have negative impacts on workers' health – Lack of guidelines for re-fuelling and chemical handling may result in groundwater contamination	– Drills should be fitted with dust collector units that should be monitored during shift inspections – Use of appropriate fuel and chemical storage and handling equipment – Develop and implement spill clean-up plans – Train personnel to use appropriate lubricants, avoiding overuse
Blasting	– Air emissions – Ground water contamination – Vibration and noise	– Blast designs should always minimise air emissions and noise, and control fly rock and vibration – Blasthole liners and emulsion explosives should be used in wet holes – Blast areas should be restricted to authorized personnel only – Remain within specified occupational health and safety noise limits

PART SIX – NAMIBIAN STANDARDS FOR PROCESSING OPERATIONS

6 THE NEED FOR STANDARDS

Mining companies must aim to actively mitigate potential environmental impacts of their processing activities to ensure compliance, commitment towards sustainable development principles, and the implementation of best practices. Effective prevention, reduction, management and mitigation of undesirable environmental impacts lies in implementing sound scientific and technological approaches—resulting in leading practices and setting standards appropriate to Namibian conditions.

Curbing of environmental impacts implies an environmental management system, environmental monitoring and reporting programs, environmental auditing and enforcement. In an effort to frequently review environmental performance and to make continuous improvements, several Namibian mines are ISO 14001 certified.

The severity of environmental impacts varies from mine to mine, mineral ore, the toxicity of waste from ore stockpiles, waste rocks and processing tailings. Furthermore, environmental impacts from processing are closely associated with geology, location and terrain cover, climate and hydrology.

A broad distinction between the processing of base metals, rare metals and precious metals can be made. Although the methodologies and complexity differ widely, the principal environmental concerns of processing, focus on ecological disturbance; noise, vibration and air pollution; water and soil contamination; and threats to public health and safety.

6.1 Mining Operations and Processing of Base Metals

In order to ensure sound environmental practices in all aspects of processing, several leading international practices along with leading practices at Namibian mines have been used to set "Namibian standards" for the mining of base metals, as illustrated in TABLE 6.

Remember to renew your mining licence no later than 12 months before the date on which such licence will expire.

TABLE 6 - BEST PRACTICE GUIDELINES APPLICABLE TO BASE METAL PROCESSING

MINERAL PROCESSING ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Processing Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Processing of zinc	– Visual and aesthetic impacts – Slags as a by-product of smelting may release metals to the environment – Erosion of mineralised waste drainage causing concentration of metals in stream sediments – Acid seepage from tailings impacts on stream habitat and groundwater – Degradation of surface and groundwater quality because of the oxidation and dissolution of metal-bearing minerals – Acid mine drainage containing pyrite (iron sulphide) contaminate groundwater – Atmospheric emissions: ○ Increase airborne dust and other emissions, such as sulphur dioxide and nitrogen oxides,[2] flue dust from smelters and refineries – Erosion and sedimentation due to tailing pond instability due to the action of wind and water – Waste generation i.e., slag – Environmental degradation	– Seepage can be prevented or reduced by constructing tailing dams with impermeable barriers, i.e., clay is placed at the bottom of the impoundment – Use of reclamation methods to facilitate runoff and prevent infiltration of surface water – Treatments and stabilisation of metal-bearing soils – Prevention and treatment of contaminated water – Reduce the energy consumption – Use renewable energy instead of fossil fuels – Mining operations should be fenced off – Trespassing warning sings must be installed – Disturbed area should be revegetated.

[2] Flue dust are fine particles of metal or alloy emitted with the gases of a smelter or metallurgical furnace.

MINERAL PROCESSING ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Processing Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Processing of lead	– Water resources contamination – Soil contamination – Waste generation ○ Waste rock, wastewater	– Wastewater to be treated before disposal – Establish monitoring boreholes – Quarterly monitoring and bi-annual monitoring of water sources – Have permissible barriers to prevent seepage and leachate of waste into the ground – Progressive rehabilitation of waste rock stockpile throughout the mine life cycle – Use of cleaner production techniques – Use waste as raw material – Reduce waste production through process re-engineering – Water must be treated at an acceptable quality before disposal
Processing of copper	– Seepage from heap leaching acid mine drainage: ○ can decrease water quality ○ can inhibit plant growth during mine reclamation	– Make use of drippers not sprinklers – Use engineered and lined pads, drainage system – Make use of locally available acid plant sources (e.g. the Dundee Tsumeb Smelter acid plant to minimise acid Import)

6.2 Mining Operations and Processing of Rare Metals

Uranium is produced by three operating mines in Namibia, all of them located in the central Namib Desert. All three mines apply an open-pit approach in mining. The technology used in the processing of uranium ore are conventional methods starting with drilling and blasting, and crushing and grinding before leaching. Further steps include ore beneficiation and slime separation, thickening (or counter current decantation), ion exchange and solvent extraction, precipitation and final product recovery.

Using the best practices outlined in TABLE 7 ensures that processing operations of rare metals are in line with leading national and international environmental practices.

