## Wetlands in Working Landscapes

# WETLAND REHABILITATION IN MINING LANDSCAPES: AN INTRODUCTORY GUIDE

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# WETLAND REHABILITATION IN MINING LANDSCAPES: An Introductory Guide

Report to the
**Water Research Commission**

by

**South African National Biodiversity Institute**
and the
**Council for Scientific and Industrial Research**

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# EXECUTIVE SUMMARY

**Wetlands ecosystems are vital ecological infrastructure that provide valuable services to people and are important biodiversity assets.** Wetlands help to buffer flood waters, soak up water to release more gradually over time, filter sediments, purify water, and provide forage for livestock and refuge for numerous species. While remarkably resilient in many ways, they are vulnerable to a range of direct, indirect and cumulative impacts. In mining landscapes changes in landscape hydrology and water quality often impact upon downstream water resources and associated users with various consequences for people and biodiversity.

**The current state of wetland ecosystems in South Africa is such that impacts on remaining wetlands have cumulative, and sometimes significant consequences.** There are indications that the cumulative loss or deterioration of services derived from wetlands is undermining the ability of the affected landscapes to deliver these functions, which in turn has social, economic and ecological implications. This is of direct relevance to the mining sector.

**Impacts on wetlands should be avoided and minimised whenever possible. Where wetland impacts or degradation do take place, wetland rehabilitation should form part of the mitigation of these impacts. Wetland rehabilitation can be successful if it is well planned and implemented.** The *Wetland rehabilitation in a mining landscape: introductory guide* provides practical, user-friendly guidance to specialists, mining houses and regulators on appropriate wetland rehabilitation strategies, planning, methods and implementation.

**The guide builds on existing guidelines and experience in wetland rehabilitation to consolidate guidance that is specific to wetland rehabilitation in *mining landscapes*.** This was necessary as the available information on mine planning, impact mitigation and rehabilitation of mining landscapes did not specifically or adequately address wetland rehabilitation in this context. Mining frequently impacts on water quality and hydrology in ways that differ from other land uses, and can create challenging water quality and hydrological conditions. Such conditions will frequently necessitate customising wetland rehabilitation approaches that ensure wetland rehabilitation structures can cope with associated water quantity and quality issues, making mining-specific wetland rehabilitation guidance necessary.

**The introductory guide is structured to provide users with the core principles that should inform planning and decision-making at different phases of wetland rehabilitation, namely planning, implementation, and monitoring and long-term management phases.** Key elements integral to wetland rehabilitation in each phase are summarised in easy-reference checklists that help users ensure that the guidelines provided in this document are adhered to. An overview of legal considerations for wetland rehabilitation in the mining landscape is also provided.

**By consolidating existing guidance on wetland rehabilitation in mining landscapes, this introductory guide aims to promote the standardised application of tools in wetland rehabilitation and improve clarity with respect to wetland rehabilitation planning, design and implementation in mining landscapes**. In particular the guidance is intended to provide appropriate practical and strategic approaches to wetland rehabilitation, and to support the development of wetland rehabilitation and management commitments and license conditions that are realistic, achievable and can be monitored. Well planned and implemented wetland rehabilitation can help to avoid a range of risks for proponents, government and affected communities and ensure compliance with environmental legislative provisions and authorisation requirements.

**The introductory guide should help to ensure that wetland rehabilitation activities leave a meaningful and lasting legacy that helps to address and to some extent compensate for some of the negative impacts that mining activities have on water resources.** In so doing, it is envisaged that this will assist the mining sector in proactively and responsibly contributing to broader water resource management objectives and so secure a more sustainable future for biodiversity and communities living in these landscapes.

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AMD | Acid Mine Drainage |
| CEMP | Construction Environmental Management Programme |
| CSIR | Council for Scientific and Industrial Research |
| DEA | Department of Environmental Affairs |
| DMR | Department of Mineral Resources |
| DWS | Department of Water and Sanitation |
| EAP | Environmental Assessment Practitioner |
| EMP | Environmental Management Plan |
| EMPr | Environmental Management Programme |
| GIS | Geographic Information Systems |
| ICMM | International Council on Mining and Metals |
| IFC | International Finance Corporation |
| MPRDA | Mineral and Petroleum Resources Development Act 28 of 2002 |
| NEMA | National Environmental Management Act 107 of 1998 |
| NEM:BA | National Environmental Management: Biodiversity Act 10 of 2004 (referred to as the Biodiversity Act) |
| NEM:PAA | National Environmental Management Protected Areas Act 57 of 2003 (referred to as the Protected Areas Act) |
| NEM:WA | National Environmental Management: Waste Act 59 of 2008 (referred to as the Waste Act) |
| NWA | National Water Act 36 of 1998 |
| SACNASP | South African Council for Natural Scientific Professions |
| SANBI | South African National Biodiversity Institute |

# Guideline navigation

In order to make the guideline as user-friendly as possible, a number of design elements have been used to draw attention to key points, case studies or further information.

Key issues, stumbling blocks and questions that need to be addressed when it comes to mining-related wetland rehabilitation are signified by this icon.

Attention is drawn to reference of existing tools, including other guidelines, methods etc. through the use of this icon.

Boxes are used to explain particular terms or concepts in more detail (such as terms that have different meaning across sectors) and to describe particular case studies or examples from which lessons can be drawn.

# 1. INTRODUCTION

This is a practical, user-friendly introductory guide to wetland rehabilitation in mining landscapes[1]. It provides guidance on appropriate wetland rehabilitation strategies, planning, methods and implementation for:

- **Specialists, including Environmental Assessment Practitioners (EAPs), ecologists and engineers responsible for developing wetland rehabilitation plans and designing rehabilitation interventions (including those required for offset purposes):** to assist in developing sound and robust wetland rehabilitation plans that meet legislative requirements and achieve desired outcomes over the long-term.
- **Mining houses (mine managers, mining environment and land managers):** to assist in developing terms of reference for the development of good wetland rehabilitation plans by EAPs, meeting legislative requirements, have the highest likelihood of achieving optimal outcomes from rehabilitation processes, and in managing risk with respect to failed interventions, lack of compliance, or limited understanding of the long-term commitments and full spectrum of rehabilitation costs.
- **Regulators, including the Department of Water and Sanitation (DWS), Department of Environmental Affairs (DEA) and its provincial counterparts, and the Department of Mineral Resources (DMR):** to support decision-making and the development of appropriate licence conditions relating to wetland rehabilitation; and to assist in assessing or evaluating wetland rehabilitation plans submitted by mining houses.

This introductory guide does not define additional rules or regulations. It rather builds on existing guidance for rehabilitation in mining impacted landscapes, for wetland rehabilitation in general, and with specific reference to guidance on wetland rehabilitation in *mining landscapes*. It draws on existing tools as well as key lessons learnt in relevant wetland rehabilitation projects. An example of the Zaalklap project is presented, which tested the use of standard Working for Wetlands rehabilitation techniques to deal with mining-related impacts on wetlands, ecosystem services and water resources (including the management of mining-related impacts on water quality). All guidance in this document is in line with relevant legal requirements for wetland rehabilitation. The guide therefore clearly differentiates between what ***should*** be done (best practice) and what ***must*** be done (used only where it is indicative of there being an existing legal requirement).

By consolidating existing guidance on wetland rehabilitation in mining landscapes, this introductory guide aims to promote the standardised application of tools in wetland rehabilitation and improve clarity with respect to wetland rehabilitation planning, design and implementation in mining landscapes for all three of the primary user groups listed above. In particular the guidance is intended to provide appropriate practical and strategic approaches to wetland rehabilitation, and to support the development of wetland rehabilitation and management commitments and license conditions[2] that are realistic, achievable and can be monitored. In doing so, this introductory guide should help to ensure that wetland rehabilitation activities leave a meaningful and lasting legacy that helps to address and compensate for some of the negative impacts that mining activities have on water resources.

[1] 'Mining landscapes' are those in which mining is one of a matrix of land uses, including agriculture, urban expansion or plantation forestry, taking place across the landscape. Mining landscapes should not be read to imply that mining is the dominant impacting activity in the landscape. It does imply the need to take cognisance of the possible implications of mining impacts in combination with the other mix of land uses e.g. wetlands directly impacted by agriculture but exposed to mining-related water quality pressures.

[2] Condition has a specific meaning in a legal context. Where an environmental authorisation, Environmental Management Programme (EMPr) or Water Use Licence is granted for the rehabilitation of a wetland, the environmental authorisation or water licence must specify certain conditions in terms of timelines, as well as requirements for the avoidance, management, mitigation, monitoring and reporting of the impacts of the proposed activity on the environment, throughout the life of the activity.

## 1.1. Rehabilitation in Mining Landscapes

There are a range of impacts typically associated with mining. These vary considerably depending on the type of mining, its scale and extent, the environmental management approach adopted by the mine, and the area and type of biodiversity and ecosystems affected. Impacts of mining and related activities in mining landscapes may be direct, indirect, induced or cumulative (DEA *et al.,* 2013). They may also endure in the short-term or may last for decades or even in perpetuity when there is a large scale structural change to the landscape. When avoidance or prevention of impacts is not possible, measures to minimize impacts and rehabilitate biodiversity and ecosystems should be implemented.

Rehabilitation refers to measures taken in the process of returning an impacted area to a condition ecologically similar to their former ('pre-mining natural state') or desired ecosystem structure, function, biotic composition and associated ecosystem services[3]. Rehabilitation thus entails undertaking certain remedial action to minimise the adverse impacts on the environment and to prevent further environmental degradation from occurring, continuing or recurring.

Rehabilitation forms part of the logical sequence of the mitigation hierarchy for dealing with negative impacts on biodiversity and ecosystems (Figure 1). Rehabilitation requirements are most often implemented in order to address impacts that cannot be avoided or minimised (for which there is well established guidance (CoM/Coaltech, 2007)), but may also be included as part of an offset requirement (see Chapter 2 for more on triggers for rehabilitation). Rehabilitation is a broad concept relevant for aquatic and terrestrial systems, but this guideline focuses on wetlands only. It should be noted that there are some ecosystems where the biodiversity and ecosystem services are of such global, national or local importance that significant impacts to these systems cannot be fully rehabilitated or offset (see Box 1). In these cases, the application of the mitigation hierarchy should be through avoiding any impact at all on these sites.

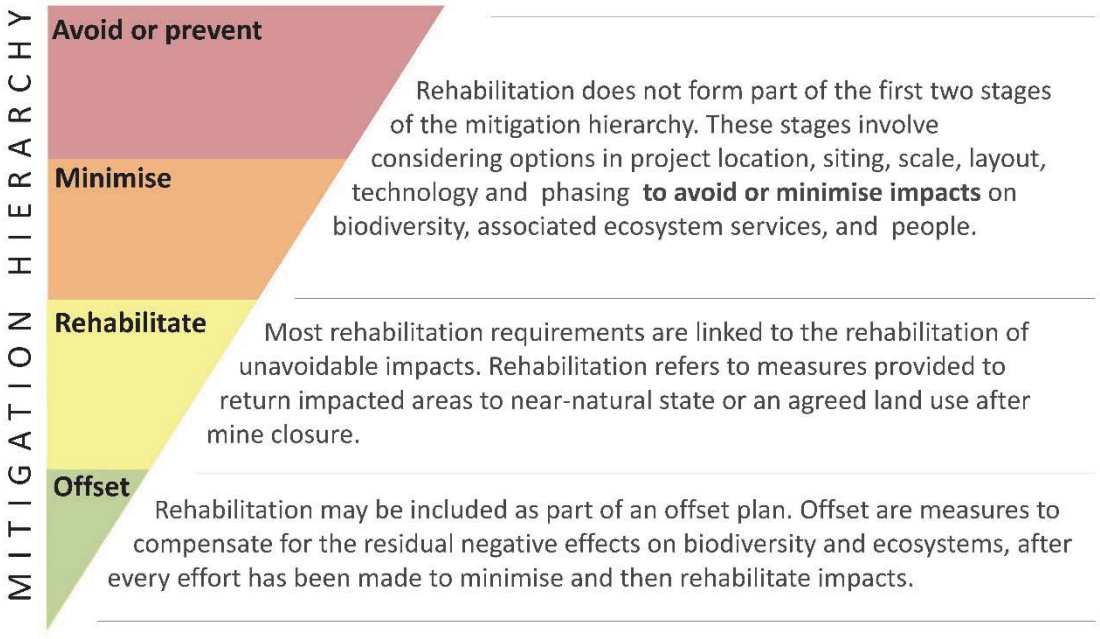


**Figure 1. Rehabilitation as part of the mitigation hierarchy for dealing with negative impacts on biodiversity (adapted from DEA *et al*., 2013)**

[3]The definition of "*rehabilitation*" is set out in the General Authorisation for section 21 (c) and (i) of the National Water Act 36 of 1998 for the purpose of Rehabilitating Wetlands for Conservation Purposes published in terms of GN 1198 of 18 December 2009.

**Box 1. What is the difference between rehabilitation, restoration and recreation/reestablishment of wetlands?**

Within the context of mining, **rehabilitation** refers to measures taken in the process of returning impacted areas to a condition ecologically similar to their 'pre-mining natural state' or an agreed land use after mine closure (DEA *et al.,* 2013). In the case of wetlands, wetland rehabilitation refers to the process of assisting recovery of a degraded wetland in terms of the wetland condition, function, and associated biodiversity, or in maintaining the health of a wetland that is threatened by degradation, through the implementation of remedial interventions or proactive preventative measures (Russel, 2009, SANBI and DWS, 2014). It involves the manipulation of the physical (e.g. blocking drainage canals), chemical, or biological characteristics (e.g. assisting the regeneration of the natural vegetation and/ or clearing of invasive alien species on the wetland site or in its buffer zone) of a degraded wetland system in order to repair or improve wetland integrity and associated ecosystem services (SANBI and DWS, 2014).

Although rehabilitation is important and necessary, unfortunately even with significant resources and effort, rehabilitation is a limited process that almost always falls short of replicating the full diversity and complexity of a natural system (DEA *et al.,* 2013). Rehabilitation does however help to restore some resemblance of ecological functioning in an impacted landscape, to avoid on-going negative impacts, and/or to provide some sort of aesthetic fix for a landscape (DEA *et al.,* 2013). This points to differences in the terms *rehabilitation* and ***restoration***, which speak to differences in the intent of the remedial activity and in the condition of the wetland prior to the commencement of the remedial activity. For the purpose of this document wetland restoration is defined as remedial activity applied to systems that have been completely and permanently, but not irreparably, altered (Grenfell *et al.,* 2007). Wetland rehabilitation in contrast refers to remedial activity applied to systems that have been degraded and have lost some degree of ecosystem structure and/or function but which have not been permanently altered (Grenfell *et al.,* 2007). Wetland restoration would therefore generally require more resources and a greater level of intervention effort than wetland rehabilitation and in many cases may be impossible, unrealistic or too expensive. While there are subtle differences in the definitions of these terms, the term 'rehabilitation' as used in this document encompasses both of these activities.

Wetland rehabilitation is also different to **wetland creation and re-establishment**. Wetland creation in this context involves creating/establishing wetlands where they did not occur previously. Re-establishment refers to where wetlands that were removed or lost by mining are re-established within the post mining or mining rehabilitation footprint.

