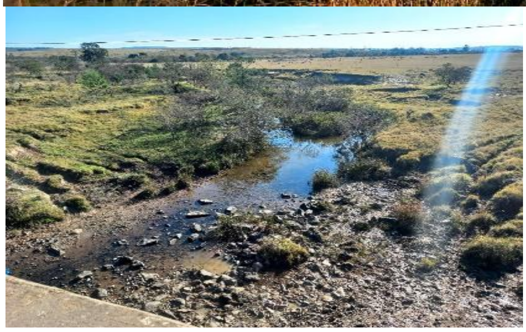
REHABILITATION MANAGEMENT GUIDELINES FOR WATER RESOURCES

VOLUME 2: WETLANDS



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Version 4.8

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2030 NDP

MAIN COVER PAGE:

The photos, on the document cover, were kindly supplied by Mr Lawrence Mulangaphuma of the Department of Water and Sanitation.

Main photo (taken on 26 July 2022)**:**

Photo taken in Msengeni village (Kommetjievlakte wetland), Eastern Cape Province

Wetland type and description: Marsh/floodplain wetland with channels.

Insert photo, bottom-left (taken on 27 July 2022)**:**

Photo taken in Hanover (eDrayini wetland), Eastern Cape Province

Wetland type and description: Channeled valley bottom wetland

Insert photo, bottom-middle (taken on 27 July 2022)**:**

Photo taken in Hanover, Eastern Cape Province

Wetland type and description: Marsh/Unchanneled valley bottom wetland

Insert photo, bottom-right (taken on 28 July 2022)**:**

Photo taken in Hogsback (Hogsback wetland), Eastern Cape Province

Wetland type and description: Channeled Valley Bottom wetland

Mr Mulangaphuma is thanked for giving us permission to use his photos on the cover of this document.

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***Project Name*:**	***Rehabilitation Management Guidelines for Wetlands***
***Report No*:**	*RDM/RMG/00/IHP/SDS/0222*
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AEWA	The African-Eurasian Migratory Waterbird Agreement
AMD	Acid Mine Drainage
BAR	Basic Assessment Report
CARA	Conservation of Agricultural Resources Act
CD: WEM	Chief Directorate: Water Ecosystems Management
CMA	Catchment Management Agency
DALRRD	Department of Agriculture, Land Reform and Rural Development
DCOGTA	Department of Cooperative Governance and Traditional Affairs
DEA	Department of Environmental Affairs
DEA&DP	Department of Environmental Affairs and Development Planning
DEDTEA	Department of Economic Development, Tourism and Environmental Affairs
DFFE	Department of Forestry, Fisheries and Environment
DMA	Disaster Management Act
DWAF	Department of Water Affairs and Forestry
EA	Environmental Authorization
ECA	Environment Conservation Act
EIS	Ecological Importance and Sensitivity
EMP	Environmental Management Plan/Programme
EWR	Ecological Water Requirements
DWS	Department of Water and Sanitation
EIA	Environmental impact Assessment
GA	General Authorization
GIS	Geographic Information System
HIA	Heritage Impact Assessment
IDZ	Industrial Development Zone
IWQM	Integrated Water Quality Management
IWRM	Integrated Water Resource Management
M & E	Monitoring and Evaluation
MPRDA	Mineral and Petroleum Resources Development Act
NDP	National Development Plan
NEMA	National Environmental Management Act
NEM: BA	National Environmental Management: Biodiversity Act
NEM: WA	National Environmental Management: Waste Act
NEM: PAA	National Environmental Management: Protected Areas Act
NFEPA	National Freshwater Ecosystem Priority Areas
NHRA	National Heritage Resources Act
NVFFA	National Veld and Forest Fires Act
NWA	National Water Act
NWRS	National Water Resource Strategy
NW&SMP	National Water and Sanitation Master Plan
PES	Present Ecological State
RAM	Risk Assessment Matrix
REC	Recommended Ecological Category
RQOs	Resource Quality Objectives
RDM	Resource Directed Measures
SA	South Africa
SAHRA	South Africa Heritage Resources Agency
SANBI	South African National Biodiversity Institute
SWSAs	Strategic Water Sources Areas
SFR	Stream flow reduction
SDCs	Sources Directed Controls
SDS	Sources Directed Studies

SPLUMA	Spatial Planning and Land Use Management Act
WDCS	Waste Discharge Charge System
WML	Waste Management License
WfWet	Working for Wetlands
WULA	Water Use License Application
WUL	Water Use License
WRC	Water Research Commission
WWTWs	Wastewater Treatment Works

GLOSSARY OF TERMS

In terms of the definition contained within the National Water Act, 1998 (Act 36 of 1998), a **watercourse** means:

- A **river** or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, dam, or lake into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; and
- A reference to a watercourse includes, where relevant, its bed and banks.

Catchment in relation to a watercourse or watercourses or part of a watercourse, is defined as the geographical area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points. This land area from which a river or reservoir is fed is also known as a drainage region, basin, or watershed.

Chlorophyll is a pigment found in plants and some microorganisms (*e.g.,* cyanobacteria) that play an important role in the conversion of solar energy to chemical energy through a process known as photosynthesis. All oxygenic photosynthetic organisms use chlorophyll-α, which contributes to the green colour of most plants and algae, but differ in accessory pigments like chlorophyll-β.

Diffuse pollution - (or "non-point source pollution") Pollution that originates from wash-off over a relatively large area. Diffuse pollution sources can be divided into source activities related to either land or water use, including failing septic tanks, agricultural and improper animal-keeping practices, and urban and rural runoff.

Ecological Water Releases pertaining to specific low and high flows for maintaining ecological conditions within a specific ecological category, in the form of assurance rules for each selected EWR site.

Ecological Water Requirements (EWRs) is the flow patterns (magnitude, timing, and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.

Effluent is the municipal sewage or industrial wastewater (untreated, partially treated, or fully treated) that flows out of a wastewater treatment works, septic system, pipe, etc.

Eutrophic is a state of an aquatic ecosystem rich in minerals and nutrients, very productive in terms of aquatic plant life and exhibiting increasing signs of water quality problems.

Eutrophication - (from the Greek *"eutrophos"* meaning *"well-nourished")* Is the process of over-enrichment of waterbodies with minerals and nutrients, which (at the right temperatures, substrate availability, flow velocity and light penetration) increasingly induce primary production, e.g., algal and macrophyte growth. Eutrophication can be regarded as either a natural aging process in waterbodies or an aging process that can be accelerated by anthropogenic activities.

Global Biodiversity Framework (GBF) aims to enable urgent and transformative action by Governments, and subnational and local authorities, with the involvement of all of society, to halt and reverse biodiversity loss, to achieve the outcomes it sets out in its Vision, Mission, Goals and Targets (*i.e.,* GBF Goal A target 2 for restoration of ecosystems). Although the DWS focuses mainly on the reporting on the SDG targets, it is recommended that the relevant authorities should use the outputs of the current RMGs for their reporting at the respective platforms.

Integrated Water Resource Management (IWRM) is a process for co-ordinated planning and management of water, land, and environmental resources. IWRM takes into account the amount of available water (surface and groundwater), water use, water quality, environmental and social issues as an integrated (combined) whole to ensure sustainable, equitable and efficient use.

Mean annual runoff is the average volume of water that flows in a river per year (annum), expressed as cubic meters per annum.

Monitoring - periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

Non-point source pollution - See "Diffuse pollution."

National Freshwater Ecosystem Priority Areas (NFEPAs) form part of a comprehensive approach to sustainable and equitable development of South Africa's scarce water resources. For integrated water resources planning, NFEPA provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act.

Point source pollution - pollutant loads discharged at a specific location by means of pipes, outfalls, or conveyance channels inter alia delivering wastewater from municipal and industrial Wastewater Treatment Works. Point sources can also include pollutant loads contributed by tributary.

Resources Directed Measures (RDM) focus on the quality of the water resource itself, regarding it as an ecosystem rather than a commodity. RDMs comprise Classes, Reserve and RQOs as components.

Resource Quality Objectives (RQOs) are a numerical or descriptive (narrative) statement of the conditions which should be met in the receiving water resource, in terms of resource quality, in order to ensure that the water resource is protected. They might describe, amongst others, the quantity, pattern, and timing of instream flow; water quality; the character and condition of riparian habitat, and the characteristics and condition of the aquatic biota.

Resource Water Quality Objective (RQQOs) are the water quality component of the Resource Quality Objective. Are numeric and/or descriptive objectives, which address the physical, chemical and/or microbiological properties of waterbodies that should be met in receiving water resources to ensure that the water quality requirements of the recognised water users and the aquatic ecosystem are sufficiently protected. Resource Water Quality Objectives are not gazetted, per se.

River Eco-status Monitoring Programme (REMP) is a programme for monitoring the ecological conditions of the river ecosystems based on the drivers and responses in the river. REMP is aimed to establish the reference condition (usually a natural or close to natural condition) of the river or reach that will used to assess the temporal conditions of that river or reach with the consideration of both the biotic (instream and riparian biota) and abiotic (hydrology, geomorphology, and physico-chemical conditions) factors of that river.

Runoff is the flow of water occurring on the ground surface when excess rainwater, stormwater, meltwater, or other sources, can no longer sufficiently rapidly infiltrate in the soil. Surface runoff replenishes groundwater and surface water resources as it percolates through soil profiles or moves into streams and rivers.

Social-Ecological System (SES) are linked systems of people and nature, emphasising that humans must be seen as a part of, not apart from, nature (Berkes and Folke, 1998).

Source: In water resource management, “source” refers to the source of an impact, usually on a water resource. The relationship between “Source” and “Resource” is similar to the relationships between “Cause” and “Effect” or “Aspect” and “Impact,” as per the ISO 14001 definitions. The “Resource” or the “water resource” is part of the receiving environment. **Sustainable Development Goals (SDGs)** are aimed ensuring the availability and sustainable management of water and sanitation for all by 2030. Every year, an annual SDG Progress Report should be produced based on the global indicator framework and data produced by national statistical systems and information collected at the regional level. **Strategic Water Source Areas (SWSAs)** are formally defined as natural source areas for water that supply disproportionately large volumes of water per unit area and that are considered of strategic significance for water security from a national planning perspective. Water from SWSAs feeds major dams and can be considered ecological infrastructure that works hand in hand with built infrastructure for delivering water. **Trophic status** refers to the degree of nutrient enrichment of surface water resources and the associated amount of primary productivity that can be sustained. **Wastewater** is any water used from domestic, industrial, commercial, or agricultural activities, surface runoff or stormwater, which may contain physical, chemical, and biological pollutants. **Water quality** - the biological, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial water use. **Weirs**, also known as low-head dams, are small overflow-type dams commonly used to raise the level of a river or stream. Water flows over the top of a weir, although some weirs have sluice gates, which release water at a level below the top of the weir.	XXX…

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EXECUTIVE SUMMARY

There has been an increase in wetland rehabilitation interest and research efforts over the last two decades in South Africa.

In 2020, the Department of Water and Sanitation (DWS) Directorate: Sources Directed Studies (SDS) initiated an in-house project for the development of the Rehabilitation Management Guidelines (RMG) for Water Resources in South Africa. The project responds to one of the objectives of the Chief Directorate: Water Ecosystem Management to conduct sources directed studies. The project aims to address the fragmentation across different projects, programmes, and initiatives due to separate mandates and various institutions responsible for wetlands rehabilitation; especially with regard to characteristics of watercourses. It is for this reason that the DWS is developing Wetland RMG to address characteristics of watercourses, namely surface flow, groundwater flows, geomorphology, water quality, habitat, and biota through following a phased approach, namely; diagnostic, planning and assessment, setting of the rehabilitation objectives, execution, and monitoring phases. The following are key aspects covered to address the shortcomings of each characteristic of watercourse:

- Description of the specific characteristics of ~~a~~ watercourses;
- Types of impacts for each characteristic of a watercourse – a brief overview and description of the impacts that gives rise to the degradation of the watercourses to better understand the problem and subsequently develop effective rehabilitation guidelines;
- Legal Considerations - applicable legislation to be considered for undertaking site-specific rehabilitation activities on a particular characteristic of watercourse; and
- Step-by-step guidelines on rehabilitation measures/interventions for executing rehabilitation - planning, design, implementation, and monitoring.

The current Rehabilitation Management Guidelines (RMGs) for wetlands have been structured per characteristics of watercourses, namely hydrology, geomorphology, water quality, habitat, and biota. Various activities impact on these characteristics of watercourses in various ways within wetlands.

Erosion, alien vegetation clearing, over abstraction and road construction are the main impacts on the hydrology of wetlands. Grazing and trampling within the wetland modifies the runoff characteristics of the catchment and impacts upon the preferential flows of the wetland. Alteration of surface runoff result in straightened channel erosion and formation of gullies within the wetland due to higher-than-normal water velocity. Rehabilitation Management Guidelines for hydrology – surface flow and runoff have been developed with a focus on rehabilitation of altered and incised wetland channels due to erosion (gully and headcut) formation and alien vegetation.

Grazing in riparian areas within wetlands is a natural phenomenon, however, excessive grazing causes alteration of the natural vegetation cover, reduces vegetation and habitat complexity. These changes reduce the flood attenuation and sediment trapping efficiencies of wetlands. Other indirect effects of grazing include trampling within wetlands, and the creation of localised erosion gullies, while severely trampled riparian areas may be more vulnerable to erosion. The current RMGs have been developed for geomorphology with a focus on improving wetland vegetation growth and sediment trapping.

Water quality within wetlands is affected by both point sources of pollution and non-point sources of pollution. Point sources of pollution emanate mainly from industries, Wastewater Treatment Works (WWTWs) and other sources within the catchment. Inadequately treated effluent from WWTWs poses a risk to wetlands. Non-point sources of pollution are caused by activities such as mining, urban developments, and agricultural return flows. Acid mine drainage (AMD) is one of the most serious and potentially enduring environmental problems for the mining industry. Rehabilitation Management Guidelines have been developed to address the discharge of raw and inadequately treated wastewater into watercourses.

In terms of Biota, human activities result in wetland habitat degradation and loss by altering water quality, quantity, and flow rates; pollutant increase; and species composition interference due to alien species introduction. Poor landscape planning/design practices, lack of development of scientific buffers, lack of protection of riparian habitat, overgrazing, and illegal harvesting for wood to make ornaments/furniture are amongst other impacts on habitat. Rehabilitation Management Guidelines have been developed to rehabilitate wetland habitat due to road construction/roadworks.

Human-induced disturbance, such as the construction of barriers within or in close proximity of wetlands alters the hydraulics and geomorphic characteristics of the wetland. These barriers also alter the wetland aquatic zone which cause changes in the physical habitats upon which biota depend. Rehabilitation Management Guidelines have been developed for biota with specific reference to:

- Restoration of wetland conditions;
- Restoration of natural hydrological and sediment conditions; and
- Prevention of erosion headcuts and limitation of incisions within the wetland.

1. INTRODUCTION

1.1 BACKGROUND

Wetlands in South Africa (SA) play an important role in sustaining the country's ecology and economy through the indispensable ecosystem services they provide. These ecosystem services range from supporting a wide variety of specialised plant, insect, bird, and mammal life; to supplying wild food, grazing, building and craft materials to people; and absorbing flood waters, improving water quality and regulating streamflow, helping to maintain ecosystem functioning downstream. Different wetland types supply different ecosystem services (WRC, 2007; 2021). However, wetlands have been severely affected by the anthropogenic activities that have drastically altered landscapes over the past few centuries (Dini & Bahadur, 2016). It has been reported that more than 50% of wetlands have been lost in South Africa, and of those that remain, 33% are in poor ecological condition due to poor management (Nel and Driver, 2015). Furthermore, the latest National Biodiversity Assessment (NBA) Report (SANBI, 2019) also states that wetlands form part of the most threatened and least protected ecosystems in South Africa.

To integrate rehabilitation efforts on South African wetland systems, the Directorate Sources Directed Studies (SDS) within the DWS initiated a project for the development of RMGs (*i.e.,* wetlands). The project responds to one of the objectives of the Chief Directorate: Water Ecosystems Management (CD: WEM) which is to conduct sources directed studies to ensure water resource protection.

In the Situation Assessment Phase of the project, it was established that a great deal of research has been conducted in South Africa to understand the discipline of wetland rehabilitation to provide locally and site-specific rehabilitation interventions. The impacts on wetlands were also clearly identified and contextualized for each of the studies reviewed. Below is a list of the main findings from the review conducted:

- The WRC ***Wetland Management Guidelines Series*** was the first of its kind to be developed in SA for effective wetland management and rehabilitation. Following various experiences gained in the application of wetland management and rehabilitation tools during the last ten years, the **WET-Rehab Evaluate, WET-Health** and **WET-Eco Services** were updated in 2019, 2020 and 2021 respectively. These guidelines provide technical methods for undertaking rehabilitation activities, the overarching legislative framework to consider for planning, designing, implementation and monitoring phases of rehabilitation interventions. In addition, the ***Buffer Zone Guidelines for Rivers, Wetlands and Estuaries (WRC, 2017)*** were developed for setting appropriate ecological buffers.
- There are also programmes and initiatives that are currently in place to ensure natural wetland rehabilitation improvement and management. A range of management options have been implemented to address the various impacts identified.

The Situation Assessment Phase concluded that the existing manuals and best practice guidelines suffice in protection and management of wetlands, with the below main gaps identified.

- Efforts across different Departments, projects, programmes, and initiatives are fragmented due to separate mandates and various institutions conducting rehabilitation work.

- Many wetland rehabilitation programmes do not address all characteristics of watercourses, as defined in the National Water Act, namely surface flow/surface runoff, groundwater flows, water quality, geomorphology, habitat, and biota.
- Most wetland studies/ programmes do not address the roles of constructed wetlands in the landscape.

1.2 WETLAND DEFINITION, CATEGORIES, AND IMPACTS

1.2.1 Definition of Wetlands

The National Water Act (NWA) (Act 36 of. 1998**),** defined a wetland as *"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".*

1.2.2 Wetland Characteristics and Indicators

There are several indicators and different site criteria that can be employed to identify wetland areas. The below four indicators have been developed to assist with the identification of wetlands (DWAF, 2008).

- **Terrain Unit Indicator** – assists with identification of those parts of the landscape where wetlands are more likely to occur. **Figure 1** below illustrates the main terrain units.

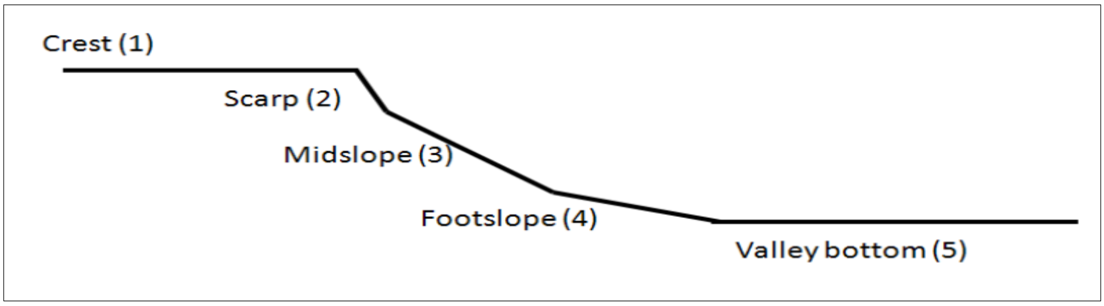

Figure 1: Five main terrain unit indicators for wetlands landscape (DWAF, 2008)

- **Soil Form Indicator** – aids to identify the type of soil form according to standard soil category system since wetlands are associated with certain soil types. Examples of soil form that are associated with wetlands are depicted in **Figure 2.**

Avalon Bainsvlei Bloemdal Cartref Dresden Estcourt Fernwood	Glencoe Kinkelbos Klapmuts Kroonstad Longlands Lamotte Montagu	Pinedene Sepane Tukulu Vilafontes Wasbank Westleigh Witfontein	Addo Brandvlei Dundee Etosha Glenrosa Groenkop	Houwhoek Inhoek Jonkersberg Kimberley Molopo Tsitsikamma
(signs of wetness for these soil forms are incorporated at the form level)			*(signs of wetness for these soil forms are incorporated at the family level)*	

Figure 2: Examples of soil forms as indicators of wetland presence (DWAF, 2008)

- **Vegetation Indicator** – helps with identification of vegetation associated with ephemeral, seasonally and permanently saturated soils.