***Note:** If a mineral licence holder carries out mining operations in areas outside the licence conditions, the removal of samples from such mineral may be subject to a fine of N$ 20,000 and/or imprisonment.*

TABLE 7 - A SUMMARY OF BEST PRACTICES APPLICABLE FOR THE MINING AND PROCESSING OF RARE METALS IN NAMIBIA

MINERAL PROCESSING ACTIVITY, POSSIBLE ASSOCIATED IMPACTS AND NAMIBIAN, STANDARDS		
Processing Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Processing of Uranium	– Dust and associated pollutants – Drainage - alkaline or neutral mine drainage – Surface and groundwater contamination – Possible rise to unacceptable radiation levels – Liquid waste from processing plants – Alteration of wildlife habitats and migratory behaviours – Erosion and sedimentation – Dispersion of fugitive gases	– Use of carbonate minerals to help buffer any effects of AMD that might occur – Recycle and re-use water before it is sent to tailings storage facilities – A clearance certificate from the Radiation Safety Section must be obtained for each transport of uranium-bearing ore – Use the IAEA Transport Regulations for disposal of hazardous waste – Every hazardous material should be accompanied by a material safety data sheet – Reuse wastewater for other processing, e.g. milling – Fence off the mining area – Segregate and treat waste before disposal – Maintaining buffer zones between stream areas and areas of exploration and mining activity can help to control runoff to streams – Capturing and containing drilling fluids

6.3 Mining Operations and Processing of Precious Metals

The processing of precious metals such as gold, silver and platinum, includes the processes of roasting and leaching; stripping and regeneration; refinery and furnace for the separation of minerals from the impurities. Some gold ores are pre-treated before they go into the leaching stage, while others are leached directly (Toovey, 2011). The release of toxic substances such as cyanide and mercury are often associated with the processing of precious metals. Currently gold mine operations in Namibia are undertaken by the Navachab and Otjikoto gold mines. The best practices standards for the processing of precious metals are summarized in TABLE 8, with special attention to gold.

TABLE 8 - BEST PRACTICE STANDARDS FOR THE PROCESSING OF GOLD IN NAMIBIA

MINERAL PROCESSING ACTIVITY, POSSIBLE ASSOCIATED IMPACTS, AND NAMIBIAN STANDARDS		
Processing Activity	**Possible Impacts**	**Leading Practices/Namibian Standards**
Processing of gold	– Contamination of surface and groundwater – Intensive water uses and depletion of water – Erosion, siltation, land subsidence – Alter runoff and drainage – Loss of biodiversity – Air pollution and pollution bearing dust, i.e. carbon oxides; sulphur oxides; nitrogen oxides; and methane – Bioaccumulation of metals such as lead, arsenic, mercury and cadmium – Land use patterns for animals is affected – Cyanide contamination can cause death in animal species – AMD tailings leachate	– Reduce water use – Recycle and reuse water at other stages of processing, i.e. milling processes and dust reduction by spraying – Reduce waste generation and storage – Maintaining biodiversity by the rehabilitating (revegetation) and culturing of endangered plant species – Use of cleaner energy technologies, i.e. solar – Reduction in energy consumption at mines can reduce greenhouse gas emissions

Always respect and make sure that you carry out your activities within the conditions of the ML. Contravention or failure to comply will lead to refusal of the renewal application.

PART SEVEN – REPORTING GUIDELINES

7 THE NEED FOR REPORTING

Reporting is an important mechanism for authorities to ensure compliance from mining companies to the conditions outlined in the Environmental Clearance Certificate, the Environmental Management Plan and any other additional requirements such as permits and licences. Namibian reporting requirements for exploration and mining companies are outlined in the Minerals Act of 1992.

Reports submitted to the state cover essential aspects of the operational activities, such as chemical reagent storage and use; (mineral) waste generation, handling and disposal; consumption of commodities such as water and energy; land disturbance; training, assurance and risk; and compliance in general. Mines belonging to global companies also do internal reporting on various aspects determined by their parent companies; some also do annual reporting to the public—to give stakeholders an overview of activities, including interaction with society, the economy and the environment. In the case of uranium mines, reporting has to be done to the National Radiation Protection Authority (NRPA) as well. All mines are also required to do scheduled reporting on personnel and workforce matters.

Once mining companies submit reports to the authorities, it is expected that the relevant state departments confirm the receipt of the reports and provide the necessary feedback. This two-way process of reporting ensures mutual transparency, honesty and accountability, and enhances integrity.

7.1 Reporting from the Mining Companies to the State

7.1.1 Reporting to the mining commissioner

Mining companies are required to submit reports to the Mining Commissioner (i.e. the Directorate of Mines) as outlined in TABLE 9. The reporting period is dependent on the type of mineral licence of the proponent. Illustrated in the toolkit appendix is a reporting template, to provide guidance.