Whilst wetland creation and re-establishment are specifically not addressed in this guideline, it is important to note that many of the principles and guidelines described in this document are relevant to wetland creation or re-establishment. Such introduction or re-introduction of wetlands into the post-mining footprint potentially provides useful opportunities to generate relevant ecosystem services, such as improving the quality of water emanating from the area.

Wetland creation and re-establishment would require local site conditions to be manipulated in order to create a suitable setting in which wetlands can form or be created. This will include the introduction of water of a certain volume and quality (either from surface runoff from the post mined landscape or water from treated or other discharge) to create suitable hydrological conditions in order to maintain the wetland as well as the placement of appropriate soils to serve as a substrate for the wetland. Whilst a number or risks would need to be managed (such as those associated with water ingress when wetlands are created or re-established on rehabilitated opencast pits), wetland creation or re-establishment provides a rehabilitation opportunity that requires further research and investigation.

It is important to point out that any decision to explore such an approach would not only involve similar steps to those advocated in this guideline, particularly in terms of proper planning and understanding that this too would require a long term commitment, but would also require the support and authorisation of the relevant regulators.

## 1.2. Why the Special Emphasis on Wetland Rehabilitation?

Wetlands are complex, dynamic ecosystems that can be thought of simultaneously as biodiversity assets with intrinsic value and as ecological infrastructure that provides valuable services to people. As ecosystems that connect terrestrial and aquatic environments, they are sensitive to the range of direct, indirect and cumulative impacts[4] found in mining landscapes. Well planned and implemented wetland rehabilitation is important for:

- **Avoiding rehabilitation projects that do not result in the desired outcomes**: Failure of wetland rehabilitation is possible where the complexity, inter-connectedness and sensitivity of wetlands is not adequately understood or taken into account. Wetlands are not isolated ecosystems. They are connected to other terrestrial and aquatic systems in complex ways. There are also many different types of wetlands characterised by various hydrological and ecological processes (see Box 2). These processes, along with the dynamic nature of wetlands, add to the complexity of these ecosystems and necessitate the use of appropriate approaches by a range of specialists to achieve successful wetland rehabilitation.
- **Avoiding rehabilitation projects that cost a lot of money**: Poor planning including site selection and intervention design can result in unnecessarily high implementation and ongoing maintenance costs. In some instances, poor performance may result in project goals not being met, which may lead to further expenditure. Implementation costs can be reduced through appropriate planning and project oversight that ensures that work is undertaken in an efficient manner. "Achieving more with less" is aided through consideration of cost per hectare equivalent[5] gains. Projects that yield high hectare equivalent gains should be prioritised, with soft interventions being first priority, as opposed to hard engineering interventions that have higher costs and risks of failure.
- **Avoiding a range of risks for proponents, government and affected communities**: Naturally functioning wetlands deliver valuable services to millions of people in South Africa. For instance, many wetlands improve water quality, while others help to dissipate the destructive energy of floodwaters, or are a crucial source of water for people and animals (particularly in dry periods), and a source of food, medicinal plants and grazing for livestock . They can be seen as nature-based equivalents of built or hard infrastructure, and can be just as important for providing services and underpinning socio-economic development. Wetlands also provide habitat for a rich diversity of species that not only support tourism and ecotourism activities (e.g. bird watching), but are likewise an important part of provincial, national and global biodiversity assets (South Africa is a Contracting Party to the Ramsar Convention on Wetlands). Wetlands have been prioritised for biodiversity conservation at national and provincial levels and receive further protection under the National Water Act (Act 36 of 1998), through their designation as water resources. Impacts that alter biodiversity and the flow of services provided by wetlands will have implications for the biodiversity value of the affected wetlands, the species they support, and pose a range of risks to proponents, government and affected communities.
- **Ensuring compliance with environmental legislative provisions and authorisation requirements:** Wetland rehabilitation may be needed in response to a range of legislative requirements. A range of legal requirements may also be triggered by wetland rehabilitation activities. The environmental legal implications of wetland rehabilitation must therefore be understood prior to undertaking any activity associated with wetland rehabilitation, and where required, the necessary environmental authorisations and/or licences must be obtained before commencing with such rehabilitation activities (See Appendix C for an overview of legal requirements).

[4] Wetlands are impacted by a range of impacts, such as direct impacts (e.g. drainage and conversion for cultivation, over-grazing, burning, urbanisation, and mining), or indirect impacts (e.g. disruption of flow regime affecting the amount and timing of water flow to wetlands, water abstraction, pollution, erosion in feeder catchments), which may act cumulatively with other impacts (Driver *et al.,* 2012).

[5] A hectare equivalent is a quantitative expression of the ecological integrity of a wetland functional area under a given land use and/or a measure of wetland functional area. It represents the common currency that enables the wetland functional area rehabilitated in the landscape compared to that removed from the landscape by any particular development.

**Box 2. What is a wetland?**

Wetlands reflect the surface or near surface expression of water that is either static or moving through the landscape. Water can originate from rain water, groundwater (including perched or shallow groundwater), surface water or a combination of all these. There are many different types of wetlands (Figure 2).

The water may be temporary, seasonal or permanent but must be present for long enough to create hydromorphic soils[6] and influence the plant species associated with these conditions. Some wetlands may remain dry (without surface water) for extended periods (years in some cases), particularly in the more semi-arid and arid parts of South Africa. Others may be more seasonal, only having surface water present or saturated soil conditions during the rainy months. Others still can remain permanently inundated or saturated depending on local rainfall, geology and groundwater influences.

Wetlands can generally be identified and delineated by using key indicators such as wetland plants (also commonly referred to as hydrophytes) and soil wetness indicators, although in some more technical cases, other indicators (such as local topography together with hydrology) may be relevant (DWAF, 2005).The National Water Act 36 of 1998 provides the legal wetland definition used in South Africa: "*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*." Wetlands are included in the definition of 'watercourse' in the National Water Act[7].

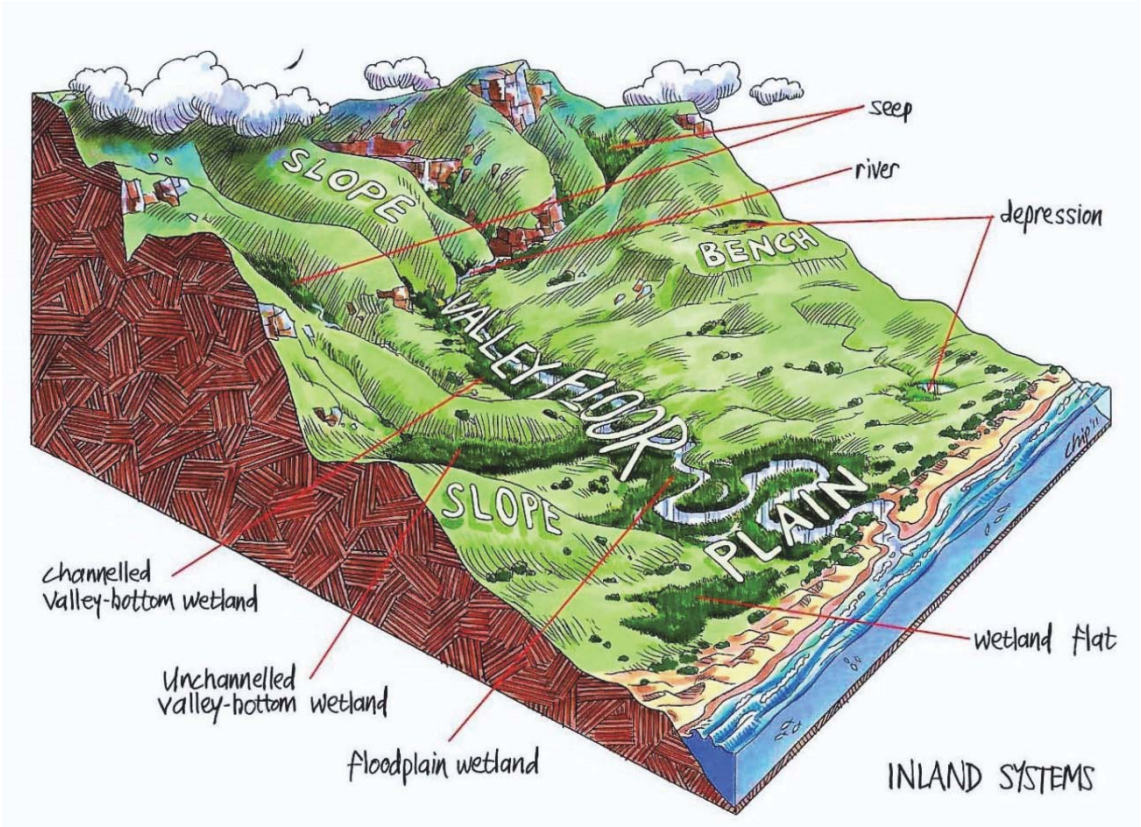


**Figure 2. Overview of different wetland types and their typical location in the landscape (Ollis *et al*., 2012)**

[6] A hydromorphic soil displays unique characteristics resulting from its prolonged and repeated saturation. Typical indicators include a soil matrix that is said to be gleyed and is greyish, greenish or bluish in colour and the presence of coloured mottles (DWAF, 2015).

[7] It is worth noting that while the National Water Act does not explicitly include pans in the definition of a watercourse, the 2014 EIA Regulations published under the National Environmental Management Act 107 of 1998 includes both wetlands and pans in the definition (see Box 6 for more on pans).

The current state of wetland ecosystems in South Africa is such that impacts on remaining wetlands have cumulative impacts. Studies in several major catchments in South Africa reveal that between 35% and 60% of wetlands have been lost or severely degraded (Kotze et al., 1995). This would affect the production and delivery of services derived from healthy wetland ecosystems and can exacerbate water quality and water security hazards with social stability and economic implications (NPC, 2011; Runciman, 2013; Water Wheel, 2013).

Well planned and implemented wetland rehabilitation, the elements of which are described by this introductory guide, has the potential to contribute to improved environmental quality, better water resource management, biodiversity conservation targets, and even job creation.

## 1.3. Why a *Mining-Specific* Wetland Rehabilitation Guide?

Whilst a range of documentation is available to inform mine planning, impact mitigation and rehabilitation of mining landscapes, existing guidance does not specifically or adequately address wetland rehabilitation in mining landscapes. Furthermore, mining frequently impacts on water quality and hydrology in ways that differ from other land uses. This means that mining in a landscape can create water quality and hydrological conditions which should influence the wetland rehabilitation approaches that might be used. For instance mining may impact on:

- Water quality, which affects the longevity or efficacy of wetland rehabilitation structures (e.g. reduction in pH will corrode gabion wire or even concrete).
- The deposition of heavy metals, or coal fines amongst other deposits in downstream areas, which impact on the health of wetlands, rate of rehabilitation and may even pose a risk of ignition of coal fines deposited in wetlands (with further environmental and human health implications).
- Hydrology (in the form of altered flow of water though the landscape),as a result of the creation of free drainage landscapes to reduce water ingress (water make) into certain mining areas, as a result of dewatering activities that lower regional water tables, or through altered topography in areas of open cast mining.

In mining landscapes it is therefore important to determine to what extent the primary drivers of wetland presence are still present in the landscape and if rehabilitation remains viable, to tailor wetland rehabilitation within the context of altered landscape topography and hydrology. It will therefore be necessary in most cases to specifically address mining-specific challenges by customising wetland rehabilitation approaches that ensure wetland rehabilitation structures can cope with associated water quantity and quality issues. This requires well planned and implemented wetland rehabilitation by appropriate specialists. Wetland rehabilitation also provides an opportunity to enhance wetland services that are particularly important in a mining landscape (e.g. by customising wetland rehabilitation to maximize water quality purification functions). In this way, wetland rehabilitation that is responsive and appropriate to the landscape within which it is being implemented can contribute to broader water resource management objectives.

The unique challenges and opportunities associated with wetland rehabilitation in a mining-specific context make an introductory guide on wetland rehabilitation in mining landscapes necessary. Such a guide is particularly pertinent in areas such as the Mpumalanga Highveld where there are both extensive wetlands and significant coal resources. The extraction of these coal resources through opencast mining operations often impacts on wetlands, which then requires extensive wetland rehabilitation. Whilst much rehabilitation may be implemented onsite and further rehabilitation may be required off-site (as part of wetland offset plans – see Chapter 2).

This introductory guide to wetland rehabilitation in mining landscapes is structured to provide users with the core principles that should inform planning and decision-making about wetland rehabilitation (Chapter 3), as well as providing guidance during the planning phases (Chapter 4), implementation phases (Chapter 5), and monitoring and long-term management phases (Chapter 6) of wetland rehabilitation projects. Figure 3 provides a simplified overview of the overall process for wetland rehabilitation in a way that distinguishes the three main project management phases. Key elements integral to wetland rehabilitation in each of the phases are highlighted in Chapters 4 to 6. These key elements are also summarised in a checklist (Appendix A) for quick reference by all user groups.

This introductory guide *does not* directly address (a) the re-creation of wetlands in the post mining footprint or (b) land tenure and stewardship arrangements required to secure completed rehabilitation work. These are important issues that will be raised where relevant but will not be addressed in detail.

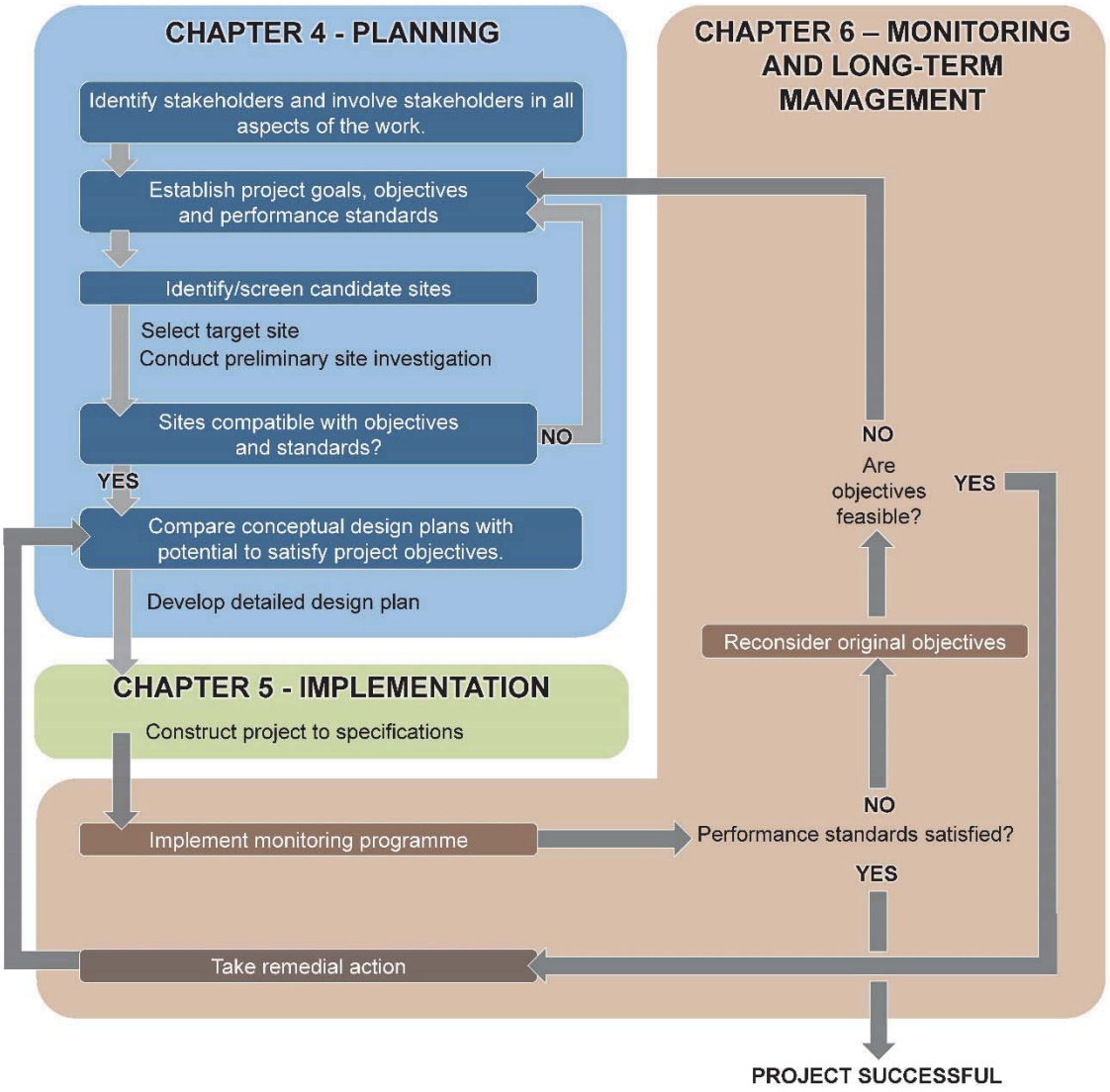


**Figure 3. Flow diagram of the overall process for wetland rehabilitation planning, implementation, monitoring and long-term management (modified from Ramsar 2010)**

# 2. BROADER CONTEXT FOR WETLAND REHABILITATION

There are many different reasons for wetland rehabilitation to be undertaken in a mining landscape. The different triggers have implications for how, where and when wetland rehabilitation is undertaken. It is therefore necessary to consider the broader context for wetland rehabilitation.