- **Soil Wetness Indicator**- assists with identification of morphological signatures in soil profiles due to prolonged periods of saturation (*i.e.*, anaerobic conditions).

1.2.3 Wetland Types and Categories

Different types of wetland areas exist in South Africa as a result of various environmental factors and topography. Cowan and Van Riet (1998) divided wetlands around the country into different regions according to climate and the geomorphology of the country. These are further sub-divided into four groups, *i.e.*, mountains, plateau, coastal plain, coastal slopes and rimland. Endorheic pans, lacustrine, riverine, estuarine, palustrine, marine, and man-made/constructed wetlands are some of the most common wetlands found in South Africa.

Marneweck and Batchelor (2002) developed a system to characterise wetland systems based on the hydrogeomorphic (HGM) characteristics (landscape settings and flow) - the way in which water moves in, through and out of them. This system follows that used by the United States Environmental Protection Agency (US-EPA) and has in the past been included as part of a proposed wetland category system for South African wetlands by Ewart-Smith *et al*., (2006).

Table 1 below presents the different types of wetlands which are grouped according to landscape settings and hydrological functions.

Table 1: Landscape settings and flow characteristics of the HGM wetland types (adapted from Rountree and Batchelor, 2008)

Wetland Type	Description	Flow Pattern	Landscape setting	
Rivers	-	Channelled	Valley bottoms	Strongly confined valley floor
Lakes	-	Standing water		Wide or unconfined valley floor
Unchannelled valley bottoms	• Valley bottom surfaces which do not have a channel; • These systems tend to be found in the upper catchment areas, or at tributary junctions where the sediment from the tributary smothers the main drainage line	diffuse		
Channelled valley bottoms	• Valley bottom surfaces which have a straight channel with flow on a permanent or seasonal basis; • These systems tend to be found in the upper catchment areas.	Channelled (parallel to valley)		
Meandering floodplain	• Valley bottom surfaces which have a meandering channel which develop upstream of a local (e.g. resistant dyke) base level, or close to the mouth of the river (upstream of the ultimate base level, the sea).	Channelled (meandering across valley)		
Seepage wetlands	• Located on the mid- and foot slopes of hillsides; either as isolated systems or connected to downslope valley bottom wetlands.	Diffuse - diffuse Diffuse – surface/channel	Slopes	

Wetland Type	Description	Flow Pattern	Landscape setting
Depressional Pans	• Pans are found in many arid zones around the world and consist of brackish, saline or alkaline lakes, flats, pans and marshes; • Endorheic pans are distinguished by shapes ranging from circular to oval and have no drainage outlet; • Pans are most frequently found in the Western, Southern and Eastern Plateau wetland regions of South Africa; • Circular or oval in shape; usually found on the crest positions in the landscape.	Diffuse flow – standing water	Crests
Flats	-	No defined direction of drainage due to very flat landscaping	Flats
Peatlands	• They are terrestrial wetland ecosystems in which waterlogged conditions prevent plant material from fully decomposing; • Consequently, the production of organic matter exceeds its decomposition, which results in a net accumulation of peat; • Peatlands occur in every climatic zone and continent	Static or flowing water	Include landscapes that are still actively accumulating peat (mires), others that are no longer accumulating and do not support the principal peat forming plants.

Thereafter, Ollis *et al*., (2013; 2016) publications were developed and used in the National Biodiversity Assessment (NBA) 2011 and 2018 for wetland ecosystem types; whereby seven primary HGM types (River, channelled valley-bottom wetland, unchanneled valley-bottom wetland, floodplain, depression, seep, wetland flat) are identified as the focal point of the SANBI classification system for inland aquatic ecosystems as depicted in **Figure 3** below. These primary HGM types were derived from the HGM types recognized in the WET-Health tool for assessing the present ecological condition and WET-EcoServices tool for assessing the ecosystem services of palustrine inland wetlands in South Africa.

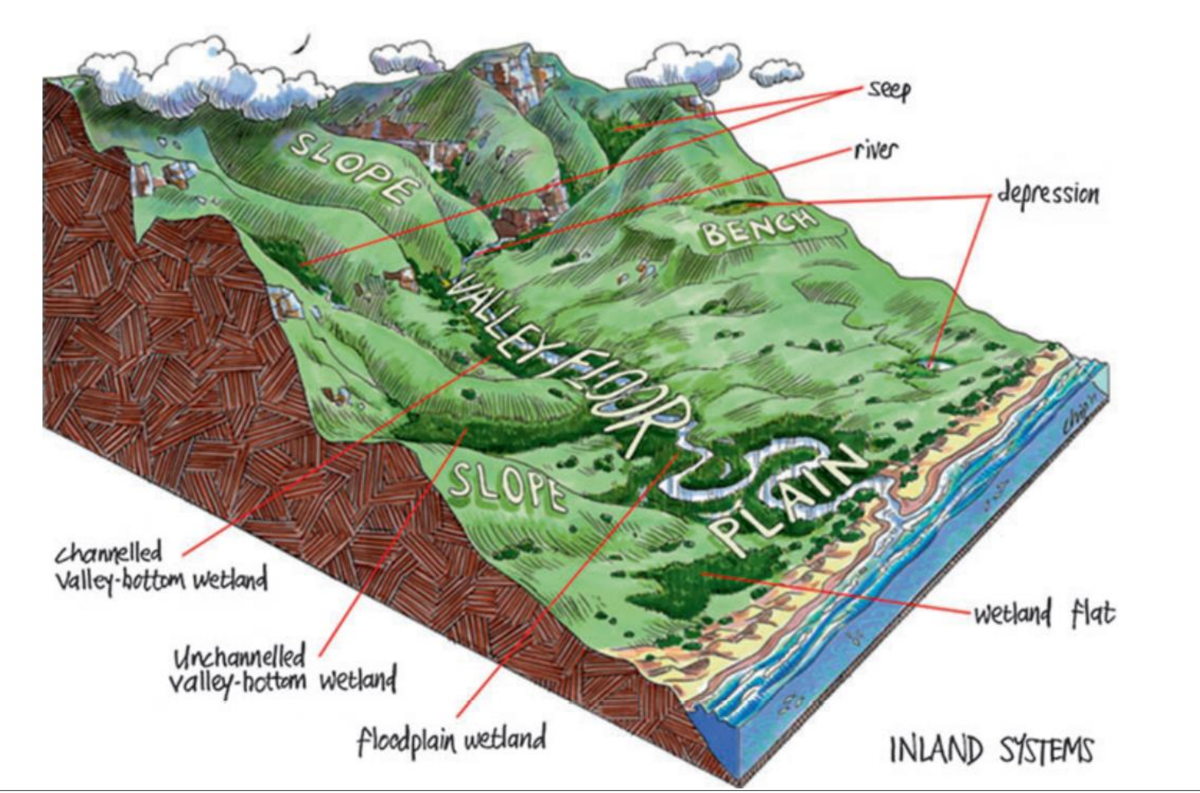

Figure 3: The seven primary HGM types for inland aquatic ecosystems and their typical landscape settings (Ollis et al., 2013)

1.2.4 Wetland Ecosystem Services

Wetlands are regarded as significant because of the beneficial services they provide. **Table 2** below provides wetland services which have been detailed in the WET-EcoServices report compiled by WRC (2008; 2021) and they are considered most important for South African wetlands as described, which is by no means exhaustive. A rapid assessment technique referred to as the WET-EcoServices is a tool that was developed to monitor the importance of ecosystem services provided by different wetland ecosystem types and riparian areas in the country. The tool also informs decision making in relation to the prioritisation of wetlands for rehabilitation.

Table 2: Ecosystem services included in, and assessed by, WET-EcoServices (WRC, 2008)

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and supporting benefits	Flood attenuation		The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
			Streamflow regulation		Sustaining streamflow during low flow periods
			Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
			Carbon storage		The trapping of carbon by the wetland, principally as soil organic matter
	Direct benefits	**Biodiversity maintenance[2]**			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		Provisioning benefits	Provision of water for human use		The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
			Provision of harvestable resources		The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
			Provision of cultivated foods		The provision of areas in the wetland favourable for the cultivation of foods
		Cultural benefits	Cultural heritage		Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
			Tourism and recreation		Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
			Education and research		Sites of value in the wetland for education or research

Other benefits include flood attenuation, stream flow regulation; water purification, provision of goods and services *(i.e.*, food, medicine and building materials); biodiversity maintenance; recreational opportunities; and groundwater recharge and discharge; which may all be important but are difficult to characterise at a rapid assessment level.

1.2.5 Wetland Impacts

In 2014, approximately 300 000 wetlands were reported to make up 2.4% of South Africa's surface area, excluding many wetlands that had already been irreversibly lost to a range of other land use activities (SANBI, 2014 and Driver *et al.,* 2012). Of the nearly 800 wetland ecosystem types, 65% were threatened (likely to become endangered within the foreseeable future). Of this 65% wetland types, 48% were critically endangered (CR) (critical danger throughout all or a significant portion), 12% were endangered (EN) and 5% vulnerable (VU) (considered to be facing a high risk) (SANBI, 2014).

The latest mapping data in the recent NBA (SANBI, 2019) indicates that inland wetlands cover 2.2% of South Africa's surface area; whereby the status persists, with an indication that "inland wetlands are highly threatened, with almost 80% of South Africa's 135 inland wetland ecosystem types categorised as threatened (61% CR, 9% EN, 9% VU). When considered by extent, this amounts to almost 88% of South Africa's estimated 2.6 million ha (26 000 km²) area for inland wetlands being threatened".

Wetland ecosystems have been mapped according to types over the years ranging from National Wetland Map (NWM) versions 1 to 5; with each NWM providing improvements and updates to the spatial extent of the various wetland ecosystems. The update of the NWM5 showed that 2.2% of the country has been mapped as inland wetlands, totalling 2,6 million ha (Van Deventer *et al.,* 2020).

The DWS monitors wetlands through the National Wetland Monitoring Programme (NWMP), the design of which was done through a WRC Project (completed in 2016). The NWMP is implemented by the DWS and seeks to assess and monitor the extent of wetlands, threats to, and the change in the present ecological state and ecosystem services provided by wetlands in the country. The Department of Forestry, Fisheries and Environment (DFFE) compiled Provincial Strategic Plans for 2019-2024 to address the identified impacts associated with wetlands per province. The most notable impacts in the literature include the following:

- Afforestation;
- Mining;
- Surface and groundwater abstraction;
- Agriculture;
- Siltation/Sedimentation of banks;
- Sewage discharge;
- Alien invasive species;
- Urbanization and Infrastructure development; and
- Industrial Development Zones (IDZs).

Depressions, particularly those around Gauteng, are being utilised as dumpsites during urbanisation. Afforestation alters the characteristics of the wetlands as well as the water supply that sustains the pans (Mackintosh *et al.,* 2017). Conversely, pans located near farming are impacted upon by fertilisers and pesticides emanating from farming activities, which leads to water enriched with nutrients and eventually eutrophication.

Main threats to depression wetlands include industrial developments, recreational demands, and pollution from agricultural herbicides and pesticides (Cowan and Van Riet, 1998; Adame *et al.,* 2019).

1.3 REHABILITATION DEFINITIONS AND CONCEPTS

Rehabilitation refers to measures taken in the process of returning an impacted area to a desired ecosystem condition or structure, function, biotic composition, and associated ecosystem services (DWAF, 2008). **Rehabilitation** 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 (DEA *et al.,* 2013; WRC, 2016) (**Figure 4**). Rehabilitation requirements are most often implemented to address impacts that cannot be avoided or minimised for which there is well established guidance (Chamber of Mines, 2007), but may also be included as part of an offset requirement.

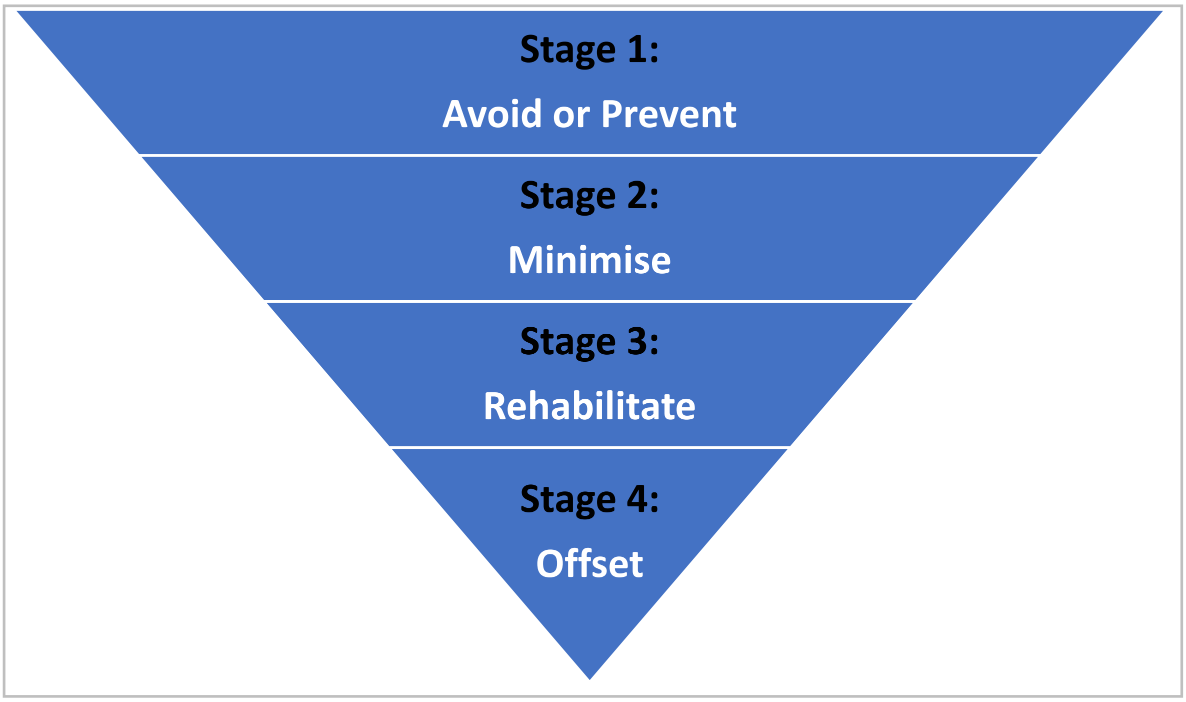

Figure 4: Rehabilitation as part of the mitigation hierarchy for dealing with negative impacts on biodiversity (adapted from DEA et al., 2013)

Stage 1 and 2:
Rehabilitation does not form part of the **Stage 1** and **2** of the mitigation hierarchy. These stages involve considering options in the project location, siting, scale, layout, technology, and phasing **to avoid/prevent or minimise impacts** on biodiversity, associated ecosystem services and people.

Stage 3:
Most rehabilitation requirements are linked to the rehabilitation of unavoidable impacts. Rehabilitation refers to the measures provided to return impacted areas to near-natural state or an agreed land use after mine closure.

Stage 4:
Rehabilitation may be included as part of an offset plan. Offset are measures to compensate for the residual negative effects on biodiversity and ecosystems, after every effort has been made to minimise and the rehabilitate impacts.

Wetland Offset Best Practices Guidelines (WRC, 2016) were developed in response to the growing need for practical guidance on wetland offsets, which are increasingly being prescribed through regulatory processes in response to ongoing loss and degradation of wetland resources. They should be applied where significant, large-scale residual wetland impacts are encountered (*i.e.,* large-scale infrastructure and opencast mining). Moreover, the guidelines provide an equally useful framework to inform wetland offset design and implementation in other contexts where there are smaller, but still significant, residual impacts and a wetland offset is still required (*i.e.,* agriculture or small development projects).

Figure 4 (specifically **Stage 4**) are in support of information contained within the *Wetland Offset Best Practices Guidelines* that wetland offsets are applied within a mitigation hierarchy and are only aimed at compensating for significant residual impacts of project development on the environment after all appropriate and feasible steps have first been taken to avoid/prevent, minimize/reduce and remediate/rehabilitate impacts. **First**, a development proposal should try to **avoid** or **prevent** negative impacts on wetlands and the ecosystem services and biodiversity they support by seeking alternative types of development, or alternative locations, different scales of development, different layouts and siting of development components, etc. When **all reasonable** and **feasible alternatives** have been **identified** and **considered**, every effort should be made to minimise remaining negative impacts and to rehabilitate or remediate affected areas.

The following important key considerations extracted from the Wetland Offset Best Practices Guidelines (WRC, 2016) should be considered prior to opting for wetland offset:

- *Wetlands offsets **cannot**, therefore, be applied as the **only** or **first mitigation option**; the prior sequence of mitigation steps **(Stage 1 to 3** in **Figure 4)** must first be **exhausted**. The guidelines details how to calculate the residual impacts of a development in terms of Water Resources and Ecosystem Services, Ecosystem Conservation, and Species of Conservation Concern.*
- *Wetland offsets are a **final compensation** or mitigation measure where an **approved** project has **significant residual impacts** after **all other reasonable mitigation measures** have been **fully implemented.** They are **not an alternative** to the full application of the mitigation hierarchy.*
- *Wetland offsets are **not** an **easy** or **quick** way out for obtaining approval for a development in an area where wetlands are impacted. The implementation of a wetland offset requires **careful identification** of **suitable** wetland **sites** which need to be appropriately **managed, secured** and **monitored** for the **long term**, and hence costs may be high.*
- *The addition of a wetland offset to an otherwise unacceptable impact on wetlands does not change the acceptability of the impact, and hence should not influence the decision-making process regarding the authorisation of a proposed development.*

The below are other considerations for users intending to undertake wetland offset (WRC, 2016):

- Implement the *Wetland Offset Best Practices Guidelines* to achieve ‘No Net Loss’ and preferably a net gain with respect to the full spectrum of functions and values provided by wetlands;
- Determining the size and characteristics of a wetland offset, and determining the requirements for its implementation;
- Once a decision on the need for a wetland offset has been taken, follow the water use authorisation process (*i.e.,* in an application for a Water Use Licence under the National Water Act) through the (DWS). Some of the key aspects of the authorisation process are reflected in Chapter 5 of the Wetland Offset Guidelines as follows:
    - Compilation of a Wetland Offset Report;
    - Development of a Wetland Offset Management Plan;
    - Development of a Monitoring Plan;
    - Submission, Review and Approval by the relevant authority *i.e.,* the DWS;
    - Implementation of the offset;
    - Monitoring of wetland offset activities;
    - Verification & sign off; and
    - Formal sign-off of the wetland offset.