TABLE 9 - REPORTING TO THE MINING COMMISSIONER

TYPE OF LICENCE	REPORTING PERIOD
– Non-Exclusive Prospecting Licence (NEPL)	– Upon request from the Commissioner
– Reconnaissance Licence (RL)	– Within 60 days after the end of the currency of the RL
– Exclusive Prospecting Licence (EPL)	– Quarterly – Within 60 days after the end of the currency of the EPL
– Mineral Deposit Retention Licence (MDRL)	– Within 60 days after the end of the currency of such MDRL – Annually
– Mining Licence (ML)	– Quarterly – Annually (60 days before the 31st of December)

7.1.2 Reporting to the Environmental Commissioner

Mining companies submit (also voluntarily) annual environmental reports to various state departments (i.e. the Directorate of Environmental Affairs, the Directorate of Mines, and the Directorate of Water Resource Management). However, these annual reports on environmental performance are not prescriptive in format or content for reporting. It is best practice to have a reporting format in place.

7.1.3 Reporting to the Labour Commissioner

Mines are required to report to the Labour Commissioner for compliance verification in respect of labour-related acts, including affirmative action employment.

7.1.4 Reporting to the National Radiation Protection Authority

The National Radiation Protection Authority (NRPA) is situated at the Ministry of Health and Social Services (MoHSS) and uranium mines are required to compile and implement a Radiation Management Plan (RMP) according to guidelines supplied by the NRPA. The RMP is approved by the NRPA and audited annually. Each uranium mine has to report uranium exports and worker exposures to the NRPA once per year. The transport, storage and/or possession of radioactive materials is subject to permission by the NRPA.

7.1.5 Reporting to the Directorate Water Resources Management

In compliance with conditions stipulated in the water permits issued by the Directorate Water Resources Management at the Ministry of Agriculture, Water and Forestry, annual reports about water abstraction; disposal and management of effluent; and vegetation monitoring, are submitted to the head office in Windhoek.

7.2 Reporting from the State to Mining Companies

Among mines there is an expectation to receive written feedback from state departments when reports are submitted. This feedback should entail a written notice from the respective state department, verifying that the report(s) has been received. This verification should be sent 7 days after receiving the report(s). An example of this notification is illustrated in the toolkit appendix. In addition a feedback report, stating the level of satisfaction with the status of a project, has to be sent back to mining companies 60 days after receiving the report. An example of this is illustrated in the toolkit appendix.

Failure of an MDRL holder to report to the Commissioner, in a reasonable period, shall be guilty of offence and be liable to pay N$50,000 and/or face imprisonment.

7.3 Reporting and Auditing Requirements in Protected Areas

The following requirements apply when carrying out operational activities in a protected area in Namibia, in accordance with the Minerals Policy of Namibia of 2000, the Mining and Prospecting in Protected Areas (PA) policy of 2018, and National Monuments policy of 1999:

- The Mining Commissioner at the Directorate of Mines and the Environmental Commissioner at the Directorate of Environmental Affairs shall be provided with a report every 6 months. The two directorates may, at liberty, conduct inspections at any time, to monitor compliance, and to verify whether mining companies meet the conditions set out in documents such as the Environmental Management Plan and other permits and licences
- In addition to inspections conducted by various state departments, a technical committee will be established to conduct inspections on mines situated in protected areas. This committee will include members from the Ministry of Environment and Tourism (MET), the Ministry of Mines and Energy (MME), and other ministries such as the Ministry of Fisheries and Marine Resources
- The MET and MME shall conduct an annual audit on MLs and EPLs located in protected areas. An independent expert may also be commissioned to conduct the audit at the licensee's cost

PART EIGHT – TRANSITION TO THE NEXT PHASE

8 INTRODUCTION

Namibia has a long history of legacy sites of mines that have not been adequately closed. It is essential that planning for mine closure starts during the operational phase of the mining life cycle and is not postponed until the site must enter the closure and completion phase. The Chamber of Mines (CoM) has developed a Namibian Mine Closure Framework (NMCF) that highlights the minimum requirements for mine closure planning. Mining companies should be familiar with the NMCF and comply with the guidelines stipulated therein, as it informs licence holders of basic social and environmental obligations. As a minimum, the following requirements have to be met:

- Compliance to all legislative and regulatory frameworks
- Consultation with stakeholders to develop a closure plan that will be beneficial to economic, social and environmental spheres
- Development of closure action plans and adherence to conditions derived from stakeholder consultations
- Implementation of the closure plan should reflect sound financial resources to achieve the closure solutions defined
- Relinquishment and post-closure monitoring

The Namibian Mine Closure Framework merely provides guidance, and should be read together with all other relevant Namibian legislative requirements. Ultimately, closure planning should not only reflect compliance, but promote sustainable solutions for after the operational phase. Premature mine closure can be caused as a result of changing market conditions, or *force de majeure;* therefore, precautionary planning should be made during the operational phase.