Wetland rehabilitation could be required across various phases of the mining life cycle, namely at the reconnaissance, prospecting, mining or closure stages (as detailed in the *Mining and Biodiversity Guidelines*; DEA *et al*., 2013). Impacts to wetlands are likely to increase through the mining life cycle as activities on the ground intensify and become ever more intrusive from prospecting through to the stage of active mining. The majority of wetland rehabilitation activities would generally be undertaken during the mining phase, but may also extend into the closure phase as part of post-mining land capability commitments.

Most wetland rehabilitation requirements in mining landscapes are linked to the remediation of mining impacts on wetlands identified through the environmental authorization process and should therefore be informed by the mitigation hierarchy (Chapter 1.2). In this, there is a distinction between on-site wetland rehabilitation, and rehabilitation as part of an offset requirement, which by definition focuses on permanent, residual impacts that cannot be addressed through on-site rehabilitation efforts:

1. **On-site rehabilitation:** This refers to rehabilitation on areas owned or managed by the mine. It includes rehabilitation of wetlands (i) directly impacted by mining activities once mining activities have ceased and (ii) other degraded wetlands that can be rehabilitated to compensate for mining impacts. DWS generally stipulates the need for the rehabilitation of wetlands as part of Section 21 (c) and (i) Water Use License applications.
2. **Rehabilitation as part of an offset requirement:** This refers to situations where the need for an offset is identified as a last resort to address residual wetland impacts that cannot be addressed through on-site rehabilitation efforts. Under this scenario, the rehabilitation of certain wetlands may be included as part of a wetland offset plan. In some cases this involves wetlands located within an alternative area owned or managed by the mine, but in most cases this involves wetlands located on land some distance away from the impacted site, often referred to as an 'offsite' area. Offsite wetland rehabilitation in cases where the rehabilitation sites are not owned by the mining house presents challenges in terms of securing and managing the site in the long term (see Box 3 and section 4.3).

Other reasons for wetland rehabilitation include:

3. **Positive reasons for rehabilitation (beyond compliance):** Not all rehabilitation is done to remediate an impact directly associated within mining activities. A mining house might go beyond this and rehabilitate wetlands as part of corporate social responsibility commitments.
4. **Rehabilitation by third parties:** Wetland rehabilitation may also be undertaken by third parties (e.g. farmers or landowners) not directly associated with mining but where the target wetlands are located within a mining environment. Such rehabilitation would still have to consider the specific constraints and challenges posed by the mining environment.
5. **Illegal activities:** Rehabilitation might be required in response to illegal activities. For instance, where an activity requiring authorisation has been undertaken without such authorisation first being obtained, and has in the process adversely impacted on a wetland[8]. Such rehabilitation would often take place onsite and thus could be seen to be similar to point 1.
6. **Emergency situations:** Unforeseen circumstances that lead to wetland degradation such as emergency situations (e.g. infrastructure failure) or non-standard closure of mines can trigger the need for wetland rehabilitation. Such emergency situations are often associated with unique circumstances and challenges that need to be considered in wetland rehabilitation plans. Furthermore there are specific environmental legal provisions that need to be adhered to in the event of an emergency situation. In this regard please refer to Appendix C for further detail on the specific environmental legal provisions.

Within the above scenarios, relevant national environmental and water legislation places certain legal obligations on the party wishing to rehabilitate a wetland. This will include identifying potential legal

[8]Section 155 of the NWA provides that the High Court may grant an interdict against such a person and order the person to remedy the adverse effects on the wetland, thus triggering the need for rehabilitation.

obligations to obtain the necessary environmental and water authorisations and other licences for wetland rehabilitation in terms of *inter alia* the following national environmental and water statues and the applicable regulations:

- The National Environmental Management Act 107 of 1998 (NEMA).
- The Environmental Impact Assessment (EIA) Regulations published under NEMA.
- The National Water Act 36 of 1998 (NWA).
- The applicable General Authorisations in terms of section 39 of NWA.
- The National Environmental Management: Biodiversity Act 10 of 2004 (NEM:BA, hereafter referred to as Biodiversity Act).
- The Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA), with authorisation under various pieces of legislation usually required.

Regardless of whether the decision to undertake wetland rehabilitation is voluntary or mandatory, or forms part of a wetland offset requirement, the principles (Chapter 3) and key aspects that need to be covered in a wetland rehabilitation plan (Chapter 4) will apply.

**Box 3. Securing rehabilitation on sites**

Conditions written into an authorisation or licence should require long-term management of any wetland rehabilitation that is implemented as a result of a legal requirement. Long-term management is made easier when rehabilitation takes place where the land and mining rights are owned by the mining house. In such cases the long-term management can be linked to the environmental management of the surface rights area, to the mine schedule and even to closure plans. In some cases long-term management of wetland rehabilitation could be coupled to a surface ownership right via formal protection. An agreement to ensure such commitment could take the form of (taken from *Biodiversity stewardship: Partnering for securing biodiversity*; SANBI, 2014):

- Formal declaration of areas under the Protected Areas Act 57 of 2003 (NEM:PAA; hereafter referred to as the Protected Areas Act) with contracts between landowners/mining houses and provincial conservation authorities that are binding on the property (title deed restriction in the case of a Nature Reserve, and title deed note in the case of a Protected Environment).
- Contracts between landowners/mining houses and the provincial conservation authority that are not binding on the property, such as a Biodiversity Management Agreement (an agreement governed by the Biodiversity Act) or a Biodiversity Agreement, which are two types of biodiversity stewardship agreements and have a typical contract length of 5-10 years.

Where wetland rehabilitation takes place outside of the area that the mining house has land or mining rights, then it is necessary to gain permission from the owner of the landholding the wetlands that will be rehabilitated. Long-term management of such rehabilitation would also need to be negotiated with the land owner. Clearly, establishing some form of formal protection under this scenario would pose additional challenges as it will require the landowner agreeing to the long-term wetland rehabilitation management strategy and possibly also agreeing to certain restrictions related to the use of the wetlands that will be rehabilitated. Compensatory mechanisms established through common law contractual instruments are likely to apply where wetland rehabilitation measures may restrict a landowners rights in terms of a lawful land use. An example may include withdrawing existing cultivation to provide for a suitable rehabilitation buffer zone around a wetland.

A key risk for any long-term wetland rehabilitation management in the mining landscape is the possibility of future mining applications that could affect (either directly or indirectly) the rehabilitation site, particularly in cases where this is located outside of the surface ownership rights area of the mine concerned. Other aspects such as future changes in upstream or surrounding hydrology or changes in land tenure may also be risks to wetland rehabilitation projects in the long-term.

# 3. PRINCIPLES BEHIND WETLAND REHABILITATION IN A MINING LANDSCAPE

This introductory guide is informed by principles that should guide planning and decision-making about wetland rehabilitation. These principles are distilled from those articulated in South Africa's constitution, NEMA, NWA, the Biodiversity Act, the National Environmental Management: Waste Act 59 of 2008 (NEM:WA; hereafter referred to as the Waste Act) and the Protected Areas Act amongst other relevant policies and documents related to wetland offsets, and international guidelines for the mining sector (including the Equator principles, and those from the International Finance Corporation (IFC), and International Council on Mining and Metals (ICMM, 2006, ICMM, 2015, ICMM IUCN, 2012)).The following principles have informed this introductory guide:

- **Legal implications of wetland rehabilitation must be considered** prior to undertaking any activity associated with rehabilitation activities. Important details on some of the identified environmental authorisations and/or licences potentially associated with wetland rehabilitation are described in Appendix C.
- **Wetland rehabilitation should be integrated with the surrounding landscape and should follow a landscape approach**. In recognition of the inter-connectedness of wetlands in landscapes, rehabilitation of wetlands within the mining landscape requires an ecosystem (as opposed to a species) approach. Wetland rehabilitation should therefore recognise the interdependence between biodiversity, ecosystems and the benefits they provide for people (Cadman *et al.,* 2010). As an example, an applicant must consider the level of modification to both drivers[9] and responders[10] in a wetland rehabilitation plan and must determine the outcome or objective for the rehabilitation very clearly. During wetland rehabilitation planning it is critical to consider landscape hydrology (both surface and groundwater), its alteration by the various land uses in the catchment, and the extent to which post mining landscape hydrology will support the wetland rehabilitation proposed.
- **Wetland rehabilitation should take place within a well-structured planning process.** It should take into consideration:
  1. Technical expertise that is needed to design and implement interventions fit-for-purpose as per set rehabilitation objectives.
  2. Legal risks and requirements in terms of environmental authorisations and/or licences under different and relevant national environmental and water legislation as indicated in Appendix C.
  3. Risk minimisation approaches, which include an appropriate and practical Construction Environmental Management Programme (CEMP), specific construction notes, and monitoring and evaluation measures.

  Wetland rehabilitation should also form part of the integrated rehabilitation and environmental management strategy of the mine and not just be a stand-alone process.

- **Wetland rehabilitation should recognise and take into consideration adaptive management.** There are unique risks associated with mining-related wetland rehabilitation which if not carefully

[9] "A driver is any natural or human-induced factor/stimulus that directly or indirectly causes a change in an ecosystem or other ecological component of the landscape" (Nelson *et al*., 2006). For example, a series of gabion/weir structures placed along an incised channelled valley bottom wetland to raise the water table would cause a change in the water distribution across a wetland and would affect a number of ecological components of the wetland. Another example is the removal of extensive high water demand invasive alien plant species within a wetland catchment area could cause a change in the water balance of the wetland and improve species diversity.

[10] "A responder is a particular component of an ecosystem that transmits a response i.e. a reaction and/or a process occurring due to the effect of antecedent factor or stimulus that directly or indirectly causes a change in an ecosystem or other ecological component of the landscape" (Nelson *et al.,* 2006). For example using the above driver (weirs) as the cause of change, responders could include water quality and aquatic macro invertebrate diversity. Raising the water table may indirectly result in an improvement in water quality by increasing residence time of water within the wetland and thereby the water quality improvement services provided by the wetland. Raising the water table and improving water quality would improve the habitat quality for aquatic macroinvertebrate biota and lead to increased species diversity.

planned for can undermine rehabilitation activities. It is also critical that rehabilitation takes a long term view by ensuring that monitoring, evaluation and adaptive management form part of the commitment to wetland rehabilitation by the mine that extends beyond the end of the life-of-mine.

- **Wetland rehabilitation should have meaningful buy-in from local people/landowners, and give adequate consideration to socio-economic factors, in particular those relating to the direct users of the wetlands.** All wetlands occur within some form of socio-economic context that may have a profound effect on management and land-use decisions affecting the functioning of the wetland. It is therefore important to ensure that the rehabilitation process is not an isolated or purely technical process, in order to ensure proper management of the rehabilitated systems.

- **Wetland rehabilitation should be implemented as early as possible.** The earlier that wetland rehabilitation can take place the better as this can have a significant impact on improving wetland conditions while impacts are minimal and also reducing future risks and costs. This approach can be particularly effective in ensuring that long term water quality problems do not become too difficult to manage. It also allows for greater chances of success with regard to re-establishing the productive potential of land and holds significant aesthetic benefits with potential implications for sectors such as tourism.

# 4. PLANNING WETLAND REHABILITATION

Wetland rehabilitation is a costly and intensive activity that has a range of social and ecological implications. A lack of adequate planning is often cited as a major reason why rehabilitation projects fail to deliver the desired ecological outcomes. Wetland rehabilitation should therefore take place within a well-structured planning, implementation and evaluation process.

This chapter deals with key elements that are integral to the planning phase of any wetland rehabilitation project taking place in a mining landscape (Figure 3). Regardless of whether one is striving to implement best practice or meet the minimum requirements for the project, the key elements remain valid. EAPs and mining houses should ensure that each of these key aspects is addressed in any wetland rehabilitation project in order to reduce project risk and make the regulatory approval process easier. Regulatory authorities should check that these elements have been addressed in reports and plans submitted for approval, in order to minimise risk of failure to achieve the objectives of rehabilitation.

The key elements that need to be addressed as part of wetland rehabilitation planning are:

1. **Planning must be undertaken with appropriate stakeholder participation:** Wetland rehabilitation has implications for local users and broader stakeholder groups including regulatory authorities and conservation agencies. Stakeholder consultation is therefore required to ensure that appropriate opportunities are provided for stakeholders to give input into the process.
2. **Desired outcomes of wetland rehabilitation must be clearly defined**: It is essential that desired outcomes be clearly defined and formally recorded up-front. This is not only necessary to inform site selection and intervention designs but also provides a critical measure against which the ultimate success of the project can be evaluated.
3. **Site selection must be carefully considered and appropriately justified:** The success of wetland rehabilitation is largely dependent on site attributes and the associated risks and opportunities present at a particular site. For projects in which there is flexibility in site selection, careful screening of alternative sites therefore becomes critical and should be informed by a range of ecological and practical considerations.
4. **Rehabilitating wetlands requires proper understanding and planning**: Planning and rehabilitation of wetlands must be undertaken with a proper understanding of the wetland system and broader landscape in which it is located. It is therefore critical that such planning be undertaken by specialists with appropriate training, knowledge and expertise. This is particularly relevant in a mining landscape where risks associated with ecological drivers such as changes in flow regimes, poor water quality and the like impose additional challenges to successful implementation.

Guidance on how to ensure each of these key elements is effectively addressed in the wetland rehabilitation planning process follows in the sections below. Also included is a section on the costs associated with wetland rehabilitation planning.

