water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP
NATIONAL DEVELOPMENT PLAN
Our Future - make it work

Rehabilitation Management Guidelines (RMGs) for Water Resources

Project Steering Committee Meeting 02

Technical Presentation for Rivers and Wetlands Reports

19 May 2023

Mr Kgotso Mahlahlane & Ms Mmaphefo Thwala

Directorate: Sources Directed Studies

Chief Directorate: Water Ecosystems Management

Project Deliverables & Progress

WE ARE HERE

PROJECT PLANNING & INCEPTION

- Gap Analysis Report
- Framework Document
- Established Committees
- PSC Terms of Reference
- Stakeholder Database
- Inception Report

Jan 2020 - Nov 2021

SITUATION ASSESSMENT

- Literature Review & Data Gathering
- Draft Report
- Review of the Report
- Situation Assesment Report

Dec 2021- Mar 2022

GUIDELINES

- Guidelines for Rivers, Wetlands, Estuaries, Lakes & Dams & Groundwater
- Review of Guidelines
- Final Guidelines

Apr 2022- Mar 2023

GUIDELINES INTO PRACTICE

- Guidelines into Practice Report for Rivers, Wetlands, Estuaries, Lakes/Dams & Groundwater
- Review of Report
- Final Report

EXTERNAL REVIEW

- Ouputs consulted with PSC
- Further updates of outputs
- External Review

Stakeholder Engagement & Capacity Building

Completed

On-going

Purpose of Rivers & Wetlands Reports

- The aim of the reports is to develop Rehabilitation Management Guidelines (RMGs) for **Rivers** and **Wetlands** that address the following characteristics of watercourses:
  - ✓ *Hydrology;*
  - ✓ *Geomorphology;*
  - ✓ *Water quality;*
  - ✓ *Habitat; and*
  - ✓ *Biota*

Water Resources Themes

- Themes identified & categorized into **Rivers**, **Wetlands**, **Estuaries, Lakes and Dams and Groundwater** as per the definition of water resource (National Water Act)

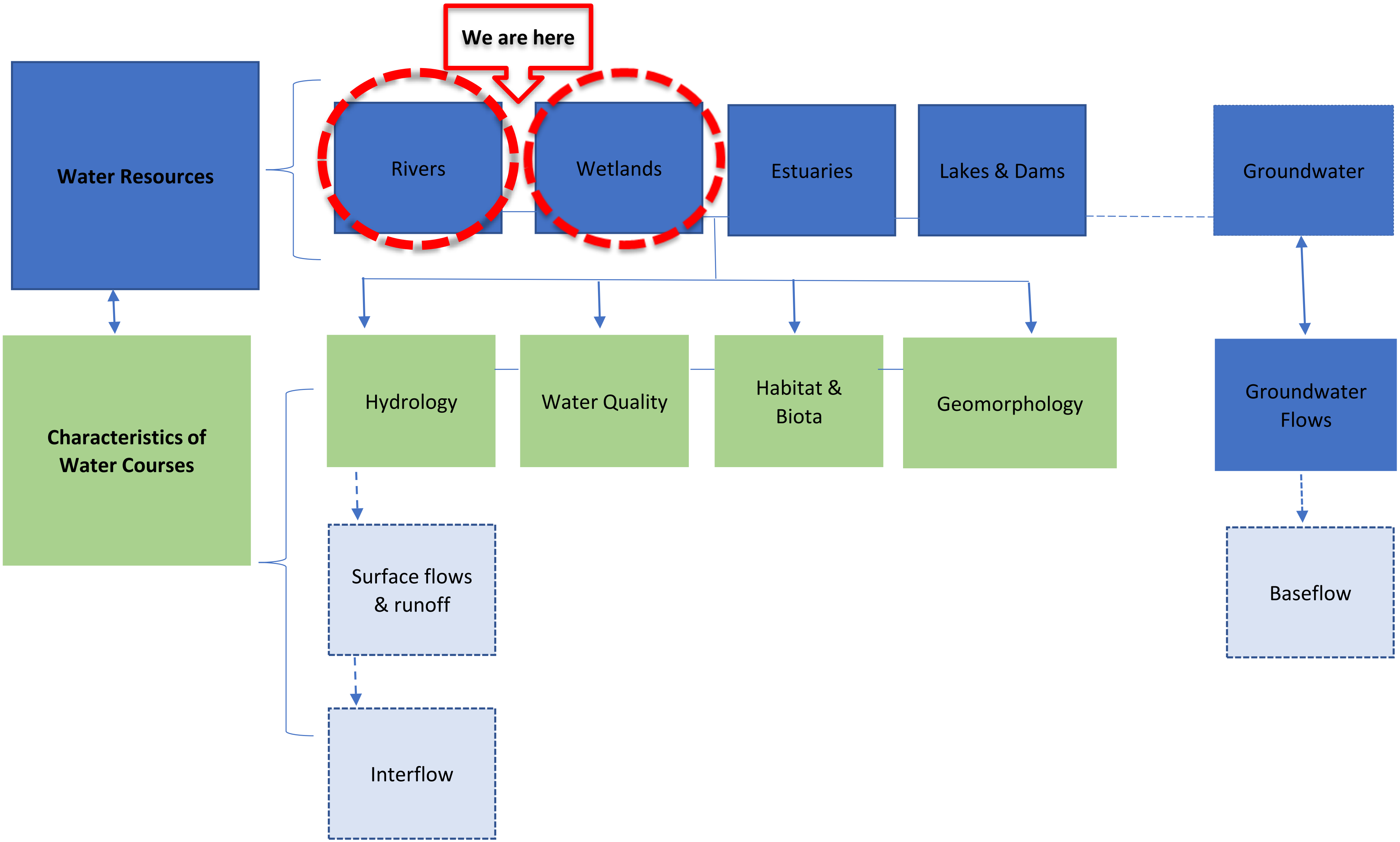
THEME 1	THEME 2	THEME 3	THEME 4	THEME 5
Rivers	**Wetlands**	**Estuaries**	**Lakes & Dams**	**Groundwater**