PART 9 – REFERENCES

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BEST PRACTICE GUIDE

ENVIRONMENTAL PRINCIPLES FOR MINING IN NAMIBIA

CARE AND MAINTENANCE, CLOSURE, REHABILITATION AND RELINQUISHMENT

A joint publication proudly published by the Chamber of Mines (CoM), Namibian Chamber of Environment (NCE), the Namibian Government and members of the Namibian mining industry.

Ministry of Mines & Energy

Namibian Chamber of Environment

Republic of Namibia
Ministry of Environment & Tourism

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DEFINITIONS AND ABBREVIATIONS

AMD	Acid Mine Drainage
ADTs	Articulated Dump Trucks
ARO	Asset Retirement Obligation
C&M	Care and Maintenance
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
IFC	International Finance Cooperation
KPIs	Key Performance Indicators
LoM	Life of Mine
MCPs	Mine Closure Plans
MET	Ministry of Environment and Tourism
ML	Mining Licence
MME	Ministry of Mines and Energy
NCE	Namibian Chamber of Environment
NGOs	Non-Governmental Organisations
NMCF	Namibian Mine Closure Framework
NSW	New South Wales
RFTs	Rigid Frame Trucks
SEMP	Strategic Environmental Management Plan
SENEREP	The Sendelingsdrif Ecological Restoration Research Programme
SMEs	Small-Medium-sized Enterprises
TSFs	Tailings Storage Facilities

PART ONE – GETTING TO GRIPS WITH MINE CLOSURE

1 INTRODUCTION

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 a mine'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 is becoming increasingly important for mining companies, 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 in place.

The Environmental Management Act (EMA), 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 draft regulations (May 2010) 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. These regulations shall come into operation by notice in the Government Gazette by the minister.

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 (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 mineral 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 into Namibia, and the protection of the environment for current and future generations—in accordance with Namibia's Constitution.

1.4 How to Use the Guide

Highlighted in the guide are guidelines for navigating mine closure and completion, including care and maintenance (C&M), 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 both Namibian and international leading practices and setting "Namibian standards". Illustrated in FIGURE 1 are key issues addressed in each section of the guide.