- Where the said guidelines are being used in other authorisation processes, the decision on the need for a wetland offset would be determined through an Environmental Impact Assessment (EIA) process and interactions with the relevant regulatory authorities *i.e.,* DFFE and Department of Minerals Resources and Energy (DMRE);
- The said guideline should be applied in conjunction with the electronic Wetland Offset Calculator (appended on the guidelines) to assist with calculations. Appendices include a list protection levels and ecosystem threat statuses for wetland groups required for the calculations of offsets and provides specific guidance on the use of the Wetland Offset Calculator which is also relevant for manually doing the calculations.

Wetland restoration is defined as remedial activity applied to systems that have been completely and permanently, but not irreparably, altered (Grenfell *et al*., 2007). Most recently, SANBI (2023) defined wetland restoration as "the process of assisting the recovery of an ecosystem that has been damaged, degraded or destroyed, towards an appropriate reference state".

Wetland re-creation involves creating/establishing wetlands where they did not occur previously whilst **Wetland re-establishment** refers to where wetlands that were removed or lost by mining are re-established within the post mining or mining rehabilitation footprint. For the purpose of developing the current guidelines, **wetland rehabilitation** definition is adopted from Russel (2009); SANBI (2013); and DWS (2014) which refers to 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. See **Appendix A** for comparison between **restoration, re-creation/re-establishment,** and **rehabilitation** of wetlands.

1.4 PURPOSE FOR DEVELOPMENT OF THE REHABILITATION MANAGEMENT GUIDELINES FOR WETLANDS

The primary objectives of the guidelines are to:

- Develop RMGs for Wetlands in terms of their interactions with characteristics of watercourses, namely; hydrology, groundwater flows, geomorphology, water quality, habitat, and biota; and
- Integrate, align, identify existing wetland management bodies, and standardize tools[1], processes, procedures, and rehabilitation strategies regarding wetland rehabilitation across various disciplines and institution.

1.5 DEFINITION OF WATERCOURSES

In terms of the definition contained within the National Water Act, 1998 (Act 36 of 1998), a watercourse means:

- A river or spring;

[1] An example of this tool is the National Wetland Management Framework (NWMF) developed jointly between the DALRRD, DFFE and DWS with a focus on guiding wetland management at a national level. Given this emphasis at a national level, the framework seeks to provide specific direction for National Departments jointly responsible for wetland management.

- A natural channel in which water flows regularly or intermittently;
- A **wetland,** dam, or lake into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; and
- A reference to a watercourse includes, where relevant, its bed and banks.

Note: *The link between water resources and characteristics of watercourses is contained in the definition above as well as in Section* ***3.1*** *and* ***3.2*** *of the report.*

1.6 GUIDING PRINCIPLES AND APPROACH FOR DEVELOPMENT OF THE GUIDELINES

The current RMGs are developed for characteristics of watercourses, namely; **hydrology** (surface flow and runoff), **geomorphology, water quality, habitat, biota, and groundwater flows.**

The following are aspects are covered under each characteristic of watercourse:

- Description of the specific characteristics of watercourse;
- Types of impacts for each characteristic of watercourse – a brief overview and description of the impacts that gives rise to the degradation of the watercourses to better understand the problem and subsequently develop effective rehabilitation guidelines;
- Legal Considerations - applicable legislation to be considered for undertaking site-specific rehabilitation activities on a particular characteristic of a watercourse; and
- Step-by-step guidelines on rehabilitation measures/interventions for executing rehabilitation - planning, design, implementation, and monitoring.

1.6.1 Guiding Principles

According to Rountree and Batchelor (2008) guidance for rehabilitation planning can be applied in terms of rehabilitation context derived from the South African National Working for Wetlands Programme, a joint initiative of DFFE, DWS and Department of Agriculture, Land Reform and Rural Development (DALRRD). Some important aspects of guidance are provided in **Figure 5** below.

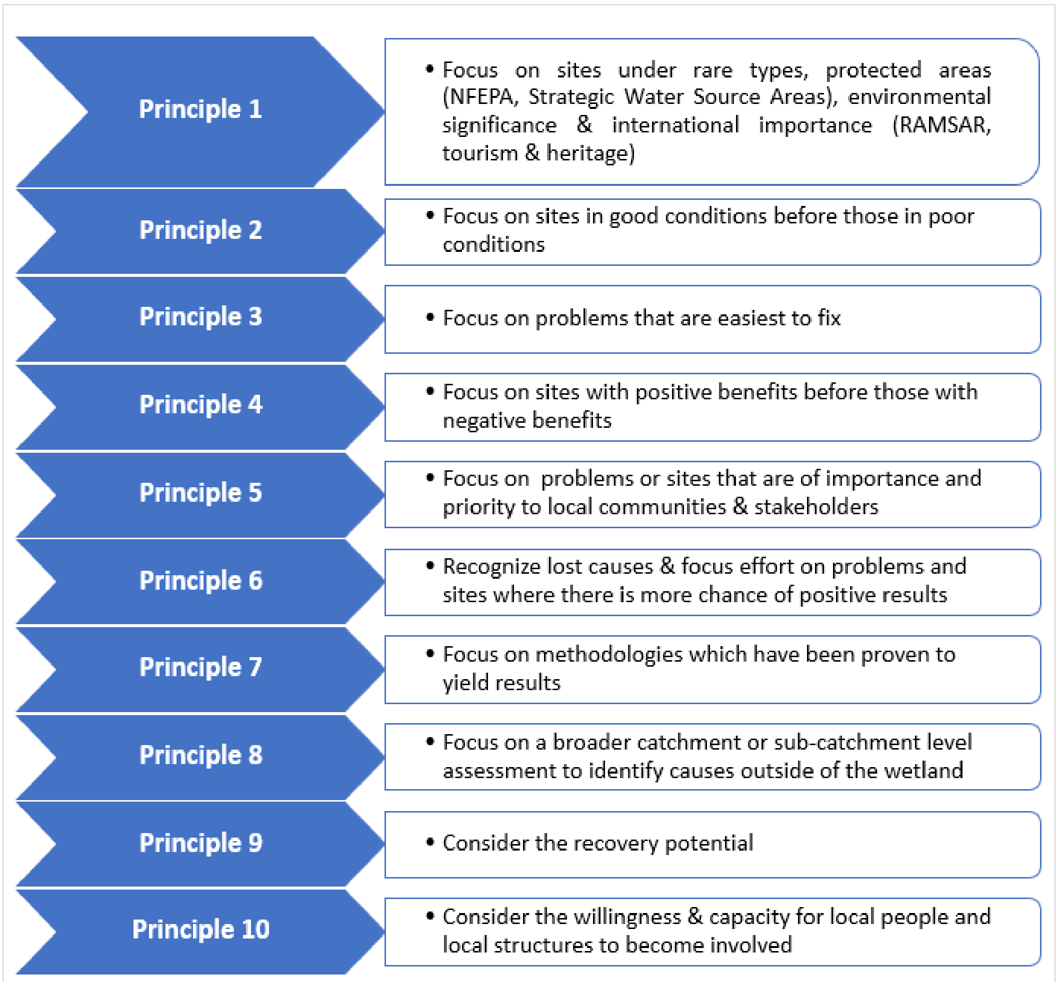

Figure 5:Rehabilitation Principles (Adapted from Rountree and Batchelor, 2008)

The need for rehabilitation arises due to degradation as reported by the National Water and Sanitation Master Plan, 2018. Although interventions may not be able to reinstate water resources to natural state, a functional state must be the aim of ecosystem recovery initiatives. King *et al.,* (2003) recommended the following key principles for rehabilitation:

- Defining rehabilitation objectives;
- The objectives for rehabilitation should be clear, and explicit;
- Rehabilitation must direct the system back towards a more natural state, and work in harmony with the major abiotic drivers of the ecosystem;
- Undertaking rehabilitation should be seen as an interdisciplinary activity, recognising that rehabilitation may be necessary over a range of spatial and temporal scales;
- Rehabilitation should aim at treating causes rather than symptoms;
- Given that ecosystems are dynamic and can naturally exist in alternative metastable states, it should be remembered that it is easier to cross a degradation threshold than to return over it;
- Monitoring should be an essential component of rehabilitation.

Below is a list of some key importance and applicability of the above-mentioned principles:

- Ecosystem-based approach;
- Re-instating natural processes;
- Enhancing biodiversity and habitat diversity;

- Improving water quality;
- Flood mitigation and erosion control;
- Stakeholder engagement and community involvement; and
- Long-term sustainability.

1.6.2 Approach

The Wetland Rehabilitation Guidelines are developed with the aim to guide users on step-by-step rehabilitation measures/interventions to be followed for executing rehabilitation with specific attention to and consideration in planning, design, implementation, and monitoring of the identified impacts. **Table 3** below presents the approach followed for development of the wetland guidelines.

Table 3: Approach to be followed for development of Rehabilitation Guidelines for Wetlands including the associated characteristics of watercourses.

Stakeholder Engagement

Phase	Description
PHASE 1: Diagnostic Phase	• The characteristics will be diagnosed to identify the cause/source of impact; and determine the level of modification and rehabilitation measures will be recommended to reinstate the conditions of the drivers. • Determine the conditions and the type, size, extent of impacts and vegetation cover/ species on characteristics of watercourses.
PHASE 2: Planning & Assessment Phase	• Conduct planning and assessment to ensure the desired rehabilitation outcomes are achieved. • Assess and collate available information from maps & datasets on the affected watercourses. • Review and assess legal considerations
PHASE 3: Define the Rehabilitation Objectives	• Identify and define the objectives of rehabilitation to ensure the impacts on the characteristics of watercourses are addressed.
PHASE 4: Execution	• Recommend techniques and methods to address the impacts identified. Consider the protection of the water resources ecosystem.
PHASE 5: Monitoring, Evaluation (M & E) and Reporting	• Monitor the results of the techniques and methods employed for rehabilitation to determine whether objectives are being achieved and whether there are any additional interventions required. • Evaluate the effectiveness of interventions against the achievement of rehabilitation objectives and outcomes. • Determine maintenance objectives. • Compilation of Rehabilitations Report.

1.7 INTENDED USERS OF THE GUIDELINES

The RMGs for Wetlands is a set of tools developed to ensure that clear and practical steps are provided on a wide range of rehabilitation measures/interventions related to characteristics of watercourses, which take cognisance of legal, ecological, social, and economic issues and aspects. The guidelines are intended for all Government Departments (National, Provincial and Local), Catchment Management Agencies (CMAs), sectoral institutions (*i.e.*, higher education institutions), civil society members, non-governmental entities, private sector (agriculture, industries, mining) and all interested and affected parties involved in the water sector. The guidelines are developed at a national scale for implementation at a catchment scale/level.

1.8 STRUCTURE OF THE GUIDELINES

The guidelines are divided into six main sections as follows:

- The opening sections contain the document signatories, document index and status, acknowledgements, table of contents, list of figures, tables, acronyms, and executive summary.
- **Section 1** provides the background of the development of the guidelines, purpose, approach, intended users and structure of the guidelines.
- **Section 2** provides the overarching legal framework for wetland rehabilitation and alignment with key policies, strategies, and principles.
- **Section 3** describes the characteristics of watercourses and their linkage to water resources
- **Section 4** provides the overarching water resource impacts and degradation impacts associated with characteristics of watercourses and the step-by-step Technical Rehabilitation Guidelines for characteristics of watercourses.
- **Section 5** provides recommendations and a way forward.

2. LEGAL FRAMEWORK

2.1 OVERARCHING LEGAL FRAMEWORK

The Constitution of South Africa is the overarching legislative tool in the country, followed by sectoral legislation on environment and natural resource management. The South African government policy on wetlands recognizes that, in order to be truly effective, strategies for wetland conservation need to include a combination of proactive measures for maintaining healthy wetlands, together with actions to reverse past degradation. This latter aspect forms the core business of the government led wetlands programme. Different institutions lead the mandate over different legislative tools applicable to wetland rehabilitation; and the processes to be followed varies across institutions. **Table 4** below presents a summary of institutions, legislative tools they administrate, and processes applicable to Wetlands Rehabilitation.

Table 4: Legislative Framework Applicable for Wetlands Rehabilitation

<table>
<tr><td colspan="4">Overarching Legislative Tool</td></tr>
<tr><td colspan="4"><u>Constitution of the Republic of South Africa, 1996 (Act 108 of 1996)</u>
Chapter 2, Section 24 provides that everyone has the right:
• To an environment that is not harmful to people’s health or well-being,
• To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:
- prevent pollution and ecological degradation;
- promote conservation; and
- secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.
Chapter 2, Section 27 provides that everyone has the right:
• To sufficient water.</td></tr>
<tr><td colspan="4">Legislative Tools per Mandated Institution</td></tr>
<tr><td>Institution</td><td>Legislative Tool</td><td>Sections</td><td>Process</td></tr>
<tr><td>DWS</td><td>National Water Act, 1998 (Act 36 of 1998)</td><td>Chapter 3 provision for the Protection of Water Resources, with Part 4 and Section 19 pertaining to Pollution Prevention</td><td></td></tr>
</table>

		19, 20, 21, 39	Water Use License Application (WULA), Waste Discharge Charge System (WDCS), General Authorization (GA)
	GN 509	21(c) and (i)	GN509 allows water users to apply for Section 21(c) & (i) under a General Authorisation (GA), as opposed to a full WULA. These water uses may include general construction, maintenance and/or emergency work, river and stormwater management activities and undertaking wetland rehabilitation works within the regulated area of a watercourse. In order for a water use (or potential) to qualify for a GA under GN 509, the proposed water use/activity must be subject to analysis by a suitably qualified natural scientist that is professional registered with the South Africa Council for Natural Scientific Professions (SACNASP) using the DWS **Risk Assessment Matrix (RAM).** ***Note: GN509 does not exempt the water user from compliance with any other provision of the Act or from any other applicable legislation, regulation, ordinance, or by-law.***
	GN 1198	21(c) and (i)	GN1198 relieves a water user from the need to apply for a license for impeding or diverting the flow of water in a watercourse in terms of section 21(c) or altering of the bed, banks, characteristics of watercourses in terms of section 21 (i) of the NWA for the purpose of rehabilitation, provided that the use is within the provision set out in the Notice. ***Note: GN1198 does not exempt the water user from compliance with any other provision of the Act or from any other applicable legislation, regulation, ordinance, or by-law.*** *GA 1198 authorizes the Working for Wetlands Program and as a result, the DFFE does its submission in terms of that to DWS. This is the current approach that is followed by DFFE in order to obtain authorization*
DALRRD	Conservation of Agricultural Resources Act,	CARA is a substantial legal instrument for protecting wetlands and remains in force to this day; specifically, Section 6, 7, 12	Application for consent Section 12

	1983 (Act 43 of 1983)		
	Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947)	Section 3(1)(2)(3), Section 7	The act provides for the registration of fertilisers, farm feeds, agricultural remedies, stock remedies, sterilising plants, and pest control operators with the aim of regulating or prohibiting the importation, sale, acquisition, disposal or use of fertilisers, farm feeds, agricultural remedies, and stock remedies. Furthermore, it governs the use of antimicrobials for growth promotion and prophylaxis/metaphylaxis and the purchase of over-the-counter (OTC) antimicrobials by the lay public (chiefly farmers).
DFFE	National Environmental Management Act, 1998 (Act 107 of 1998)	• Section 24N relating to EMPr • Section 24P relating to financial provisions for remediation of environmental damage • Section 30 and Section 30A relating to emergency incidents. • 2014 EIA Regulations	EIA Regs, BAR, Environmental Management Plan/Programme (EMP) Gazetted Environmental Management Programmes (EMPr)
	National Environmental Management Act, 1998 (Act 107 of 1998)	• The 'duty of care' principle enshrined in section 28 of the NEMA requires landowners to take reasonable measures to prevent, minimize and rectify environmental degradation on their properties	• The WfWet programme also offers technical expertise to landowners and collaborates with local partners to set rehabilitation objectives with the intention of improving the integrity and functioning of ecosystems. Rehabilitation measures address both the causes and effects of degradation;
		NEMA also formally regulates a number of activities that negatively impact the environment, including wetlands, through published lists of activities that require Environmental Authorization prior to such activities commencing, and the establishment of a regulatory application framework including Environmental Impact Assessments (EIA). Several listed activities are linked directly to activities within and in close proximity to wetlands	• EIA process
	National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) (NEM: BA)	• Section 57 relating to restricted activities in terms of ecosystems that are threatened or in need of protection • Chapter 7 relating to permit requirements in terms of restricted activities. • Stipulates that Municipal Integrated Development Plans at the local scale must align with the national biodiversity framework and bioregional plans	Environmental Impact Assessment (EIA), Basic Assessment Report (BAR) It establishes the South African Biodiversity Institute (SANBI) as the regulatory body on biodiversity and makes provision for several planning tools such as bioregional plans and biodiversity management plans

		• Section 52 (1) (a) & (b) and 52(2) of the Act makes provision for the conservation of threatened ecosystems (*i.e.,* including wetlands) in need of protection	
	National Environmental Management: Protected Areas Act, 2003 (Act 57 of 2003) (NEM: PAA)	The purpose of the Act is to effect a national system of representative protected areas to preserve the country's biodiversity, natural landscapes, and seascapes, including wetlands and wetland dependent species, and manage such areas in a sustainable manner	
	National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEM: WA)	The Act regulates disposal of waste at the local scale and requires municipalities to obtain waste management licenses and develop an integrated waste management plan which has to be submitted to and approved by the relevant MEC. Thereafter the IWMP needs to be integrated into the municipality's Integrated Development Plan. Through the regulations above, water resources are protected and dumping of waste along with a suite of other activities which may adversely impact on wetlands are prohibited. 45, Chapter 8 relating to the provisions on contaminated land.	Water Management License (WML), Licence in terms of section 45
	National Environmental Management: Integrated Coastal Management Act, 2008 (Act. 24 of 2008) (NEM: ICMA)	The Act provides for various mechanisms to regulate activities in the coastal zone, including coastal wetlands situated within the zone. Where a wetland falls within the coastal protection zone, additional considerations are relevant in making a decision whether to grant an environmental authorization. Municipalities are also required to adopt coastal management programmes whilst the regulations for formulating estuary management plans are also stipulated.	
	Environmental Conservation Act, 1989 (Act.73 of 1989) (ECA)	This Act has been superseded by NEMA. Nevertheless, a Section 31A directive can still be enacted by the competent authority, local authority or government institution to legally instruct a person that is currently causing or has caused damage to the environment (including wetlands) to either cease the activity in question or take steps, within a period specified in the directive to eliminate, reduce or prevent the damage danger or detrimental effect.	
South Africa Heritage	National Heritage Resources Act,	Section 38	Heritage Impact Assessment (HIA) Permit in terms of section 48

Resources Agency (SAHRA)	1999 (Act 25 of 1999)		
Department of Minerals Resources and Energy (DMRE)	Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)	Section 23, 27	Permit in terms of section 27 or right in terms of section 23
Municipalities	By-laws	Sanitation, Land use Management and Waste Management by-laws	Applicable (per area) municipal by-laws need to be considered by every person(s) undertaking rehabilitation.