## 4.1. Planning Must Be Undertaken With Appropriate Stakeholder Participation

Stakeholder interaction is mandated as part of the public participation processes that by law must be completed when applying for authorisation to undertake specific activities with a potential negative impact on the environment. While such interaction may be dealt with as part of a broader environmental authorization process, there is often a need to specifically consult with stakeholders during the development of a wetland rehabilitation plan. The requirements for such consultation will be dictated by the specific legal context. However, the principle of obtaining inputs from local users and broader stakeholder groups, including regulatory authorities and conservation agencies, remains valid for any wetland rehabilitation project.

Discussing the project with agencies that are involved in regulating and managing natural resources in the project area is often a useful starting point for understanding the landscape context and other initiatives, which may complement or compromise planned rehabilitation activities. Such agencies may also be able to provide examples of templates and supporting information that can help to streamline the planning process. Obtaining information about mineral deposits and associated mineral rights is another critical aspect in the mining landscape as this could compromise the feasibility of a rehabilitation project.

Engagement of local stakeholders is important, ever more so where wetland rehabilitation will take place on land that is not owned by the proponent. Landowners and local users often have important local knowledge

about natural processes (e.g. flooding) and biota that use the wetland that can add value to the planning process. From local stakeholders it is critical to understand current wetland use and management practices, particularly those that that exacerbate degradation of wetland ecosystems. This can affect the choice of intervention options, inform long-term management and monitoring requirements, and guide measures to raise awareness and influence behaviours and practices that address drivers of wetland degradation in the surrounding landscape matrix. It is likewise important to recognise that wetland rehabilitation interventions can affect neighbouring properties (e.g. through increased flooding) making it necessary to interact directly with adjacent landowners as part of the stakeholder participation process.

Successful rehabilitation requires long-term management that may influence that may influence the current management of the land. Early engagement with landowners is therefore critical to ascertain willingness and to integrate local management considerations. In many instances, resolutions made during the consultation process, will need to be codified through formal agreements to reduce risk to both parties. The nature of such agreements typically increase in detail from an initial planning phase (where a simple landowner consent may be sufficient) to formal legal contracts prior to project implementation.

## 4.2. Desired Outcomes of Wetland Rehabilitation Must Be Clearly Defined

Clearly defining the scope and desired outcomes is widely regarded as the most important component of project planning as it sets the expectations, drives detailed plans of action and determines the kind and extent of post-project monitoring. These need to be tailored for each project in line with the scope and reasons for the rehabilitation and should be aligned with the expectations of regulators and key stakeholders.

Desired outcomes are typically expressed in term of goals, objectives and targets:

- ***Goals*** are general statements about desired outcomes of the rehabilitation project. Stating goals allows all stakeholders to understand, in general terms, the desired direction of a project.
- **Objectives** are specific statements about desired project outcomes. Rehabilitation projects typically have more than one objective, reflecting the different values that wetlands provide.
- **Targets** (sometimes called performance standards) are observable or measurable attributes that can be used to determine if a project meets it's intended multiple objectives. Each objective will have one or more associated targets.

Depending on the specific project, goals may be orientated around different themes as illustrated in Figure 4. Each theme reflects different values that wetlands provide and it is therefore common for multiple objectives and targets to be set for a specific rehabilitation project.

The first theme, ***Water Resources and Indirect Services***, focuses on the re-instatement or maintenance of ecosystem services provided by wetlands. Here, rehabilitation goals are typically directed to the enhancement of key regulating and supporting services provided by wetlands. Water quality enhancement is often the most highly valued wetland service in the mining landscape, although services such as flood attenuation and sediment trapping may be particularly important in some contexts. Maintenance or enhancement of direct values such as the provision of grazing for livestock, harvestable natural resources or recreational opportunities for local communities may be an additional consideration in some circumstances. It is important that goals for targeting specific services are identified up-front as this will affect the type of wetlands and associated problems targeted through wetland rehabilitation activities.

***Ecosystem Conservation*** emphasises the importance of rehabilitating wetland habitat to a state good enough to contribute towards national, provincial and local targets for habitat protection. These targets are typically translated into wetland rehabilitation targets which are measured as an extent of intact habitat type that needs to be secured through an appropriate legal protection mechanism

The final theme relates to ***Species of Conservation Concern***, and is directed towards conserving populations or habitat of particular species. Here, objective setting needs to be informed by appropriate knowledge of specific target species and must therefore be informed through consultation with appropriate specialists. Targets are then typically communicated in the form of an area of suitable habitat (appropriately defined) or a number of individuals that need to be secured.

Where rehabilitation requirements are specifically linked to mining activities, project-level objectives and targets for rehabilitation are typically set in accordance with the *Wetland Offset Guidelines* (SANBI and DWS, 2014).


**Figure 4. Range of typical themes targeted through wetland rehabilitation activities (adapted from SANBI and DWS, 2014).**

Whilst environmental authorizations may define the over-arching rehabilitation outcomes that a mining house is expected to achieve, it is also critical that objectives and targets are set at an individual site level. Here, it is important that targets set are realistic and achievable. Setting of targets should therefore be based on realistic rehabilitation outcomes, which can only be set following detailed planning.

A **Wetland Offset Calculator** (Macfarlane and Holness, 2014) has been developed to support implementation of these Wetland Offset Guidelines. This is an Excel spreadsheet and associated guidance document specifically designed to set wetland offset targets for each of the themes in Figure 4. It may also be used by mining houses during the early planning stages of their mining or other operations, to assess risks involved.

The approach and methodologies used to assess losses and gains as part of this calculator are equally applicable in cases where wetland rehabilitation is not being pursued as part of an offset. Offset currencies nonetheless provide useful measures against which performance targets can be set for non-offset related wetland rehabilitation.

It is worth pointing out that not all rehabilitation projects will aim to promote a return to pre-disturbance conditions. Indeed, there is a growing recognition that wetland rehabilitation should be designed with specific purposes in mind, which may mean modifying attributes of a degraded wetland in order to enhance particular services or habitat attributes that are highly valued by society (see 4.4.2). Where this is the case a clear justification for moving away from reference conditions in preference for an alternative desired state must be provided.

Finally, the feasibility of achieving pre-defined goals should be revisited throughout the design and implementation process to ensure that expectations of the landowner, regulators, and stakeholders are being met. It is here that monitoring and evaluation become critical components of a wetland rehabilitation project (see 6.1).

## 4.3. Site Selection Must Be Carefully Considered and Appropriately Justified

In some instances, rehabilitation projects will be initiated in response to environmental authorization requirements at a particular site. This is typical of on-site rehabilitation activities, in which case planning will be informed by the local context and specific wetland characteristics. In other instances, as is typical of many wetland offset projects, rehabilitation planning will commence without a specific site in mind. Under such circumstances, an opportunity exists to investigate a range of sites and to carefully select one that is best aligned with the goals for the rehabilitation project.

Taking a landscape perspective is critical to such planning (as described in the principles, Chapter 3). This is important because mining impacts often extend beyond a particular site and impact on water resources at a much broader scale. Rehabilitation also provides an opportunity to contribute to broader societal imperatives and if carefully planned, can make a meaningful contribution towards water resource management and conservation objectives. Key social priorities may include very poor water quality or rapid sedimentation that threaten an important water supply dam. Conservation priorities on the other hand are often directed towards protecting highly threatened species and habitats.

Once goals have been clearly formulated, site selection criteria need to be developed to guide the prioritization process. A range of ecological criteria have been identified as part of the Wetland Offset Guidelines in order to guide this process and to assist regulators in evaluating the suitability of potential offset sites. From a water resources perspective, criteria include targeting specific wetland types, distance from the impacted wetland and the suitability of the site to compensate for key regulating or supporting services. From an ecosystem conservation perspective, criteria such as alignment with regional and national conservation plans and the viability of the site in maintaining conservation values are key considerations.

The risk of land use change and catchment-related impacts undermining the success of rehabilitation initiatives should also be taken into account. Permanent modification of surface and groundwater hydrology that mining, especially opencast mining, frequently brings about is a key risk. As is the risk of future mining activities that may directly or indirectly impact on wetland rehabilitation projects. It is therefore important to not only consider existing mining activities but to also integrate information on other mining rights. Other land use changes, such as urban development that increases flood peaks, can also increase the risk of erosion and structural failure. It is therefore useful to consider mining rights and developments within the catchment that could increase risk of failure as part of the site selection process.

Once appropriate site selection criteria have been defined, site selection typically commences with the consolidation of available information that can best represent these criteria in a spatial way. Fortunately a wide range of spatial data is now available to inform planning of this nature and includes national and regional-scale wetland mapping, water resource information and systematic conservation plans. The availability of information varies across different areas but it is important that such information be obtained and that this is integrated into the site selection process. Geographic Information Systems (GIS) can be used to inform the site screening process as they provide a suitable spatial platform through which to undertake multi-criteria analyses.

Once potential focal areas have been identified, desktop screening is typically undertaken by interrogating aerial photography and undertaking rapid site assessments. Such an approach is particularly useful when screening sites to meet multiple rehabilitation objectives. Final site selection must however be based on a thorough assessment of local site conditions, during which a range of practical considerations will also need to be taken into account. Some of the most important practical considerations include:

- ***Accessibility:*** Depending on the nature of planned rehabilitation, it may be necessary to convey people, equipment and materials to and from a site. It is therefore important to consider accessibility during site selection and to engage with prospective land owners on these matters.
- ***Expected outcomes:*** Opportunities to meet rehabilitation goals are highly variable between sites. Key factors that affect this include the size of the wetland, longitudinal slope, current state, habitat attributes and the extent of rehabilitation opportunities on offer. It is therefore important that opportunities be appropriately assessed, at least through a rapid site-based assessment as part of the site-selection process.
- ***Ownership and control:*** Where sites are owned by third parties, issues such as financial compensation, management responsibilities and the like will need to be resolved prior to project

implementation. Concerns over long-term control are also very real in some contexts such as in communally owned land where land rights and aspirations are shared by communities. Consideration should therefore be given first to properties already owned by the proponent within the focal area being investigated.

- ***Permanence of conservation outcomes:*** Whilst this is an important consideration for any rehabilitation project, it is particularly relevant where rehabilitation is linked to offset commitments. This is because formal protection of wetlands is a standard requirement for any offset project. It is also important to note that formally securing offset sites for longer than the minimum requirement generates higher offset gains[11].Options for legal protection will therefore need to be discussed as part of the landowner engagement process.
- ***Financial cost:*** The cost-effectiveness of rehabilitation can also vary significantly. This is often linked to the type of rehabilitation interventions required, with hard engineered structures typically being most costly to implement. All of these are likely to be influenced by the site characteristics therefore appropriate scoping and cost estimates should be undertaken at least at a superficial level as part of the site selection process.

Of the range of site selection criteria discussed, issues of land tenure and risks that could compromise rehabilitation outcomes (e.g. future mining activities) are particularly relevant in the mining landscape. There are also concerns that multiple mining houses may target the same wetlands to meet their environmental authorization requirements. Site selection should therefore be undertaken in a systematic manner with appropriate regional collaboration to ensure that rehabilitation outcomes are optimised through wetland rehabilitation activities (see Box 4).The outcomes of such an assessment are typically documented as part of the strategic planning process.

**Box 4. Opportunities for regional collaboration**

The notion of 'no net loss' of wetland ecosystems is becoming entrenched in policy and practice. This is leading to an increasing demand for suitable wetland rehabilitation sites in mining landscapes. With this, comes the risk of the same wetlands being targeted for rehabilitation by different mining houses. There are opportunities to maximise outcomes by working collaboratively rather than undertaking planning on a case-by-case basis. The following points are worth considering in this regard:

- A ***regional database*** should be developed by authorities, which clearly documents the location of wetlands being targeted for rehabilitation subject to existing licensing or offset requirements. By making this information available, this would help to prevent different mining houses targeting the same areas for wetland rehabilitation.
- ***Strategically important areas*** for wetland rehabilitation should be identified by conservation agencies and regulatory authorities. This would serve to simplify the planning process for mining houses and would help to direct wetland rehabilitation activities to high priority areas.
- Maximum ecological outcomes could be achieved through implementing ***regional-scale offset/ wetland rehabilitation projects*** that target areas of highest importance. Such an approach would also help to ease the burden of management and monitoring through the economies of scale that could be achieved through such an approach.

## 4.4. Rehabilitating Wetlands Requires Proper Understanding and Planning

Once a rehabilitation site has been selected, a wetland rehabilitation plan must be developed to guide the rehabilitation process (Box 5).Developing such a plan is a technical exercise which needs to be done by experts, using appropriate methods and protocol to avoid mistakes and the wasting of significant time and

[11] According to the Wetland Offset Guidelines (DWS and SANBI, 2014), any offset site must be secured through an appropriate legal mechanism in order to prevent change of land use to a type incompatible with maintaining desired wetland offset state. The minimum requirement here is that the site is secured through a conservation servitude or similar mechanism for at least 30 years or the period for which residual impacts of the specific project would endure. Where the proponent commits to a higher level of protection for a longer period, the gains from offset activities may be adjusted by up to twice that obtained when minimum protection mechanisms are applied.

resources. Whilst a range of people may be involved in the planning process, this should include at a minimum:

- **Wetland ecologist:** A wetland ecologist is required to compile a specialist wetland assessment report and to ensure that ecological aspects are addressed as part of the rehabilitation process. Registration with the *South African Council for Natural Scientific Professions* (SACNASP) in an appropriate field of practice with good wetland rehabilitation experience should be regarded as minimum requirements.
- **Rehabilitation engineer**: An engineer is typically required to design interventions which are fit-for-purpose and aligned with best engineering practice. The selected engineer should be registered with the *Engineering Council of South Africa* and have experience appropriate to the level of engineering input required[12].
- **Environmental Assessment Practitioner**: In most instances, a suitably qualified EAP will need to be contracted to help address legal requirements including the coordination of an appropriate public consultation process.

Technical insight and experience is also needed to engage with the proponent/landowner/land-users of the site in order to understand what practical constraints or limitations may apply. These may include concerns regarding impacts to infrastructure (e.g. road crossings) and land use (e.g. agricultural lands) together with how management may need to change post-rehabilitation (e.g. livestock grazing, fire management etc.). It is therefore critical that proposals are discussed, understood and supported by the proponent, landowner and/or other key users before commencing with detailed planning (as described in 4.1).

**Box 5. What is a wetland rehabilitation plan?**

A wetland rehabilitation plan is a document that is developed by specialists to guide the implementation of a wetland rehabilitation strategy. The strategy refers to the specific methods employed or chosen to bring about desired outcomes that are part of the overall plan. These methods are aimed at addressing specific impacts and need to take into consideration the surrounding environmental conditions and land-use practices. In a mining context, the rehabilitation plan and associated strategies must be developed according to the regulators' specifications and must ensure that anticipated post mining land-use is factored into the design of the rehabilitation strategies and overall plan to ensure successful long-term maintenance. The plan usually forms part of an environmental authorization process and is typically submitted to relevant authorities for approval as supporting documentation to an environmental authorisation. The plan is generally compiled by an EAP appointed by a mining house and includes inputs from wetland specialists and environmental engineers. Content of the plan may vary and depends on the scope and level of assessment undertaken. This may include:

- ***Strategic planning***: This is typically relevant for large projects where wetland rehabilitation is typically taken across a number of sites. Activities typically focus on clearly defining desired outcomes, spatial planning, site selection and outlining a broad plan of action for project implementation.
- ***Conceptual planning***: Once a particular site/sites have been identified, a scoping exercise is typically undertaken to assess the financial, practical and ecological feasibility of the project. The outcomes of this phase assist in evaluating options necessary to inform site selection.
- ***Detailed planning***: This stage involves detailed site work, specific engineering input, and the development of bills of quantities, costings and supporting documentation to inform the implementation process.