Definition of Watercourses

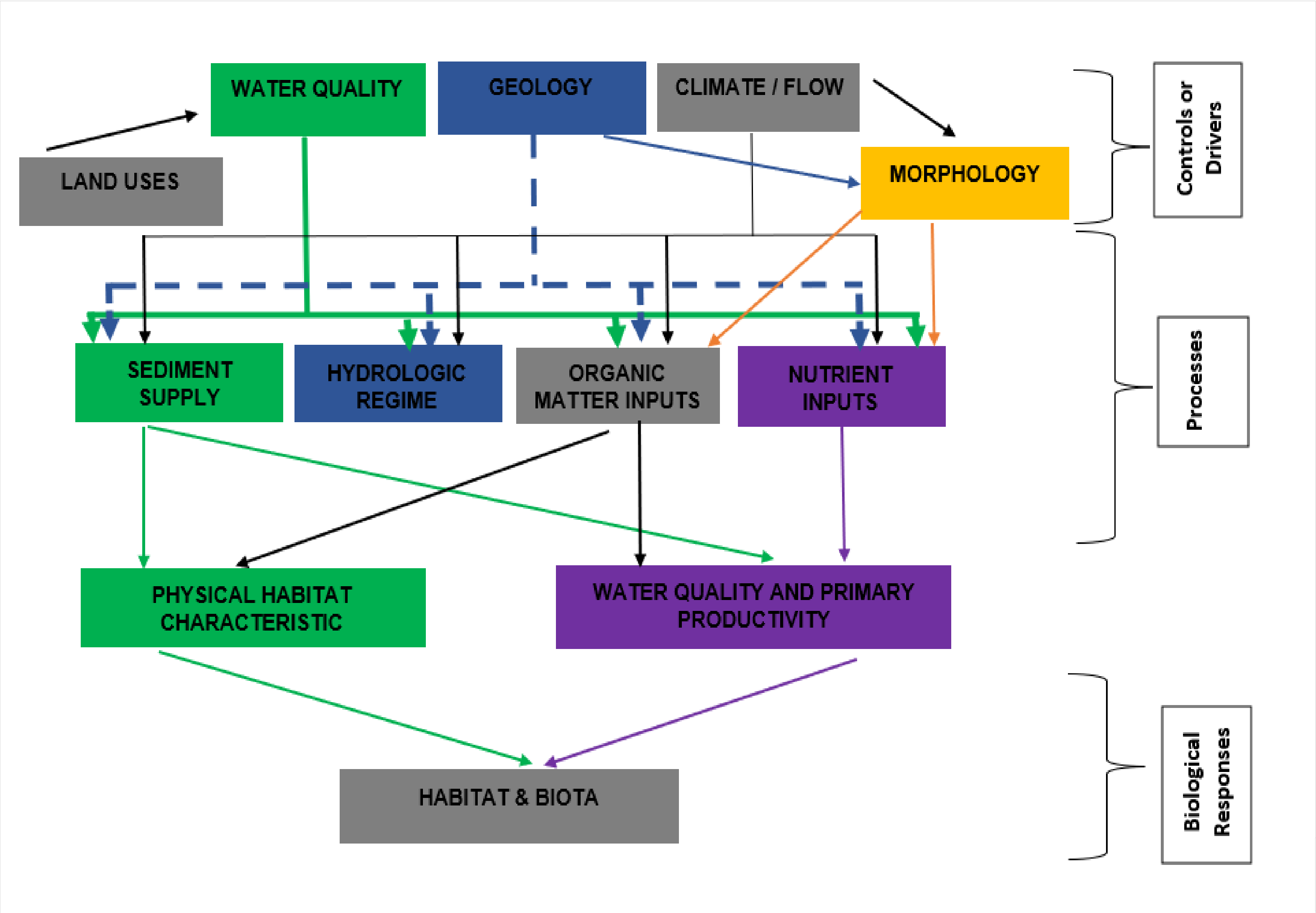
- In terms of the definition contained within the NWA, Act 36 of 1998, a watercourse means:
  - ✓ *A **river** or **spring**;*
  - ✓ *A **natural channel** from which water flows regularly or intermittently;*
  - ✓ *A **wetland**, **dam**, or **lake** into which, or from which, water flows;*
  - ✓ ***Any 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***

Link between Water Resources & Watercourses



Interlinkages between drivers and responses



Adapted from Beechie and Bolton (1999)

Guiding Principles for Rehabilitation

Principle 1	• Focus on sites under rare types, protected areas (NFEPA, Strategic Water Source Areas), environmental significance & international importance (RAMSAR, tourism & heritage)
Principle 2	• Focus on sites in good conditions before those in poor conditions
Principle 3	• Focus on problems that are easiest to fix
Principle 4	• Focus on sites with positive benefits before those with negative benefits
Principle 5	• Focus on problems or sites that are of importance and priority to local communities & stakeholders
Principle 6	• Recognize lost causes & focus effort on problems and sites where there is more chance of positive results
Principle 7	• Focus on methodologies which have been proven to yield results
Principle 8	• Focus on a broader catchment or sub-catchment level assessment to identify causes outside of the wetland
Principle 9	• Consider the recovery potential
Principle 10	• Consider the willingness & capacity for local people and local structures to become involved

Adapted from Rountree and Batchelor (2008)

Rehabilitation Approach

PHASE 1:

Diagnostic Phase

Determine the conditions and the type, size, extent of impacts on characteristics of watercourses

PHASE 2:

Planning & Assessment Phase

- Assess and collate available information from maps & datasets on the affected watercourses
- Review and assess legal considerations

PHASE 3:

Identify & Define the Rehabilitation Objectives

Detail the objectives of rehabilitation to ensure the impacts on the characteristics of watercourses are addressed

PHASE 4:

Execute

Recommend techniques and methods to address impacts identified. Consider protection of water resources ecosystem services, people & livelihoods.