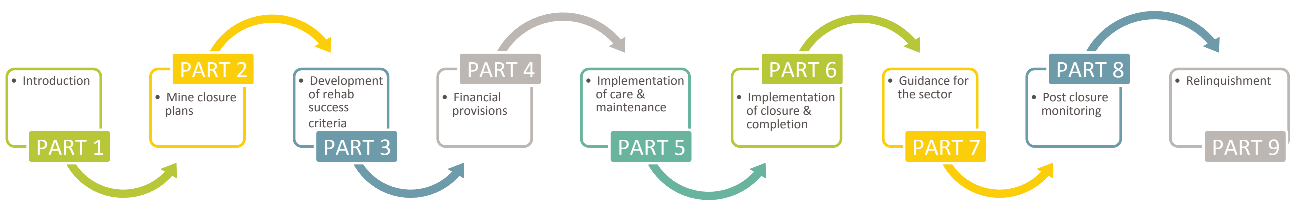


FIGURE 1 - NAVIGATING THROUGH THE GUIDE

PART TWO – PLANNING FOR MINE CLOSURE

2 INTRODUCTION

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

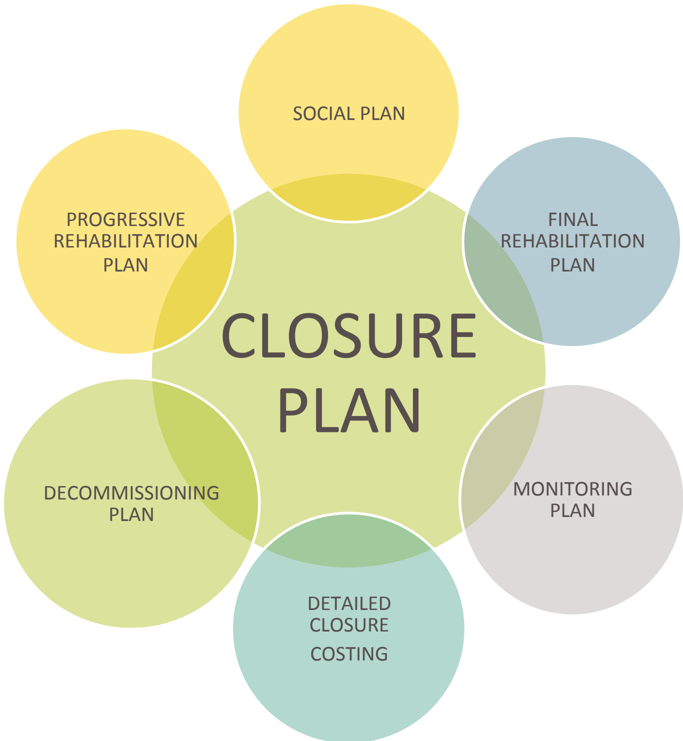


FIGURE 2 - SUGGESTED CONTENT OF A MINE CLOSURE PLAN

Content for a mine closure plan can be obtained from sources such as the risk register, the aspect and impact register, and the Environmental Management Plan 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, 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 – Early exit of employees with critical skills, brain drain, loss of institutional memory, knowledge and experience – 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 – Manning during and after decommissioning; staff retention measures – 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 – Issues with authorities (e.g. licence renewal, transfer of responsibilities, institutional arrangements, unable to relinquish) – Consultation, information sharing, awareness, stakeholder perceptions – Disagreement and/or no agreement on end land use, unclear/unconfirmed completion criteria and expected outcomes, unachievable and unrealistic expectations – Redundancy of service providers, income loss and unemployment, knock-on socio-economic effects because of termination of contracts with local suppliers – Early exit of service providers, quality loss, shortage in supplies and services – Planning of contract termination of redundant service providers; obligations beyond mine completion, breach of contracts – Disenchantment, disputes, boycotts, sabotage upon notification of mine closure
Decommissioning of the site	– Infrastructure demolition, removal of unwanted infrastructure inappropriate, insufficient – Security and access control during decommissioning and post-decommissioning; illegal movement of people; harm to third parties; unsafe areas – Work safe and health impacts, insufficient contractor management, lack of supervision during and after decommissioning – Health disputes and claims, retention of medical records, liabilities; radiation exposure – Decommissioning activities uncoordinated; undetailed decommissioning plan and schedule; inadequately supervised, uncontrolled, unauthorised – Remediation of contaminated areas impossible; costs inhibit decontamination and clean-up – 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) – Rehandling of cover material is too costly; cover material contains contaminants; remaining landforms are unsafe and unstable – 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 – Ecological disconnection, dysfunction; unable to restore ecological disturbance – Re-disturbance of rehabilitated areas (scavenging, public access, seismic activity, flooding) – 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 – Not limited to biophysical parameters – Environmental monitoring during decommissioning and post-decommissioning is inappropriate and non-confirmatory – 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 – Inadequate provision for unplanned mine closure and/or care-and-maintenance scenario – Compensation claims; anti-lobbying; contractual disputes; breach of contracts; reputation damage – Protracted and no relinquishment

The requirements are part of the Strategic Environmental Management Plan (SEMP), and, as such, are evaluated in each annual report. The 2012 SEMP of the Central Namib Uranium Province highlights the following considerations for the development of a mine closure plan for uranium mines:

- The planning process should start at the feasibility study stage
- The mine closure plan 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 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 site into specific domains. Each domain is subsequently treated as a separate entity with a specific task in terms of addressing the key issues of the mine closure plan. When developing the tasks for each of these domains, the following should be considered:

- The level and area of disturbance
- Monitoring
- Rehabilitation plan
- Research
- Cost estimates
- Erosion control
- A plan for deconstruction and decommissioning
- Risk assessment and hazardous areas
- Mitigation and contamination
- Required earthworks
- Applicable legislations

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, tailings storage facilities (TSFs), and the processing area.

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.

2.6 Ongoing Management

The goals of all tasks of the mine closure plan 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 mine closure plan, consideration needs to be made of management and monitoring requirements that will continue post-closure. It is critical that the post-closure requirements are 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.

The Atomic Energy and Radiation Protection Act, No. 5 of 2005 deals with radiation protection, including protection on mines, as well as the permitting, auditing and safeguarding facilities that are used in the handling and final disposal of radioactive materials in Namibia. Regulations of the Act came into operation in January 2012. The regulations are not clear in terms of the closure of uranium mines, although referencing is made to decommissioning and the handling of radioactive waste, as well as the keeping of health records for each employee *"until the person to whom the record relates has or would have attained the age of 75 years, but in any event for at least 50 years from the date of the last entry made in it."* In short it means that uranium mines have a long post-closure record management responsibility.

2.7 Objectives, Targets and Time frames

To remain on track with mine closure targets, realistic time frames need to be set, during which certain closure objectives need to be carried out. As such, the monitoring needs to be conducted to determine the level of adherence to these set targets. Should established targets not be met in the given time frame, interventions need to be implemented to ensure compliance with the requirements of the mine closure plan.

2.8 Financing Closure in Namibia

Regulatory guidance about the provision of funds for mine closure in Namibia remains vague. Current legislation refers predominantly to costs related to the operational phase of a mine only. 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, 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 (IFRS) 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 mine closure plan. 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 mine closure plan, typically accrued over the life of the operation. Accounting standards form the basis of the financial provision.

PART THREE – DEVELOPMENT OF REHABILITATION SUCCESS CRITERIA

3 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.

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.

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).

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.