Note:

- *The DWS GA 509 was published for 60 days Public Review with a due date of **9 May 2023**. The GA makes provision for rehabilitation work in general that will enhance the PES of watercourses/ water resources. In general, the RMGs do not only concentrate on water use authorisations for new applications but also on historic activities that were undertaken without proper authorization.*
- *The DWS does not authorize rehabilitation, but it authorizes the impeding, diverting, or changing of bed/banks of characteristics of watercourses; and if any of those activities in terms of rehabilitation constitute those water uses, they need to get authorized accordingly.*
- *The RMGs provide guidance to other external persons (i.e., private) for any rehabilitation activities that may impede, divert, and change the bed/banks of characteristics of watercourses; if these other person(s) are impeding, diverting, and changing the bed/banks then they should apply for authorization for which there is a provision for within the DWS.*

2.2 OTHER RELEVANT LEGISLATIVE TOOLS

- Spatial Planning and Land Use Management Act (No. 16 of 2013) (SPLUMA) – SPLUMA is the framework legislation regulating land use planning in South Africa and was developed to govern the planning permission and approval process, sets parameters for new developments and lists the various lawful land-uses in South Africa. Municipalities are required to plan and grant land use approval in line with the framework set out in SPLUMA. SPLUMA includes a number of key development principles which municipalities need to keep in mind during the regulation of land use and development within their jurisdictions. These principles should be integrated into the policies they develop for governance, specifically the integrated development plans developed by the municipality which must be aligned with SPLUMA and should include environmental components/considerations highlighted in environmental legislation. This provides opportunity for the incorporation of a wetland inventory layer into spatial development plans and land-use schemes at the local level providing an opportunity for important wetlands to be considered during the initial planning phase of any development.

- Disaster Management Act, 2002 (Act 52 of 2002) (DMA) – the Act focuses on avoiding or decreasing the risk of disasters, as well as dealing with emergency response planning and mitigation measures during and post-disaster through a coordinated cogent policy. It also requires national, provincial and municipal government institutions to compile disaster management plans at the appropriate scale, The importance of wetlands as critical ecological infrastructure which contributes to water quality enhancement and as part of buffering strategies against disasters such as droughts or floods should be integrated into these plans. Doing so could improve wetland management by elevating the importance of wetlands as a critical element of disaster management policy and implementation plans.

- National Veld and Forest Fires Act, 1998 (No. 101 of 1998) (NVFFA) – the purpose of the Act is to prevent and combat veld, forest, and mountain Fires throughout the Republic. It provides for a variety of institutions, methods, and practices to achieve its purpose. Where the burning of fire breaks includes burning reeds in wetlands, the requirements of this Act must also be complied with.

- National Heritage Resources Act, 1999 (Act 25 of 1999) (NHRA) – the Act aims to enable the provinces to establish heritage authorities which must adopt powers to protect and manage certain categories of heritage resources; to provide for the protection and management of conservation-worthy places and areas by local authorities; and. to provide for matters connected therewith.

- Environmental provisions of the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) (MPRDA) to ensure that urban and commercial developments do not significantly affect or alter the natural state and function of wetlands.

- Municipal Systems Act, 2000 (Act 32 of 2000) (MSA) – the Act requires municipalities to develop a Spatial Development Framework which comprises a key component of their Integrated Development Plans. Integrated Development Plans are a legal requirement that consists of a comprehensive five-year plan which is revised annually for an area that gives an overall framework for development. The aim of an IDP is to improve interdepartmental coordination at the municipal level as well as between local, provincial, and national government through a holistic plan directed at improving the quality of living within the municipality in question. Within the Spatial Development Framework consideration should be given to the protection of valuable natural resources such as ecological corridors, agricultural land and wetlands. There is also an opportunity to include environmental projects in the IDP.

- Municipal by-laws
  Municipal by-laws such as Sanitation, Land use Management, Waste Management, Stormwater Management and Diffuse Water Quality Management by-laws [applicable (per coastal area)] need to be considered by every person(s) undertaking rehabilitation.

2.3 ALIGNMENT WITH POLICIES, STRATEGIES AND PRINCIPLES

Various policies and strategies inform Wetlands Rehabilitation Management in South Africa, and these include, but not limited, to the items:

Policies and Strategies

- National Development Plan (NDP)

- The National Water Resource Strategy (NWRS II) (2013)
- The National Water and Sanitation Master Plan (NW&SMP) (2018)
- The Integrated Water Quality Management (IWQM) Policies (2016) and Strategies for South Africa (2017)
- Eutrophication Management Strategy for South Africa – Second Edition (2023)
- The Draft Environmental Rehabilitation Policy (2014)
- National Biodiversity Strategy and Action Plan
- National Biodiversity Assessment
- National Freshwater Ecosystem Priority Areas (NFEPA)
- The implementation of Gazetted Resource Directed Measures (RDM), particularly the Reserve, Resource Quality Objectives (RQOs), Water Resource Classification and Sources Directed Controls (SDCs) as per principles of improving water resources quality and reducing deterioration where applicable
- The Catchment Management Strategies as informed by the National Water Policy and promotes the sustainable balance between utilisation and protection of water resources in a catchment.

<u>Key Water Resource Management Principles and Concepts</u>

- Integrated Water Resource Management (IWRM) - a process for co-ordinated planning and management of water, land, and environmental resources. It takes into account the amount of available water (surface and groundwater), water use, water quality, environmental and social issues as an integrated (combined) whole to ensure sustainable, equitable and efficient use.
- Sustainable Development Goals (SDGs) - are aimed ensuring the availability and sustainable management of water and sanitation for all by 2030. Every year, an annual SDG Progress Report should be produced based on the global indicator framework and data produced by national statistical systems and information collected at the regional level.
- Social-Ecological System (SES) – are linked systems of people and nature, emphasising that humans must be seen as a part of, not apart from, nature (Berkes and Folke, 1998).
- Global Biodiversity Framework (GBF) - aims to enable urgent and transformative action by Governments, and subnational and local authorities, with the involvement of all of society, to halt and reverse biodiversity loss, to achieve the outcomes it sets out in its Vision, Mission, Goals and Targets. Although the DWS focuses mainly on the reporting on the SDG targets, it is recommended that the relevant authorities should use the outputs of the current RMGs for their reporting at the respective platforms.
- Chapter 1 of NEMA principles – guiding all organs of state regarding the approach they should have to environmental management (including wetland management). Section 2 (4) (a) (r) mentions wetlands specifically: "sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resources usage and development pressure".

3. CHARACTERISTICS OF WATERCOURSES

3.1 INTRODUCTION TO CHARACTERISTICS OF WATERCOURSES

A comprehensive process of water resources rehabilitation requires attention to be given across the board for characteristics of watercourses, namely;

- Hydrology (surface flow and runoff)
- Geomorphology
- Water quality
- Habitat,
- Biota, and
- Groundwater flows.

For all the above-mentioned characteristics, rehabilitation of watercourses is limited. Generally, rehabilitation concerning shaping, re-vegetation, and alien eradication is limited under the NWA. Rehabilitation interventions and practices that focus and include water quality issues such as pollution from WWTWs and from non-point sources are also limited. There are multiple concerns around issues of rehabilitation and the main factors are mines, WWTWs as well as poor compliance and implementation of legislation in terms of buffers to watercourses. Therefore, the need ~~to~~ for the development of rehabilitation guidelines with a focus on characteristics of watercourses is essential.

To this end, to develop such guidelines, it is important to consider factors (drivers and responses) that underpin water ecosystem health and functionality including the interactions between the physical patterns, products (e.g., ecosystem services) and materials (e.g., aquatic ecosystems). **Figure 6** below depicts the Ecological Water Requirements (EWRs) components for ecosystems. This figure demonstrates that water flow, water quality and geomorphology are the main drivers of EWRs and the habitat (instream and riparian habitat) and biota (fish, aquatic, invertebrates, and riparian vegetation) being the responses but are interlinked.

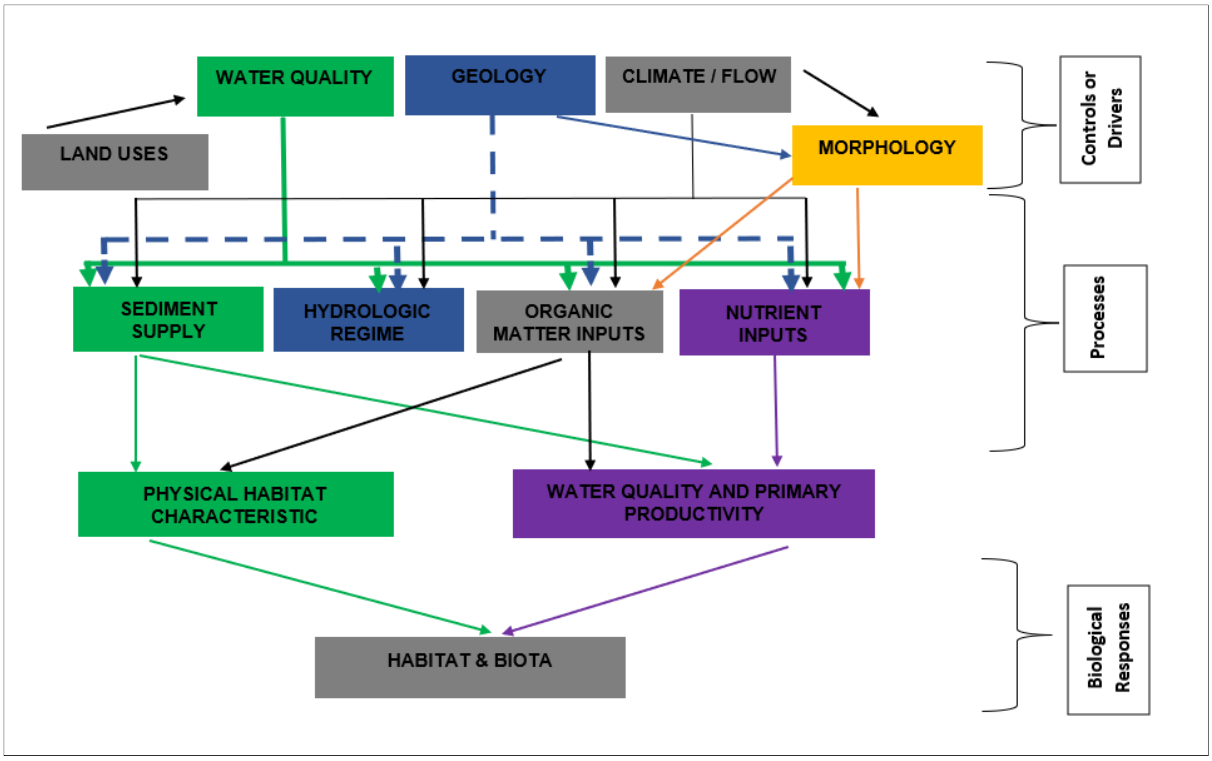

Figure 6: The Ecological Water Requirements of the Reserve including drivers and responses (adapted from Beechie and Bolton, 1999).

3.2 LINK BETWEEN WATER RESOURCES AND CHARACTERISTICS OF WATERCOURSES

The rehabilitation of water resources is directly linked to the rehabilitation of the characteristics of watercourses (drivers and responses) because impacts on water resources may be as equally prevalent on all these characteristics of watercourses. **Figure 7** below illustrates the link between water resources and characteristics of watercourses.

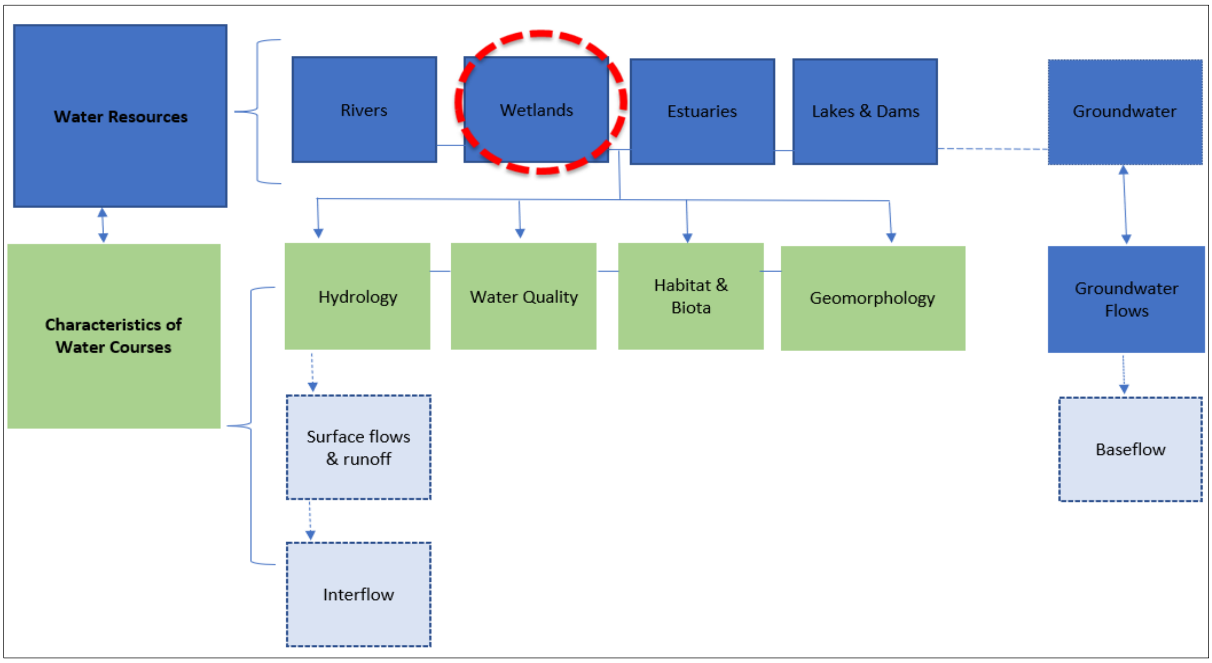

Figure 7: Diagram depicting the link between water resources and characteristics of watercourses.

4. GUIDELINES FOR CHARACTERISTICS OF WATERCOURSES

4.1 HYDROLOGY

Hydrology is the science which deals with terrestrial waters, their occurrence, circulation and distribution on our planet, their physical and chemical properties, and their interaction with the physical and biological environment, including the effect on them of the activity of man (IHE,1998).

The hydrological cycle is the circulation of water within the earth's hydrosphere, involving changes in the physical state of water between liquid, solid, and gas phases and the exchange of water between atmosphere, land, surface, and subsurface waters. There is interaction between different components of the hydrological system and water movement and storage.

4.1.1 Components of the Hydrological Cycle

The hydrological cycle is divided into various components. These components are listed below, and they form an important part of the development of the guidelines:

- Direct rainfall;
- Surface flow and runoff;
- Interflow;
- Baseflow/Groundwater flow; and
- Stream flow.

4.1.2 Definitions of the components of the Hydrological Cycle

The below component of the hydrological cycle will be the focus of the guidelines. The component is described below as follows:

- **Surface flow/surface runoff** – total stream discharge of water, including all surface and subsurface flows derived from rainfall on a catchment surface, usually expressed in cubic metres of water yield per year.

4.1.3 Wetland Hydrology Impacts

Wetlands are important to local communities in terms of providing ecological services and goods. Important services provided by the wetlands are attributed to the wetland form, function, overall biodiversity and the system's **hydrology** and its interactions to the catchment where it is located. These includes **stream flow regulation**, retention of sediment, nutrient trapping, and biodiversity maintenance. The **hydrology** of wetlands and their natural inter- and intra-annual hydrological regime cycle of their ecosystems are important. According to the NBA 2018 (SANBI, 2019), changes to the hydrological regime of inland wetlands negatively impacts their biodiversity with the potential to lead to ecosystem collapse. Water is the key driver of wetland formation, and it is essential to their functionality as many ecosystem services are attributed to the manner in which wetlands regulate water fluxes. However, various impacts modify wetland integrity and ecological connectivity, and these impacts are attributed to the following:

- Agricultural activities relating to extensive grazing and cultivation within the wetlands and the catchment in general. Overgrazing influences and modifies the **runoff** characteristics of catchment as well as other soil surface modification used in agriculture;

- Mining activities which destroy the wetlands or alter the wetland's hydrological regime and water quality characteristics;
- Grazing **and trampling** within the wetland impacting upon the preferential flows within the wetland;
- The **poor management of roads, fires, incision of the channel** at places, sediment plumes and the diversion of water impacts the system's hydrology;
- **Surface runoff** from road construction causes headcuts at the toe of wetlands;
- **Alteration of surface runoff** resulting in straightened channel erosion and formation of gullies within the wetland due to higher-than-normal **flow velocity**
- Over-abstraction and changes in flow drivers have a direct impact on ecological category, habitat, and biota;
- Poor Land Management practices such as agricultural practices interrupt flow paths and connectivity between wetlands and groundwater and other water resource components such as rivers, groundwater, and estuaries;
- Poor stormwater management around wetlands.

4.1.4 Rehabilitation Management Guidelines for Hydrology

The guidelines to be developed will address **erosion** (**gully** and **headcut)** formation within wetlands caused by (amongst others) the discharge of high water-velocity from management of roads; increased peak flows from upstream portions of the wetland; grazing and trampling which alter preferential flows.

Scenario 1: Rehabilitation of altered and incised wetland channels due to erosion (gully and headcut) formation

PHASE 1: Diagnostic Phase:

Step 1: Determine the areas within the wetland which are incised or impacted by erosion.
Step 2: Initiate communications with the responsible authorities (*i.e.,* local and district municipality as well as DWS Regional Office) responsible for the catchment in which the resource affected is located.
Step 3: Identify and determine the causes of erosion.
Step 4: At a desktop level, employ available tools such as Google Earth/ Pro /Google Earth Engine/Sentinel, ensuring the use of high spatial resolution (<10 m) satellite imagery, GIS, and remote sensing to identify the areas impacted by erosion and their extent. Soil erosion mapping can also be undertaken to ascertain the extent of the impact.

PHASE 2: Planning and Assessment

Step 1: Conduct a site visit survey with the relevant specialists *(i.e.*, Wetland Specialist, Engineer and Environmental Assessment Practitioner) to:

- Describe the hydro-geomorphic setting and characteristic of the wetland impacted.
- Assess the overall health of the wetland using WET-Health Guidelines (WRC, 2008; 2020)
- Identify the specific impacts to be addressed by rehabilitation and describe it in more detail where necessary. For example, for headcut erosion, the specific dimensions and level of activity of headcuts would be described.
- Field observation, describe in detail areas impacted and the type of erosion impacts observed. Below are some of the examples of erosion that might be prevalent:

- Sheet, rill, interrill or tunnel erosion
- Gully erosion;
- Headcut erosion;
- Donga erosion;
- Stream channel/bank erosion.

Step 2: Map and delineate the wetland impacted and clearly show the extent. This will inform the rehabilitation methods or techniques to be employed.

Step 3: Site layout, rehabilitation objectives together with the proposed interventions must be agreed by the team upon completing the site visit. In selecting the interventions, consider the following:

- Intervention option(s) selected must be the most appropriate to achieve the rehabilitation objectives.
- Appropriate dimensions of the wetland locations must be measured in order to be able to design and calculate the bill of quantities for the interventions.

Step 4: An Environmental Authorization (EA) inclusive of Environmental Impact Assessment (EIA) and Basic Assessment Process must be lodged with the National Department of Forestry, Fisheries, and Environment (DFFE) for rehabilitation activities in terms of the National Environmental Management Act (NEMA). Below is a list of some key supporting documentations for the application:

- Basic Assessment Report
- Wetland Assessment Report
- Rehabilitation Plan Report
- Designs and Interventions Report – the report must include the following:
  - Hydrological assessment to inform the selection of the design flow to be applied to the intervention.
  - Construction materials to be selected based on site specific criteria.
  - The intervention design demonstrating a plan view, a longitudinal section and front elevation at appropriate scales, and appropriate dimensions.
  - Bills of quantities calculated for the designs including cost estimates .