PHASE 5:

Monitoring & Evaluation

- Monitor the results of the techniques and methods employed for rehabilitation
- Evaluate the effectiveness of interventions against achievement of rehabilitation objectives and outcomes
- Determine maintenance objectives

Approach (2)

- Guidelines developed entail the following:
  - ✓ *Identification of impacts on each characteristic of watercourses;*
  - ✓ *Legal Considerations - applicable legislation to be considered for undertaking site-specific rehabilitation activities on a particular characteristic of watercourse; and*
  - ✓ *Development of Rehabilitation Guidelines -* ***Step by step*** *guidelines on rehabilitation measures/interventions for executing rehabilitation*

Approach (3)

- Step-by-step RMGs are developed for each of the characteristics to include the following components:
  - ✓ *Description of the specific characteristic of watercourse*
  - ✓ *Steps to be undertaken for rehabilitation of each characteristic*
  - ✓ *Special consideration to be applied for rehabilitation*
  - ✓ *Assessment studies to support the rehabilitation intervention*

List of applicable legislation for Rivers & Wetlands

Characteristics of Watercourses	Applicable Legislation	
	Rivers	Wetlands
Hydrology	• **NWA**, Act 36 of 1998 – Section 21 (c), (d), (i), 36(2); • **CARA**, Act 43 of 1983 • **NEM:BA**, Act of 2004 • **Mountain Catchment Areas Act**, Act 63 of 1970 • **National Forests Act**, Act 84 of 1998 • **National Veld and Forest Fire Act**, 101 of 1998	• **NWA**, Act 36 of 1998 - Section 21 (c) & (i), Section 36(2); • **NEMA**, Act 107 of 1998
Geomorphology	• **NWA,** Act 36 of 1998 - Section 21(c), (i) & (d) • **NEMA**, Act 107 of 1998 • **NEM:BA**, Act of 2004	• **NWA,** Act 36 of 1998 - Section 21 • **NEMA,** Act 107 of 1998 • **NEM: BA,** Act 10 of 2004 • **NEM: WA,** Act 59 of 2008
Water Quality	• **NWA,** Act 36 of 1998 - Section 21 of NWA • **NEMA,** activity 19 • **GN.704,** regulation 4(c)	• **NWA**, Act 36 of 1998 - Section 21 of NWA • **NEMA**, activity 19
Habitat	• **NWA,** Act 36 of 1998 - Section 21(c) & (i) • **CARA,** Section 6(i)	• **NWA**, Act 36 of 1998 - Section 21 (a), (c) & (i) • **CARA**, Section 6(i)
Biota	• **NWA**, Act 36 of 1998 - Section 21(c) & (i), (e)-(h) • **NEMA**, Act 107 of 1998 • **NEM:BA**, Act of 2004 • **Environmental Conversation Act**, Act 76 of 1989	• **NWA**, Act 36 of 1998 - Section 21(c) & (i), (e)-(h) • **NEMA**, Act 107 of 1998 • **NEM:BA**, Act of 2004 • **Environmental Conversation Act**, Act 76 of 1989 • **NEM: PAA,** Act 57 of 2003 • **NEM: ICMA,** Act. 24 of 2008

Rehabilitation Management Guidelines for Rivers Scenarios

REHABILITATION MANAGEMENT GUIDELINES SCENARIOS

HYDROLOGY

Scenario 1

Rehabilitation and Management of stream flow reductives activities i.e., afforestation

Scenario 2

Control and Clearing of Alien Invasive Species

GEOMORPHOLOGY

Scenario 1

Rehabilitation of deteriorated culverts to manage upstream floods and promote free flows

WATER QUALITY

Scenario 1

Rehabilitation of poor water quality attributed to effluent discharge from WWTW into rivers

Scenario 2

Rehabilitation of AMD water decanting from opencast workings into rivers

HABITAT

Scenario 1

Rehabilitation of disturbed habitat due to disturbances caused by anthropogenic activities

BIOTA

Scenario 1

Re-establishment of biota migratory routes (i.e., fishways)

Rehabilitation Management Guidelines for Wetlands Scenarios

REHABILITATION MANAGEMENT GUIDELINES SCENARIOS

HYDROLOGY

Scenario 1

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

Scenario 2

Control and clearing of IAS from wetlands and their immediate catchments to reduce water uptake from wetlands

GEOMORPHOLOGY

Scenario 1

Rehabilitation of over-grazing and vegetation alteration to improve wetland vegetation growth and sediment trapping

WATER QUALITY

Scenario 1

Improvement of water quality degraded by effluent discharging from WWTW

HABITAT

Scenario 1

Rehabilitation of disturbed habitat due to access road construction/roadworks causing erosion and sedimentation

BIOTA

Scenario 1

Rehabilitation of improperly designed weirs to restore free-flowing wetland conditions

RMGs FOR RIVERS

Hydrology

Identified Impacts

- **Afforestation**
- Alien Vegetation
- Over-abstraction
- Poor Land Use Management (forestry, agriculture, river diversion & developments

Scenario 1: Rehabilitation and Management of stream flow reduction activities i.e., afforestation

Phase 1: Diagnostic

STEP 1:

Identify areas where afforestation plants (like Eucalyptus) need to be removed. Either due to being unlawful plantations, or areas where plantation species have spread to (invaded), or sensitive areas (like riparian areas and wetlands) with established plantations where buffers need to be implemented

STEP 2:

At a desktop level, employ available tools such as Google Earth, satellite images, ArcMap, and Remote Sensing to map out the targeted areas and their extent

STEP 3:

Using Google Earth, satellite imagery, mapping techniques and Remote Sensing, and other available information, describe in detail the area identified, proximity to water resources, natural vegetation type, soil type that produces less runoff/inflow (or outflow) than it would have produced if it were a natural area i.e., visual description, catchment vs. sub-catchment area, extent/type of infestation & conditions upstream & downstream of affected area

Phase 2: Planning and Assessment

STEP 1:

Conduct a ground survey survey to accurately identify and ascertain area(s) affected by afforestation

STEP 2:

Based on **Step 1-3**, identify the type of afforestation i.e., Pines, Eucalypts & Wattle

STEP 3:

Map and delineate all affected areas. Also consider upstream and downstream conditions of the affected areas

STEP 4:

Use existing maps to ascertain the following: existing afforestation; proposed afforestation activities; existing surrounding land use activities; infrastructure and landscape features

Phase 3: Defining Rehabilitation Objectives

STEP 1:

Define clear rehabilitation objectives based on information gathered in **Phase 1 & 2**

Examples:

Some of the common objectives for rehabilitation of afforestation activities are to:

- Improve dry season stream flow
- Improve access of flow of water to rivers

Phase 4: Execution

METHODS

Physical Control

i.e., manual or mechanical

Examples: uprooting, felling, cutting or burning

Chemical Control

i.e., use of weed killers

Examples: weed killers registered for use in connection with such plants in accordance with the directions for the use

Biological Control

i.e., application of biological control agents

Examples: herbicides, pesticides

Phase 5: Monitoring

STEP 1:

Monitoring of areas must be undertaken to ensure that treatment methods employed are adequate and effective to ensure that no additional measures are required

STEP 2:

Monitoring of areas must be undertaken to allow learning from past practices, so that ongoing initiatives are constantly improving and are in accordance applicable legislation

Hydrology (2)

Identified Impacts

- Afforestation
- **Alien Vegetation (*)**
- Over-abstraction
- Poor Land Use Management (forestry, agriculture, river diversion & developments

Scenario 2: Control and Clearing of Alien Invasive Vegetation

(*) This scenario is applicable to both Rivers and Wetlands. As such, it will be covered here under Rivers and will not be repeated under Wetlands to avoid duplication.

Phase 1: Diagnostic

STEP 1:

Identify areas infested by Alien Vegetation

STEP 2:

At a desktop level, employ tools such as Google Earth & Remote Sensing to identify infested areas

STEP 3:

Use tools in **Step 2** to describe in detail the infested areas i.e., visual description, catchment vs. sub-catchment area, extent of infestation & conditions upstream & downstream of affected area

STEP 4:

Based on **Step 1-3**, identify the areas of Alien Vegetation of concern i.e., Riparian and Non-Riparian

Categorize Alien Vegetation types i.e., Short trees (1.5-2m) Tall trees (2-2.5m) & Tall Shrubs (>2.5)

Note:

- ✓ Other examples of known aquatic species include water hyacinth, water Lettuce, and kariba weed
- ✓ Other examples of known vegetation species include climbers, creepers, grasses, and reeds

Phase 2: Planning & Assessment

STEP 1:

Conduct a site visit to accurately confirm and ascertain the preliminary findings acquired in Diagnostic Phase

STEP 2:

Consider the below aspects when undertaking fieldwork:

- Photographs and GPS co-ordinates
- Details relating to the calculation of estimated hectare of the infested areas.

STEP 3:

Follow the below steps during planning and assessment:

- Identify priority invasive plant species for control and clearing
- Identify sensitive indigenous vegetation that should be protected during clearing operations
- Mark individual species of vegetation to guide workers on site during clearing and prevent accidental damage
- Identify the most appropriate clearing method or combination of methods
- Identify approaches and areas for the disposal of cleared material

Phase 3: Defining Rehabilitation Objectives

STEP 1:

Define clear rehabilitation objectives based on information gathered in **Phase 1 & 2**

Examples:

Some of the common objectives for Alien Vegetation clearing are to:

- Increase space for flood alleviation by clearing vegetation
- Improve biodiversity of natural indigenous riverine flora

Phase 4: Execution

METHODS

Physical

i.e., manual or mechanical

Examples: hand pilling; cutting, slashing, burning, felling using a chainsaw brush-cutting

Biocontrol

i.e., use of pathogens and grazers

Examples: insects, mites, fungi, and bacteria

Chemical

i.e., application of herbicides

Examples: selective and non-selective herbicides

Phase 5: Monitoring

STEP 1:

Conduct site visits to ensure the treatment methods employed are adequate and require no further additional measures

STEP 2:

- Compile fixed point photographic record showing the affected area before and after treatment
- Use historical google images to observe spatial records of extent and effects

Geomorphology

Identified Impacts

- **Poorly designed culverts and channels**
- Biota movement restriction
- Impeding of flow
- Deforestation
- Vegetation clearing
- Agricultural and mining activities

Scenario 1: Rehabilitation of deteriorated culverts to manage upstream floods and promote free flows

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Phase 1: Diagnostic

STEP 1:

Develop a realistic rehabilitation **vision** and **goal** prior to undertaking any planning & assessment work

An example of **vision** - to restore river x to its pre-impact dynamic equilibrium state, or to rehabilitate all the poorly designed culverts as well as to maintain all culverts along river x to allow water to flow unobstructed and to prevent flooding

Whereas a **goa**l may be set as follows: To improve the instream and riparian biodiversity within the stream corridor and to make it a safe, attractive, and indigenous recreational green belt

STEP 2:

Choose a site with more than one poorly designed or maintained culvert using tools such as Google Earth, existing maps and ground truthing

Phase 2: Planning & Assessment

STEP 1:

Map the culverts identified along the channel. A specialist must also describe the natural (pre-impact) state. Include the water velocity using appropriate theoretical equations

STEP 2:

Classify the channel. This is important to understand the connection between characteristics and features of the different rivers. Use the Geomorphology Driver Index Assessment tool to achieve this step