Mine:

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 Life of Mine along the Orange River. Sendelingsdrif mine has an expected Life of Mine 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 Life of Mine 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 (RFTs), bulldozers, front-end loaders and graders. Articulated dump trucks (ADTs) 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 Life of Mine 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 Life of Mine 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

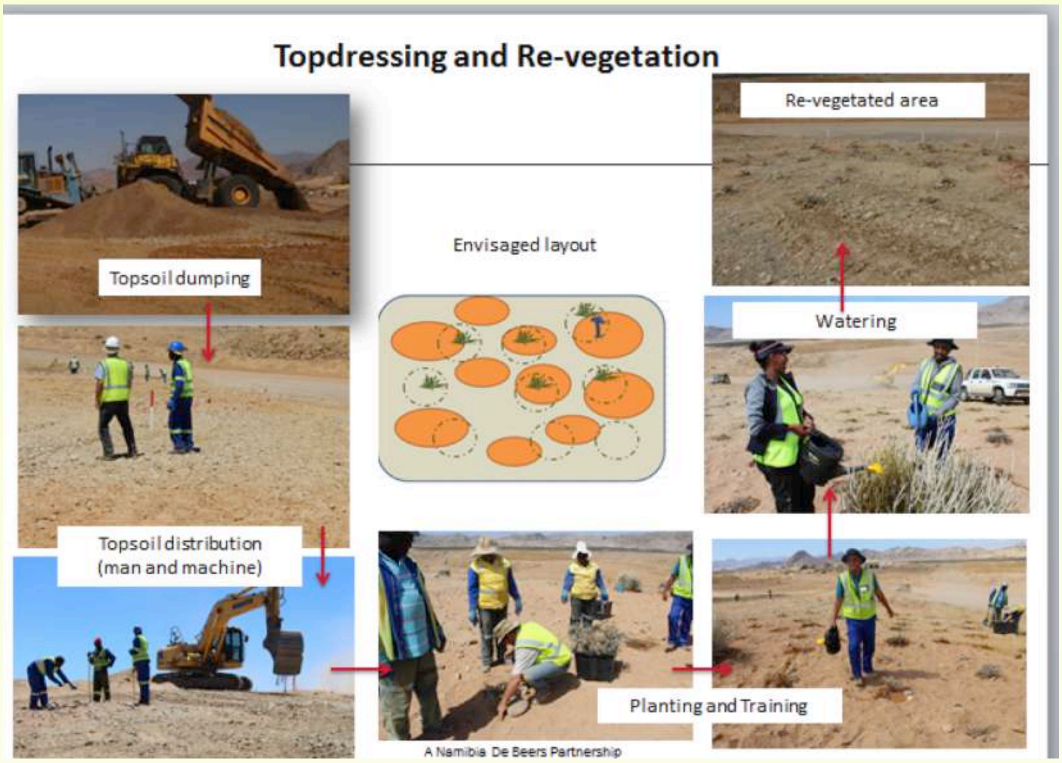
The Mine Site software programme is populated with mining parameters, and then the design and mining plan for the month is assessed and communicated at the mine planning meetings. An action tracker consisting of key deliverables, such as alignment with the mine plan, topsoil harvesting and storage, changes 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 (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 jeopardising 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)

Conclusion

An integrated Life of Mine 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 Life of Mine approach makes a good business case, since value in various forms is added in the process.



3.1 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.

In the last few decades, 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 over 200 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 legislation that addresses mine closure aspects.

The process of developing rehabilitation criteria commences with clearly defined objectives and setting key indicators. 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.

Steps in developing success criteria

- 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 Mining Licence (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.

3.2 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

3.3 FINAL REHABILITATION

The objectives of final rehabilitation, decommissioning and mine closure plans (MCPs) 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.

Mine:

Trekkopje Mine owned by Orano Mining Namibia.

Location:

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

Brief description:

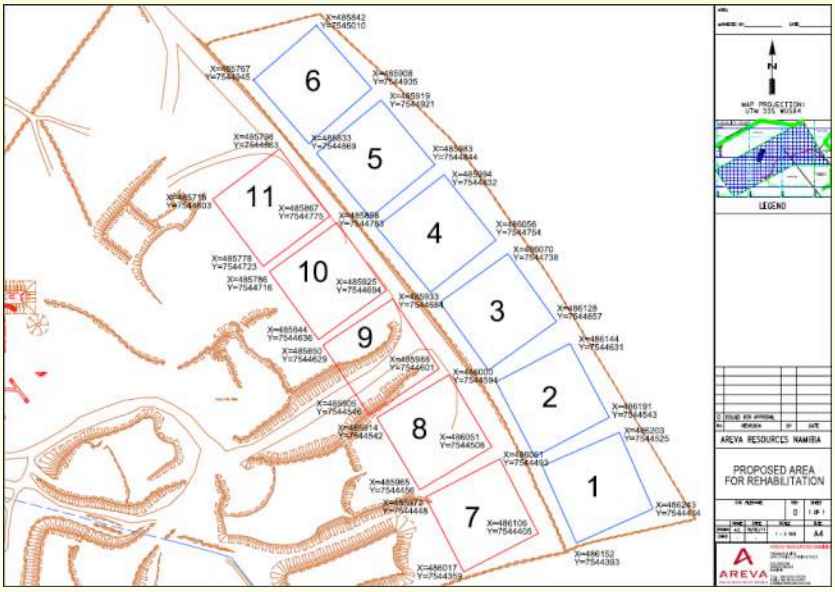
The Trekkopje mine is a currently inactive uranium mine. The objective of the project was to test various rehabilitation measures and to document their progress throughout the operational phase. Vegetation and soil properties are monitored annually to see how soon plants start growing on topsoil that 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 (Figure 1). 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 (no. 11 was not used):

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

PART FOUR - FINANCIAL PROVISION

4 COST ESTIMATION

Financial arrangements may be included in the mine closure plan 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.