Step 5: A Water Use License Application (WULA)/General Authorization (GA) must be lodged with the Department of Water and Sanitation in order for certain wetland rehabilitation activities to be undertaken. These activities include '*impeding or diverting the flow of water in a watercourse*' and '*altering the bed, banks, course or characteristics of a watercourse*'. where they are specifically undertaken for the purposes of rehabilitating a wetland for conservation purposes. Below is a list of some key supporting documentations for the applications:

- Wetland Delineation and Assessment Report - this report must clearly demonstrate the impacts on resource quality characteristics (impact/modification to flow regime as ecosystem drivers); the proposed rehabilitation interventions and the possible changes to PES and EIS of the wetland system.
- Environmental Impacts Assessment Report

Note: *No wetland rehabilitation work may be undertaken until such time that an EA and WUL/GA is granted by the DFFE and DWS respectively.*

PHASE 3: Identify and define the Rehabilitation Objectives

The objectives of rehabilitation will entail addressing the incised wetland using the appropriate measures. These objectives must be informed by the information and data collated in **Phase 1 and 2** above. As an example, when the primary threat to the wetland was identified as headcut erosion threatening to propagate through the wetland; the appropriate rehabilitation objective would be to halt and prevent the propagation of the erosion headcut using various methods/techniques.

PHASE 4: Execution

Step 1: Employ the appropriate rehabilitation methods or techniques **(Figure 8-12)** informed by the submitted and approved Designs and Interventions Report (refer Phase 2 to see what the report entails)

Step 2: Employ one or a combination of the below available soft and hard engineering interventions. (**Note:** these examples and guidance are informed by local knowledge acquired from the Working for Wetland Programme Rehabilitation Interventions applied in South Africa.

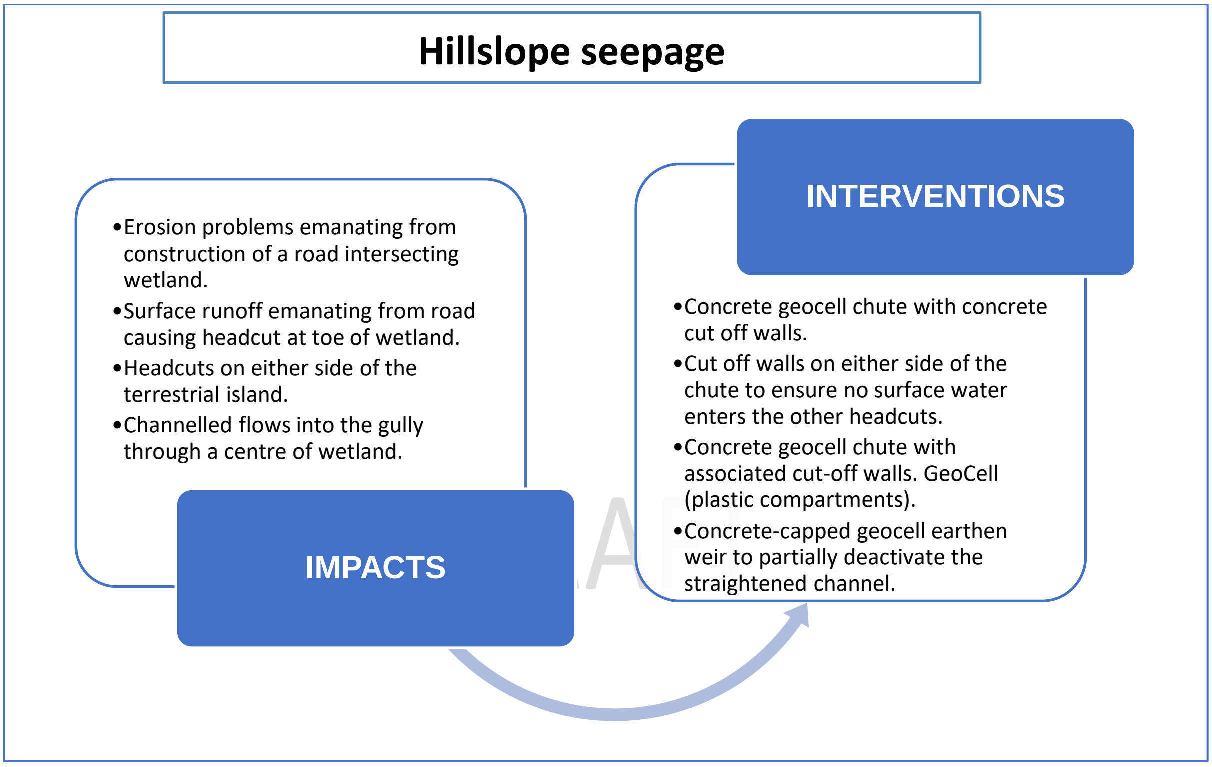

Figure 8: Rehabilitation Inventions for erosion (headcuts) impacts.

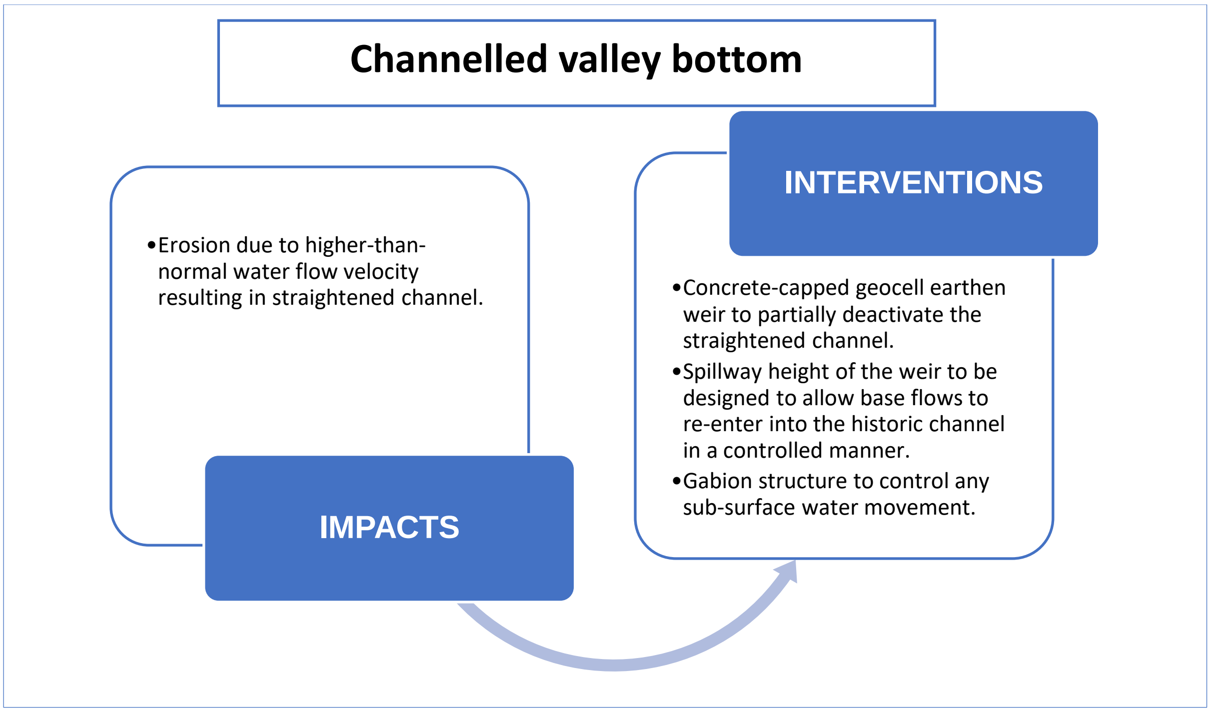

Figure 9: Rehabilitation Interventions for straightened channel erosion.

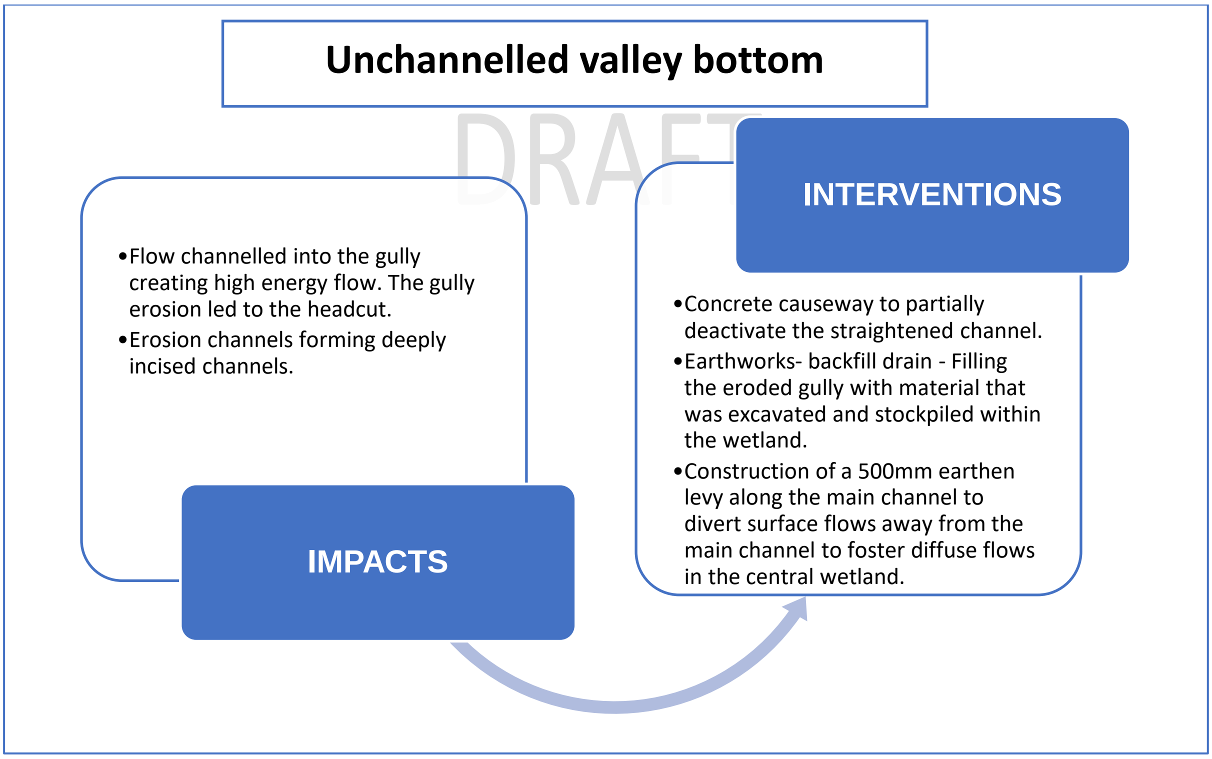

Figure 10: Rehabilitation Interventions for channelled flow impacts.

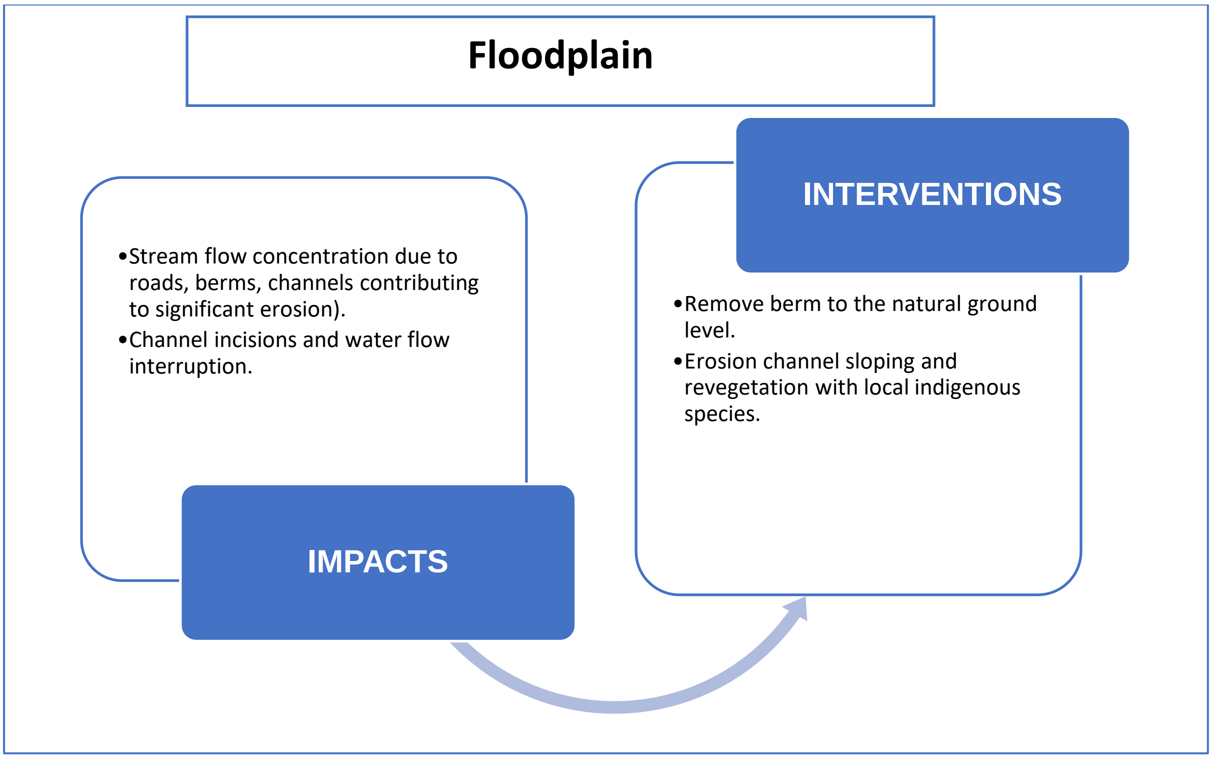

Figure 11:Rehabilitation Interventions for structures impeding flow.

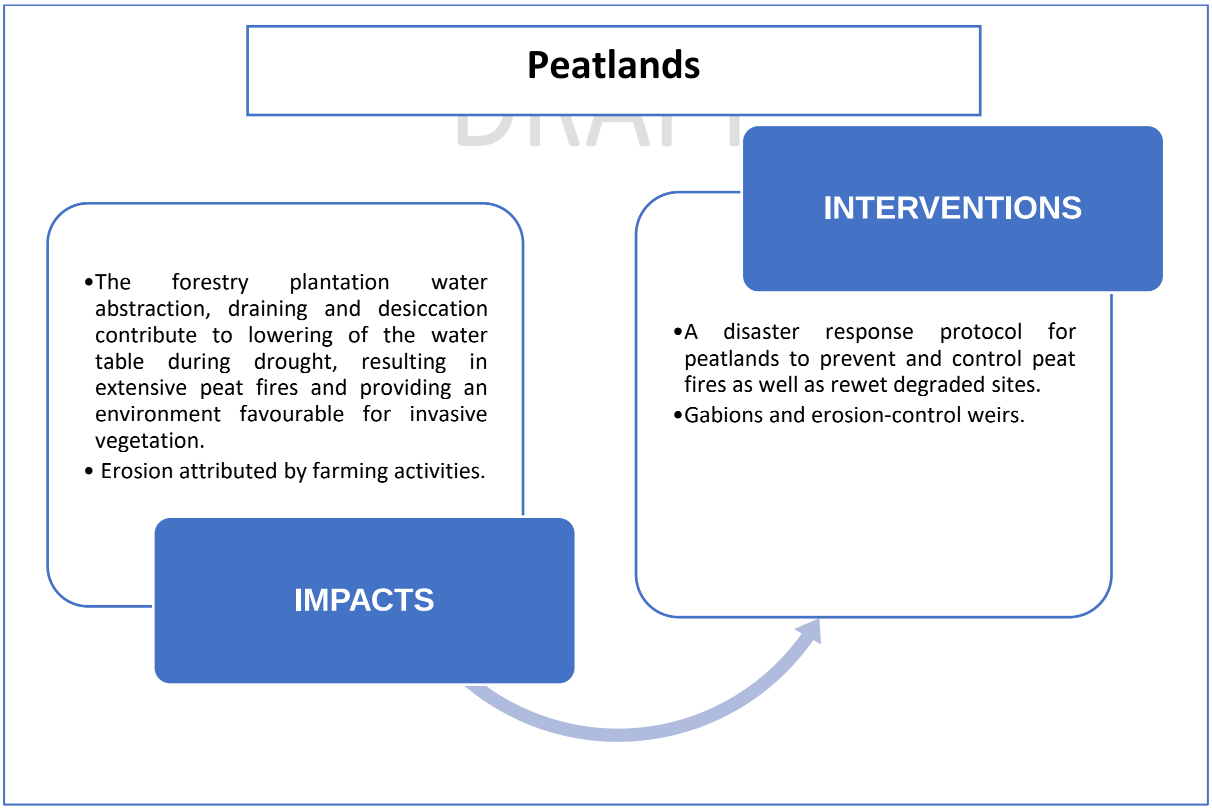

Figure 12: Rehabilitation Interventions for peatland wetlands.

Box 1
Notes:

Although the above intervention types and structures are packaged according to various wetland types, the main factor informing and dictating the most suitable intervention is the type of impacts prevalent on site. Below is a list of some commonalities observed across the various recommended interventions regardless of the type of wetland in question:

- Structures such as gabions, berms and weirs are suitable for diverting or redistributing water to more natural flow paths, or for the prevention of erosion by unnatural flow rates that result from unsustainable land use practices or development;
- Concrete and gabion weirs act as settling ponds which reduce flow velocity or re-disperse water across former wetland areas thereby re-establishing natural flow paths;
- Concrete or gabion structures stabilise headcut or other erosion and prevent gullies;
- Earth or gabion structure plugs are best suitable for raising channel floors and reduction of water velocity;
- Concrete and/or reno mattress strips are best suited for road crossings to address channels and erosion in wetlands;
- Natural engineering designs like groyns, rock mattress at angles, appropriate size rip rap, geotextiles, topsoil, vegetation is preferred above concrete and vertical placed gabion baskets.

PHASE 5: Monitoring, Evaluation and Reporting

<u>Monitoring</u>

Undertake routine and systematic inspection of the rehabilitated wetlands to determine whether the conditions are improving or further degrading. The following are some of the parameters/variables to be monitored depending on the impacts:

- Water levels across the site – wetland hydrology function.
- Habitat conditions.

<u>Evaluation</u>

- Evaluate the effectiveness of interventions against the achievement of rehabilitation objectives and outcome.
- Determine maintenance objective.

Additional management measures must be implemented in the event the conditions do not improve.

<u>Reporting</u>

A Rehabilitation Report should be compiled and be accompanied by supporting information such as:

- A map of disturbed and rehabilitated areas; and
- Before and after photos of rehabilitation including a significant landmark for comparison purposes, with a brief description including location, and date.

Scenario 2: Control and clearing of Invasive Alien Species from wetlands and their immediate catchments to reduce water uptake from wetlands.

PHASE 1: Diagnostic Phase

Step 1: Identify the areas within the wetland that are invaded by invasive alien species.

Step 2: Initiate communications with the responsible authorities (*i.e.,* local and district municipality as well as DWS Regional Office) responsible for the catchment in which the resource affected is located.

Step 2: Utilize tools such as Google Earth/ Pro /Google Earth Engine/Sentinel, ensuring the use of high spatial resolution (<10 m) satellite imagery, GIS, and remote sensing to identify the areas within the wetland which is invaded *i.e.,* invasion of alien species along the channel of a wetland.

Step 3: Using information obtained from Google Earth satellite images and Remote Sensing as ground truthing to describe in detail the zone within the wetland that is affected in terms of the following:

- Species types *i.e.,* woody alien vegetation;
- Density and the zone within the wetland into which invasion occurs.
- Visual description of the zone affected;
- The conditions upstream or downstream of the affected wetland zone.