STEP 3:

Describe the river conditions including the features that have changed over time. Assess all impacts. This step will assist to identify priority areas ranking from low to high priority

Phase 3: Defining Rehabilitation Objectives

STEP 1:

Define the rehabilitation objectives based on the set vision and goal

STEP 2:

Prioritization areas or segments of the river identified in the assessment phase

Examples:

Objectives to be defined must be feasible and include:

- Prevention of degradation
- Improvement of waterways/environment
- Each prioritized area may have its own objective based on ecological, infrastructural, social or recreational categories

Phase 4: Execution

METHODS

- **Paved invert**
  - **Description:** involves the placing reinforced concrete on the invert of existing culverts. Culverts with diameters greater than 90 cm can receive paved inverts since personnel entry is possible.
- **Cured-in-place pipe liner (CIPP)**
  - **Description:** involves the insertion of a felt or fibre tube saturated with resin.
  - Two methods of installation are pulled-in-place and inversion
- **Sliplining**
  - **Description:** involves inserting a pipe liner of smaller diameter directly into a deteriorated culvert. Liners are inserted into the host by either pulling or pushing the liner into place.
- **Centrifugally cast liner**
  - **Description:** Applied to the culvert by an electrical or air powered rotating head.
  - The liners can be constructed of cementitious mortar or other material.

Adapted from Bruce & Leggield (2014)

Phase 5: Monitoring

STEP 1:

Routine and systematic inspections of the culverts and the stream using the established condition assessment rating to determine whether the conditions are degrading; and if the original priorities need to be modified.

STEP 2:

Routine monitoring will assist in determining when repairs should be made before rehabilitation or replacement is required, as well to assist with monitoring of impacts on the river.

Water Quality

Identified Impacts

- Point source pollution:
  - Rehabilitation of poor water quality attributed to effluent discharge from WWTW into Rivers (*)
- Mining activities
  - Acid Mine Drainage
- Diffuse pollution from surface runoff from agricultural activities

Scenario 1: Rehabilitation of poor water quality attributed to effluent discharge from WWTW into Rivers

Scenario 2: Rehabilitation of AMD water decanting from opencast into rivers

(*) This scenario is applicable to both Rivers and Wetlands. As such, it will be covered here under Rivers and will not be repeated under Wetlands to avoid duplication.

Phase 1: Diagnostic

STEP 1:

Identify WWTW negatively impacting on the water resource

STEP 2:

Use GIS & Google Earth maps to identify land use changes associated with changes in water quality

STEP 3:

Conduct ground survey to identify visible signs of water quality changes in the resource such as:

- Extremely foul odour
- Dead fish
- Leached plants (loss of biodiversity)
- Visible clumps of sewage in the river

Phase 2: Planning

STEP 1:

Request local government officials (including DWS regional office i.e., responsible catchment manager) and community forums responsible to assist with identifying point source of inflow and providing guidance on available regulatory processes

STEP 2:

Investigate other sources of pollution and water quality e.g. non-point sources of pollution

Phase 2: Assessment

STEP 1:

- Collect the actual final effluent water samples from the source i.e., WWTW
- Collect representative water quality samples from the resource i.e., River:
  - 1 upstream of the WWTW discharge point,
  - 1 downstream of the WWTW discharge point
- Have samples analysed at an accredited laboratory to determine the water quality at the source and resource, respectively.

STEP 2:

- 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 water quality standards if they have not yet been established for that catchment

Phase 3: Defining Rehabilitation Objectives

STEP 1:

- Define clear rehabilitation objectives based on information gathered in Phase **1 & 2**

Example:

Common objectives for management of WWTW include preventing poor effluent discharging into water resources

Phase 4: Execution

STEP 1:

Implement environmentally sustainable solutions through stakeholder engagements, communication within water sector & between government departments

STEP 2:

Ensure treatment of effluent from point sources prior to discharge.

STEP 3

Implement surface water management around the WWTW. Install cut-off trenches around the WWTW to divert surface runoff to drain back into the natural drainage lines and environment

STEP 4:

Construct temporary berms along the river to prevent further offsite migration/discharge of effluent into the river

Phase 5: Monitoring

STEP 1:

Continuous monitoring of WWTW effluent and water quality to capture changes in the River (i.e., odour and colour) to help determine the water quality and the extent to which further treatment is necessary

STEP 2:

Continue with monitoring for a year and observe the changes in water quality over time

Water Quality (2)

Identified Impacts

- Point source pollution:
  - Rehabilitation of poor water quality attributed to effluent discharge from WWTW into Rivers
- Mining activities
  - **Acid Mine Drainage (*)**
- Diffuse pollution from surface runoff from agricultural activities

Scenario 2: Rehabilitation of AMD water decanting from opencast working into rivers

(*) This scenario is applicable to both Rivers and Wetlands. As such, it will be covered here under Rivers and will not be repeated under Wetlands to avoid duplication.

Phase 1: Diagnostic

STEP 1:

Identify source of AMD i.e decanting from an opencast pit

STEP 2:

At a desktop level and from existing info assess and determine dewatering rates, seepage rates, recharge rates, groundwater levels & lowest topographic level

STEP 3:

Collect groundwater samples and submit to an accredited lab for analysis. The results will inform the possible treatment methods/options

STEP 4:

Collect samples of waste rock material for geochemical analysis – the results will determine whether the material is suitable for backfilling the pit

Phase 2: Planning & Assessment

WULA Process to be followed

Apply for applicable Sec 21 water uses

Typical water uses triggered:

Sec 21 (f) – discharging of treated water

Sec 21 (g) – temporary storage of water pumped

Sec 21 (j) – dewatering of groundwater

GN.704, Reg 4(c) – backfilling of pit

Phase 3: Defining Rehabilitation Objectives

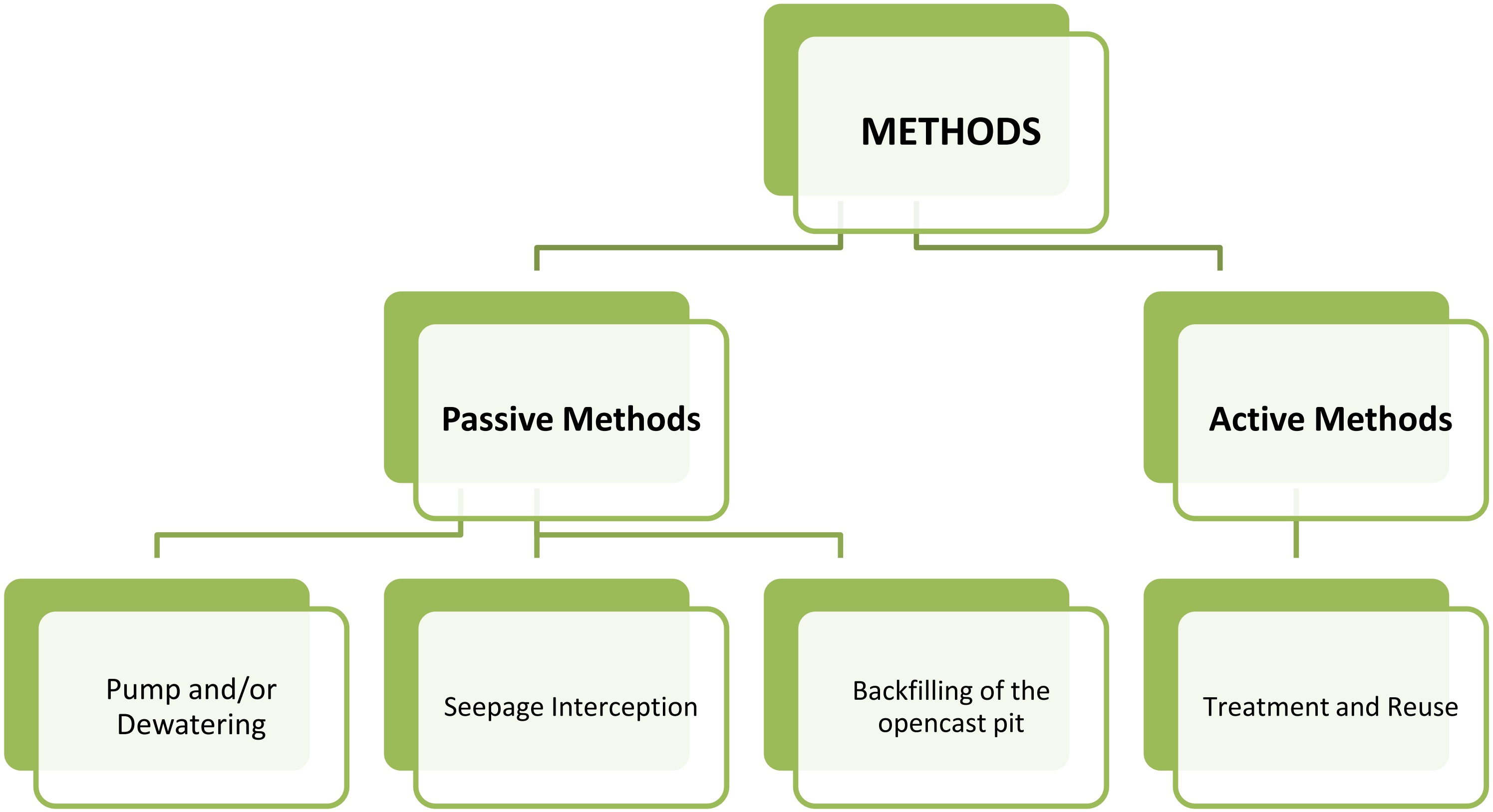
STEP 1:

- Define clear rehabilitation objectives based on information gathered in **Phase 1 & 2**

Examples:

- Common objectives for rehabilitation of the AMD emanating from a pit must be to:
  - Reduce and maintain groundwater levels below decanting levels
  - Treat AMD polluted water to acceptable standards

Phase 4: Execution



Phase 5: Monitoring

Pump and Treat:

Monitor groundwater levels within the opencast daily and report to the DWS on a monthly basis

Seepage Interception:

Monitor the water quality at the trenches and downstream of the constructed wetland to assess the quality trends

Backfilled Opencast Pit:

Develop & Implement a dedicated monitoring programme to monitor groundwater level recovery and pit water quality around the rehabilitated opencast area

Note:

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

Habitat

Identified Impacts

- Anthropogenic activities causing an increase in erosion which affects the habitat
- Floods which alter channel dimensions due to high discharge frequency
- Overgrazing along riparian zone

Scenario 1: Rehabilitation of disturbed habitat due to disturbances caused by anthropogenic activities i.e erosion

Phase 1: Diagnostic

STEP 1:

Identify cause of disturbance/change i.e., upstream of site or within the broader catchment

STEP 2:

Investigate history and the rate of change over time through consultation with local residents

STEP 3:

Obtain historical aerial photographs to evaluate issues of concern i.e., erosion. GIS & Google Earth can also be used to obtain more recent images

Phase 2: Planning & Assessment

STEP 1:

Note all existing activities impacting on the riparian areas

STEP 2:

Use aspects such as topography, vegetation and alluvial soils to delineated the riparian areas

STEP 3:

For aquatic assessment, visual conditions must be carefully noted

STEP 4:

Habitat integrity and suitability for aquatic macro-invertebrates and fish community must be assessed both upstream and downstream

Phase 3: Defining Rehabilitation Objectives

STEP 1:

Define clear rehabilitation objectives based on information gathered in Phase **1 & 2**

Examples:

Common objectives for habitat rehabilitation are to implement mitigation measures such as bank stabilization, restoration of topographical sequences and protection of indigenous vegetation

Phase 4: Execution

STEP 1:

Communication and collaboration between the water sector, DFFE and other relevant governmental departments must be ensured

STEP 2:

Apply for a WUL in terms of NWA (Act 36 of 1998) to obtain authorization of any activities within the riparian zone

STEP 3:

Similarly, obtain an environmental authorization (through carrying out a Basic Assessment and Environmental Impact Assessment) from DFFE in terms of NEMA to ensure you comply with regulations relating to restriction of conducting activities within the demarcated riparian zone

Phase 5: Monitoring

STEP 1:

A suitable qualified specialist must monitor rehabilitated areas for the first 3 months and thereafter on a bi-annual basis

STEP 2:

Monitoring must be conducted to assess revegetation areas, slope stabilities and to ensure that reprofiled areas are compatible with the natural environment

Biota

Identified Impacts

- **Dams and weirs creating barriers and preventing biota migration (*)**
- River diversion causing disconnection from floodplains
- Grazing within the riparian zone
- Sand & gravel mining

Scenario 1: Re-establishing biota migratory routes

(*) This scenario is applicable to both Rivers and Wetlands. As such, it will be covered here under Rivers and will not be repeated under Wetlands to avoid duplication.

Phase 1: Diagnostic

STEP 1:

Determine whether the river affected is located in an inland or coastal area

STEP 2:

At a desktop level, identify the river in which the biota migratory routes are affected

STEP 3:

- Describe the specific details of the river affected – Primary or Secondary River
- Describe the specific reach of the river affected – Upper, Middle and Lower reaches

Phase 1: Diagnostic (2)

STEP 4:

Describe the migratory region in which the affected river is located, according to the following regions:

Inland Migratory Regions (A):

- Orange-Vaal region
- Upper Limpopo region
- Lower Limpopo, Inkomati & Pongola region
- KZN inland region
- Cape inland region

Coastal Migratory Regions (B):

- South-East region
- South Coast region
- West Coast

STEP 5:

Describe the types of migratory aquatic biota species affected, specifying whether they are inland or coastal species

Phase 2: Planning & Assessment

STEP 1:

Assess the ecological need for a fishway at an instream barrier

STEP 2:

If the assessment result prove that there is no need for a fishway consider the following alternatives and mitigation measures:

- Artificial spawning beds;
- Captive breeding; and
- Capture and transport.

STEP 3:

If there is a need for a fishway, quantify the ecological impact of the instream barrier on migratory species present – i.e., importance of providing a fishway at the barrier

Phase 2: Planning & Assessment (2)

STEP 4:

Once the need and importance are identified and determined, conduct a cost benefit analysis of an effective fishway to be designed and constructed at the instream barrier

STEP 5:

Prepare a motivation and secure appropriate funding

Phase 3: Defining Rehabilitation Objectives

STEP 1:

Define clear rehabilitation objectives based on information gathered in **Phase 1 & 2**

Examples:

Common objectives for rehabilitation of instream barriers are to:

- Provide alternative migration routes between fresh and sea water
- Provide routes for spawning, feeding, dispersion and colonisation depending climatic and seasonal changes

Phase 4: Execution

STEP 1:

Based on the information gathered, an Engineer must design a fishway

STEP 2:

The fishway to be designed will depend on the site conditions. Based on the conditions, the Engineer must design the fishway – inland coastal or fishway based on the general inland and coastal hydraulics

STEP 3:

The fishway designs must be informed by the following key factors for both inland and coastal species:

- Species composition
- Types of migration
- Season/time period when species are active
- Swimming ability of species
- Swimming speed of species
- Endurance of species
- Physiological factors of species i.e., aerobic vs anaerobic muscles
- Current velocities and turbulence factors

Phase 4: Execution (2)

STEP 4:

The fishway design process must be supported by and include the following:

- Ecological, Hydrological and Engineering studies
- Analysis of the barrier hydraulics
- Selection of a suitable location for the proposed fishway
- Hydraulic analysis of the selected fishway type(s)
- Provision for maintenance of the fishway

STEP 5:

Identify the appropriate fishway design suitable for the site-specific conditions (inland and coastal regions)

STEP 6:

The fishway must be constructed 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**.

Phase 5: Monitoring

STEP 1:

Conduct site visits to ensure the rehabilitation methods employed are adequate and require no further additional measures

STEP 2:

Monitor the following categories of parameters:

- **Biological / Ecological Parameters** i.e., size and numbers of species that successfully pass through the fishway
- **Physical Parameters** i.e., temperature, conductivity, pH, turbidity

DISCUSSION

RMGs FOR WETLANDS

Hydrology

Identified Impacts

- **Erosion**, **gully** and **headcut** formation caused by discharge of high-water velocity from management of roads and increased peak flows from upstream portions of the wetland
- Alien Invasive Species

Scenario 1: Altered and incised wetland channels due to erosion (gully and headcut) formation

Phase 1: Diagnostic

STEP 1:

Determine and identify areas within the wetland which are incised or impacted by erosion

STEP 2:

At a desktop level, employ remote sensing to identify the areas impacted by erosion and their extent

STEP 3:

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 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

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. This information will be used to calculate the bill of quantities (i.e., construction material required and costs)

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

Phase 3: Defining Rehabilitation Objectives

STEP 1:

Define clear rehabilitation objectives based on information and data gathered in **Phase 1** and **2.** The objectives of rehabilitation will entail addressing the incised wetland using the appropriate measures

Examples:

If primary threat to the wetland is 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

Hillslope seepage

- Erosion problems emanating from construction of a road intersecting wetland
- Surface runoff emanating from road causing headcut at toe of wetland
- Headcuts on either side of the terrestrial island
- Channelled flows gully a through centre of wetland

IMPACTS

INTERVENTIONS

- Concrete geocell chute with concrete cut off walls
- Cut off walls on either side of the chute to ensure no surface water enters the other headcuts
- Concrete geocell chute with associated geocell plastic compartments
- Concrete-capped geocell earthen weir to partially deactivate the straightened channel

Phase 4: Execution

Channelled valley bottom

IMPACTS

- Erosion due the higher-than-normal water flow velocity resulting in straightened channel

INTERVENTIONS

- Concrete-capped geocell earthen weir to partially deactivate the straightened channel.
- Spillway height of the weir to be designed to allow base flows to re-enter into the historic channel in a controlled manner
- Gabion structure to control any sub-surface water movement

Phase 4: Execution

Unchannelled valley bottom

IMPACTS

- Flow channelled into the gully creating high energy flow. The gully erosion led to the headcut
- Erosion channels forming deeply incised channels.