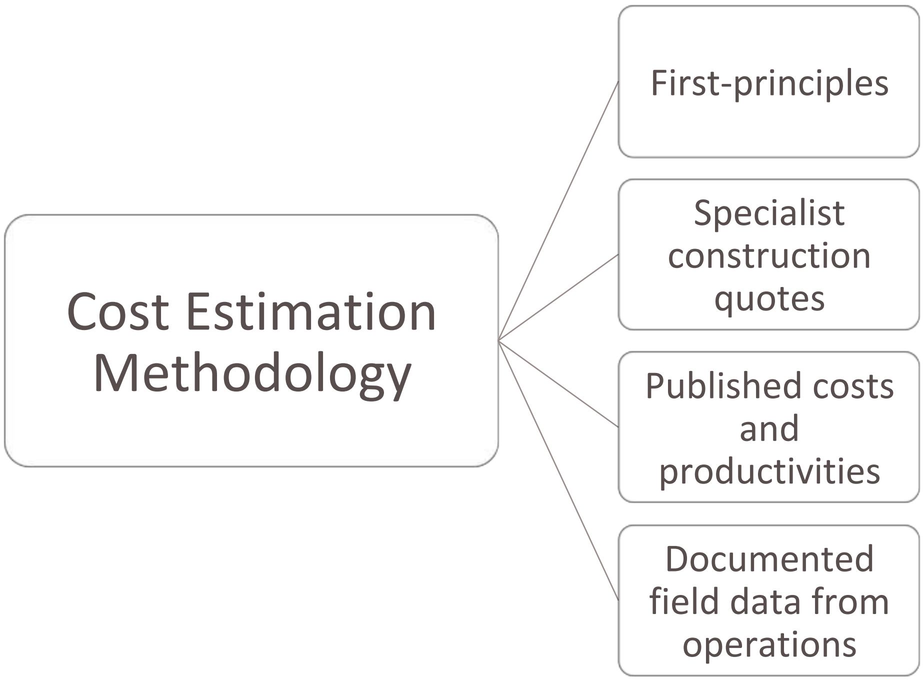


FIGURE 3 - SEVERAL COST ESTIMATION METHODS THAT CAN BE USED BY MINING COMPANIES (Parshley, 2014)

4.1 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 plans.

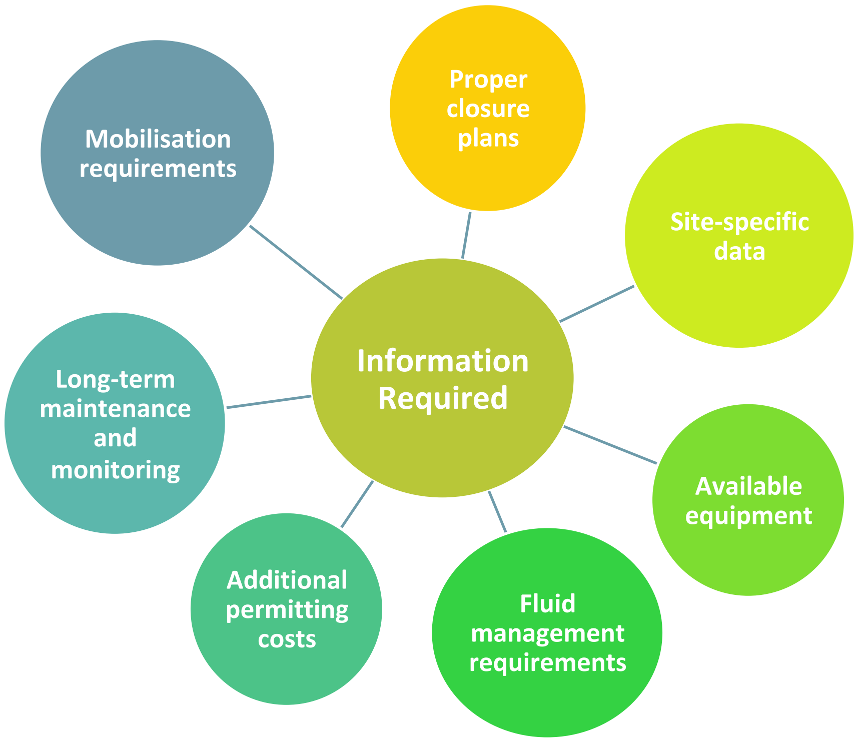


FIGURE 4 - A SUMMARY OF INFORMATION NEEDED FOR CLOSURE COST ESTIMATES

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. A shift in this direction (planning for closure), will result in a significant evolution in Namibia. 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: – Pre-feasibility/feasibility	Financial security required under governing regulations	Financial reporting to shareholders

	LIFE OF MINE (LoM)	FINANCIAL ASSURANCE	ASSET RETIREMENT OBLIGATION (ARO)
	– Due diligence – Accrual allocation		
Rate Basis	– Operator – Third party	Third party	– Operator – 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

4.2 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.