### 4.4.1. Key elements to be addressed during the preliminary planning phase

Wetlands are a function of the catchment and ecological setting in which they are located. This gives rise to a variety of wetland types (Figure **2)**, each of which poses different challenges to successful rehabilitation. It is therefore absolutely essential that the drivers of wetland formation and the processes operating within the wetland are appropriately understood. Initial planning is therefore typically informed by a wetland assessment with a key focus on identifying impacts and understanding the drivers that influence wetland

[12]Recommended levels of competency for designing rehabilitation structures are detailed in Chapter 16 of WET-RehabMethods (Russel, 2009).

form and function. Preliminary stakeholder interaction is also typically initiated at this point through focussed discussions with the landowners about proposed rehabilitation activities.

Once an appropriate understanding of the site has been obtained, and the impacts on the wetland have been identified, opportunities for securing and enhancing key wetland functions or values can be investigated. This initial planning is typically undertaken by the wetland specialist although engineering support may also be required. In some instances, this may need to be informed by specific research that may focus around aspects such as how best to enhance a particular service, improve a particular habitat or address a particularly complex problem.

This exploratory phase typically culminates in the development of a **Conceptual Rehabilitation Plan** which includes:

- A contextual overview of the site.
- Wetland mapping and classification.
- An assessment of wetland condition including the level of modification to key wetland drivers.
- Evaluation of ecosystem goods and services provided by the wetland.
- Identification of key wetland impacts and how these could be halted or remedied.
- The development of a preliminary wetland rehabilitation strategy.
- An evaluation of potential ecological outcomes linked to the objectives and targets of the project.

The Conceptual Rehabilitation Plan document provides a preliminary basis against which to compare the suitability of different sites for rehabilitation and to inform further planning without going to the initial expense of developing detailed rehabilitation plans.

**WET-Health** (Macfarlane *et al.,* 2008) is a commonly applied tool for assessing wetland health. It is also particularly useful in helping to understand the drivers of change and impacts to a wetland.

This tool can also be used to forecast ecological outcomes in terms of an expected improvement in wetland vegetation, hydrology or geomorphology. Other tools such as WET-EcoServices (Kotze *et al.,* 2009a) are also available and can be customised to obtain an indication of expected improvements to specific wetland services.

*Wetland in a grazing landscape that is being severely eroded through head-cut advancement.*

### 4.4.2. Designing interventions that are fit-for-purpose

Once a site has been selected and in-principle support for the proposed rehabilitation strategy has been obtained, a **Detailed Wetland Rehabilitation Plan** is developed in line with legal requirements. There is also almost always more than one way to work toward project objectives. Cross-disciplinary collaboration is therefore beneficial to successful project design. This is typically achieved through collaborative site visits and discussions between project team members where ecological, engineering and social aspects can be appropriately integrated. This detailed plan typically includes refinement of the initial rehabilitation strategy, detailed engineering drawings and site instructions, bills of quantities and accurate cost estimates. The plan should also include a schedule of the proposed activities to be undertaken as part of the rehabilitation

project. In a mining-related wetland rehabilitation strategy, it may be appropriate to phase the rehabilitation implementation to coincide with the mine schedule (how the mining will progress, in which direction and over what time period). This would enable the mining house to align the costs of implementation with the project schedule and overall budgeting strategy for the mining project.

The wetland assessment together with baseline monitoring results is also typically updated concurrently with the detailed rehabilitation plan to provide a baseline against which project success can be evaluated.

Wetland formation and habitat attributes are driven largely by the availability and movement of water through a wetland. The provision of wetland services, such as water quality enhancement, is also largely dependent on wetland hydrology with diffuse surface flows necessary to maximise water quality enhancement (see Box 7). The establishment of favourable hydrological conditions is therefore widely recognised as central to effective rehabilitation. Interventions that can re-instate suitable hydrological regimes are therefore often most successful in meeting rehabilitation objectives. This means that particular attention should be given to designing structures with the most beneficial hydrological outcomes in mind. Aspects such as spillway height in the case of weirs and the interval between successive interventions should therefore be carefully considered during the detailed planning process. If hydrological regimes can be successfully reinstated, vegetation and other biota will tend to follow with limited further external intervention.

Wetland systems are also dynamic and are highly responsive to changes in water inputs from the upstream catchment. The risk of damage to structures is particularly high in wetlands subject to high flood peaks and where wetland attributes such as slope and width give rise to high flow rates. Any rehabilitation structures must therefore be designed with due consideration of flood risks to ensure that they are strong enough and durable enough to withstand flood events. Risks of structural failure are particularly high in floodplain wetlands characterised by high flows and dynamic channels. It is because of these risks that the Working for Wetlands Programme has moved away from working in active floodplain systems. The need to accommodate for long-term hydrological changes linked to predicted land use and climate change needs to be factored into the design process. Interventions should therefore be designed to limit the risk of structural failure and the need for ongoing maintenance.

A wide range of intervention options are available to address different wetland impacts. Interventions selected will need to be matched with the type of impact and aligned with the specific objectives in mind. Guidelines for selecting and designing appropriate interventions are included in the WET-RehabMethods manual (Russel, 2009), which is an essential read for anyone involved in the technical aspects of wetland rehabilitation. It is important to note however that whilst designs from textbooks and other reference material are a good starting point, they need to be tailored according to local site conditions and specific rehabilitation objectives.

The choice of materials used should also be carefully selected to ensure that the need for ongoing maintenance is minimised. This is particularly relevant in the mining landscape where a range of specific challenges and constraints linked to water quality need to be accounted for during the design process. An overview of some of these key challenges and recommendations are outlined in **Table 1.**

Long-term use of the wetland must also be considered when finalising the choice of interventions and materials to be used. Livestock for example can trample structures, particularly where they provide a logical opportunity for crossing a drain or channel. This can undermine any attempts at re-vegetation and may mean that exclusion fences or other deterrents may be required, at least until good vegetation cover has become established. Earthen berms are particularly susceptible to trampling and options to improve the stability of these structures may also need to be considered. The integration of cattle and vehicle crossings, concrete road strips and the like may also need to be integrated in some instances. Fire is another management aspect that needs to be taken into account as it can destroy some materials commonly used for wetland rehabilitation.

The rehabilitation and management of buffer zones adjacent to wetlands is another important aspect that should ideally form part of any wetland rehabilitation strategy. Buffers are known to trap diffuse pollution, helping to reduce the impacts from adjacent land uses (Macfarlane *et al.,* 2014). This is particularly relevant for seepage wetlands, where the removal of agriculture or invasive alien plant species from wetlands and buffer zones may be sufficient to improve the functioning of these wetlands. Buffer zones also provide important habitat for wetland-dependant species. Actions designed to protect and manage terrestrial buffer zones are therefore recognised in the Wetland Offset Guidelines as legitimate activities to help meet ecosystem conservation targets (SANBI and DWS, 2014).

**Table 1. Key challenges of wetland rehabilitation in a mining landscape and recommendations for addressing these.**

Gabion weirs are commonly used for wetland rehabilitation. The use of gabion structures should be considered carefully and even avoided and/or limited within the mining landscape as poor water quality, such as the formation of Acid Mine Drainage (AMD), can compromise the effectiveness and longevity of such rehabilitation structures. For example, water with low PH will corrode the wire mesh used to make gabion baskets (even when plastic-coated) and thus result in the premature collapse of these structures.

Water quality can also dramatically affect plant community structure. High salinity or nutrient levels for example, may promote the establishment of tolerant species at the expense of more desirable ones. The bulrush (*Typha capensis*) and common reed (*Phragmites australis*) are species that can often proliferate under these conditions. It is important to take these factors into account when choosing plant species for re-establishment and when evaluating potential long-term project outcomes. Further guidance for using vegetation in wetland rehabilitation is provided in Chapter 6 of the WET-RehabMethods manual (Russel, 2009).

Whilst not only relevant in mining areas, dispersive soils can also lead to structural failure. The engineering properties of soils should therefore be assessed as part of the rehabilitation planning process. In some instances, it may be possible to improve these properties through the addition of lime or other products. Similarly, the effects of changing water quality on soil properties may also need to be considered.

Whilst concrete structures are generally more resilient than gabions, their integrity can also be affected by water quality. For example, acids cause deterioration of concrete by dissolving both hydrated and un-hydrated cement compounds, as well as calcareous aggregates. In most cases the chemical reaction forms water-soluble calcium compounds, which are then leached away. Siliceous aggregates are resistant to most acids and other chemicals and are sometimes specified to improve the chemical resistance of concrete. A detailed water characterization may therefore be necessary to understand water quality risks and adapt implementation accordingly.

From a wetland perspective, the presence of numerous depressions (pans) in the Mpumalanga Highveld, as well as extensive hill slope seepage wetlands, is particularly interesting but poses very specific challenges from a wetland rehabilitation perspective (Box 6). A broader look at the wetlands catchment may be required when managing hill slope seepage wetlands due to possible interflow links that may extend way beyond the boundary of the wetland itself. While pans have more easily defined surface catchments, one needs to be aware that groundwater links may extend beyond the surface catchment boundary. Scenarios that include a combination of shallow interflow and groundwater links will always pose unique challenges when dealing with these types of wetlands.

**Box 6. Pans and hill slope seepage wetlands common in the Mpumalanga Highveld**

Pan wetlands, which are currently classified as a type of depressional wetland, are a regular occurrence in the Mpumalanga Highveld and are frequently subject to mining-related activities that have a direct or indirect impact on them. Pans are different to most other wetland systems in the region as they are mostly endorheic (inward draining systems with no outflow) and are maintained by a combination of surface flow, interflow and sometimes also deeper groundwater, and typically have complex geochemistry as a result. This means that water quality and quantity in pans (aspects affecting pan functioning) are directly influenced by activities in the catchment of the pan. Assessing the Present Ecological State (PES) or health of pans is problematic as none of the wetland assessment tools currently available provide an adequate means for doing this. A thorough pan assessment requires a multimetric approach by studying various levels of ecosystem functionality to adequately assess pan health and ecological importance and sensitivity.

*A pan in the Mpumalanga Highveld*

The rehabilitation of pans generally also requires a different approach to other wetland types. Rehabilitation activities for pans are generally more appropriately designed to address issues in the pan *catchment* rather than the pan basin itself in order to achieve desired state changes in the pan basin. Water quality issues including geochemistry are also critical to consider in pan rehabilitation. This often results in unique challenges when it comes to trying to rehabilitate pans. The approach towards pan rehabilitation may thus differ from site to site and pan to pan, whilst variation between different types of pan types must also be taken into account. Provision should thus be made for this as well as adaptive management when it comes to wetland rehabilitation projects that include pans.

As with pans, numerous hill slope seepage wetlands occur in the Mpumalanga Highveld and mining-related activities often either directly or indirectly impact on these. Hillslope seepage wetlands are typically characterised by subsurface seepage of water and are maintained by the emergence of interflow and/or shallow groundwater from deeper terrestrial soils in the wetlands catchment. Maintenance of the supporting hydrology and recharge areas for interflow and shallow groundwater are therefore critical to the maintenance of not only hill slope seepage wetland habitat, but most wetlands on the Highveld. Unlike pans, often activities can be undertaken to address problems within the seepage systems themselves such as the closing of drains and/or the pulling back of agricultural activities (such as ploughing in the wetland) from the systems. However, it may also simply be the provision of a suitable buffer around the system (provided the hydrological drivers remain intact) that could potentially result in a marked improvement in the system. In some cases appropriate rehabilitation may thus be more related to improved long-term management of the system than to direct interventions. Provision should thus be made for more innovative approaches when it comes to rehabilitating these systems which should also include adaptive management.

*A hillslope seepage wetland in the Mpumalanga Highveld*

## 4.5. Costs Associated With Planning Of Wetland Rehabilitation Project

The cost of wetland rehabilitation should generally be spread across three project management phases illustrated in Figure 3 i.e. planning, implementation, and monitoring and long term management. To avoid repetition, and to emphasize the fact that costing should be taken into account from the planning phase, this section covers costing associated with wetland rehabilitation at all three project management phases.

Budgeting provision generally needs to be made for costs associated with the following components of wetland rehabilitation planning:

1. Developing and compiling a situation assessment.
2. Specialist investigations (wetland specialist studies) including intervention concept designs (usually undertaken by a suitably qualified engineer).
3. Stakeholder consultation and environmental authorization.
4. Development of the rehabilitation strategy and compilation of a rehabilitation plan.
5. Implementing the rehabilitation strategy.
6. Geotechnical investigations and site surveys if appropriate.
7. Detailed design.
8. Compilation of the necessary applications for regulatory authorisation
9. Collection, compilation and assessment of baseline monitoring and evaluation data (Box 8).
10. Compilation of a CEMP and specific construction notes.

It is not unusual to notice varying costs when planning a number of the same structures within the same system. Costs can be expected to be variable and will be affected by structural design, ease of site accessibility and the condition of the construction site. Within the mining landscape, engineering and scientific advice is also required for each wetland rehabilitation project. There may be specific material and coagulants used to bind the concrete to prevent cracking due to high acidic water and these may have direct impacts on bill of quantities of these structures during project planning. These elements will further influence costs. Geotechnical investigations, hydraulics and acidic water or soil contamination assessments are usually necessary to develop appropriate rehabilitation strategies and management objectives. These elements go hand in hand with structural design, to ensure that structures operate as intended.

It is emphasised that both a short- and long-term financial provision must be made available during financial planning of amine comprising of initial capital costs for planning and implementation of rehabilitation, followed by ongoing operational costs for maintenance. In terms of costing the following should be noted:

1. Short-term financial provision is normally catered for under operational costs of the mine as this consists of cost associated with concurrent rehabilitation.
2. Long term financial provision is normally catered for under both operational and closure costs.

It should however also be indicated that financial provision can sometimes only be made available as part of the operational costs of the mine depending on the scale of mine and associated impacts to wetlands and determined wetland rehabilitation requirements for that specific mine. Estimates for costs should be included in the initial financial plan and be updated throughout the project life cycle, as appropriate. In early stages of the mining life cycle, estimates are probably imprecise, so it may be helpful to provide an accompanying description of the key factors affecting rehabilitation costs and how these factors may change.

In addition to ensuring that costs are adequately captured in the budget for the mine's operation, it is also important to ensure that yearly provisions are made throughout the entire lifetime of the mine in the accounts of the operating company, in line with relevant accounting practices and legal requirements. These provisions should take into account the overall estimated rehabilitation cost allocated throughout the timeline of the mine, while accounting for progressive/concurrent rehabilitation activities.

For each of the three project management phases, the location of the target wetlands (onsite versus offsite) and the mining sequence and timeframes should guide the rehabilitation implementation timeframes as these aspects will have a direct impact on the costing associated with each of the levels. The following are broad guidelines that should be applied to the timing of wetland rehabilitation within the mining landscape:

- **Onsite wetland rehabilitation**: in cases where onsite wetland rehabilitation is being planned, which will be influenced by mining activities, it is necessary that the timing of rehabilitation is planned such that the anticipated impact first occurs before rehabilitation is implemented.