PHASE 2: Planning and Assessment

Step 1: Conduct a site visit survey to accurately confirm and ascertain the preliminary findings acquired in **Phase 1**. Below are some important aspects to consider when undertaking fieldwork pertaining to observation made for the wetland in question:

- Photographs and GPS co-ordinates;
- Fixed-point photography (in accordance with the guidelines outlined in WET-Rehab-Evaluate: Cowden and Kotze, 2008);
- WET-Health information (allowing the comparison of wetland ecological integrity before and after rehabilitation activities); and
- Details relating to the calculation of estimated hectare equivalents affected.
- Species growth form (*i.e.,* tree, seedling, or creeper);

Step 2: The below summarised list of steps **(Figure 13)** must be considered during the planning and assessment phase of alien vegetation clearing. These steps are adapted from WRC (2016) and applied when undertaking clearing of alien vegetation for rivers but can equally be applicable for clearing of alien species invading wetlands.

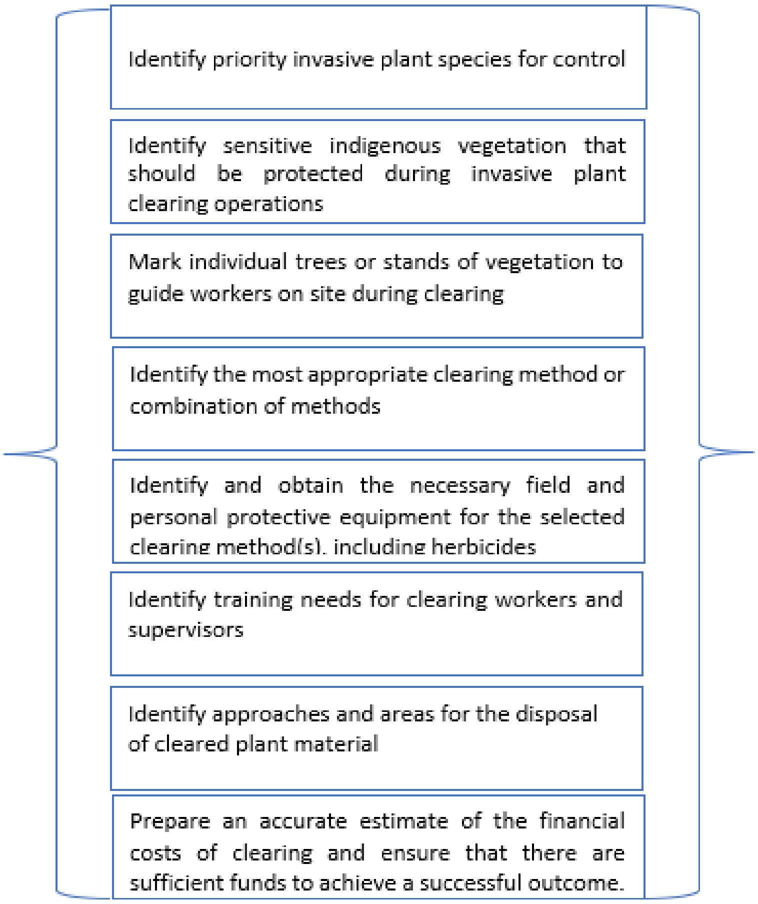

Figure 13: Planning and Assessment Phase steps for alien vegetation control and clearing (adapted from WRC, 2016)

PHASE 3: Identify and define the Rehabilitation Objectives

The objectives of rehabilitation of alien vegetation must be defined and be clear at the start. These objectives must be informed by the information and data collated in **Phase 1 and 2** above. Below is a list of common aims and objectives:

- To improve biodiversity by allowing the establishment / generation of natural indigenous wetland flora;
- To increase space for flood alleviation by clearing vegetation to increase the conveyance or the natural flow of water;
- To rehabilitate a more natural wetland flow regime by releasing trapped sediments and allowing erosion processes to restore natural river levels.

PHASE 4 – Execution:

Alien vegetation clearing and control methods are divided into three main categories, namely **physical** (or mechanical) control, **chemical** control, and **biocontrol (Figure 14)**. A combination of these approaches may be implemented for the clearing and control of invasive plant species. These methods must be supported by a Plant Species Plan developed by a landscape architect or botanist.

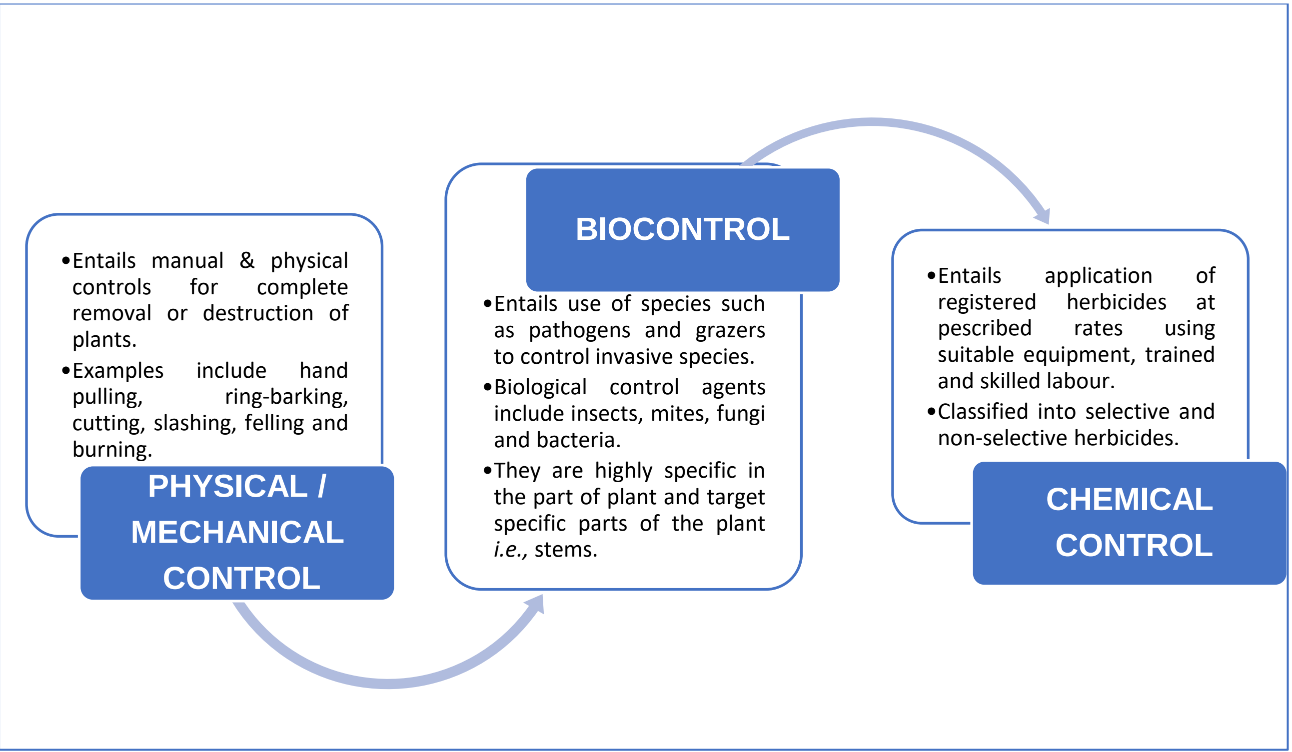

Figure 14: Alien vegetation clearing and control methods.

Note: *The chemical control method which entails the application of herbicides should be carried out in accordance with the stipulations of the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947).*

Box 2 contains information on other known methods that should be considered for the clearing and control of alien vegetation.

Box 2

Cultural Control Methods focus on altering the environmental conditions to discourage the growth and spread of invasive plants *i.e.,* altering water levels, modifying soil conditions, implementing proper land management practices, or promoting the growth of native plant species to outcompete invasives.

Preventive Measures includes early detection and rapid response to new infestations, implementing strict biosecurity measures to prevent the introduction and spread of invasive plants, and promoting awareness and education about the risks associated with invasive species.

PHASE 5 – Monitoring, Evaluation and Reporting

Monitoring

Monitoring of rehabilitated areas must be undertaken to:

- Ensure that treatment methods employed are adequate and effective to ensure that no additional measures are required;
- Allow learning from past practices, so that ongoing invasive alien plant clearing initiatives are constantly improving and are in accordance with seasonal changes.

The following monitoring suggestions are recommended by WRC (2016):

- A fixed-point photographic record should be collected, showing the affected wetland before, during and at regular time periods after initial alien clearing has taken place;
- Historical Google Earth images should be used over time, to provide a spatial record of clearing extent and effects;
- Monitoring using tools such as remote sensing and GIS.

Note:

Alien vegetation must be replaced with the appropriate indigenous vegetation. This is especially important when trees are removed, indigenous tree species must be brought in. Furthermore, alien management must be in a phased approached both eradication (to manage re-growth) and revegetation (to ensure growth success).

Evaluation

- Evaluate the effectiveness of interventions against the achievement of rehabilitation objectives and outcomes.
- Determine maintenance objectives.

Reporting

A Rehabilitation Report should be compiled and be accompanied by supporting information such as:

- A map of disturbed and rehabilitated areas; and
- Before and after photos of rehabilitation including a significant landmark for comparison purposes, with a brief description including location, and date.

4.2 GEOMORPHOLOGY

4.2.1 Description

Geomorphology is a science focused on understanding Earth surface processes and landscape (such as wetlands, mountains, valleys, river channels and estuaries) evolution (Keller, *et.al.,* 2020). It is also regarded as the study of physical features on the earth and their relation to geological structures. Geomorphological understanding is central to environmental flows because it is the interaction between flow, form, and substrate that influences habitat type, condition, availability and biotic use across space and time (Meitzen *et. al.,* 2013).

The long-term geomorphological evolution is strictly controlled by the interplay of tectonic activity and climate changes, and close to coastal zones, sea-level oscillations also contribute to modifying this natural system, as well as anthropogenic activities which also contribute to the modification of wetlands ecosystems.

Wetlands are key components of many landscapes worldwide and are regarded as providing a wide range of direct and indirect socio-economic services to the human beings. Hence, understanding how wetlands are structured, how they function and how they may change is important. It is therefore very important to note that the geomorphology of wetlands is an important aspect that needs to be considered when doing wetland rehabilitation. **Figure 15** below is an illustration of the relationship between wetlands process, geomorphology, climate change and human activities.

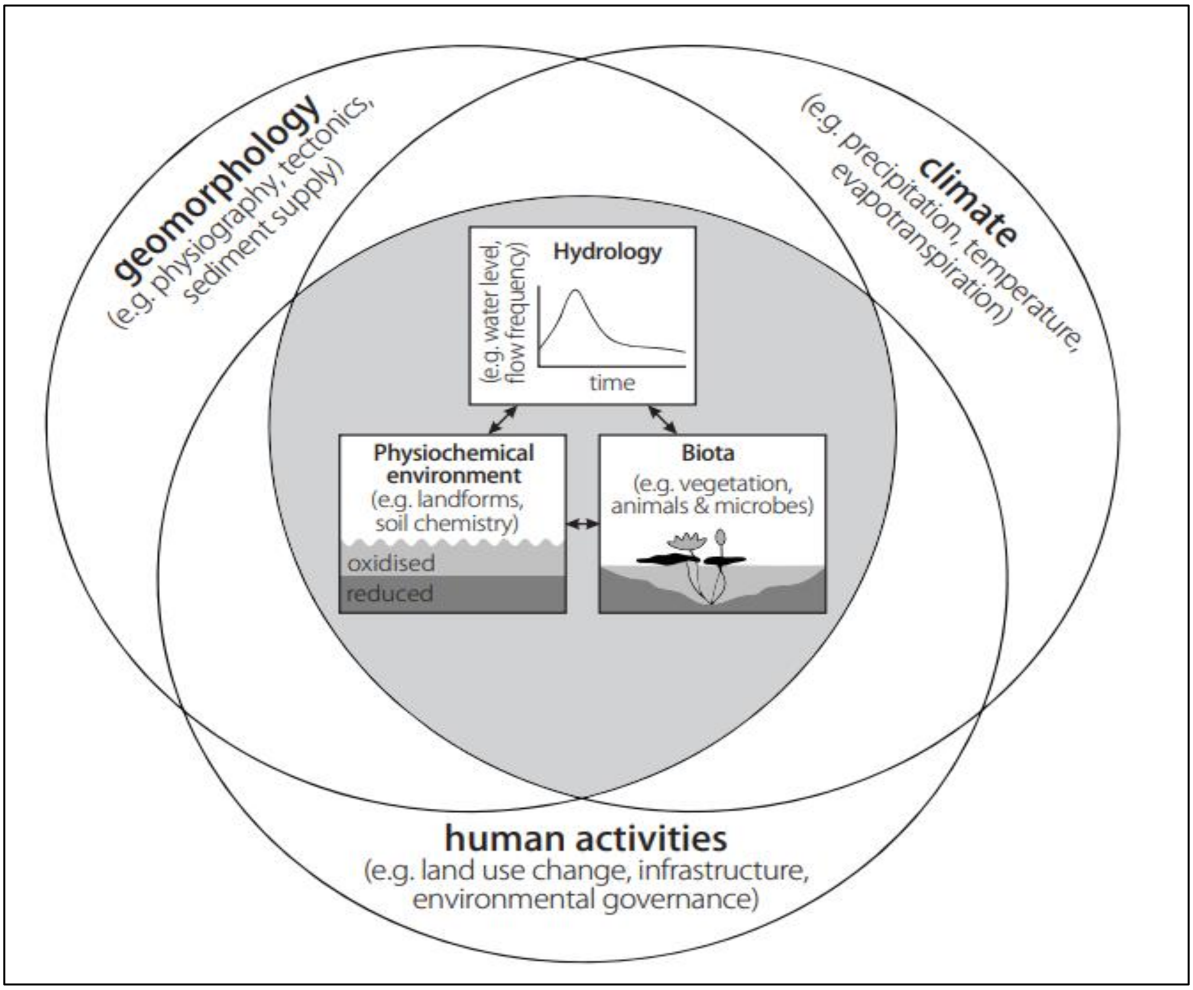

Figure 15: Relationship between wetlands process, geomorphology, climate change and human activities (Tooth, et. al., 2015)

4.2.2 Factors Influencing Geomorphological Impacts

Scale is an important consideration, with process-form interactions occurring over a huge range of space (spatial scale) and time (temporal scale) (Charlton, 2008). The two considerations for management that come from geomorphology is time and space. Soil erosion is a major environmental problem that is associated with geomorphology. Such that, once the topsoil has been removed, the lower soil layers are exposed. These layers have poor structure and are low in organic matter and nutrients, as a result they are less permeable leading to increased overland flows which increases the sedimentation supplied to wetlands (Freeman and Rowntree, 2005).

Human interventions on the other hand have had an influence on modification of wetland systems for many years. Activities such as scouring of the channel bed deepens the channel, therefore channel engineering, deforestation, vegetation clearing, agriculture, and mining activities affects the flow of water and production of sediment.

4.2.3 Rehabilitation Management Guidelines for Geomorphology

Grazing in riparian areas within wetlands is a natural phenomenon, however, excessive grazing causes alteration of the natural vegetation cover, reduces vegetation and habitat complexity. These changes reduce the flood attenuation and sediment trapping efficiencies of wetlands. Other indirect effects of grazing include trampling within wetlands, and the creation of localised erosion gullies, while severely trampled riparian areas may be more vulnerable to erosion.

Scenario 1: Rehabilitation of over-grazing and vegetation alteration to improve wetland vegetation growth and sediment trapping.

PHASE 1: Diagnostic Phase

Step 1: Using Remote Sensing, Google Earth Images and historic satellite imagery to identify the areas within the wetland that have lost vegetation cover and to inform changes and rate of changes.
Step 2: Initiate communications with the responsible authorities (*i.e.,* local and district municipality as well as DWS Regional Office) responsible for the catchment in which the resource affected is located.
Step 2: Identify and describe the main causes and effects of loss of vegetation cover *i.e.,* overgrazing causes loss of vegetation which leads to erosion impacts within the wetland.
Step 3: Describe the biome and vegetation types within which the wetland in question is located.

PHASE 2: Planning and Assessment

Step 1: Conduct a ground truthing survey to accurately ascertain area(s) within the wetland affected by vegetation loss. The survey results must include the following:

- All areas affected by vegetation loss including photographs and GPS co-ordinates;
- The causes and effects of vegetation loss;
- The type(s) of vegetation prevalent on site;
- The extent of the affected areas with the details relating to estimated hectares.

Step 2: Map and delineate the areas clearly indicating the extent in hectares of the area(s) affected. This step must also consider upstream and downstream conditions of the area(s) affected.
Step 6: Scientific buffers to be determined and implemented.

PHASE 3: Identify and define the Rehabilitation Objectives

The objectives of rehabilitating altered vegetation must be defined and be clear at the start. These objectives must be informed by the information and data collated in **Phase 1 and 2** above. Below is a list of common aims and objectives:

- To re-establish vegetation cover with the potential to restrict sediment loss while deactivating causes of erosion. The resultant trapping of sediment would thus be valuable in that it would promote characteristic wetland vegetation growth.
- A secondary objective is to halt the sediment lost through erosion which could possibly add to siltation of the water resources downstream.
- Shaping to better or original topography.
- Ensuring that carrying capacity and livestock grazing programmes are determined and implemented.

PHASE 4: Execution

Vegetation alteration and loss as well as overgrazing (which include trampling) are the main impacts identified in this scenario. Natural engineering interventions (see below **Figure 16**) are recommended for this scenario to offer successful rehabilitation methods. This includes but is not limited to the following:

- Gabion structures such as mattresses, blankets, baskets, geofabric liners;

- Sediment fence.

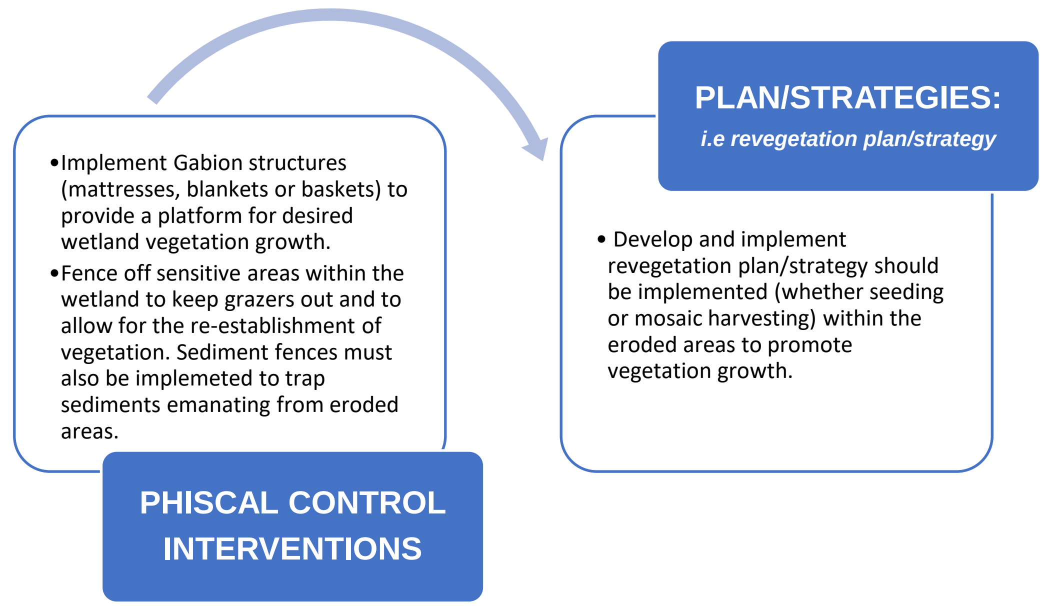

Figure 16: Interventions for addressing vegetation loss impacts.