INTERVENTIONS

- Concrete causeway to partially deactivate the straightened channel
- Earthworks- backfill drain - filling the eroded gully with material that was excavated and stockpiled within the wetland
- Construction of a 500mm earthen levy along the main channel to divert surface flows away from the main channel to foster diffuse flows in the central wetland

Phase 4: Execution

Floodplain

IMPACTS

- Stream flow concentration due to roads, berms, channels contributing to significant erosion
- Channel incisions and water flow interruption

INTERVENTIONS

- Remove berm to the natural ground level
- Erosion channel sloping and revegetation with local indigenous species

Other available techniques/methods

- 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** stabilize 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

Phase 5: Monitoring

STEP 1:

Undertake routine and systematically inspection of the rehabilitated wetlands to determine whether the conditions are improving or further degrading

STEP 2:

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

Hydrology (2)

Identified Impacts

- Erosion, gully and headcut formation caused by discharge of high-water velocity from management of roads and increased peak flows from upstream portions of the wetland
- **Alien Invasive Species (*)**

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

(*) This scenario was covered under the Rivers theme. As such, please note that it is applicable to Wetlands as well but not repeated here.

Geomorphology

Identified Impacts

- Excessive grazing causing alteration of the natural vegetation cover which reduces vegetation and habitat complexity
- Loss of vegetation causing reduction of flood attenuation and sediment trapping efficiencies

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

Phase 1: Diagnostic

STEP 1:

Using Remote Sensing and Google Earth Images, identify the areas within the wetland that have lost vegetation cover

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 & 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

Phase 3: Defining Rehabilitation Objectives

STEP 1:

The objectives of rehabilitation 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**

Examples:

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 eventually end up in the dam and could possibly add to siltation of the water resource

Phase 4: Execution

PHYSICAL CONTROL INTERVENTIONS

- Implement gabion structures (mattresses, blankets or baskets) to provide a platform for desired wetland vegetation growth
- Fence off sensitive areas within the wetland to keep grazers out and to allow for the re-establishment of vegetation
- Sediment fences must also be implemented to trap sediments emanating from eroded areas

PLAN/STRATEGIES:
i.e revegetation plan/strategy

- Develop and implement revegetation plan/strategy to promote vegetation growth of affected areas

Other available techniques/methods

- 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 stabilization
- Local indigenous grass seed mixture must be used to **revegetate** the area
- **Determine** and **implement** livestock management grazing carrying capacity **plans**

Phase 5: Monitoring

STEP 1:

Monitoring of rehabilitated and revegetated areas must be undertaken periodically to ensure that interventions methods employed are adequate and effective

STEP 2:

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.

Water Quality

Identified Impacts

- Point source pollution:
  - **Improvement of water quality degraded by effluent discharging from WWTW (*)**
- Mining activities
  - Acid Mine Drainage
- Diffuse pollution from poorly designed stormwater management facilities

Scenario 1: Improvement of water quality degraded by effluent discharge from WWTW

(*) This scenario was covered under the Rivers theme. As such, please note that it is applicable to Wetlands as well but not repeated here.

Habitat

Identified Impacts

- **Habitat disturbance due to roadworks causing erosion & sedimentation**
- Vegetation damage due to domestic animal grazing
- Alien invasive plant species that compete with indigenous species
- Pollution inputs
- Hydrologic alterations

Scenario 1: Rehabilitation of disturbed wetland habitat due to access road construction/roadworks causing erosion and sedimentation of wetland habitat

Phase 1: Diagnostic

STEP 1:

Collect and collate data pertaining to historical information of wetland and site location in question

STEP 2:

Employ aerial photographs and topographic maps of the wetland in order to diagnose the present ecological state (PES) of wetland affected

Phase 2: Planning & Assessment

STEP 1:

Use drones 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 development a 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

Phase 3: Defining Rehabilitation Objectives

STEP 1:

- Define clear rehabilitation objectives based on information gathered in Phase **1** and **2**

STEP 2:

Common objectives for habitat rehabilitation are to improve the present ecological state of the wetland habitat by addressing riparian rehabilitation due to roadworks and restore it back to its pre-impact state/condition

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 buffers 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.

Phase 4: Execution (2)

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 reductions of speed and runoff volume from hardened surfaces prior to it reaching wetland areas (this must be supervised/overseen by a qualified rehabilitation specialist/landscaper

Phase 5: Monitoring

STEP 1:

A suitable qualified specialist must monitor rehabilitated areas for the first 3 months and thereafter on a bi-annual basis

STEP 2:

Monitoring must be conducted to assess present ecological state of the wetland habitat

Biota

Identified Impacts

- **Dams & weirs have connectivity impacts on physical habitat, biota & negative impact on ecology due to the prevention of the migration of biota (*)**
- Water abstraction – flow impediment
- Sand & gravel mining causes alteration of flow of water and increased production of sediment

(*) This scenario was covered under the Rivers theme. As such, please note that it is applicable to Wetlands as well but not repeated here.

THANK YOU