- **Offsite wetland rehabilitation:** in cases of offsite rehabilitation, where there is no direct dependence of rehabilitation on the degradation or loss of other wetlands due to mining, ideally the rehabilitation should precede the loss of wetlands within the mining landscape in order to avoid a period when there is a net loss of wetlands functionality, before the benefits of rehabilitation take effect.

It is also important to note that the costs associated with wetland rehabilitation will likely be highly variable for each project depending on the mine plan, mining methods, scale of mining and the extent of wetlands affected. Each wetland rehabilitation project may differ and have unique site specific requirements and different objectives. It can be expected that these differences and unique requirements will influence the monitoring and evaluation as well as maintenance costs.

## 4.6. Checklist for Wetland Rehabilitation Planning

This chapter dealt with several 'key' elements that are integral to the planning phase of any wetland rehabilitation project taking place in a mining landscape.

EAPs, mining houses and regulatory authorities should ensure that each of these key aspects is addressed in the planning of a wetland rehabilitation project. To ensure that key elements of wetland rehabilitation planning have been adequately considered and addressed, the wetland rehabilitation plan should provide answers to the following questions:

1. Is rehabilitation planning being undertaken by specialists with appropriate qualifications and experience?
2. Are stakeholders identified, informed and consulted regarding the proposed rehabilitation action and in line with legal requirements?
3. Are legal requirements including relevant conditions associated with relevant authorisations clearly understood and integrated into the planning process?
4. Has the site selection process been documented and motivated and communicated to the stakeholders?
5. Have landscape-scale risks including land use change and catchment-related impacts been taken into account during the site selection process?
6. Have practical considerations including accessibility, expected outcomes, ownership and control, permanence of rehabilitation outcomes and financial costs been duly considered as part of the site selection process?
7. Has the exact location, name and description of the target wetlands been provided to all stakeholders?
8. Has the wetland delineation and classification been done in accordance with the relevant wetland delineation guidelines (DWAF, 2005 or as updated) and South African wetland classification system (Ollis *et al*., 2012)?
9. Was the wetland assessment undertaken using recognised and applicable tools and methods (e.g. Wet-Management series, SANBI and DWS (2014) Wetland Offset Guidelines)?
10. Has the socio-cultural and heritage importance of the wetlands been adequately considered?
11. Have desired rehabilitation outcomes, including clear, measurable targets and objectives, been documented?
12. Has due consideration been given to the establishment of favourable hydrological regimes during detailed planning?
13. Has flooding and the risk of intervention failure been considered during intervention design?
14. Have water quality risks been duly considered when selecting materials for construction purposes?
15. Have management considerations, design specifications and associated costs been integrated into the rehabilitation planning process?
16. Has appropriate planning and financial provision been made to formally documenting baseline conditions and long-term monitoring and evaluation requirements.

A complete checklist is provided in Appendix A for quick reference by all user groups.

**Box 7. Zaalklapspruit wetland case study: Rehabilitating a wetland subject to acid mine drainage impacts**

The Zaalklapspruit wetland is located close to Emalahleni (formerly Witbank) in the Mpumalanga Highveld and was targeted as a mining-related wetland rehabilitation demonstration project by SANBI, Department of Environmental Affairs (Working for Wetlands) and the CSIR with funding from the coal mining sector through the Coaltech Research Association. The site is located directly downstream of mining operations and receives water contaminated with mining pollutants.

A desktop review of available information was undertaken as part of the rehabilitation planning process in order to understand which attributes were most important for water quality enhancement. This revealed that diffuse flow patterns, shallow surface water depths and vigorous plant growth are amongst the key attributes that promote the desired water quality enhancement functions. A portion of the wetland that had been heavily impacted by historic agricultural activities but still had good rehabilitation potential was selected for detailed planning. Rehabilitation interventions were then designed to enhance the desirable wetland attributes. These focussed on raising the water table, slowing down water flow and allowing water to distribute across the width of the wetland again rather than racing through a large incised channel. This entailed the construction of a series of concrete weirs down the central channel and the construction of supplementary concrete walls, earthen berms and earthworks in the broader wetland system. Gabion weirs were specifically not considered due to concerns about corrosion of gabion wire baskets by the highly acidic water.

*Site visit by Coaltech, SANBI and CSIR to inspect wetland rehabilitation measures at Zaalklapspruit.*

Within the first year following rehabilitation, monitoring undertaken by the CSIR showed remarkably positive outcomes (de Klerk *et al.,* 2015). The pH and alkalinity were increased to levels in the natural freshwater range, where many of the metals become insoluble and precipitated out of the water column. The sulphate concentration decreased by 65% and the total dissolved solids decreased by 50% compared to pre-rehabilitation levels. The improvements in water quality provided by the rehabilitated wetland translate to an economic value of between **R2.6 - R11.4 million per year**[13] (de Klerk *et al.,* 2015). The benefit is considered high when compared with the R1.7 million invested in rehabilitation at the site. Little is known about the long-term potential of wetlands to deliver water quality enhancement benefits in this environment. Longer-term

[13] The economic valuation is currently expressed as a range because the period of monitoring has not yet been long enough to accommodate seasonal fluctuations. As a result maximum and minimum values have been provided.

monitoring is being implemented to shed further light on the ability of wetlands to address water quality impacts linked with AMD over longer periods of time.

Whilst the initial responses were above expectations, ongoing monitoring has revealed that more could be done to improve rehabilitation outcomes. Whilst the structures function well during summer periods when flows are high, flows again become concentrated over a small portion of the wetland during low flow periods. This is linked to minor topographic variations in the wetland, including old ridges formed during historic cultivation practices. This means that the effective working width of the wetland declines considerably during the dry season, when pollutants are most concentrated. Receding water levels and associated desiccation also means that algal growth needs to be re-initiated during the summer period which could lead to a lag before water quality functions are optimised.

These issues will be resolved by making very minor adjustments to spillway heights and undertaking further earthworks to encourage water to spread out further during low flow periods. This illustrates the importance of adaptive management or a learning-by-doing approach in ensuring that rehabilitation benefits are optimised.

*A view upstream of one of the rehabilitation structures in the Zaalklapspruit wetland. Reduced flow rates and diffuse, rather than concentrated flows have contributed significantly to addressing water quality impacts caused by AMD.*

# 5. IMPLEMENTING A WETLAND REHABILITATION PROJECT

The success of a wetland rehabilitation project ultimately depends on successful project implementation and appropriate aftercare. Implementation should therefore be guided by proper planning and be supported by oversight and monitoring by suitably qualified individuals. These requirements are typically integrated into the Construction Environmental Management Programme (CEMP). This is essentially an environmental management tool that should address all aspects related to both the implementation and post-implementation (operational) phases of the project. The CEMP typically forms part and parcel of the contract or agreement between client and any other implementing agent. Aspects of particular importance that should be addressed during the implementation phase include:

- ***Planning of construction activities*:** Special consideration needs to be given to the equipment to be used in rehabilitation and how best to access sensitive areas. Where construction is done with the aid of large machinery, management oversight is particularly important and should be guided by well formulated and communicated method statements. This should specifically address site access and measures to minimise unnecessary disturbance and potential sedimentation risks. Safety risks also need to be appropriately considered and managed, particularly when working in deep drains subject to bank collapse or in situations where water quality poses a health risk.
- ***Ensuring appropriate project oversight*:** Whilst successful implementation ultimately rests with the project manager/implementer, it is still critical that regular monitoring be undertaken to ensure that implementation proceeds according to specification. Whilst general oversight could be undertaken by the proponent, the support of the wetland ecologist and engineer responsible for developing the plan is strongly recommended as their involvement will increase the chance of the final interventions delivering intended outcomes in line with the rehabilitation plan. This also provides an opportunity to adjust intervention designs to cater for local site conditions and outcomes which cannot always be predicted during planning.
- ***Ensuring appropriate mitigation and management of environmental impacts during construction implementation*:** These requirements are typically integrated into the CEMP and it is important that regular monitoring be undertaken to ensure that implementation impacts are mitigated and managed. Management oversight of this by a suitably qualified environmental practitioner is important, not only to assist with compliance monitoring, but also to advise on specific environmental issues that may emerge during construction, or related to particular environmental risks or mitigation requirements that may arise during implementation.
- ***Ensuring appropriate management of any health and safety risks associated with construction implementation*:** As with the management of environmental impacts, the health and safety requirements are typically integrated into the CEMP and it is important that regular monitoring be undertaken to ensure that health and safety risks are appropriately considered and managed. Most mining houses also have their own specific health and safety risk procedures and requirements and it is critical that these are complied with and integrated into any CEMP for a particular mining-related wetland rehabilitation project.
- ***Maximizing social benefits***: Another aspect that should be considered is the social benefits of the project. Working for Wetlands has demonstrated that wetland rehabilitation can be done with limited mechanical intervention and in ways that can maximise employment and capacity building opportunities for vulnerable and marginalised communities. Mining houses should therefore consider the choice of more labour-intensive options as this can result in employment and other opportunities that have additional positive benefits for local communities.
- ***Monitoring and maintenance:*** Rehabilitation inevitably requires maintenance, particularly during the first few years when the wetland is adapting to new hydrological conditions. Appropriate provision must therefore be made in the CEMP to ensure that these longer-term aspects are duly addressed. This is dealt with in further detail in Chapter 6. If wetland rehabilitation implementation is phased to coincide with the mine schedule (which is the schedule for how the mining will progress, in which direction and over what time period), then it is important to consider aligning the monitoring schedule with this.

## 5.1. Costs Associated With Implementation of Wetland Rehabilitation Project

Rehabilitation implementation should be considered as a core part of the business, and should be fully integrated within the planning of any mining operation (refer back to section 4.5 if necessary). Similarly, the rehabilitation plan and closure plan need to be fully integrated, so that activities undertaken during operation and closure of a mine do not impair the ability to execute the rehabilitation plan. The implementation of the rehabilitation plan involves carrying out the actions and processes detailed in the plan to meet the established objectives. While specific techniques and practices employed will be dependent on the objectives of the rehabilitation plan and on the characteristics of the site in question, the following costs should generally be provided for.

1. **Costs associated with land acquisition or compensation**: In the case of offset activities, a major cost is likely to relate to the direct and indirect transaction costs of purchasing or otherwise formally securing wetland rehabilitation sites. Where sites are not purchased, compensation for lost revenue or uses may be required.
2. **Health and Safety associated costs**: Health and safety should always be the first concern. Adequate induction must be undertaken by the mine to ensure that all safety regulations are understood and taken into consideration while performing duties within the mining environment. Cost for undertaking full induction, including medicals, should be provided for within the project implementation and operational budget. An overview of some of the typical risks that workers may encounter during wetland rehabilitation, together with recommendations for safety measures are included in Wet-RehabMethods (Russel, 2009) and can be used as the basis for risk assessments and to complement the existing induction requirements of the mining houses.
3. **Securing the resources (financial and otherwise) required for the implementation of the wetland rehabilitation plan**: The primary costs include purchasing of materials, securing required machinery and equipment, and labour costs (including training) associated with intervention construction. Costs for appropriate project oversight and reporting including provision of technical support to the construction/implementation teams also needs to be catered for. Additional costs may be linked to compliance with CEMP requirements including monitoring and evaluation requirements.
4. **Concurrent wetland rehabilitation costs**: Progressive rehabilitation should be undertaken wherever possible.
5. **Stakeholder engagement associated costs**: Expertise, resources and skills of stakeholders should be involved wherever possible to help implement the rehabilitation plan, e.g. local communities can be involved in replanting programs. Sharing information on progress and activities related to rehabilitation on a regular basis will foster the relationship with stakeholders and help identify mutual benefits. Management of stakeholders' expectations is necessary to accomplish a win-win outcome in this process. Mining houses should provide adequate resources (financial and otherwise) to ensure effective stakeholder participation and engagement throughout the wetland rehabilitation process.

During the implementation of the project, the objectives of the rehabilitation plan and processes may need to be modified to reflect the operating environment. Such modifications and the reasons for them should be clearly communicated to all stakeholders. There may be additional costs associated with this and provision should be made in the overall budget for such circumstances.

## 5.2. Checklist for Wetland Rehabilitation Implementation

This chapter dealt with several 'key' elements that are integral to successful project implementation and appropriate aftercare of any wetland rehabilitation project taking place in a mining landscape.

EAPs, mining houses and regulatory authorities should ensure that each of these key aspects is addressed when it comes to wetland rehabilitation implementation. To ensure that key elements of wetland rehabilitation implementation have been adequately considered and addressed, the following questions should be asked:

1. Has adequate financial provision been made to account for the full suite of implementation costs?

2. Is rehabilitation implementation being undertaken by appropriately experienced construction and civil contractors?
3. Has adequate training been made allowance for, including budget considerations, to ensure the appointed contractors and/or workforce is suitably prepared to work within a wetland and mining environment?
4. Have the health and safety issues associated with working in a wetland and mining environment been clearly spelled out and are they understood by the contractor?
5. Has a Construction Environmental Management Programme (CEMP) been designed to adequately address construction risks?
6. Are site-specific construction notes associated with interventions within the mining environmental clearly spelled out within the plan and have these been communicated to the contractor?
7. Does the plan make provision for implementation support to the contractor by the design engineers and other specialists that assisted in compilation of the plan?
8. Is management oversight sufficient given the scale and intensity of planned operations?

A complete checklist is provided in Appendix A for quick reference by all user groups.

# 6. MONITORING AND LONG-TERM MANAGEMENT

Any wetland rehabilitation requires monitoring and long-term management. It is therefore essential that long-term management is factored into planning and costing, that the necessary management measures are implemented and that the effectiveness of rehabilitation is monitored and reported on. Without monitoring there is no way to determine whether the rehabilitation measures implemented has achieved the desired outcome and without long-term management, it is unlikely that the desired outcomes will be achieved.

This chapter deals with the monitoring and long-term management of any wetland rehabilitation project taking place in a mining landscape. Mining houses should therefore ensure that both these aspects are addressed in any wetland rehabilitation project in order to reduce project risk and make the regulatory approval process easier. Regulatory authorities should therefore check that these two aspects have been considered as part of any mining-related wetland rehabilitation project.

Guidance on what may be important to consider when it comes to monitoring and long-term management of a mining-related wetland rehabilitation project is provided in the sections below. The key aspect that is emphasized though is that **wetland rehabilitation is a long-term commitment**. Monitoring of a project's performance, which includes assessing the environmental outcome of the interventions implemented, is considered vital to inform the evaluation of wetland rehabilitation success (Cowden and Kotze, 2009). Monitoring and evaluation is thus fundamental to the wetland rehabilitation process. Whilst the details of monitoring and evaluation will vary according to the specific site and the objectives set, it is essential that monitoring specifically addresses the ecological outcomes achieved as part of the project and the structural integrity of rehabilitation interventions. The latter is covered in more detail in Chapter 6.2.

Recognising that wetland rehabilitation is a long-term commitment is fundamental to any rehabilitation project. This is essential to ensure that desired outcomes are realised and that these are not degraded over time. The project does not end on completion of implementation, but needs to continue in the form of monitoring and evaluation, maintenance of the interventions, and adaptive management to ensure the rehabilitation objectives are achieved over time. It is therefore critical that both the proponents/implementers (such as a mining house) and affected landowners (in cases where the implementer is not the landowner) fully understand the consequences of such a rehabilitation project which may require a long-term commitment, as well as some form of agreement (refer to Box 3 for a more detailed explanation of this) ensuring such commitment. Even if the interventions are designed for self-maintenance (which would mean less long-term maintenance), wetland rehabilitation still generally requires long-term stewardship, the resources required to support this stewardship, and a commitment to delivering this stewardship.