PHASE 5: Monitoring, Evaluation and Reporting

Monitoring

Monitoring of rehabilitated and revegetated areas must be undertaken periodically to ensure that interventions methods employed are adequate and effective. Additional measures must be implemented in the event the monitoring results show no substantial changes *i.e.,* if erosion persists after revegetation, erosion control geo-fabric blankets should be placed over the re-worked area to limit erosion until vegetation has fully established.

Box 3

Notes:

- Prior to implementing the revegetation plan, it is important to ensure that the affected area is reworked and sloped appropriately to promote vegetation growth and stabilisation;
- Local indigenous grass seed mixture must be used to revegetate the area;
- Determine and implement livestock management grazing carrying capacity plans.

Evaluation

- Evaluate the effectiveness of interventions against the achievement of rehabilitation objectives and outcomes.
- Determine maintenance objectives.

Reporting

A Rehabilitation Report should be compiled and be accompanied by supporting information such as:

- A map of disturbed and rehabilitated areas; and
- Before and after photos of rehabilitation including a significant landmark for comparison purposes, with a brief description including location, and date.

4.3 WATER QUALITY

4.3.1 Description

The primary water quality constituents that affect wetlands are the concentrations and/or loading of phosphorus and nitrogen nutrients, ammonia, various heavy metals, suspended solids, and their load of absorbed compounds (Turpie *et al*., 2010).

4.3.2 Types of Water Quality Impacts

Water quality in wetlands is threatened by uncontrolled fires, invasive plants, livestock, undomesticated animals *i.e.,* wild animals, lack of properly designed drainage, water abstraction, climate change, poor agricultural practices, and construction (earthworks) (Newton *et al*, 2020)**.** Point sources of pollution emanating from industries also pose a risk to wetlands.

Contaminants of Emerging Concern (CECs) are an emerging concern to wetlands, and they emanate from agricultural runoff. This also includes contaminants and pathogens of emerging concern; Emerging pathogens and/or CECs including endocrine disruptors emanating from pharmaceutical industries enter the systems from WWTWs and contribute to pollution of wetlands.

The impacts of these activities and encroachment include (Mao *et al.*, 2014; Chen *et al*., 2018):

- Excessive nutrient availability caused by rapid algal growth which obstructs sunlight and in the case of blue-green algal blooms, production of harmful toxins to humans, animals, and the environment;
- The introduction of contaminants such as fungicides, insecticide, and herbicides;
- Loss of vegetation causing rising water levels;
- An upsurge of soil salinity as naturally occurring soil salts migrate to the surface, thus hindering vegetation growth;
- Acid and metal release into the soil, thus compromising water quality, which may result in fish disease, acid-tolerant species dominance, groundwater contamination, and corrosion-related infrastructure damage;
- Acid mine drainage emanating from mining activities;
- Discharge of raw and inadequately treated wastewater into watercourses due to malfunctioning WWTWs;
- Poor stormwater design.

4.3.3 Rehabilitation Management Guidelines for Water Quality

Water quality is globally impacted by human activities, and nutrient levels in water resources are constantly rising. This is mainly due to agricultural runoff (from agro-chemicals, drug residues, saline drainage, organic matter), urban non-point source pollution and sewage (Doetterl *et al*., 2012; UNEP, 2016). The associated waste, which includes manure, has serious consequences for water quality.

Scenario 1: Rehabilitation of AMD water decanting from operations into wetlands.

PHASE 1: Diagnostic Phase

Step 1: Identify the source of AMD *i.e.,* AMD decanting from the operations.
Step 2: Initiate communications with the responsible authorities (*i.e.,* local and district municipality as well as DWS Regional Office) responsible for the catchment in which the resource affected is located.
Step 3: At a desktop level and from existing information, assess the conditions of the opencast pit or underground operations to determine the following:
- Dewatering rates (if there is such an activity taking place);
- Seepage rate into the operations;
- Recharge rate into the operations;
- Groundwater levels; and
- Lowest topographic level (where regional piezometric head of the aquifer intersects the topographical setting – This is important because decant/seepage point(s) are normally located here.

Step 4: Collect groundwater samples from the operations in question and submit them to an accredited lab for groundwater quality analysis. The results from the analysis will inform the treatment methods/options to be employed for water that will be dewatered from the operations.
Step 4: Collect waste rock material samples for geochemical assessment. The results of the assessment will inform whether the backfill material is suitable to be used for backfilling the operations. The material to be used for backfilling must be non-acid generating.

PHASE 2: Planning and Assessment

Step 1: Rehabilitation of AMD water emanating from the operations trigger Section 21 water uses.
Step 2: The person undertaking rehabilitation must determine the water uses likely to be triggered by the rehabilitation activities. Examples are:
- Section 21 (j) – dewatering of groundwater.
- Section 21 (g) – temporary storage of water pumped.
- Section 21 (f) – discharging the treated water.
- Section 21 (c) and (i) for decant in regulated areas.
- Exemption from Regulation 4(c) of GN704 for backfilling activities into the operations.

Step 3: The person undertaking rehabilitation activities must determine the below:
- Geohydrological conditions of the operations terms of the geology, aquifers, inflows and outflow rates, and groundwater levels.
- Rates of inflow and outflow in the operations.
- Geochemical assessment detailing the type of waste material to be used for backfilling.

PHASE 3: Identify and define the Rehabilitation Objectives

Define clear rehabilitation objectives based on information gathered in **Phase 1** and **2.** Below are some of the common aims and objectives of the rehabilitation of opencast pit which decants into water resources:
- Pump water from the operations to reduce and maintain groundwater levels below decanting levels.
- Treat AMD water to acceptable standards and reuse.

- Backfill the opencast pit and use the rehabilitated land for other purposes *i.e.,* agricultural purposes.

PHASE 4: Execution

Figure 17 and **18** presents both passive and active methods that can be employed for rehabilitation of decanting mining operations.

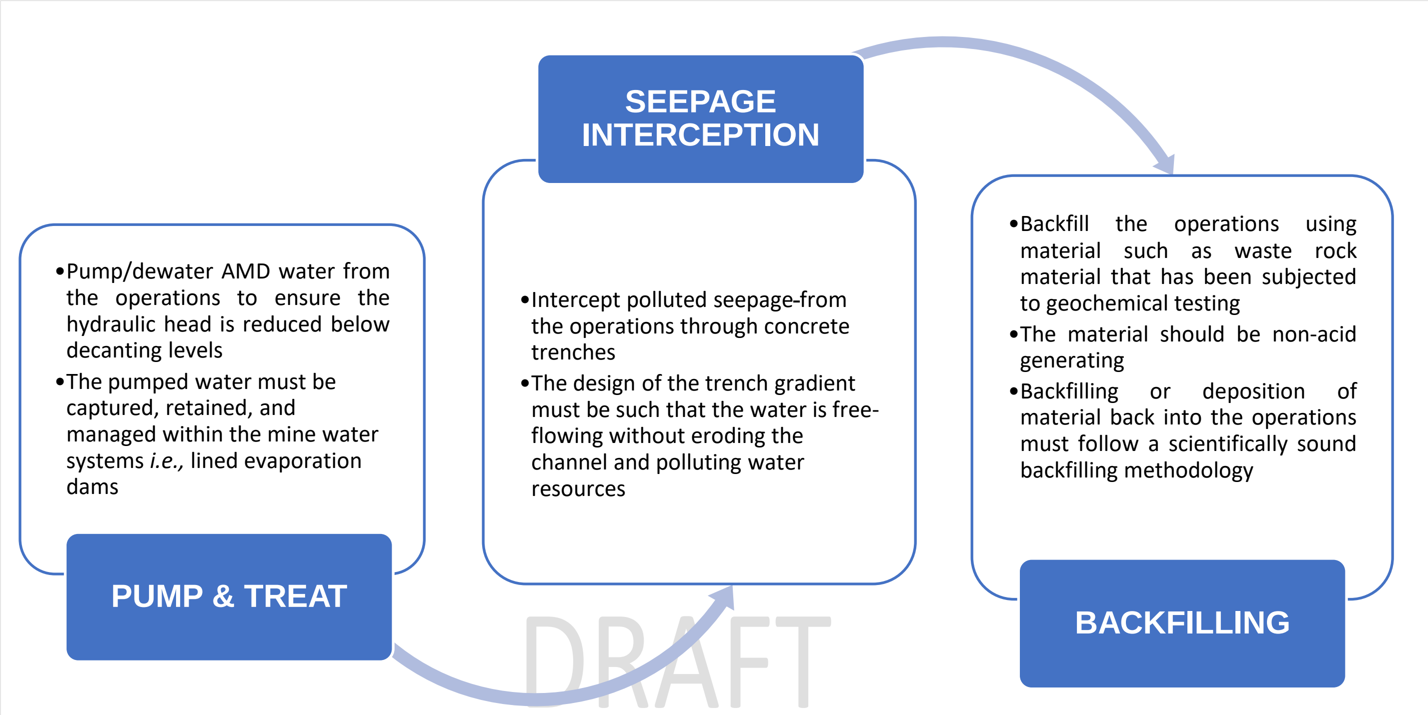

Figure 17: Passive Treatment Methods.

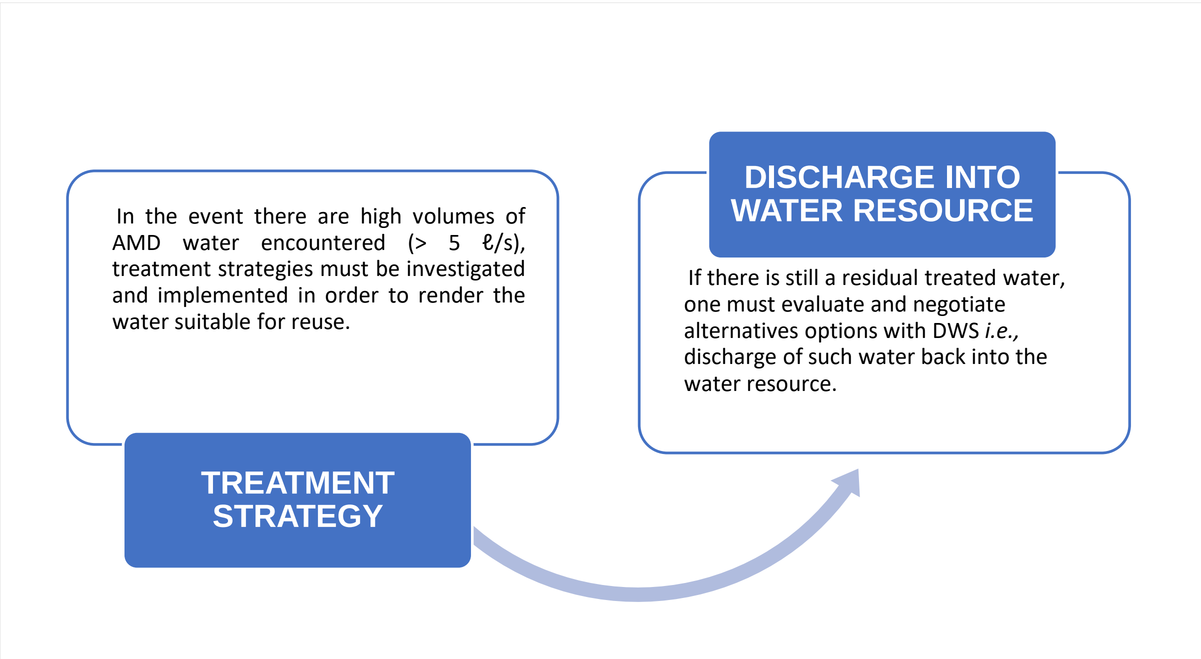

Figure 18: Active Treatment Method

PHASE 5: Monitoring, Evaluation and Reporting

Monitoring

- **Pump and/or Dewatering –** Monitor the groundwater levels within the operations daily and report to the DWS on a monthly basis.
- **Seepage Interception –** monitor the quality of water at the trenches and downstream of the constructed wetland to assess the changes in quality of water over time.
  - **Backfilled opencast area -** develop and implement a dedicated monitoring programme to monitor the groundwater level recovery and pit water quality of the rehabilitated/backfilled area.

Evaluation

- Evaluate the effectiveness of interventions against the achievement of rehabilitation objectives and outcomes.
- Determine maintenance objectives.

Reporting

A Rehabilitation Report should be compiled and be accompanied by supporting information such as:

- A map of disturbed and rehabilitated areas; and
- Before and after photos of rehabilitation including a significant landmark for comparison purposes, with a brief description including location, and date.

4.3.4 Special considerations to be applied for Rehabilitation using Passive Treatment Methods

Consideration must be given to the passive treatment methods to include constructed wetlands and nature-based solutions.

Scenario 2: Rehabilitation of wetland contamination due to lack of wastewater and industrial treatment facilities or the release improperly treated wastewater into watercourses.

Effective wastewater effluent treatment should be prioritized in order to avoid adverse health effects on users and the aquatic ecosystem. The discharge of raw and inadequately treated wastewater into watercourses has both short and long-term environmental and human health consequences.

PHASE 1: Diagnostic Phase

Step 1: Using WET-Health (Version 2.0) tool, an assessment of the integrity of the wetland should be undertaken, this can give a clear indication of the deviation of the wetland from its natural reference condition guided by vegetation, hydrology, geomorphology, and water quality.

Step 2: Initiate communications with the responsible authorities (*i.e.,* local and district municipality as well as DWS Regional Office) responsible for the catchment in which the resource affected is located *i.e.,* local landowners, as well as other interested and affected parties to assess social uses of the wetland in question.

Step 3: Undertake a desktop assessment to identify the WWTWs and industries whose effluent may negatively impact water quality of the Wetlands.

Step 4: Utilize tools such as Google Earth/ Pro /Google Earth Engine/Sentinel, ensuring the use of high spatial resolution (<10 m) satellite imagery, GIS, and remote sensing to map disturbance units, which show the extent of various types of disturbances caused by water quality impacts within the wetlands.

PHASE 2: Planning and Assessment

Step 1: This phase will require site visits attended by a team consisting of a wetland ecologist, Environmental Assessment Practitioners (EAPs), and Independent Design Engineers for example, to assess the extent to which the discharge of improperly treated wastewater from a treatment plant has affected the water quality of a wetland.

Step 2: Investigate the source of pollution and level of water quality decline over time in that area.

Step 2: Request local government officials (municipal as well as Provincial DWS/CMAs and DFFE Offices) and local NGOs community forums responsible to assist with identifying point sources of pollution to provide guidance on available regulatory processes.

Step 3: Investigate other sources of pollution and water quality *e.g.,* non-point sources of pollution.

Step 4: Undertake the following:

- Analysis of the historical data (water quality) to see the trend and reference point.
- Collect the actual final effluent water samples from the sources *i.e.,* WWTW and industrial facility.
- Collect monthly water quality samples from the resource *i.e.,* Wetland.
  - 1 upstream of the WWTW and industrial facility discharge points.
  - 1 downstream of the WWTW and industrial facility discharge points.
- Have samples analysed at an accredited laboratory to determine the water quality at the sources and resource, respectively.

Step 2: Undertake the following:

- Compare laboratory-generated water quality data to the expected state for the identification of areas of concern.
- Data analysis should be compared against the RQOs/RWQOs, or Aquatic Ecosystem Water Quality Standards if they have not yet been established for that catchment.

PHASE 3: Identify and define the Rehabilitation Objectives

The objective should be to rehabilitate the present ecological state of the wetland water quality by taking the impact of the discharge into account. Furthermore, these objectives should be set in accordance with the relevant stakeholders. The rehabilitation objectives should be based on information and data gathered in **Phases 1** and **2.** Common objectives are to manage and prevent poor effluent from WWTWs and industrial facilities from discharging into water resources *i.e.,* estuaries.

Improvements of existing WWTWs or industrial facilities (resulting in untreated effluent composition or volume) can be implemented.

PHASE 4: Execution

The following steps must be followed by practitioners for the rehabilitation of water quality activities:

Step 1: Implement environmentally sustainable solutions through stakeholder engagements, communication within the water sector and between government departments sector, and between DFFE and other relevant government departments.

Step 2: Undertake the following:

- Ensure treatment of effluent from point sources prior to discharge;

- Effluent which does not meet the discharge standards should be temporarily stored for further intervention and/or treatment; and
- Monitor the effluent before discharge to ensure that it is of acceptable quality standard.

Step 3: Undertake the following:

- Implement surface water management around the WWTWs and industrial facilities;
- Install cut-off trenches around the facilities to separate clean and dirty water and direct clean water back into natural drainage lines and the natural environment; and
- The dirty water channels should be drained to an emergency holding dam for treatment.

Step 4: Construct temporary berms along the rivers to prevent further offsite migration/discharge of effluent ending into the river.

The primary response however should be to improve the efficacy and capacity of the WWTW, to avoid effluent non-compliance.

Box 4 contains information on other known methods that should be considered for poor water quality associate with effluent discharge from WWTW.

Box 4

Complementing treatment at WWTW running at capacity or having treatment challenges with floating treatment wetlands, constructed wetlands, microbial treatment, and algae as phytoremediation to be integrated upon feasibility investigation.

<u>Note:</u>

In general, the approach of DWS to water quality management is to promote the reduction of discharges of waste or water containing waste into water resources. Where waste discharges are unavoidable, the impact on other users, water resources and the public are controlled by specifying the permissible levels and concentrations of the constituents of the discharge in the conditions of authorisation.

In the case of emergency situations, where harmful substances are accidentally or negligently discharged into water resources, the NWA (Chapter 3, Part 5, Section 20) provides for those who have caused the pollution responsible for remedying its effects. However, Catchment Management Agencies may, where necessary, accelerate the clean-up process by arranging for the work to be done by others and recovering any costs incurred from the responsible party. At present all pollution incidents must be reported to the DWS so that appropriate responses can be co-ordinated, in conjunction with the National Disaster Management Centre, with the relevant emergency services and disaster management centres. Ultimately this responsibility will be passed to the catchment management agencies.

PHASE 5: Monitoring, Evaluation and Reporting

Step 1:

- Undertake monthly water quality monitoring in the rivers depending on the volume discharge, local municipal by-laws, and the type of permit allowed;
- Continuously assess WWTWs and industrial facilities to assist with defining the quality of the water and extend to which treatment is required (records of up to a year are desirable to characterise the state of the of the facilities).

Step 2:

Monitoring parameters for WWTWs:

- Nutrients (phosphorus and nitrogen), and bacteria (*E.coli* or *coliforms*).

Monitoring parameters for industries:

- Metal concentrations and distributions at least once every 3-5 years for industrial facility;
- Metal concentrations in tissues of fish/mussels (bio-accumulation) at least once every 3-5 years.

Evaluation

- Evaluate the effectiveness of interventions against achievement of rehabilitation objectives and outcomes.
- Determine maintenance objectives.

Note: *The expected outcomes of monitoring and evaluation can be achieved through the use of available knowledge hubs on emerging pathogens and/or CECs emanating from pharmaceutical industries, agricultural runoff, WWTWs etc. Pesticide residues, transformation products and endocrine disruptors in estuaries should be considered for monitoring, where applicable. The outputs of monitoring should be reported to the relevant international frameworks i.e., SDGs, GBF.*

Reporting

A Rehabilitation Report should be compiled and be accompanied by supporting information such as:

- A map of disturbed and rehabilitated areas; and
- Before and after photos of rehabilitation including a significant landmark for comparison purposes, with a brief description including location, and date.