Life of mine (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.

4.3 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.

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. – Retrenchment provision – New employment opportunities – Re-training costs
Social aspects (sustainability of associated communities)	– Exit strategy (the process by which mines cease to support initiatives) – Social transition (communities receiving support for transition to new economic activities)
Demolition and rehabilitation costs	– Infrastructure breakdown, salvage and or disposal at the site, or transition to end uses – Ecosystem rehabilitation costs of the site (i.e. rock dumps, tailings facilities)
Post-closure monitoring and maintenance	– Monitoring program(s) (to track progress toward set objectives and maintenance)
Project management	– Administration and management costs during the decommissioning period e.g. legal; laboratories; offices; vehicles; and equipment for closure management

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.

4.4 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 Life of Mine, 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 Life of Mine 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 had started 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 demonstrates good practice through planning and engagement with stakeholders as the mine prepares for the care and maintenance phase, as shown in

FIGURE 5.

Namibian mine prepares for care and maintenance decision

Reported: 26 April 2018

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.

FIGURE 5 - PUBLICATION OF LANGER HEINRICH MINE IN PREPARATION FOR CARE AND MAINTENANCE PHASE, NAMIBIA (World Nuclear News, 2018)

4.5 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 Life of Mine 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.

PART FIVE – IMPLEMENTATION OF CARE AND MAINTENANCE

5 INTRODUCTION

The term Care and Maintenance (C&M) 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 C&M 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 C&M, 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 C&M plan.

Compliance

The pre-existing mine closure plan should be used as a basis for preparing the C&M plan, which will ultimately address the environmental risks identified during the audit. The plan must be submitted to the relevant regulatory bodies, including the Ministry of Environment and Tourism, and the Ministry of Mines and Energy. The C&M plan must highlight that environmental responsibilities will be adhered to throughout the closure period.

Namibian Standards

5.2 Care and Maintenance in Protected Areas and National Parks

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

Tailings storage facilities present similar risks as waste rock dumps, with the additional catastrophic risk of failure of the facility. During the C&M 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 C&M 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 C&M 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 C&M 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 done to the relevant authorities, and transparency needs to be maintained during this reporting process.

5.3 Financing Care and Maintenance

Mining companies need to effectively plan for the cost of C&M. 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.

5.4 Transitioning back into Operations or onto Closure

A mining operation that has moved into C&M 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.

PART SIX – IMPLEMENTATION OF CLOSURE AND COMPLETION

6 INTRODUCTION

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 life of the mine. 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. TABLE 4 shows a summary of compliance requirements for the cessation of mining operations.

Compliance

TABLE 4 - COMPLIANCE REQUIREMENTS FOR TEMPORARY OR PERMANENT CESSATION OF MINING OPERATIONS

ACTIVITY	ACT	RELEVANT MINISTRY	TIME FRAME FOR NOTICE
Permanent cessation of mining operations	– Minerals Act 1992	MME	6 months
Temporary cessation of mining operations	– Minerals Act 1992	MME	30 days
Reduction in mining operations	– Minerals Act 1992	MME	7 days

Namibian Standards

In 2010, the Chamber of Mines of Namibia produced the Namibian Mine Closure Framework (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 a mineral licence 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).

6.2 Closure and Completion in Protected Areas and National Parks

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.

6.3 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 mine closure plan 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

7 INTRODUCTION

The result of mining activities leaves behind infrastructure including tailings storage facilities, 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 tailings storage facilities 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 the 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 (NGOs), 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 life cycle of the mine. 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 Life of Mine, 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 the towns of Uis and Arandis). 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 (SMEs), 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 geologies. 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 throughout the mining industry:

- 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.

PART EIGHT – POST CLOSURE MONITORING

8 INTRODUCTION

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 legal framework for mine closure in Namibia remains weak and vague. Although 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, they lack specific regulations and authorised procedures. In addition, there aren't sufficient resources for implementing requirements. There is also no formal system for handling the approval of closure plans; there is no mandatory financial assurance mechanism to cover the costs of mine closure; 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.

This scenario presents an ongoing challenge to the mining industry in Namibia. As a result, mines in Namibia are guided by international standards, guidance from 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 International Atomic Energy Agency (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 (IFRS) 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 Namibian Standards for Ongoing Post-closure Monitoring

8.1.1 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.

8.1.2 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.

8.1.3 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, through frequent monitoring it can be detected 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

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

8.1.4 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

PART NINE – RELINQUISHMENT

9 INTRODUCTION

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. Although vague in terms of relinquishment, 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.

Indicators and performance targets should be established. The indicators allow 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 mineral 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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