**WET-RehabEvaluate** (Cowden and Kotze, 2009) is a key tool when it comes to developing a monitoring plan as it provides guidelines for monitoring and evaluating wetland rehabilitation projects. Four important aspects indicated in WET-RehabEvaluate that should be considered when developing a monitoring and evaluation plan to specifically address the ecological outcomes achieved as part of the project include:

1. The level of monitoring;
2. The frequency and timing of monitoring;
3. Who will be responsible for the monitoring; and
4. How monitoring information is collected, stored, accessed and reported on.

## 6.1. Monitoring Of Wetland Rehabilitation

### 6.1.1. The level of monitoring

The level of detail of the monitoring to be undertaken can vary from visual evaluations of indicators of erosion to detailed measurement of erosion progression, or in-situ water quality measurements to detailed laboratory analyses. The choice of indicators and detail as to how these are measured therefore largely define the level of detail in monitoring. The level of detail for monitoring and use of specific indicators may be prescribed in conditions in a mining authorisation pertaining to wetland rehabilitation. It is important to check

the relevant authorisations to make sure that the necessary indicators, and level at which these need to be monitored, is covered in the monitoring plan. Whilst the details may vary from site to site and depending on the conditions in the authorisation as well as the indicators being assessed, some fundamentals should always apply:

- The monitoring plan and level of monitoring must be designed so as to be able to determine whether or not the objectives set for the rehabilitation have been met (Cowden and Kotze, 2009).
- Consideration must also be given to making sure that the level of monitoring is suitable for the compliance requirements, which may form part of any authorisations.
- The costs of monitoring should be duly considered when deciding on the level monitoring required.

### 6.1.2. The frequency and timing of monitoring

The frequency and timing of monitoring needs to be stipulated in the monitoring plan and will usually depend on the particular indicators that are being examined and the resources that are available (Cowden and Kotze, 2009). Again, specific conditions in a particular mining authorisation pertaining to wetland rehabilitation may also require monitoring to be undertaken at a particular frequency and with a certain timing. It is important to check the relevant authorisations to make sure that the necessary schedule of monitoring complies with the conditions stipulated and is included in the monitoring plan. Provision should thus be made for specific frequency, timing and duration requirements that may form part of the mining authorisation or Water Use Licence conditions. Again, whilst the details may vary, there are some other key aspects worth highlighting here:

- If wetland rehabilitation implementation is phased to coincide with the mine schedule, then it is important to consider aligning the monitoring schedule with this.
- Seasonality of monitoring needs to be carefully considered (Cowden and Kotze, 2009). For example, in some cases it may be better to monitor erosion indicators in the drier months when they are easily visible, while it may only be possible to monitor certain vegetation indicators during the growing season.
- Consideration should always be given to trying to time monitoring visits to coincide, as far as is reasonably possible, with measuring multiple indicators even if the frequency of these varies. This would ensure cost effectiveness.

### 6.1.3. Who will be responsible for the monitoring?

Who will be responsible for the monitoring and evaluation of projects should be identified prior to the implementation of the wetland rehabilitation project (Cowden and Kotze, 2009). Mining houses should make the necessary resources available to oversee this process. This should include the necessary management and reporting structures and appointment of suitably qualified persons or organisations to undertake the monitoring. The implementation of the monitoring should ideally be undertaken by qualified independent persons or organisations not actively involved with the implementation of the project, although under certain circumstances, monitoring may be able to be carried out internally with permission from the relevant authority. Where no formal requirements are set, monitoring should still be carried out to inform maintenance and adaptive management of rehabilitation interventions and to evaluate the success of the project. A review of the process should take place on a regular basis throughout the duration of the monitoring (Cowden and Kotze, 2009). This would generally be undertaken by suitably qualified independent persons or organisations and provision should be made for this as well.

### 6.1.4. How monitoring information is collected, stored, accessed and reported on

How information collected from monitoring is stored, accessed and reported on is vital to ensure that monitoring and evaluation is repeatable and accurate and that the lessons learnt from success or failure can be easily shared (Cowden and Kotze, 2009). Again specific conditions in a particular mining authorisation pertaining to wetland rehabilitation may also require reporting of monitoring results to the relevant authority, which is necessary to assess the project outcomes. It is important to check the relevant authorisations to make sure that the necessary reporting structure and schedule complies with the conditions stipulated. Besides the requirements relating to reporting, making suitable provision for the storing and accessing of the monitoring information also typically allows the implementer to better analyse the results and track changes

over time. This also makes reporting and the evaluation of the outcomes easier for implementers and the authorities alike. Due consideration must be given to this in the development of the monitoring and evaluation plan.

**Box 8. Importance of collecting good baseline data**

In all cases baseline data must be collected, and if possible, baseline monitoring should be undertaken, prior to implementation of the wetland rehabilitation. This allows for comparison as it provides a baseline against which project outcomes can be evaluated. This is relevant to all levels and durations of monitoring.

The level of data collection required will largely depend on the nature and scale of proposed rehabilitation activities. This is normally undertaken by a suitably qualified wetland specialist and typically includes and assessment of Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) as a minimum. EIS should be undertaken using a suitable method, preferably that described in DWA (2012). Ecosystem services are also normally estimated for each system using WET-EcoServices (Kotze *et al.,* 2009a).The PES assessment is normally undertaken using the appropriate PES assessment tool such as WET-Health Level 1 or 2 (Macfarlane *et al.,* 2007) or the Wetland Index of Habitat Integrity (DWAF, 2007) for valley bottom and floodplain systems, and in some cases using a modification of the methods described in DWAF (1999). The limitations of these tools/methods in terms of their application to pans and hill slope seepage wetlands should be noted (refer to Box 6).

Collecting other baseline data on, for example, plant species composition, diatoms, relevant invertebrates and hydrological (such as shallow aquifer information) are also very useful as these can be used as indicators for the measurement of changes that result from the wetland rehabilitation. Additional data may also need to be collected on species of conservation concern. In areas subject to AMD, baseline water quality sampling should be undertaken to inform intervention design and as a basis for evaluating the effectiveness of wetlands in addressing water quality risks.

It is also important to point out that long-term wetland rehabilitation monitoring may also need to be integrated into the mine closure plan. Section 43 of the MPRDA provides for the closure of a mining operation. Section 24R of NEMA provides additional environmental requirements for closure of a mining operation by specifically requiring an environmental authorisation to be obtained for the closure of a mining operation. Appendix 5 of GN R982 (2014 EIA Regulations) sets out the requirements of a closure plan. It is also noted that an environmental authorisation granted for the closure of a mining operation and the closure plan thereof needs to be audited by an independent auditor in terms of section 24Q of NEMA and regulation 34 of GN R982.

## 6.2. Long-Term Management

### 6.1.5. Long-term management of the rehabilitation site and associated interventions

Long-term management refers to the management of a rehabilitation site over an extended period post the initial implementation (post construction). For the purpose of this document, this refers to a period of longer than 5 years following the initial implementation.

While the details of long-term management related to a particular rehabilitation project will vary according to the specific site and the rehabilitation objectives, it is essential that management of the site continues over the long-term to ensure that the desired outcomes are achieved and maintained as far as reasonably possible. An important part of long-term management has to do with monitoring and managing the interventions themselves, including the structural integrity of intervention structures such as weirs, berms and gabions. Long-term management of the rehabilitation site (which includes the interventions) would therefore normally be required throughout the life-of-mine and this may extend to closure as well as post closure management[14]. This is needed to:

[14]From an environmental legal perspective, in terms of section 24 R of NEMA, the holder of a mining right remains responsible for any environmental harm caused as a result of the mining activities, irrespective of whether a closure certificate has been issued.

- Maintain existing structures such as weirs, gabions, berms, water control structures, or levees.
- Maintain and implement a specific management plan, which may have been developed for the site. Such a plan may be aimed at maintaining desirable plant communities for example, which could require the implementation of a specific burning, mowing or grazing strategy.
- Address problems, such as invasive species or excessive sediment deposition.
- Address unexpected events, such as structural failure.

### 6.1.6. The need for adaptive management

It is important to consider that all ecosystems undergo constant change and that there will always be a measure of natural variability that may require some form of adaptive management as time progresses. Adaptive management should thus be built into any long-term management of a wetland rehabilitation project.

As a project develops and the interventions and affected wetland adjust to the rehabilitation, modifications may be necessary to accommodate unforeseen developments or take advantage of possible improvement opportunities. It is also possible that new knowledge or resources may become available over time that can be used to improve the outcome. Adaptive management should thus involve a structured, iterative process in which decisions are made using the best available information at the time (also considering the existing response of the system to the interventions implemented). Its purpose is to achieve the original planned outcome or possibly even achieve a better outcome based on the current trajectory.

The information that is used to inform the adaptive management process is often captured through monitoring and evaluation of the project but sometimes it may be derived from experience on other projects (considering the outcome at other sites) or from inputs or the experience of other specialists or stakeholders. It is also important to point out that any modifications to a project over the long-term as a result of adaptive management should still be evaluated against the established goals, objectives, and performance standards of the project. In this way, while initial planning is aimed at achieving the best possible outcome, it is acknowledged and accepted (by all parties concerned including the regulator) that some adjustments may be likely, or even necessary, over time to ensure that optimal outcomes are achieved.

## 6.3. Costs Associated With Wetland Rehabilitation Monitoring and Long-Term Management

Consideration needs to be given to the expected costs of wetland rehabilitation monitoring as well as the long-term management of the rehabilitation site and associated interventions including the maintenance and repair of any structures that may form part of the rehabilitation (refer back to section 4.5 if necessary). This will need to include how this will be funded and over what period. If implementation is phased to coincide with the mine schedule, then it is important to consider aligning the costs of the relevant components of the monitoring, maintenance and long-term management of the site with this. Similarly monitoring, maintenance and long-term management costs that may extend beyond the life of the mine will also need to be budgeted for and may need to form part of the overall long-term mine rehabilitation monitoring and management budget.

Section 24P of NEMA deals with the financial provisions for the remediation of environmental damage and requires a mining company to demonstrate compliance with the prescribed financial provisions for the rehabilitation, closure and on-going post decommissioning management of adverse environmental impacts. In terms of section 24P of NEMA, the mining company, is also required to submit an audit report to the Minister responsible for Mineral Resources on the adequacy of its financial provisions from an independent auditor.

Once a rehabilitation plan has been finalised, costs associated with monitoring activities and long term management of the rehabilitated wetland sites need to be catered for in order to document and compile an inventory of the progress made on the rehabilitation objectives and targets set. Sufficient funds should be budgeted for these activities, including the identification and implementation of maintenance and corrective measures. Costs anticipated being associated with monitoring and long term management of rehabilitation interventions are those costs associated with:

1. Payment of landowners under management agreements.
2. Resources required for continuous monitoring of the wetland rehabilitation.
3. Implementation of the monitoring plan.
4. Implementation of corrective measures.
5. Reporting and stakeholder feedback.
6. Maintenance and management of the interventions (post rehabilitation).

All of the above costs should make provision for labour costs and technical support (i.e. engineering and specialist support) and additional material and equipment costs that may be required to ensure adequacy and proper functioning of corrected and additional interventions, depending on the situation.

Rehabilitation is a particularly important instrument in the mining sector to ensure productive and functioning landscapes post mining. It is true that rehabilitation within the mining landscape (due to the nature and extent of impacts) is often expensive in the context of rehabilitating the entire mine and associated operations post closure. Therefore, financial provisions need to be made available upfront i.e. during the planning phase of the mine, and updated throughout the project life cycle.

Due to the costs associated with the long-term management of wetland rehabilitation, which can be over the life-of-mine and post closure, it is recommended that concurrent rehabilitation is applied (where possible) to ensure that closure rehabilitation needs and costs are minimised. The application of the general principle of "the earlier the better" to rehabilitation can have a significant impact on reducing future risks and costs. This approach can be particularly effective in ensuring that long term water quality problems do not become too difficult to manage. It also allows for greater chances of success with regard to re-establishing the productive potential of land and holds significant aesthetic benefits with potential implications for sectors such as tourism.

In addition to ensuring that costs are adequately captured in the budget for the mine's operation, it is also important to ensure that yearly provisions are made throughout the entire life of the mine in the accounts of the operating company, in line with relevant accounting practices and legal requirements. These provisions should take into account the overall estimated wetland rehabilitation cost allocated throughout the timeline of the mine, while accounting for progressive/concurrent rehabilitation activities.

## 6.4. Checklist for Wetland Rehabilitation Monitoring and Long-Term Management

This chapter dealt with several 'key' elements that are integral to the monitoring and long-term management of any wetland rehabilitation project taking place in a mining landscape.

EAPs, mining houses and regulatory authorities should ensure that each of these key aspects is addressed when it comes to wetland rehabilitation monitoring and long-term management. Doing so will support wetland rehabilitation projects that are realistic, achievable and monitored. To ensure that key elements of wetland rehabilitation monitoring and long-term management have been adequately considered and addressed, the following questions should be asked:

1. Does the monitoring plan clearly indicate the variables to be monitored (i.e. water quality, structural integrity, vegetation and etc.), including the frequency and timing of monitoring activities and is this aligned with the relevant conditions contained in the relevant authorisations?
2. Have monitoring responsibilities been appropriately specified in terms of specific requirements (e.g. independent consultant, minimum qualifications, submission of results to authorities etc.)?
3. Have ecological monitoring requirements been developed and are these aligned with the specific targets for the wetland rehabilitation project?
4. Have measures been put in place to ensure monitoring results feed back into evaluation and adaptive management?
5. Is site security, including long-term management commitments, clearly defined?
6. Have the full spectrum of rehabilitation costs been accommodated in budgeting including long-term management, monitoring and maintenance?

7. Are the necessary landowner agreements in place, are they being renewed and updated as necessary, and are both parties in compliance with their responsibilities under these agreements?
8. Have handover arrangements for the plan and management areas (rehabilitated wetlands) been identified?

A complete checklist is provided in Appendix A for quick reference by all user groups.

# 7. CONCLUSIONS

Wetlands are both important biodiversity assets with intrinsic value and important ecological infrastructure that provide valuable services to people. This is particularly relevant in mining landscapes, where changes in landscape hydrology and water quality impacts often negatively affect downstream water resources and associated users. Wetland rehabilitation offers a positive opportunity for mining houses to secure and enhance the inherent values of wetlands and so secure a more sustainable future for biodiversity and communities living in these landscapes.

This document provides guidance for planning, implementing, monitoring and long-term management of mining related wetland rehabilitation. Whilst much of the guidance is relevant to broader wetland rehabilitation projects, this guideline highlights a number of the challenges that are specifically relevant in a mining context. This includes but is not limited to:

- Ensuring that planning of wetland rehabilitation is considered as early as possible during mine planning and any environmental authorisation process (and that all the relevant environmental legal requirements are addressed) so that it can be included in the overall environmental rehabilitation planning and budgeting process. This would also facilitate alignment with the mining and closure schedule and the relevant environmental legal applications required for mining authorisation. This could also help prevent delays in the rehabilitation authorisation process.
- Changes in catchment hydrology and water quality parameters pose specific challenges to intervention design. The choice of structures and specifically materials used must therefore be carefully selected to ensure that the need for ongoing maintenance is minimised.
- Pans and hill slope seepage wetlands which are common features in the mining landscape may also require alternative strategies when it comes to rehabilitation. Revising the existing wetland assessment tools or developing new ones for determining the Present Ecological State (PES) of pans and hill slope seepage wetlands is an avenue for further research as this will improve the baseline data and monitoring capabilities for these systems.
- Recognising that wetland rehabilitation is often a long term commitment that requires resources and stewardship that extend well beyond implementation. In the mining landscape land tenure commitments, the prospect of future mining of the area, as well as landscape change and water quality risks may pose particular challenges to the long-term success of wetland rehabilitation projects.