4.4 HABITAT

4.4.1 Description

Habitats are areas that provide sufficient nutrition, water, shelter, and living space for wetland animals. The four habitat zones found in the majority of wetlands are (i) in the water (aquatic), (ii) around the edge of the water (emergent), (iii) around the edge of the wetland (fringing/riparian) and iv) sediment as a habitat. Together, these wetland zones offer the fundamental characteristics of a wetland which include a range of vegetation types, aquatic features (e.g., islands and snags), connectivity (both over land and through the water), and water (Sieben *et al.,* 2014).

4.4.2 Types of Habitat Impact

A functioning, healthy wetland is essential for safeguarding the environment and the general public. However, most of the wetlands in South Africa are endangered as historically they were viewed as wastelands (Dale *et al.,* 2000; Phethi and Gumbo, 2019). Human activities result in wetland habitat degradation and loss by altering water quality, quantity, and flow rates, pollutant increase, and species composition interference due to alien species introduction. Poor landscape planning/design practices, lack of development of scientific buffers, indiscriminate clearing, lack of protection of riparian habitat, overgrazing, illegal harvesting for wood to make ornaments/furniture are amongst other impacts on **Table 5** outlines some of the anthropogenic activities that cause wetland habitat degradation.

Table 5: Types of factors affecting wetland habitat

Properties	Type of impact/activity
Vegetation damage	• Domestic animal grazing • Alien invasive plant species introduction that competes with natives • Vegetation removal for peat mining or crop production
Pollution inputs	• Sediments, fertiliser, nutrient addition, human sewage, animal waste, pesticides, selenium, and heavy metals are the main pollutants
Hydrological alterations	• Deposition of fill material for development • Farming and development drainage • Increased impervious surface area in the watershed, thus increasing water and pollutant runoff into wetlands

4.4.3 Rehabilitation Management Guidelines for Habitat

The following rehabilitation guidelines will address disturbance to wetland habitat due to access road construction/roadworks; thus, addressing erosion, and sedimentation of wetland habitat.

Scenario 1: Rehabilitation of wetland habitat due to road construction/roadworks

PHASE 1: Diagnostic Phase:

Step 1: Collect and collate data pertaining to historical information of the wetland and the site location.

Step 2: Initiate communications with the responsible authorities (*i.e.,* local and district municipality as well as DWS Regional Office) responsible for the catchment in which the resource affected is located.

Step 3: Employ aerial photographs and topographic maps of the wetland in order to diagnose the present state of the wetland affected.

PHASE 2: Planning and Assessment

Step 1: Use drones (or other relevant/available sensors) and Geographic Information System (GIS) to determine spatial extent, density, pattern, and size of affected wetland.

Step 2: Undertake WET-Health assessment to evaluate the overall health of the wetland and its habitat

Step 3: Relevant specialists must be consulted to undertake ground truthing survey and to develop robust rehabilitation plans in accordance with the appropriate legislation

Step 4: An Environmental Authorization (EA), General Authorization (GA) and Water Use License Application (WULA) must be lodged and approved prior to executing any rehabilitation interventions according to the following regulations:

- The Environmental Impact Assessment (EIA) Regulations published under NEMA.
- The applicable General Authorisations (GA) in terms of section 39 of NWA.
- The National Environmental Management: Biodiversity Act 10 of 2004 (NEM:BA, hereafter referred to as Biodiversity Act).

Step 5: Investigate use of constructed wetlands. Examples of these wetlands are as follows:

- Free Water Surface (FWS) - systems mimic natural systems in the that water flows over the bed of the Wetlands as a shallow water pond and is filtered through the dense stand of aquatic plants; and

- Subsurface Flow (SF) - systems promote water flow in a horizontal or vertical flow path through a shallow, permeable, media in which the plants are established. Treated effluent is collected in an underdrain for discharge.

Step 6: Scientific buffers to be determined and implemented.

PHASE 3: Identify and define the Rehabilitation Objectives

The common objectives are to improve the present ecological state of the wetland habit by addressing wetland rehabilitation due to roadworks to ensure it continues to deliver ecosystem services.

PHASE 4: Execution

DISTURBED WETLAND AREA REHABILITATION
i.e disturbances due to filling, grading & removal of vegetation

- Reprofile and reshape the wetland areas on either side of the road to make them blend in longitudinally and perpendicularly with the surrounding wetland areas.
- Distribute piled-up topsoil throughout the wetland.
- Plant Species Plans must be compiled and implemented by a landscape architect or botanist.
- Landscape/Watercourse Planning Management Plans must be compiled and implemented by relevant specialist.
- Scientific buffer zones must be determined and implemented – when determining these buffer zones, the user must consult the Buffer Zone Guidelines (Buffer Zone Guidelines for Wetlands compiled by WRC, 2017) - guidelines provide guidance for activities planned around and adjacent to rivers, wetlands, and estuaries.

MAINTAINING WETLAND BUFFER AREA

- Buffer areas should be rehabilitated and stabilized before wetland areas as this will assist in the reduction of sediment and erosion to wetland habitat;
- Deactivate desiccation drains within the buffers;
- Remove sugarcane and invasive species from watercourse buffer zones;
- To achieve a more natural topography, reframe and reprofile the buffer area;
- Plant indigenous tufted graminoid species with a high basal cover in terrestrial buffer areas for the reduction of speed and runoff volume from hardened surfaces prior to it reaching wetland areas (this has to be

supervised/overseen by a qualified rehabilitation specialist/landscaper.

PHASE 5: Monitoring, Evaluation and Reporting

Monitoring

A suitable qualified specialist must monitor rehabilitated areas. Monitoring must be conducted periodically to assess the present ecological state of the wetland habitat.

Evaluation

- Evaluate the effectiveness of interventions against the achievement of rehabilitation objectives and outcomes
- Determine maintenance objectives

Reporting

A Rehabilitation Report should be compiled and be accompanied by supporting information such as:

- A map of disturbed and rehabilitated areas; and
- Before and after photos of rehabilitation including a significant landmark for comparison purposes, with a brief description including location, and date.

4.5 BIOTA

4.5.1 Description

Biota/aquatic biota is described as the community of plants and animals with a biotic integrity, which reflects the health, community structure and distribution which is dependent on habitat (DWAF, 1999). A habitat is made of physical (abiotic) and living (biotic) factors. Abiotic factors are physical, non-living components that affect living organisms. Abiotic factors include:

- Light intensity;
- Moisture (availability of water);
- Humidity;
- Salinity;
- pH; and
- Temperature

Biotic factors are the living parts of the ecosystem with which an organism must interact. Biotic factors include:

- Predators;
- Prey;
- Food sources; and
- Parasites.

4.5.2 Types of Biota Impacts

Human-induced disturbance such as water abstraction and construction of barriers within in close proximity or upstream and downstream of wetlands alters the hydraulics and geomorphic characteristics of the wetland. These barriers also alter the flow velocities which cause changes in the physical habitats upon which biota depend. Below are examples of human induced disturbances on biota:

- Water abstraction – flow impediment impact;
- Dams and weirs – these structures have connectivity impacts on the physical habitat and biota and negative impact on the ecology of the wetland due to prevention of the migration of biota up and down the wetland.

Additional to the above impacts, species composition interference due to alien biota introduction. Sand and gravel mining in close proximity to wetlands result in the alteration of flow of water and production of sediment within the wetlands. Various species such as shrimps are endangered. Other species are reported to be endangered due to poaching.

4.5.3 Rehabilitation Management Guidelines for Biota

Scenario 1: Re-design and maintenance of improperly designed weirs to restore/improve flow characteristic/conditions of associated wetland.

The presence of barriers such as dam walls and weirs placed across wetlands to control the flow of water for variety of reasons have negative impacts on wetlands. From a wetland rehabilitation point of view, weirs are constructed to flatten the slope of watercourses to enable a slower flow velocity and then have less erosion and sediment transport.

Despite the potential benefits for construction of weirs, their incorrect design, construction, or placement may result in the smothering of downstream habitats and biota through the pulsed release (and increased overall) sediment loads as accumulated sediment from upstream of the weir structure is flushed downstream.

Phase 1: Diagnostic Phase

Step 1: Determine the type of impacts (erosion, incision etc) within the wetland requiring intervention through the re-design and maintenance of weirs.

Step 2: Initiate communications with the responsible authorities (*i.e.,* local and district municipality as well as DWS Regional Office) responsible for the catchment in which the resource affected is located.

Step 3: Describe the specific details of the section within the wetland affected and provide a motivation for the re-design and maintenance of the weir

Phase 2: Planning and Assessment

Step 1: A relevant qualified specialist must conduct a hydrological study to gather information pertaining to the path that water will take through a wetland, how deep it will flow over a structure like a weir and what force will be exerted on such a structure.

Step 2: Based on the results obtained from the study conducted in **Step 1** above, the type of weir to be re-designed and maintained must be selected and must be informed by the classification according to the structural elements used to provide stability to the structure, namely:

- Gravity wall
- Buttress weir
- Arch weir
- Sloping weir

Step 3: A relevant qualified specialist *i.e.,* Engineer and/or Aquatic Specialist must undertake a weir re-design process which amongst others must include the following:

- Ecological and Engineering Studies.
- Selection of the appropriate weir type.
- Selection of a suitable location for the construction of the weir.
- Analysis of the weir hydraulics.
- Provision for maintenance of the weir.

Step 4: The selected weir must be re-designed according to the approved engineering standards and must be informed by the selected designs, dimensions and all the results of analysis conducted in **Step 3**.

Step 5: The Engineer must ensure that the construction material used for re-designing of the weir is suitable for the type of intervention in question. Weirs can be re-designed out of a variety of materials including rock filled gabions, reinforced concrete, mass concrete, and concrete plus blockwork.

Step 6: The relevant qualified specialist *i.e.,* Engineer and/or Aquatic Specialist responsible must ensure the dimensions of the selected type of weir mimic more natural outflow rates and flood peak sizes in order to protect the downstream environment***.***

Step 7: Investigate use of constructed wetlands as part of rehabilitation or as additional measure to enhance ecological category.

Phase 3: Identify and define the Rehabilitation Objectives

The common objectives of rehabilitation of the wetlands through the construction of wetlands include the following:

- Restoration of free-flowing wetland conditions;
- Reinstate migration routes for instream biota;
- Restoration of more natural flows and sediment delivery to downstream reaches; and
- Prevention of erosion headcuts and limitation of incisions within the wetland

The above objectives for rehabilitation must be informed by the data collated in **Phase 1 and 2.**

Phase 4: Execution

The following are some of the common weir structures **(Figure 19)** available to be employed for restoring free-flowing wetland conditions.

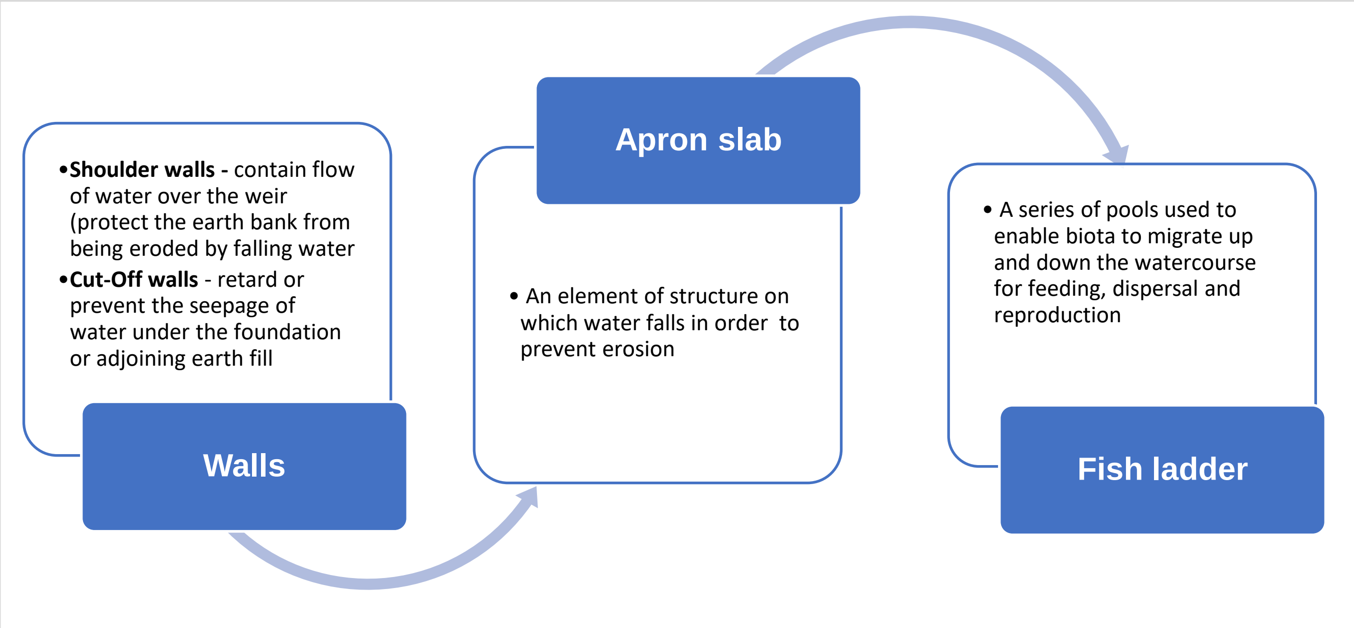

Figure 19: Weir structures available for wetland rehabilitation.

Note:

- *Structures such as dams, weirs and fishways were historically built without considering the migratory species functions.*
- *It has become a worldwide phenomenon to demolish structures that form barriers for the improvement of environmental ecology, flow of water, sustainability, and landscape.*
- *The removal of non-functioning structures acting as barriers to the flow of water, should be considered to form part and parcel of the available rehabilitation interventions based on the site-specific conditions.*
- *The **demolition of weirs** should be only considered in cases where there **are environmental problems experienced**. In addition, historic dams and weirs do not cater for fishways and ecological flow releases; therefore, where there are impacts that **cannot** be **mitigated,** then one should consider the demolition of such structures.*

Phase 5: Monitoring, Evaluation and Reporting

<u>Monitoring</u>

<u>Monitoring and Maintenance</u>

<u>Monitoring</u>

- Weirs require regular maintenance and monitoring to remain in ~~a~~ good working condition and to ensure these structures work in harmony with the environment;
- The re-designed weir must be monitored quarterly, before the rainy season and directly after a heavy rainfall event to ensure the crest of the weir is in good condition and free of obstructions. Furthermore, ensure that the weir remains in a safe working condition through continuous monitoring during the implementation phase *i.e.,* avoid slumping, cracking, or obvious changes to the crest of the wall;
- Determine maintenance objectives.

<u>Maintenance</u>

- Maintenance activities include clearing debris from the crest, removing silt, from upstream of the weir, providing safety booms, and carrying out repairs to the structure are also critical;
- Future maintenance of the upstream and downstream of the weir should also be considered in the implementation phase.
- Activities such as clearing vegetation, cutting back overhanging trees, removal of silt and repairs to erosion protection may form part of the channel maintenance regime in the vicinity of the weir.

Note: *Weirs that incorporate a fish pass, regulating gates, and/or flow/level monitoring equipment are likely to require more maintenance than a standard weir structure. The specific requirements of any particular installation must be considered in the design process, and the design tailored to facilitate safe maintenance activities.*

Evaluation

- Evaluate the effectiveness of interventions against the achievement of rehabilitation objectives and outcomes.
- Determine maintenance objectives.

Reporting

A Rehabilitation Report should be compiled and be accompanied by supporting information such as:

- A map of disturbed and rehabilitated areas; and
- Before and after photos of rehabilitation including a significant landmark for comparison purposes, with a brief description including location, and date.

5. RECOMMENDATIONS AND WAY FORWARD

The Wetland RMGs have been developed to address characteristics of watercourses, namely surface flow, groundwater flows, geomorphology, water quality, habitat, and biota through a phased approach. In implementing these guidelines, the below is a summary of recommendations to users per characteristics of watercourses:

Hydrology (surface flows and runoff)

- Rehabilitation of impacts relating to flow regime such a surface flow and runoff must also include the reinstatement of flow drivers in the landscape.
- Alien vegetation must be replaced with the correct indigenous vegetation. This is especially important when trees are removed, indigenous tree species must be brought in. Furthermore, alien management must be in a phased approached both eradication (to manage re-growth) and revegetation (to ensure growth success). Revegetation and Re-planting Plans must be compiled and submitted to the DWS for approval.

Geomorphology

- Prior to implementing the revegetation plan, it is important to ensure that the affected area is reworked and sloped appropriately to promote vegetation growth and stabilisation.
- Local indigenous grass seed mixture must be used to revegetate the area.
- Determine and implement livestock management grazing carrying capacity plans.

Water Quality

- Rehabilitation activities relating to impacts on water quality must consider the priority areas which are sensitive and must be protected. These priority areas that must be protected are Strategic Water Source Areas, NFEPA and RAMSAR wetlands. Additionally, wetlands that form part of other international obligations such as the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA).
- The DWS must ensure on-going monitoring of various wetland indicators such as water quality, biota, hydrology, and application of citizen science.
- The DWS must implement and enforce polluter pays principles.
- Consideration must be given to developing maintenance and upgrading plans for all malfunctioning WWTWs.
- Scientific buffer zones – when determining these buffers zones the user must consult the Buffer Zone Guidelines - *Buffer Zone Guidelines for Wetlands (WRC, 2017)* - guidelines provide guidance for activities planned around and adjacent to rivers, wetlands, and estuaries. They are to be used and applied as part of a broader suite of tools to ensure that water resource management is appropriately integrated into development planning and land use management.

Habitat and Biota

- Scientific buffer zones must be determined, implemented, and continuously evaluated for success and effectiveness – when determining these buffers zones the user must consult the Buffer Zone Guidelines (WRC, 2017).
- Desiccated and burning peatlands should be used to adjust Water Use Licenses in catchments.
- Plant Species Plans must be compiled by a relevant specialist within the field.
- Prioritize as per the guiding principles outlined in **Figure 5**.

General

- Constructed wetlands must be considered as a rehabilitation option for all characteristics of watercourses and their status must not be affected by the rehabilitation activities undertaken.
- A Recommended Ecological Category (REC must be obtained).
- Hydrological and ecological connectivity and ecological integrity must be enhanced by the rehabilitation efforts whether by flow driver or responses rehabilitation or both.
- Compliance, monitoring, and enforcement must be strengthened in terms of human resources and capacity for all completed rehabilitation work to be undertaken.
- Remote Sensing and GIS must be considered and employed instead of only relying on fixed-point photographs for monitoring aspects of rehabilitation work completed.
- Existing DWS Data and information from the databases (*i.e*., Green drop) must be considered before exploring options of the monitoring and collecting data from new proposed sites.
- Collaboration between the DWS, other government departments and private institutions is recommended to find the best way possible to assist each other in implementing rehabilitation.
- Capacity building and funding must be linked to existing policy statements regarding departmental funding or charges.
- Consideration must be given to translating the guidelines to be developed into Policy.

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APPENDICES

APPENDIX A

Rehabilitation	Restoration	Re-creation/Re-establishment
• **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) ○ **Rehabilitatio**n 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). ○ **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). • 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). • This points to differences in the terms of **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. • 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)	• **Restoration** is defined as remedial activity applied to systems that have been completely and permanently, but not irreparably, 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 re-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.