Apart from the technical guidance provided in this document, checklists have also been included at the ends of Chapters 4 to 6 and summarised in Appendix A. These highlight the key aspects that need to be addressed through the rehabilitation process and should prove useful to users who need to ensure that the guidelines provided in this document are adhered to. Whilst key legal issues have been alluded to in the document, an overview of the legal considerations for wetland rehabilitation in the mining landscape is described in Appendix A.

Finally, it is also important to emphasise that adaptive management is critical to the long-term success of wetland rehabilitation projects as wetland rehabilitation, particularly in the mining landscape. Rehabilitation planning, design and implementation must therefore be seen as an iterative process in which decisions are made using the best available information at the time. Adaptive management supported by long-term monitoring provides an opportunity to adjust a strategy for the benefit of the environment and the project if necessary. It also provides an opportunity for all stakeholders concerned to learn and improve on techniques and approaches to wetland rehabilitation in this challenging landscape. In this way, while initial planning is aimed at achieving the best possible outcome, it is acknowledged and accepted (by all parties concerned including the regulator) that some adjustments may be likely, or even necessary, over time to ensure that optimal outcomes are achieved.

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# APPENDIX A: CHECKLIST - HAVE THE KEY ELEMENTS OF REHABILITATION BEEN ADDRESSED?

| PLANNING | YES | NO |
|---|---|---|
| 1. Is rehabilitation planning being undertaken by specialists with appropriate qualifications and experience? | | |
| 2. Are stakeholders identified, informed and consulted regarding the proposed rehabilitation action and in line with legal requirements? | | |
| 3. Are legal requirements including relevant conditions associated with relevant authorisations clearly understood and integrated into the planning process? | | |
| 4. Has the site selection process been documented and motivated and communicated to the stakeholders? | | |
| 5. Have landscape-scale risks including land use change and catchment-related impacts been taken into account during the site selection process? | | |
| 6. Have practical considerations including accessibility, expected outcomes, ownership and control, permanence of rehabilitation outcomes and financial costs been duly considered as part of the site selection process? | | |
| 7. Has the exact location, name and description of the target wetlands been provided to all stakeholders? | | |
| 8. Has the wetland delineation and classification been done in accordance with the relevant wetland delineation guidelines (DWAF, 2005 or as updated) and South African wetland classification system (Ollis *et al*., 2012)? | | |
| 9. Was the wetland assessment undertaken using recognised and applicable tools and methods (e.g. Wet-Management series, SANBI and DWS (2014) Wetland Offset Guidelines)? | | |
| 10. Has the socio-cultural and heritage importance of the wetlands been adequately considered? | | |
| 11. Have desired rehabilitation outcomes, including clear, measurable targets and objectives, been documented? | | |
| 12. Has due consideration been given to the establishment of favourable hydrological regimes during detailed planning? | | |
| 13. Has flooding and the risk of intervention failure been considered during intervention design? | | |
| 14. Have water quality risks been duly considered when selecting materials for construction purposes? | | |
| 15. Have management considerations, design specifications and associated costs been integrated into the rehabilitation planning process? | | |
| 16. Has appropriate planning and financial provision been made to formally documenting baseline conditions and long-term monitoring and evaluation requirements | | |
| **IMPLEMENTATION** | **YES** | **NO** |
| 1. Has adequate financial provision been made to account for the full suite of implementation costs? | | |
| 2. Is rehabilitation implementation being undertaken by appropriately experienced construction and civil contractors? | | |
| 3. Has adequate training been made allowance for, including budget considerations, to ensure the appointed contractors and/or workforce is suitably prepared to work within a wetland and mining environment? | | |
| 4. Have the health and safety issues associated with working in a wetland and mining environment been clearly spelled out and are understood by the contractor? | | |
| 5. Has a Construction Environmental Management Programme (CEMP) been designed to adequately address construction risks? | | |
| 6. Are site-specific construction notes associated with interventions within the mining environmental clearly spelled out within the plan and have these been communicated to the contractor? | | |

| | | |
|---|---|---|
| 7. Does the plan make provision for implementation support to the contractor by the design engineers and other specialists that assisted in compilation of the plan? | | |
| 8. Is management oversight sufficient given the scale and intensity of planned operations? | | |
| **MONITORING AND LONG TERM MANAGEMENT** | **YES** | **NO** |
| 1. Does the monitoring plan clearly indicate the variables to be monitored (i.e. water quality, structural integrity, vegetation and etc.), including the frequency and timing of monitoring activities and is this aligned with the relevant conditions contained in the relevant authorisations? | | |
| 2. Have monitoring responsibilities been appropriately specified in terms of specific requirements (e.g. independent consultant, minimum qualifications, submission of results to authorities etc.)? | | |
| 3. Have ecological monitoring requirements been developed and are these aligned with the specific targets for the wetland rehabilitation project? | | |
| 4. Have measures been put in place to ensure monitoring results feed back into evaluation and adaptive management? | | |
| 5. Is site security, including long-term management commitments, clearly defined? | | |
| 6. Have the full spectrum of rehabilitation costs been accommodated in budgeting including long-term management, monitoring and maintenance? | | |
| 7. Are the necessary landowner agreements in place, are they being renewed and updated as necessary, and are both parties in compliance with their responsibilities under these agreements? | | |
| 8. Have handover arrangements for the plan and management areas (rehabilitated wetlands) been identified? | | |

# APPENDIX B: LIST OF TOOLS AND RESOURCES

Useful tools and resources include, but are not limited to, those listed in Table 2.

**Table 2. Useful tools and resources in wetland rehabilitation**

| Tool/Resource | Source |
|---|---|
| **WET Management Series of handbooks:**<br>• **WET-Priorities**: Guidelines for prioritising wetlands at national, regional and local scales (Rountree *et al*., 2009).<br>• **WET-Legal**: Wetland rehabilitation and the law in South Africa (Armstrong, 2009).<br>• **WET-EcoServices**: A technique for rapidly assessing ecosystem services supplied by wetlands (Kotze *et al*., 2009a).<br>• **WET-Health**: A technique for rapidly assessing wetland health (Sieben, 2009).<br>• **WET-RehabPlan:** Guidelines for planning wetland rehabilitation is South Africa (Kotze *et al*., 2009b).<br>• **WET-RehabMethods**: National guidelines and methods for wetland rehabilitation (Russell, 2009).<br>• **WET-RehabEvaluate**: Guidelines for monitoring and evaluating wetland rehabilitation projects (Cowden & Kotze, 2009).<br>• **WET-OutcomeEvaluate**: An evaluation of the rehabilitation outcomes at six wetland sites in South Africa (Kotze and Ellery, 2009). | Water Research Commission Series<br>• Available at www.wrc.org.za |
| **Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector** (DEA *et al*., 2013). | Available from DEA at https://www.environment.gov.za/sites/default/files/legislations/miningbiodiversity_guidelines2013.pdf |
| **Wetland Offsets: A best-practice guideline for South Africa** (SANBI and DWS, 2014) | Available from SANBI at http://bgis.sanbi.org/Mining/Wetland%20Offset%20Guidelines%20Version%207%20For%20stakeholder%20comment.pdf |
| **Mpumalanga Highveld Wetlands** (project mapping extent, distribution, condition and type of freshwater ecosystems in Mpumalanga Highveld coal belt) | Available from SANBI at http://bgis.sanbi.org/MHwetlands/project.asp |
| **Land Rehabilitation Society of South Africa publications**, including those related to rehabilitation of mining impacts | Available at the LaRSSA website, www.larssa.co.za |
| **Chamber of Mines Guidelines for the rehabilitation of mined land** | Available from the Chamber of Mines South Africa at https://commondatastorage.googleapis.com/comsa/Guidelines%20for%20the%20rehabilitation%20of%20mined%20land%20Nov07.pdf |
| **IFC Performance Standards on Environmental and Social Sustainability** (IFC, 2012) | Available from International Finance Corporation at http://www.ifc.org/wps/wcm/connect/c8f524004a73daeca09afdf998895a12/IFC_Performance_Standards.pdf?MOD=AJPERES |

| Tool/Resource | Source |
|---|---|
| **International Council on Mining and Metals (ICMM) guidance** | Available from ICMM Publications at http://www.icmm.com/publications |
| **Draft Minimum requirements for land use planning for integrated environmental management** | Available from DEA |
| **Ramsar Handbooks** (Guidance provided in 21 handbooks on various aspects of wetland use, policies, inventory, assessment, management, rehabilitation and monitoring) | Available from Ramsar Resources at http://www.ramsar.org/resources/ramsar-handbooks |
| **Strategic environmental assessment (DEAT, 2004)**, one of an Information Series on integrated environmental management. | Available from DEA at https://www.environment.gov.za/sites/default/files/docs/series10_strategic_environmental_assessment.pdf |

# APPENDIX C: LEGAL CONTEXT FOR WETLAND REHABILITATION IN THE MINING LANDSCAPE

Relevant legislation referred to in this document:

- The NEMA – including the following sections:
  - Section 24N relating to EMPr provisions;
  - Section 24P relating to financial provisions for remediation of environmental damage;
  - Section 24R relating to mine closure, section 28 relating to duty of care; and
  - Section 30 and Section 30A relating to emergency incidents.
- The 2014 EIA Regulations.
- The NWA – including section 21 of the NWA relating to the list of water uses that require a Water Use Licence, section 19 relating to the duty of care, section 20 relating to emergency incidents in terms of water resources, section 39 relating to general authorisations and the applicable general authorisation regulations.
- The Biodiversity Act – including section 57 relating to restricted activities in terms of ecosystems that are threatened or in need of protection and Chapter 7 relating to permit requirements in terms of restricted activities.
- The Waste Act – including Chapter 8 relating to the provisions on contaminated land.
- The MPRDA – including section 43 relating to mine closure.

The environmental legal implications of wetland rehabilitation must be considered prior to undertaking any activity associated with wetland rehabilitation, and where required, the necessary environmental authorisations and/or licences must be obtained before commencing with such rehabilitation activities. The environmental legal considerations that must be taken into account include but are not limited to:

- Section 21 of the NWA provides a list of water uses, that if undertaken require a Water Use Licence. It is highly likely that when rehabilitating a wetland, due to mining and related activities, a water use listed in section 21 of the NWA may be triggered. In that instance, the applicant would need to assess whether the particular water use may be generally authorised in terms of section 39 of NWA or whether in fact a Water Use Licence application is required. Failure to obtain a Water Use Licence, when required, will result in an offence been committed in terms of section 151 of NWA and could result in the issue of a directive in terms of section 53 of the NWA.

- Certain rehabilitation activities may require an environmental authorisation in terms of NEMA. Failure to obtain an environmental authorisation prior to commencing with the listed activity would result in an offence being committed in terms of section 49A of NEMA. Upon conviction of such an offence, a person may be criminally prosecuted and/or may be held liable to pay an administrative fine not exceeding R10 million. Where a person has unlawfully commenced with a listed activity, the person would be required to submit a section 24G application for the rectification thereof and may be subject to a further administrative fine not exceeding R5 million. The main source of obligations relating to the rehabilitation of a wetland are likely to be found in the mining company's Environmental Management Programme (EMPr) prepared in terms of section 24N of NEMA. The purpose of an EMPr is to provide information on the proposed management, mitigation, protection or remedial measures that will need to be undertaken by the applicant in order to adequately address the environmental impacts of the proposed activity. The EMPr further includes the applicant's rehabilitation plan for the environment. Where the rehabilitation of a wetland needs to be included and/or amended in the applicant's rehabilitation plan, the EMPr may need to be amended in accordance with the current provisions contained in regulation 37 of the 2014 EIA Regulations published in GN R982 on 4 December 2014.

- Notwithstanding the provisions of the Companies Act 71 of 2008 and the Close Corporations Act 69 of 1984, the directors of a company or members of a close corporation may be held *jointly and severally liable* for *any negative impact on the environment, whether advertently or inadvertently caused* by the company or close corporation which they represent, including damage, degradation or pollution to the environment, in terms of section 24 N (8) of NEMA.

- It is further possible that when rehabilitating a wetland, a restricted activity involving a listed threatened and protected species in terms of the Biodiversity Act may be undertaken. If so, a permit

in terms of Chapter 7 of the Biodiversity Act would need to be obtained. Failure to obtain the necessary authorisations or licences prior to commencing a listed activity related to wetland rehabilitation may result in offences being committed in terms of section 101 of the Biodiversity Act.

- Duty of care, remediation of environmental damage and the polluter pays principle: The duty of care principle emanates from the Constitution, section 28 of NEMA and section 19 of the NWA. It places an obligation on a wide range of persons to take reasonable measures to prevent harm to the environment from occurring, continuing or recurring or where such harm is authorised by law, to minimise and rectify such harm to the environment. Where a person fails to discharge their duty of care towards the environment, the Competent Authority may issue a directive in terms of section 28 (4) of NEMA directing that person to undertake specific remedial measures by a certain date, failing which the Competent Authority may then undertake the necessary reasonable measures to remedy the harm and recover the associated costs from the polluter. The Polluter Pays Principle embodied in section 2(p) of NEMA provides that the costs of remedying environmental harm and preventing, controlling or minimising further environmental harm must be paid for by those responsible for harming the environment.
- Where there is an emergency incident/situation and harm to the environment or a water resource, such as a wetland occurs, section 30 and section 30A of NEMA and section 20 of the NWA are applicable. These emergency provisions in NEMA and the NWA ensure that an emergency incident/situation is reported in a timely fashion to the relevant competent authorities and specify the reasonable measures that must be undertaken by the responsible person to contain and minimise the effects of the pollution on the environment or water resource, as the case may be.
- Although unlikely, it would be prudent for a mining house to consider the list of waste management activities in GN 921 of 29 November 2013 and determine whether the rehabilitation of a wetland would trigger any of the listed activities. In the event that a listed waste management activity is triggered, a waste management licence would need to be obtained prior to commencing with the rehabilitation of the wetland. The Competent Authority responsible for issuing waste management licences relating to mining activities is the Minister responsible of Mineral Resources. Failure to obtain a waste management licence will result in an offence been committed in terms of section 67 of the Waste Act. Upon conviction of such an offence, a person may be criminally prosecuted and sentenced to imprisonment for not more than 10 years and may be held liable to pay an administrative fine not exceeding R10 million.
- In the event that it becomes evident or it is suspected during the rehabilitation of the wetland that the land is "*significantly contaminated*" by the mining activities, then the mining house will be duty bound to notify the DEA of the contamination in terms of section 36 of Waste Act. This will result in the need for the mining house to conduct an assessment of the extent of the contamination and a report to be submitted to the DEA. Based on such report the DEA can declare the site as contaminated or not. The implications of the site being declared as contaminated are far reaching and can include an order being issued for the land to be rehabilitated, alternatively that the mining house would have to monitor and manage any risk that the contamination may present to the environment as well as health and safety.


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